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# Linguistic personology – a new science in paradigm of anthropological linguistics

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**Abstract:** Linguistic personology presents a new theoretical and applied scientific approach to speaker characterization on the basis of voice transformations in forensic phonetics. The applied aspect describes the physiognomic features of the speech markers and their anthropophonic indicators, which enable the construction of a personal speech profile based on the interaction of two domains: personal identity and personal voice with its unique properties.
*Keywords***:** linguistic personality, human voice, anthropological linguistics

In the most general sense, the idea of anthropology boils down to the following concise definition: the science of studying human diversity. Specialists in cultural anthropology consider archaeology (i.e. material culture), anthropological linguistics (i.e. descriptive linguistics, structural linguistics, sociolinguistics, and ethnolinguistics), and ethnology to stand out as the most important components (Belik 2009: 38).

Edward Sapir was one of the linguistic pioneers who connected personology with linguistics on the basis of his concept of speech. He formulated the thesis that "a common speech serves as a peculiarly potent symbol of the social solidarity of those who speak the language," stating that "The psychological significance of this goes far beyond the association of particular languages with nationalities, political entities or smaller local groups… The use of such words at once declares the speaker a member of an unorganized but psychologically real group" (Sapir 1933: 159–160). This gives him grounds to assert that "In between the recognized dialect or language as a whole and the individualized speech of a given individual lies a kind of linguistic unit which *is not often discussed by the linguist but which is of the greatest importance to social psychology* [emphasis added]" (Sapir 1933: 159). Sapir claims human speech to be a subject worthy of analysis and proposes the idea that speech (and more specifically, speech behavior) be examined as a personality trait.

Given this approach, the attention of this American linguist was directed to a large degree towards questions of variation in elements of language formation such as voice and voice dynamics, in which he includes intonation, rhythm, continuity of speech, tempo, and volume; in Sapir's words, "The fundamental quality of one's voice, the phonetic patterns of speech, the speed and relative smoothness of articulation, the length and build of the sentences, the character and range of the vocabulary, the stylistic consistency of the words used, the readiness with which words respond to the requirements of the social environment, in particular the suitability of one's language to the language habits of the person addressed all these are so many complex indicators of the personality" (Sapir 1933: 160). And exactly these peculiarities of speech, in Sapir's opinion, appear in speech behavior as characteristic traits of a given individual. This was the basis for the author's conference paper that he published in 1927, "Speech as a Personality Trait" (Sapir 1927). The conclusion he draws here is that the *language habits* (from Latin *habitus* – quality, inclination, attitude) of a person are exceptionally important as unconscious indicators of the most essential traits of his personality.

Regardless of the author himself having characterized his approach more as intuitive, his insights as a professional observer and researcher of live spontaneous speech can be boldly acknowledged. According to Sapir, "there are several distinct levels in speech behavior," among which "the lowest or most fundamental speech level is the voice" (i.e., *phonation quality of the voice* in modern terminology), and as "the voice is a complicated bundle of reactions," "from a more general point of view, voice may be considered a form of gesture" (1927: 894–895). Further on, Sapir says that "Voice is generally thought of as a purely individual matter," but asks whether the voice might have "a social quality as well as an individual one" (ibid, 895). And if one attempts to extract fundamental individual characteristics from the voice, it is necessary to distinguish the social element from the purely personal, because the voice is in a real sense a symbolic indicator of personality as a whole. Precisely in the voice of an individual there is something indicative of his personality. We can learn and understand a great deal can about a person on the basis of his or her voice.

Sapir describes the next level of speech as *voice dynamics*, which he explains as the voice proper plus multiple variations of behavior intertwining with the voice to give it its dynamic quality. He counts among

these variations intonation, relative ease/continuity of speech, and speech tempo, concepts which we now generalize under the term *speech prosody*. The third level of speech analysis is what the author calls *pronunciation* in its entirety; more specifically, he differentiates individual nuances of pronunciation marked by specific coloring, i.e., *timbre*, representing qualitative characteristics of the voice. The fourth level of speech level is *vocabulary*, which is well known to be connected with a person's preferences, attitudes, and inclinations, meaning that he may prefer to avoid the use of certain speech elements. The vocabulary used as a result of these preferences, attitudes, and inclinations presents distinctive features of the individual's locale, status, or professional occupation. Sapir proposes the observation of *style* as the fifth level of speech analysis. He specifies that style realistically presents everyday speech that characterizes both the social group and the individual; these characteristics as a whole are illustrated through voice, voice dynamics, pronunciation, vocabulary, and style. And on the basis of these five levels of speech, stereotypes of human expression are formed.

The predominant anthropological linguists of the second decade of the 21st century define the basic idea of this science in the following manner: "the study of language in both its biological and sociocultural context" (Salzmann et al. 2012: 382). This formulation is extremely important to the statement which follows below.

Alessandro Duranti describes three paradigms for the three periods in the development of anthropological linguistics (Duranti 2003: 323–335).

The first paradigm is connected with the theory of linguistic relativity, represented in the works of Franz Boas, Edward Sapir, and Benjamin Whorf. From this paradigm, the contributions of Sapir, with his descriptions of the aforementioned five levels of speech through which the linguistic traits of a given individual can be decoded, are especially important to linguistic personology. This approach is called "linguistic description" and is used as an instrument both for fieldwork research and for cultural research.

The second paradigm is focused most generally on the sphere of interactional sociolinguistics, based on the contributions of Dell Hymes, John Gumperz, and Erving Goffman towards research on communicative acts (different types of discourse), ethnography of communication (in particular, in the ethnography of speaking and speech variety in the behavior of individuals fulfilling different social roles in communicative interactions), and not least, in the ways of speaking and the oral narrative as a means of organizing culture and society. Here the application and methodological contributions of Mikhail Bakhtin and Valentin Voloshinov on the living word (discourse) and on dialogic communication in general find their place.

The third paradigm in anthropological linguistics reflects the continuity of ideas established within the previous two paradigms from the 20th century and the beginning of this century, when language began to be understood as a means of characterizing and indexing society and culture. In particular, identity, gender, sexuality, and regional origins are studied as social and personal particularities of the individual, and more concretely, the idea has been developed that besides the study of vocabulary and grammar, a no less important linguistic resource turns out to be the prosodics, tempo, and dynamics of speech, along with gestures, body language, writing instruments and conventions, and visualization (Duranti 2011:35). In this way, the thesis is argued that language is an instrument of social differentiation, and under the conditions of the modern virtual interactive society, language can be presented holistically in a multimodal linguistic perspective through the use of different possible channels of communication.

The assertion that, as a whole, "all meaning-making is in fact multimodal" (Lemke 2012: 82) is indisputable. It is necessary to formally differentiate *modalities* (different channels for broadcasting meaning as a semiotic resource of a system) and *media* (different technologies for the realization of meaning), because the multimedia phenomenon relates to the sensory channels used by different technologies (auditory-acoustic, visual, tactile, etc.). For example, when we speak, we generally also gesticulate; even when the gestures are not visible, however, other auditory-acoustic systemic conveyors of meaning are present (tone of voice, local accent, a quality of voice that conveys the speaker's health, mood, and so on). This multimodal, multimedia characteristic of making and reflecting meaning stands out as especially obvious in academic communication – in situations of teaching and learning.

What has been said up to this point should present a sufficient provocation and temptation for linguists to turn their attention to living speech. On the other hand, however, this is definitely not enough if researchers are not equipped with the necessary experience and knowledge in the area of experimental phonetics or do not have the necessary competence to struggle with advanced technology to the degree of applying it to multimodal analysis. All of this argues for the necessity of teamwork in laboratory conditions.

The author of this present contribution has had the privilege to direct the Laboratory of Applied Linguistics "Aksela Lazarova" at Konstantin Preslavsky University of Shumen, and as an experienced researcher of speech norms and pathology with approximately 30 years of practice, to participate in the development of local and international projects. This long-term laboratory research has resulted in a series of publications in the journals and collections like "The responsibility in front of the language" (*Отговорността пред езика*), "Trends and processes in Bulgarian language" (*Тенденции и процеси в българския език*), "*Proceedings of the 4th International Congress on Early Prevention in Children with Verbal Communication Disorders*, among others; in addition, forthcoming works include a separate full issue of the German journal *Germanistische Linguistik*, Heft 171-172/2003; the publication part of the results of research carried out in *ZAS-Papers in Linguistics 33*, 2004: "Studies on the development of grammar in German, Russian and Bulgarian"; work in the collection *Speech and Language 2015: Fundamental and Applied Aspects of Speech and Language* and in Speech and Computer (SPECOM 2015). Published monographs include "Early ontogenesis of event modality" – *Ранната онтогенеза на събитийната модалност (върху материал от българска детска реч)* (2017a) and "Approaches to child language research" – *Подходи в изследването на детската реч* (2017b), with Velka Popova, as well as "Linguistic personology" – *Лингвистична персонология* (2016), which represents the culmination and a general summary of the author's long years of research in the field of live human speech, with a view to highlighting the personal and social characteristics of the speaker and the embodiment of their voice (cf. Popov 2016).

The writing of this last book was motivated by the absence of this sort of research in Bulgarian linguistics, despite its necessity; it was provoked in particular by a rethinking of some observations in Professor Stefana Dimitrova's work on the occasion of her jubilee publication entitled "On the spiral of linguistic ideas" (*По спиралата на лингвистичните идеи*) (Актуални проблеми/Actualni problemi 2016: 13–25).

In an interview, professor S. Dimitrova expresses the idea that "the fundamental task of modern linguistics is to delve deeper into the human brain" (Dimitrova 2015). At first glance, carrying out such a task seems impossible. But after prolonged reconsideration and a more careful look into the material, it turns out that it is both possible and desirable to delve into the cognitive mental mechanisms (the *mirror neurons* of Rizzolatti et al. 2006) that give an idea of the understanding of the speech activity and verbal behavior of individuals in different spheres of modern communicative situations. This provided a final impetus to study many ideas from different fields, the result of which is Dimitar Popov's book "Linguistic personology through speech: The embodiment voice" (*Лингвистична персонология по говора: Превъплъщенията на гласа*). Dimitrova of course does not claim this to be an exhaustive volume on the topic, but it is a self-confidently bold new attempt at a newly discovered horizon in the field of Bulgarian anthropological linguistics.

The urgency of the themes connected with linguistic personology draw attention to the connection between the realization of different practical tasks and goals: identifying the speaker by voice and creating a profile of the speaker's speech behavior; recognizing the identity of a person by their voice; diagnosing speech disturbances connected with speech pathology by voice data; characterizing the pronunciation habits and specifying pronunciation style according to the manner of speech in terms of norms and pathology; determining the socio-demographic indicators (education, trade, profession, locale, sex, etc.) of a given individual by voice, and so on. The work brings in specifics through experimental phonetic research and descriptions of speech prosody, in order to verify, based on evidence, the identification of the speaker on the basis of decoding, analysis, perception, and recognition of their unique voice print. This contributes to the modeling and illustration of a personal voice profile grounded in anthropophonic methodology.

The term *anthropophonics* was used for the first time by the German physiologist Carl Ludwig Merkel to designate the articulatory aspect of the sounds of speech, but it was introduced in phonetics by Mikołaj Kruszewski, a student of Jan Baudouin de Courtenay, in his work by the one-word title *Anthropophonics*, published posthumously in Kazan in 1893. There Kruszewski defines the sounds of the human speech mechanism and their conditions for emergence and alteration as the object of anthropophonics, and he asserts that the sound units of anthropophonics may not correspond to sound units in phonetics. This extremely valuable observation was consequently confirmed by A. A. Reformatsky and other phoneticians who have taken into account the communicative significance of the resources of "non-canonical phonetics."

The monograph "Linguistic personology" (*Лингвистична персонология*) is the first Bulgarian multi-faceted study of the phenomenon of *linguistic personology through speech*, which has at the same time theoretical, methodological, and applied characteristics. The object of research is the speaking person, viewed as an instrument of reproduction of individual prototypical speech forms on the basis of the specifics of their speech

potential. The subject of study in linguistic personology includes the different aspects of description and identification of the linguistic personality – for example, the variation in voice quality and vocal variation, expressions and connotations in speech and text, specific figurative use, typical mistakes in oral and written speech, evidence of speech pathologies, and other personal peculiarities. An attempt has been made to differentiate linguistic personology as an autonomous interdisciplinary scientific paradigm (between psycholinguistics, sociolinguistics, anthropolinguistics, pragmatics, semiotics, and phonetic stylistics), as the scientific field called upon to study variations in speech behavior individuals and the characteristic features of identity signaled by means of personal voice expression. The work is structured in the following manner: foreword, introduction, three chapters, conclusion, bibliography, and a summary in English.

The conceptual contribution, stated as an intention in the very introduction of the work, is that in the framework of the conceptual sphere of linguistic anthropology, the research priority must be focused on the speaking individual, conceived of as the epicenter of the universe. In this case, the stress falls concretely on the analysis of the person through language and on language through the person. The realization of the research on individual speech in the framework of this anthropocentric paradigm becomes possible through the application of a synergetic approach, in which the speech of the individual can be presented as a multidimensional quantity, insofar as it can be explained through the physical I, the social I, the intellectual I, and the emotional I, and every one of these aspects can be significant for determining the characteristics of the voice code of a given individual.

In the first chapter of the monograph, which leads the reader gradually into the conceptual apparatus of personology, the theoretical basis for the research is laid out. Key concepts are defined, including *linguistic personality*, *speech individuality*, and *voice uniqueness* in the framework of the linguistics of variation; on this basis the notion of the science of linguistic personology is construction. For the first time, a hierarchical model for presenting speech phenomena through the trichotomy *standard – substandard – non-standard* is introduced. It is worth drawing attention to the fact that, in its entirety, the interpretation is realized within the framework of an anthropocentric paradigm of speech research.

Especially important to the methods and methodology of analysis is the second chapter, in which the idea of linguistic personology is made concrete through the concepts of *voice* and *identity*. These are interpreted through the prism of different scholarly disciplines: anthropology, sociology, philosophy, neurology, psychology, and cognitive linguistics on the one hand, and physiology, speech acoustics, perception theory, etc., on the other. The parameters of the *voice* are presented through its tone, prosody, and quality (type of phonation), which express aspects of human *identity*. The description of the mechanisms of voice production and articulation as a physiological process is connected with acoustic features of the speech signal. The taxonomy of phonation types based on modulations of the vocal tract illustrates the possibility of identifying an idiolect of the speaking individual and of working up the individual's voice stereotype. In an applied aspect, the anthropophonic methodology of analysis presented here suggests promising possibilities for profiling an individual by their manner of speech and the capacity for establishing speech portraits. The second chapter ("Voice and identity") prepares the reader to understand the empirical research presented in the third chapter.

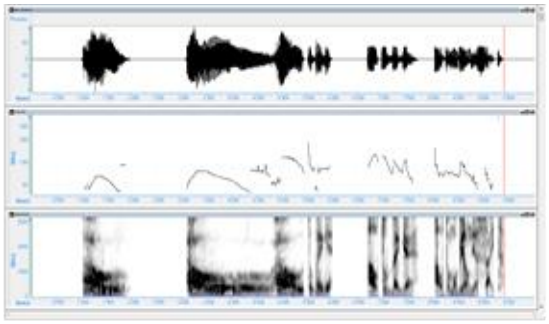
The third chapter of the study, "Speech portraits", illustrates ways of creating a speech portrait of a speaker on the basis of verbal, paraverbal, and extraverbal information. The profiling itself is based on different acoustic parameters which signify characteristics (iconic and indexical) and mark voice stereotypes of the speaker. All of this is summed up in an original authored model of prosodic semiosis, whose concrete sound images are presented audially (through sonograms, intonograms, and oscillograms) and multimodally—through audio-visual channels of communication. The inherent prosodic variability is shown experimentally on the basis of three types of linguistic variables: *indicators*, *markers*, and *voice stereotypes*. The unique voice specifics are interpreted on multiple planes – in the framework of sociolinguistics (through the identification of dialect, sociolect, and foreign accent), psycholinguistics (through the identification of the emotions and psychological features of the individual), gender linguistics (for determining the biological and psychological sexual identity of the speaker), orthology (for determining the level of education of the speaker), and stylistics (for identifying the manner of speaking or the stylistic connotations of the discourse). In this way, the interpretation of separate audio images or models of stereotypes of individual vocal behavior, studied and collected into a unified whole, supports the application of a holistic approach to research of living speech. The illustrations and visual representations of the results of the research have been realized thanks in a large part to the competent use of specialized equipment of advanced modern computer technology and to the corresponding professional multimedia program packages intended for the achievement of different analytical goals in the branches of

applied linguistics, as well as to the use of the forensic phonoscopy and sociophonetics. For this reason, additional contributions are also due to the toolbox of resources used for multimodal linguistics, such as the modern technological design of simultaneously multichannel measurement of speech phenomena, intended for purposes of simultaneous interpretation.

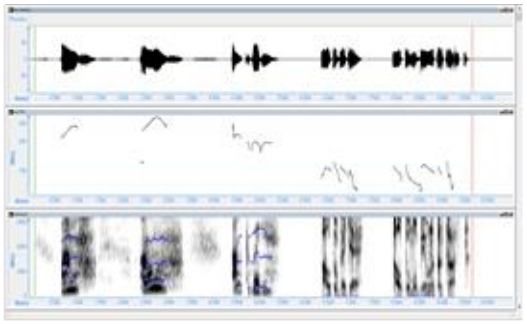
In the conclusion of the monograph, the emphasis is on the practical-applied aspect of research on the voice. Multiple possible research perspectives are indicated for further linguistic work in the same applied field. The precise integrative study of the human voice can find application not only in biometric analysis for the purpose of criminalistics, but also in the field of voice recognition in advanced technology.

As a whole, the work also presents the first attempt of its type to design a systematic university course in linguistic personology, which theoretically and methodologically can contribute to biometric research of voice characteristics, for the identification and recognition of the voice, and to finding specific applications in both the interpretation of human personology on the basis of the physical forms of the human voice and on the development of voice interfaces.

In conclusion, that which has been discussed up to this point can be illustrated with several voice excerpts, whose acoustic sound forms depict the audio-visual idea of gender differentiation of the speakers, the voices of whom attest to their gender categories of male, female, and transgender female:



Фиг. 1: Мъжки глас

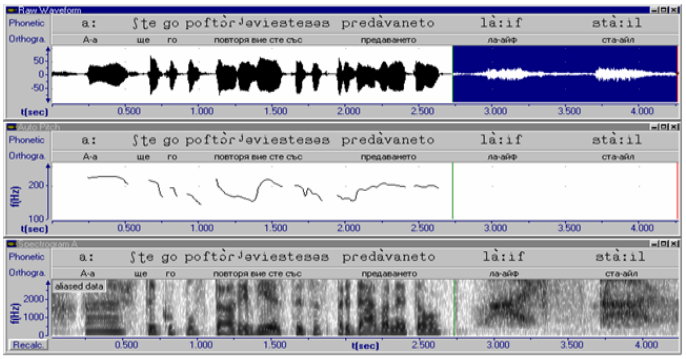


Фиг. 2: Женски глас

The contrast in the acoustic parameters are seen quite clearly along the spectra of the two soundtracks of recordings from Bulgarian automobile advertisements (www.auto.bg)— expressions in a male voice (Fig. 1: *Au-au, auto bg – avtomobilniyat sayt 'the automobile site'*) and expressions in a female voice (Fig. 2: *Au-au, auto bg – avtomobilnata strast 'automobile passion'*). The female voice is, on the whole, perceived of as higher than the male voice. The is because vocal chords of men are thicker and longer than those of women, who have a shorter vocal tract than men. The average frequency of the basic pitch among women is around twice as high as that of men. With regards to emotions, women's voices give the impression that they are more generous in vocal expression than men. In these recordings, the gendered sexolect most characteristic for men (Fig. 1) is the vibration of the voice in the range of low registers, with the slow frequency of tempo and lengthening of the voice as an expression of high satisfaction, while for the female gendered sexolect (Fig. 2), a tense shrill utterance is observed in the upper register and an increased frequency of tempo, which is also indicative of orgasm.

The determination of the sexolect of the speaker with a transgendered orientation as a characteristic type of speech "portrait" until recently has not been a subject of attention in Bulgarian linguistics. The first attempt to describe this specific sexolect manifestation in the Bulgarian public speech arena was made in the framework of the observation of Bulgarian gender group manifestations by the author of this present work.

Figure 3 presents the speech "portrait" (acoustic image) of the voice of a transgender female radio host advertising her program:




**Фиг. 3:** Джендърен сексолект на травестит

In the gendered sexolect of the transgender woman there is a combination of falsetto, breathiness, and whispered phonation that may come across as confidential or confessional. The overall impression stylistically of this advertising discourse is that the vocal coloring conveyed by the breathy, whispering phonation and the falsetto connote attention, softness, and affection to the listener.

The necessity of studying the phonetic characteristics of Bulgarian speech produced by people of different sexes and gender identities is motivated in the present moment by the practical needs of modern society, and above all – by the necessity of developing systems for automatic voice recognition and speech synthesis. The human voice is formed under the influence of both physical and biological factors. In addition to this, the differences in the functioning of male and female vocal chords can also be caused by social factors. The vocal ranges in the pitch of the basic tone among men and women also overlap to a certain degree. This endows the individual with different possibilities for variation, including the possibility to present as a different gender with the help of the voice (masking through speech); this vocal transgendering relies on communicative conditions, the emotional state of the speaker, and the speaker's attitude and conviction of belonging to a specific gender group. Sexual stereotyping polarizes voices in general as male and female, and this creates a basis in principle to speak of a ***masculine stereotype*** (physical masculinity, aggression, bluntness) and a ***predominantly feminine stereotype*** (feminine softness, tolerance, friendliness). The existence of transgender voices, with their irrefutable richness of phonational connotations, disrupts the status quo of the traditional dichotomy and points to the conclusion that perceptions of voice stereotypes in the area of gender are relative, contextually dependent, and still quite ambiguous in their determination. In spite of this, however, they present a real idea of the rich scale of possible nuances in the human voice, and of the voice print as a biometric visiting calling card of the individual.

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# Assistive character of speech technology

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**Abstract.** Different aids for people with disabilities are based on speech technologies. The achievements and trends in the development of speech technologies are presented in the paper. Speech technology is presented as assistive technology for different types of people with disabilities. The examples of assistive applications aimed at improving the life quality of several specific classes of users, as well as applications useful to everyone, are also given in the paper.

## 1 Introduction

Among numerous obstacles that people with disabilities face, access to information and communication poses a significant challenge. This type of obstacle is not as obvious and visible as physical, architectural, psychosocial (prejudice, intolerance, pity and unease) and institutional obstacles, which refer to the educational system and the possibility of employment, as well as the right to social equality due to prejudices or economic dependence, [1].

Development of the assistive technologies in Europe is a necessity, since one quarter of the population in Europe in 2020 will be above 60 years [2-3]. The assistive technology should provide the elderly with an opportunity to extend their independent lives for as long as possible.

Limited access to information and communication affects those with sensory disabilities (seeing and hearing) first and foremost, but it also affects those with verbal and cognitive impairment, and leads to further discrimination and marginalization.

- Persons with impaired sight are not able to read newspapers unless a large font is used, or the paper is printed in Braille, or it is offered as an audio recording. Furthermore, video is also inaccessible, unless accompanied by audio description.
- Persons with impaired hearing cannot easily access communicational tools, such as telephone and radio, or even audio programs on TV – they need devices for subtitling, or an interpreter to translate it into sign language.
- Persons with impaired speech are not able to use a telephone, or have a spoken dialogue in person – they need devices that will talk instead of them, in their own voice if possible (for those whose speech impairment is acquired).
- Persons with deficits in verbal and/or written communication need devices for so-called alternative-augmentative communication.

Modern societies with developed technology can overcome these obstacles for the most part, but in order to make that possible, social awareness needs to be at a significantly higher level than it is today. Since recently, the EU parliament has been preparing the European Accessibility Act [4], that would render many products and services in the EU more accessible for persons with disabilities, including: televisions and TV programs, e-books, online shopping websites and mobile applications. Since the Republic of Serbia is in EU accession negotiations, we can expect similar legislation in the future. The goal of this paper is to do just that – to raise social awareness through the presentation of speech technologies which present a tremendous leap forward in information and communication accessibility for people with a range of disabilities.

Assistive technology is a term that includes assistive and rehabilitative aids that increase, maintain, or improve functional capabilities of persons with disabilities, [5]. It creates greater self-confidence and independence, as well as control for disabled individuals. Assistive technology enables people to perform tasks that they were formerly unable to accomplish and to participate more fully in all aspects of life (home, school, and community) and increases their opportunities for education, social interactions, and potential for meaningful employment. Information related to assistive technology has to be available to all, particularly to parents, teachers and students, since assistive technologies also introduces new aids into education.

The development of speech technology opens up perspectives for their increasingly widespread commercial use. At the same time, there is little talk about their use as aids for people with disabilities, although it has great impact to the society at large. In this paper, emphasis is placed on the assistive character of speech technologies and their applications for people with disabilities, but also for the elderly, as well as students who could benefit from alternative ways of learning and communication. Basic speech technologies for converting text to speech (TTS) and speech to text (automatic speech recognition – ASR) are fundamental for a range of sophisticated aids for people with visual, hearing or speech impairment, [6]. Recent trends in the development of speech technologies also enable speaker identification, voice conversion and emotional speech synthesis and recognition, and therefore open some new possibilities for the development of aids – they will all be discussed in this paper.

## 2 Aids based on speech synthesis (TTS)

Speech synthesis is a term related to artificial production of human-like speech. It is a speech technology primarily designed to perform conversion of a given text to the synthesized speech. TTS is the acronym for text-to-speech technology and often a synonym for speech synthesis.

The most important characteristics of artificially synthesized speech are naturalness and intelligibility. Naturalness describes how closely the synthesized speech resembles human speech, while intelligibility is related to the ease of understanding synthesized speech by the listener.

### 2.1 Development of speech synthesis technology

TTS is historicaly the first speech technology. Inspiration to have artificial speech and talking head can be found in Greek legends and later in medieval Arabic poetry. Long before the invention of electronic signal processing, some people tried to build mechanical machines to emulate human speech. The first talking machines were designed from mechanical models of the human vocal tract that could produce the five long vowel sounds (Christian Gottlieb Kratzenstein, Denmark, 1779). The next, bellows-operated acoustic-mechanical speech machine added models of the tongue and lips, enabling it to produce consonants as well as vowels (Wolfgang von Kempelen of Pressburg, Hungary, 1791). More details of the speech synthesis history, from mechanical to electronic TTS devices, can be found at [5].

Today, there are several dominant approaches to generate synthetic speech waveforms: concatenative synthesis, formant and articulatory synthesis, and parametric synthesis such as HMM-based and DNN-based speech synthesizers. Each technology has strengths and weaknesses, and the intended uses of a synthesis system will typically determine which approach is used.

#### *2.1.1 Concatenative speech synthesis*

Concatenative speech synthesis is based on the concatenation of natural speech segments from a pre-recorded database. Although concatenation of human speech segments may seem to be the most promising approach to synthesizing most natural-sounding speech, the automated techniques for segmenting and connecting the waveforms sometimes result in audible glitches in the output because of the differences related to natural variations in speech. There are three sub-types of concatenative synthesis.

**Domain-specific speech synthesis** concatenates prerecorded words and phrases to create complete utterances. The technology is very simple to implement and these systems produce high level of naturalness if the variety of texts is limited to a particular domain such as weather reports or navigation systems. However, simple word-concatenation system can only synthesize the combinations of words and phrases with which they have been preprogrammed. A general-purpose TTS system would require additional complexity to be context-sensitive.

**Diphone speech synthesis** is based on concatenation of diphones containing all sound-to-sound transitions occurring in a language. The number of diphones in a speech database depends on the language, for example, Serbian has about 900 diphones although some of them actually occur in speech only across word boundaries. Only one instance of each diphone in a speech database is not enough because of the effects of coarticulation. Digital signal processing techniques (linear predictive coding, TD-PSOLA) and pitch modification techniques in the source domain are used at runtime to modify the intonation and temporal structure of the set of speech

units required to build an utterance, bringing it closer to the target values required by the language processing module. Although the diphone synthesis suffers from the sonic glitches as concatenative synthesis and the robotic-sounding nature as formant synthesis, it has a considerably smaller memory footprint and requires far less processing power than other approaches and there are a number of freely available software implementations in commercial applications.

**Unit selection speech synthesis** uses larger databases of recorded speech and provides much greater naturalness, because it usually needs to apply only a small amount of digital signal processing to achieve the desired intonational and temporal properties of the target utterance, and/or to smooth the waveform at the point of concatenation. Speech database contains recorded utterances segmented into phones (sometimes subphones), diphones, syllables, morphemes, words, phrases, and sentences. Usually, the labeling (division and alignment) into speech segments is done in two steps: using a modified automatic speech recognizer in a forced alignment mode, and then some manual correction using visual representations such as the waveform, energy, pitch (the fundamental frequency) and spectrogram [7]. Annotation of the units in the speech database is then created based on the segmentation and acoustic parameters like the pitch, duration, position in the syllable, and neighboring phones [7]. Finally, the unit selection process is usually based on a weighted decision tree enabling that the target utterance is created by selecting the best chain of units from the database. The first unit selection speech synthesis in Serbian was developed in 2002, [8]. Although the techniques used to modify the speech signal do not introduce perceptible distortion into speech segments, the unit selection process is sometimes less than ideal, and the segments identified for concatenation are not always a good acoustic match. Consequently, better quality and naturalness typically require unit-selection speech databases to be very large, in some TTS systems ranging into the gigabytes of recorded data, representing dozens of hours of speech. Recently, researchers have proposed various automated methods to detect unnatural segments in unit-selection speech synthesis systems, [9].

#### *2.1.2 Articulatory and formant speech synthesis*

**Articulatory speech synthesis** is based on models of the human vocal tract and the articulation processes occurring there. The first articulatory synthesizer was developed in the mid-1970s based on vocal tract models developed at Bell Laboratories in the 1960s and 1970s, [5]. Until recently, articulatory synthesis models have not been incorporated into commercial speech synthesis systems. The gnuspeech system, first marketed in 1994, provides full articulatory-based text-to-speech conversion using a waveguide or transmission-line analog of the human oral and nasal tracts controlled by Carré's "distinctive region model". More recent synthesizers, developed by Jorge C. Lucero and colleagues, incorporate models of vocal fold biomechanics, glottal aerodynamics and acoustic wave propagation in the bronqui, traquea, nasal and oral cavities, and thus constitute full systems of physics-based speech simulation [5]. New devices such as Electromagnetic Articulography systems are capable to make digital recording, presentation and evaluation of the movements of the articulators [10] and enable progress in the development of fully articulatory speech synthesizers.

**Formant speech synthesis** creates synthesized speech using additive synthesis. Formants as the main bands of energy can be replaced with pure tone whistles in a technique called sinewave speech synthesis, or modeled by an acoustic model of formants based on parameters such as fundamental frequency, voicing, and noise levels, which are varied over time to create a waveform of artificial speech. Since the formant syntesizers (also called rules-based synthesizers) do not use human speech samples at runtime, they have smaller footprint than concatenative systems and therefore can be used in embedded systems with limited memory and microprocessor power, but this technology generates artificial, robotic-sounding speech that is clearly distinguished from human speech. However, maximum naturalness is not always the primary goal of a speech synthesis system, e.g. high-speed synthesized speech is used by the visually impaired to quickly navigate computers using a screen reader. Formant-synthesized speech can be reasonably intelligible, reliable even at very high speeds, avoiding the acoustic glitches that commonly plague concatenative systems. Since formant-based systems enable complete control of all aspects of the output speech, a range of intonational and rhythmic varitions can be output, conveying not just questions and statements, but also a variety of emotions and tones of voice.

#### *2.1.3 Parametric speech synthesis*

Parametric speech synthesizers are based on models whose parameter values are obtained by training on existing speech databases. They have two stages – training and synthesis. In the first phase, the model is

trained, while in the second phase the trained model is used to predict acoustic features necessary for creating a waveform, which is finally done by vocoder. In comparison to concatenative synthesizers, the parametric ones have smaller memory footprint and they are more flexible in terms of voice characteristics manipulation.

**HMM-based speech synthesis** is a method based on hidden Markov models, also referred to as statistical parametric speech synthesis. In this system, the vocal tract (frequency spectrum), pitch of voice source (fundamental frequency), and duration (rhythm) of speech are modeled simultaneously by HMMs. Speech waveforms are generated from HMMs themselves based on the maximum likelihood criterion. However, speech synthesized by HMM usually sounds very muffled and smoothed since modeling of one context-dependent phone is based on only part of the database corresponding to it, while there is usually not enough data for modeling each context-dependent phone well enough. These drawbacks are intended to be overcome with neural networks (NN) approach, since NNs are able to generalize better based on more complex mappings between input linguistic data and output acoustic data. Although the neural network model has been known for more than 40 years, only just recently, the development of hardware and software has enabled its practical use in TTS. This is particularly true for deep neural networks (DNN), which consist of multiple hidden layers and have proved to be a lot more powerful than shallow NNs.

**DNN-based speech synthesis** is a method based on deep neural networks. In this approach, phone durations and acoustical features are modeled separately, by two different neural networks. Before the training stage, labels from database have to be HMM-state aligned, which is usually done by forced alignment using mel-frequency cepstral coefficients and HMM modeling. In the first network, the one for duration modeling, input features are phone aligned linguistic features. They are YES/NO answers on a number (typically several hundreds) of questions regarding the phoneme identity of current, previous and next phone, accent, semantic focus, number of phonemes and syllables in word, number of phones in a word, number of words in the utterance, etc. The output features represent the durations (typically 3 to 5) of each HMM state of the phoneme. For the second network, the one for acoustic modeling, besides the input which is the same as in the first network, some additional frame and state features are added (based on output features from the first network), while the output features are acoustic features, usually consisting of cepstral coefficients, fundamental frequencies and band apperiodicities. Networks are trained by backpropagation, using mean square error as cost function calculated between output and target features, where the target features are derived from the database.

A pure feedforward network, or a network with long short-term memory (LSTM) layer as the final hidden layer, is considered as the most appropriate architecture with 4 to 6 hidden layers [11-12]. For high quality synthesized speech, around 3 hours of speech have proved to be sufficient for training, which typically lasts several hours to several tens of hours (depending on the implementation and usage of CPU or GPU). The speech quality is a lot higher than with HMM synthesizer and for some languages it has been reported as even better or near the quality of unit selection synthesizer [13-14], although it should be noted that speech synthesized from concatenative vs. parametric systems suffers from quite different drawbacks, and that direct comparison is not straightforward. With these characteristics, as well as dramatically increased flexibility in terms of introducing different speaking styles and speaker identities, DNN synthesizers are currently the most promising choice [15].

## 2.2 Speech synthesis as assistive technology

Firstly, text-to-speech (TTS) technology can help the visually impaired and all people who are unable read or prefer to listen to synthesized speech, including the dyslexic, the elderly, the physicaly disabled etc. Moreover, TTS provides a useful aid for the speech impaired as well as all those who are unable to produce speech like laryngectomized persons, or people with stroke or autism.

### *2.2.1 TTS-based aids for the visually impaired*

Assistive technology for the visually impaired include Braille embossers, voice recorders, screen magnifiers and desktop video magnifiers, as well as screen readers and speech synthesizers. The last two are aids related to speech technologies. Screen readers are software programs that bring information (cursor position or text) from display to the speech synthesis unit, which converts this information to speech. A well-known screen-reading software is Jobs Access With Speech (JAWS) [17], but it has so far included text-to-speech technology support for just several languages. TTS in a native language provides huge benefits for the visually impaired, regardless of whether a person’s sight impairment is partial or total.

**The visually impaired** can access or manipulate any text from the screens of their computers, phones, or other assistive devices – by listening to the synthesized speech. TTS as an aid for visually impaired computer users provides an important contribution to their equality in education, information access and privacy in communication, allowing them to perform tasks and apply for jobs that would otherwise have been inaccessible to them. There are about 2,000 visually impaired computer users all over the former Yugoslavia and most of them use *anReader* as their aid of choice, [6]. It has consequently been recognized as an aid for the visually impaired by the Institute for Health Insurance of the Republic of Serbia (RZZO). Several ICT services have been developed based on *anReader*, including: (i) *Audio library for the visually impaired*, (ii) Voice portal *Contact* for the visually impaired, (iii) Speech enabled web sites, [6]. Smartphone and computer are the main accessibility aids for blind people as regards both everyday life and meaningful employment. The main problem is how to convey the cursor position on either computer monitor or smartphone screen through speech. The cursor position vocalization can be prompted by touching the screen or by clicking "enter" on a computer keyboard if their default functions are initiated by double touching the screen or double clicking the "enter" button on a keyboard.

**Persons with dyslexia** can also have benefits from using TTS. The reading ability of the dyslexic can be impaired with regard to both accuracy and reading speed, which also affects their ability to completely understand a written text. Dyslexia is particularly disastrous for children and young people as developing individuals, but can also significantly reduce the quality of life of the elderly. TTS can help them to acquire information from text more efficiently.

TTS can also be very useful as an educational tool for **general population**. It gives the possibility to convert lessons or other textual material into audio files and make it accessible to everyone. Listening to audio-books is also interesting for the elderly, as well as physicaly disabled who are unable to hold a book in their hands. Furthermore, anyone can read/listen using their mobile phones or MP3 players even when they otherwise would not be able to read (on the road, during some physical activity, etc.).

For some Internet users it is much more convenient to listen to natural sounding speech instead of having to read the text on a web page, particularly in situations where it is important that eyes and arms should be free for other tasks. Listening to the news is a particularly useful option for smart phones due to their small screens. For people with a range of disabilities this is the only possibility to access web pages. In order to make the visually impaired less dependent on screen readers, web pages have been made more accessible from any of the widely used web browsers by using the specialized server-side TTS software.

#### *2.2.2 TTS-based aids for the speech impaired*

Speech disorders include difficulties in pronouncing certain voices, replacing and adding phones, nasal speech, unintelligible pronunciation or stuttering, [1]. Incorrect pronunciation of certain phones or irregular speech detracts listeners' attention, affects communication and causes difficulties on the emotional and social level as well. Speech communication is one of the most important forms of human interaction and people with speech disorders are in a significantly inferior position when it comes to socialization and everyday communication with others, regardless of whether their condition is congenital or acquired (e.g. due to laryngectomy).

An efficient alternative to using devices that initiate vocal fold vibration and thus enable mute persons to speak is text-to-speech (TTS) software, which allows **mute** or otherwise speech disabled persons to convert typed text into intelligible and natural sounding speech using a smart phone or a similar portable device. Most of the speech impaired persons can write down what they would want to say, and the speech generating device will produce the sound for them. TTS applications for smart phones are available as aids for the speech impaired for many languages, and one has been developed for Serbian, called "The power of speech". It is initially intended for the people who have undergone laryngectomy. Recent achievement in speech morphing enable voice conversion based on several minutes of recorded voice of a person, [15]. Owing to the voice conversion technology, since recently it is possible for **laryngectomized** individuals to have speech synthesizers in their own voices.

#### *2.2.3 Speech-related augmentative alternative communication (AAC) aids*

Speech disorders are often consequences of hearing loss, neurological disorders, physical impairments or surgery, but they may be related to intellectual disability as well. Language difficulties involve difficulties in expression characterized by poor vocabulary, short sentences, often incorrectly composed. Children with **language and speech disorders** have problems with finding names of objects, events and persons from the

environment. They often repeat phrases, talk to theirselves and they are not able to follow instructions, which causes problems in their communication, [1]. For example, children with autism can have undeveloped speech or speech that sounds unusually monotonous and even robot-like. Children with cerebral palsy can exhibit different levels of speech development, from complete absence of speech to very well developed speech. Nevertheless, children find their own ways of communication depending on their intellectual capabilities, and it is of utmost importance to provide them with adequate techological support.

Complex systems with speech technologies included in dialogue systems, together with language technologies and cognition aspects of speech communication, can help people who cannot use either speech or text as conventional communication channels. For example, people with **autism** are usually able to choose the sequence of images or symbols in order to express their thoughts, questions or commands. The sequence of images and symbols has to be converted to corresponding text and subsequently to audible synthesized speech. People with autism or intellectual disability often use such a type of communication, termed **augmentative alternative communication**. AAC is a term describing any communication method for those with impairments or restrictions on the production or comprehension of spoken or written language, [6]. There is a wide range of speech-related AAC applications which depend on the capabilities of the user, from basic aids as pictures on a board that are used to request food, drink, or other care, to advanced speech generating devices, based on speech synthesis upon construction of spoken utterances from sequences of selected images, that are capable of storing hundreds of phrases and words.

## 3 Aids based on speech recognition (ASR)

Automatic speech recognition (ASR), sometimes called speech-to-text (STT), is another important speech technology, which enables the recognition and translation of spoken language into text by machines. Used together, ASR and TTS provide two-way human-machine speech communication. Both speech technologies, ASR and TTS, are interdisciplinary research and development problems, requiring knowledge in a range of fields including linguistics, acoustics, signal processing as well as computer science. Apart from recognizing what was spoken, sometimes is useful to identify the speaker or his/her mood. Recognizing the speaker can simplify the task of translating speech in systems that have been trained on a specific person's voice or it can be used to authenticate or verify the identity of a speaker as part of a security process. Recognizing speaker emotion can improve human-machine dialogue. However, speaker and emotion recognition can be extremely hard tasks in the case of people with speech disorders.

### 3.1 Development of automatic speech recognition

From the technology perspective, ASR has a long history with several waves of major innovations, [16]. After the first trial with a toy dog named Rex which responded to the voice resonance at 500 Hz in the word Rex, more complex systems have been developed in the second half of 20th century.

Early attempts to design ASR systems (1952-1968) were mostly guided by the theory of acoustic-phonetic relations; they are implemented on analog filter banks and electronic logic circuits capable of recognising vocals and numbers, some phonemes and syllables using phoneme statistics for the first time. The second generation of ASR systems (1968-1980) is related to the appearance of digital signal processing techniques based on microprocessor development; they enabled application of fundamental concepts of linear predictive coding (LPC), which greatly simplified the estimation of vocal tract response from speech waveforms and fundamental **pattern recognition** technology to speech recognition. ASR development has taken the advantage of a finite state network to reduce computation and efficiently determine the closest matching string. The progress is based on the development of algorithms for graph search, aimed at discovering the sequence of words (or sounds) that matches given audio under specific knowledge constraints given by language model, keeping the number of working hypotheses under control during the entire decoding process.

After 1980’s the research was characterized by a shift in methodology from the more intuitive template-based approach (a straightforward pattern recognition paradigm) towards a more rigorous **statistical modeling framework**. The basic idea of the hidden Markov model (HMM) was dominant until recently [18]. Most recently, the field of ASR has greatly benefited from technology advances in **deep learning** [19]. More

scientific papers are published in the field and the main speech industry players have adopted a variety of deep learning methods in the design and deployment of speech recognition systems.

## 3.2 Speech recognition as assistive technology

Even a small vocabulary ASR is sufficient for the recognition of spoken commands, e.g. in a smart home of a person with a physical disability, who can lock the door, turn the light on or off, change a TV program, or make a telephone call, using speech commands from his/her bed or wheelchair.

More useful ASR systems for the disabled are large vocabulary continuous speech recognition (LVCSR) systems. Such systems are very complex and they still have not been developed for many languages, especially languages with scarce language resources, but they can be expected to appear quite soon [20]. For Serbian, as is the case with dominant world languages, such as English, Spanish, Chinese, Arabic, etc., LVCSR systems have been developed to achieve accuracy being acceptable for commercial purposes as well within assistive devices [21-25].

### *3.2.1 ASR-based aid for the hearing impaired*

Hearing impairment is a partial or total inability to hear. A person is considered deaf if he or she has little to no hearing. Hearing loss can be temporary or permanent and may occur in one or both ears. Hearing problems can affect the ability of children to learn a spoken language, while in adults they can reduce the capability to perform many jobs.

Since most deaf children are unable to learn to articulate speech reasonably clearly, each mute person or person with speech disorders can have benefits from using speaking machines, as discussed in Section 2.2.2. The work of speech therapists with such children is irreplaceable, but ASR can be used to check pronunciation accuracy when practicing individually [26]. The same approach can be applied to normal hearing children with speech disorders. Furthermore, it can be used to correct phoneme and word pronunciation during learning of second language [27].

As the hearing impaired have problems in following TV programs that are not subtitled, LVCSR systems can be used for automatic subtitling, and this option can be used via digital TV broadcasting which supports several versions of the same TV program e.g. suitable for different kinds of people with disabilities [28-29]. Apart from subtitling for the hearing impaired, digital TV can provide a program with an audio description for the visually impaired etc. This possibility has been available for some time in some of the more developed countries, and the development of such a service for Serbian is to be expected [3].

### *3.2.2 ASR-based aid for the physically disabled*

LVCSR enables people to create text documents such as letters or e-mail messages, to browse the Internet or navigate through applications and menus by voice. That significantly facilitates the way of using state-of-the-art technology by the persons unable to move unaided or unable to use their hands, but able to speak. Additionally, even a small vocabulary ASR system implemented in a smart home in order to recognize voice commands would be most beneficial, as it would allow the disabled to control devices such as lights or home appliances in a much more convenient way. Speech commands should be issued through a microphone near the speaker or through a mobile device such as a smart phone, while some smart homes are equipped with microphone arrays that can locate the speaker and, to some extent, cancel the noise coming from other directions.

The physically disabled like the paraplegic, the dystrophic, as well as those with multiple sclerosis or infantile cerebral palsy are often unable to read, but are usually able to issue speech commands and to listen to information in the form of speech. However, some of them have speech disorders and if their speech is not comprehensible, ASR system has to be adapted to each of them personally. Apart from the physically disabled, the principal beneficiaries of speech-enabled smart homes include the elderly, but also all people who prefer giving voice commands to using their hands.

### *3.2.3 ASR for children with learning disabilities*

Speech technologies can be helpful for children with dysgraphia, dyslexia, and other learning and attention issues that impact reading and writing [30-31]. One way to overcome these problems is to practice reading and dictation. Such practice is highly time consuming and requires the involvement of parents or teachers, and it

would be highly beneficial if these individuals could be replaced by a LVCSR system specifically intended for dictation. Through a combination of ASR for dictation and TTS a pupil can improve his/her reading and spelling skills. In case of dictation, children should pronounce the whole sentences (large groups of words at time), in order to also train working memory and attention. By using machines, these children work independently form tutors, which, in turn, develops their self-reliance and sense of independence.

## 4 Conclusions

New technologies can help people with disabilities to overcome most obstacles only if the social awareness of their problems reaches a significantly higher level than it is today. This paper is an attempt to contribute in that direction, by raising social awareness through the presentation of speech technology as assistive technology, providing basic information related to the people with disabilities and their needs for speech technology as accessibility aids.

Speech technology has enabled human-machine speech communication, enabling humans to just speak and listen, as if they were talking to another human. Therefore, speech communication can help people who cannot use their eyes or arms, as well as the voice-disabled and the hearing-disabled. The visually impaired cannot see any written text, but can listen to speech synthesized from any given text by text-to-speech (TTS). On the other hand, the hearing impaired cannot listen to speech, but can receive it if it is converted to text by automatic speech recognition (ASR). Moreover, TTS can help the speech impaired, who can write any text that will be converted to audible speech by TTS (possibly in the person's original voice), while ASR can understand voice commands and help most people to manage home appliances in a smart home – it is particularly useful for the physically disabled: the paraplegic, the dystrophic, people with cerebral palsy, etc.

The aforementioned problems of the disabled affect their independence in both work and personal life. This is particularly disastrous for children and young people as developing individuals, but can also significantly reduce the quality of life of the elderly. A large vocabulary ASR and high-quality TTS enable the development of more complex dialogue systems which can recognize different speakers living in the same house and adapt the dialogue to the interlocutor and to his/her speech disorder and even to his/her emotional state. To conclude, it should be noted that speech to text and text-to-speech technologies also enable communication among blind, deaf and mute persons – which is their unique feature.

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## Asistivni karakter govornih tehnologija

Velik broj pomagala za osobe sa invaliditetom oslanja se na govorne tehnologije. Rad predstavlja dostignuća i trendove u razvoju govornih tehnologija sa posebnim naglaskom na njihovu primenu kao asistivnih tehnologija namenjenih širokom krugu osoba sa invaliditetom. Pored toga, u radu je predstavljen i velik broj primera asistivnih aplikacija namenjenih unapređenju kvaliteta života različitih specifičnih grupa korisnika, ali i asistivnih aplikacija od kojih svi mogu imati koristi.

# Валеологические аспекты речи, звуков, букв

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В настоящее время о философских воззрениях и вере древних славян, мы, их потомки, знаем слишком мало и в этом зачастую кроются неосознанные проблемы, отсутствие поддержки от Родов своих, чувства связи с корнями своими, с вековыми традициями, которые помогали сохранить культуру, здоровье, счастье и жизнь своих славных Родов. В связи с проявлением стремления к духовности и самосовершенствованию у наших современников пробуждается интерес к наследию Предков. В последнее время появляются научно-исследовательские работы, посвященные исследованию традиций, культуры, письменности славян, сопоставление общепринятых суждений с археологическими находками и с литературными источниками, при этом обнаруживается система ошибок, заблуждений и заведомо ложных представлений об истории и культуре Предков. Данная статья проливает свет на некоторые аспекты влияния на здоровье нации письменности и речи русскоязычного населения.

**Ключевые слова**: образное восприятие, правое и левое полушария мозга, символ

Стоит задуматься о смысле мудрого выражения: «Кто не знает своего прошлого, тот не имеет будущего», ведь многое из нашей истории не известно, искажено, скрыто.

В 2010 году в г. Краснодаре вышла книга под названием «Родовой Букварь Древнесловенской Буквицы» [3]. Авторы Ефимцева Л.В. и Ошуркова Т. Ф., опубликовавшие своё исследование, являются академиками Кубанской народной академии. В обращении к читателям авторы пишут, что «о культуре и письменности древних славян сегодня пишут авторы многочисленных учебников по Культурологии. Издана обширная учебная литература по данному предмету - синтезу лучших достижений всех национальных культур различных народов, населяющих нашу планету. Однако своеобразию национальной культуры Древних славян дохристианского периода авторы этой литературы уделяют мизерное внимание. А некоторые из них отчего-то считают, что славяне, как цивилизованный народ, сложились только после принятия христианства».

Вопрос о философских воззрениях и вере древних славян, безусловно, сложен, и прежде всего из-за скудости дошедших до нас сведений, поскольку с приходом христианства на Русь все Древние Святилища, книги, ведическая философия и её носители уничтожались.

Еще одна сложность состоит в удивительной ёмкости понятий и образов, существовавших у древних славян. Жизнь наших предков была неразрывно связана с природой, и они, являясь её частью, познавали естественные законы мироздания через себя, изнутри. Поэтому их мировосприятие было живым и многомерным».

Именно «удивительная ёмкость понятий и образов» древних славян непостижима и непонятна их потомкам, так как в письменности, в буквицах или символах, заключены образы, объемное, истинное восприятие мира, и, если хотите, счастье и здоровье носителей этой грамоты, а также возможности телепатического общения и другие способности, которые мы себе и представить не можем, так как с обеднением письменных символов просто утратился инструмент образного восприятия и родовая генетическая память.

Есть утверждения, что в древнеславянской письменности (Всеясветная грамота) было более 147 символов, которые были объёмными, многомерными, но имели и плоское начертание. Они являлись корнями слов, восстанавливали генетическую память, отражали смысл понятий, заключенных в символах, обозначали средства творчества.

Авторы [3] являются исследователями одного из видов письменности – Буквицы, содержащей 49 букв, в которой после «реформ» осталось чуть больше половины, и этим урезанным вариантом мы сейчас пользуемся как азбуками русского, украинского и белорусского языков.

Ни одна из реформ письменности не была благом. Напротив, это было грубое вмешательство в физиологию носителей языка, в здоровье нации. Суть этих реформ сводилась к тому, что «реформаторы» убирали из Букваря определенные буквицы, несущие в себе самые высокие образы и звуки, особо важные для сохранения физического и духовного здоровья, а у оставшихся буквиц изымалась образность, вкладывался в слова иной смысл, с подменой образов и понятий.

Вопреки данным многих исследователей, создателями славянской письменности упорно продолжают называть двух византийских монахов Кирилла и Мефодия. При этом «Паннонское житие» Кирилла сообщает,

что когда он прибыл в Корсунь (Херсонес Таврический) в конце 860 г. от Р.Х., то там ему показали церковные книги, написанные «русскими письменами». А монахи создали лишь упрощенную церковно-славянскую азбуку, адаптированную для христианской церкви, убрав из древнерусского Букваря 5 буквиц.

По словам Екатерины II, наши Предки еще задолго до рождения Христа «многие письмена имели». К этим «письменам» относились:

**Тьраги.** Это образные символы, которые соединяют в себе сложные объёмные знаки, передающие многомерные величины и многообразные смысловые нагрузки. Часть этих криптоиероглифических символов легла в основу криптограмм критомикенской культуры, иероглифического письма Древнего Египта и Междуречья, китайских, корейских и японских видов иероглифического письма.

**Каруна.** Союз 256 рун, или жреческое письмо. Каруна легла в основу древнего санскрита, деванагари, использовалась жрецами Индии и Тибета. В упрощенном виде Каруна использовалась западными Родами. Сейчас на книжных прилавках появляются работы западных исследователей Футарка, одного из её упрощённых вариантов.

**Рассенские Молвицы, или Образно-Зеркальное письмо.** Данную письменность называли ЭТРУССКИМ письмом, так как им писали ЭТРУСКИ, которые сами называли себя Расенами. Это письмо легло в основу древнего финикийского алфавита.

**Святорусские Образы или Буквица** были самым распространенным письмом среди наших Родов в древности. Известны различные варианты сокращённой буквицы: Древнесловенский букварь и Древнерусская азбука; Велесовица или шрифт Велесовой книги; шрифт Святорусских волхварей - текстов, записанных на дощечках из священных деревьев; церковно-славянский алфавит.

Древнесловенский и Древнерусский языки легли в основу многих европейских языков, в том числе и английского языка.

**Глаголица или торговое письмо** использовалась для записи священных текстов, а также для оформления сделок, торговых договоров и ведения амбарных книг.

**Словенское народное письмо,** «берестяное» письмо, или «черты и резы» было самым простым, использовалось для кратких сообщений.

**Воеводское письмо** - система тайных шифров.

**Княжеское письмо** - язык дипломатических писем.

**Церковнославянский и Древнерусский** языки и начертания буквиц имеют много общего с прародителем - **Древнесловенским языком.**

Почему мы называем наш праязык словенским? Потому, что этим языком уже активно пользовались наши Предки во времена князя Словена, знаменитого тем, что в 2395 году до Рождества Христова, на реке Мутной он поставил град Словенск, который стоит и поныне, и зовется Великий Новгород.

К бытовому письму относятся **черты и резы, узелковое письмо** [1, 3].

Исследователь русского правописания И.И. Костючик в книге «Нашествие варваров на русский язык» утверждает, что «Не реформа была проведена, а искажение, коверкание русского языка, и при этом - умышленное, отрыв русского языка от его славянских корней, денационализация русского письма, русской этимологии, фонетики, русского мышления».

Наибольшую нагрузку при звучании речи получают часть языка, мышцы лица, губ. На поверхности языка находятся биологически активные точки. На задней части языка точки почек; на средней - селезенки; по бокам печени; на кончике языка - точки сердца. Для артикуляции современной русской речи характерна большая нагрузка на среднюю часть языка и слабая - на заднюю и переднюю.

Нёбо является сферой сохранения и оздоровления энергии человека, так как на нём имеются выходы двух энергетических каналов: управляющего, идущего от копчика к твёрдому нёбу, и функционального, уходящего от твёрдого нёба к промежности. При высоком подъёме языка к твёрдому нёбу при произношении [и], [й] эти каналы замыкаются в микрокосмическую орбиту, по которой жизненная энергия приходит в движение и гармонично распределяется между внутренними органами, давая организму кратковременный баланс энергии.

Была большая группа буквиц, объединённых общим именем «ижейные, которые передавали звук [и] разной долготы звучания. В Древнесловенской Буквице их было 7, а в Глаголице их осталось 3.

Долгота звучания гласных выполняла в нашем языке, как и в ряде современных индоевропейских языков, смыслоразличительную функцию.

К примеру, различная долгота звучания [і] в слове [мір] изменяла смысловую значимость слова, что на письме отображалось через различные ижейные буквы: Миръ, где [і] долгий, означало «состояние без войны»; Міръ, где [і] ровное -«Вселенная»**;** Мїръ, где [і] полукратный — «община», «людское сообщество»; было слово Ма́ръ**,** где

[і] краткий, обозначавшее «меру времени», дающее понятие объёмности. Убирая из языка «ижейные» буквы, различные по долготе звучания звуков [і], реформаторы изъяли и ряд других букв, передававших указанное фонетическое явление.

Заодно с буквицами, которые передавали разную долготу звучания, убрали сложные гласные звуки, начало и конец которых имеют различное звучание.

Сокращение количества [і] в языке не могло не сказаться на нашем здоровье, ведь мы теперь реже замыкаем свои микрокосмические орбиты, реже даём своему организму звуковую подпитку.

Неразвитость чакры «чело» (межбровная чакра), которую стимулирует звук [і], не даёт возможности развиваться ясновидению.

Из русского языка были убраны буквицы, передававшие носовые звуки. Назальность, или гнусавость в произношении:

а). открывает в голове евстахиевы трубы, дающие способность яснослышания;

б). активизирует одновременную работу обоих полушарий мозга.

в). стимулирует гипофиз - центр воли.

Чтобы звук сформировался в носовой полости, необходимо перекрыть доступ воздуха в ротовую полость путем поднятия задней части языка (точки почек) к мягкому нёбу.

Как на нашем здоровье отразилась потеря носовых звуков? - Помимо того, что почки перестали получать дополнительную звуковую стимуляцию, ослабла и наша связь с Духом, т.к. верхние три чакры стали получать меньше вибраций.

Назальность, как фонетическое явление, существует в ряде языков. Так, в английском языке насчитывают восемь частей речи, в основе которых находится специфический носовой звук. Носитель английского языка ежедневно произносит его многочисленное количество раз.

Горловые звуки и гласные с придыханием (как при протирании очков) также оказались непосильными для восприятия первых «реформаторов» - греков.

Бьют «реформаторы» по энергетике языка через гласные звуки, воплощение активной мужской энергии. Образно говоря, гласные - это река, согласные — женская энергия - её берега. Мельчает река, берега рушатся, жизнь вокруг замирает.

Из 27 гласных Древнесловенского Букваря к сегодняшнему дню осталось всего 6. Восемьдесят процентов активной языковой энергии утрачено, что наглядно отражается на физическом здоровье мужского населения.

В итоге, в современном русском языке остались лишь монофтонги — гласные одного качества звучания и не имеющие фиксированной долготы звучания. Их шесть: а - [а], э - [е], о - [о], и - [і], у - [u], ы - [у]. Тем не менее, эти шесть «жемчужин» подобны драгоценному ожерелью, оставленному нам в наследство для того, чтобы оно оздоравливало тех, кто его носит, носителей родного русского языка. Спросите свою родовую память: «Какого цвета звук?» А звуки ведь имеют цвет: [а] - красный, [е], [о] - от оранжевого до зеленого; [і] - голубой, синий; [у] - серый, коричневый; [u] - фиолетовый.

Оказалось, что литературы по звукотерапии ничтожно мало [2]. Тем не менее, удалось понять, что на внутренние органы человека, независимо от его национальности, благотворно влияют дифтонги (составные гласные) и долгие гласные.

Так, сердце получает цвето-звуковую подпитку от дифтонга «ауу!».

Последние научные исследования свидетельствуют о том, что акустическое поле – это динамичная система, генерируемая всеми органами организма. Оно воспринимается не только слуховыми рецепторами и анализаторами, но и сознанием клеток, органов, тканей. Языки ДНК хромосом и человеческая речь имеют общие корни и универсальную грамматику.

По мнению президента Института Квантовой Генетики П. Гаряева, ДНК - это такой же текст, как текст книги; структура человеческой речи и структура последовательности ДНК математически близки.

Звук, рождая в мире тонких энергий цвет, запах, форму, обладает мощным лечебным действием, т.к. осуществляет связь между миром Природы и Человеком.

В книге [2] читаем: «Звук освобождает энергию, заключённую в тонких телах. Рожденный в груди и диафрагме, звук гармонирует и снимает напряжение в эмоциональном (астральном) теле. Энергетический дисбаланс астрального тела обладает негативным зарядом, его устранение дает ощущение мира и очищения. Механизм этого явления заключается в том, что определённая нота, обладая своей вибрацией, находит в организме соответствующие качества, выравнивая при этом энергетический баланс организма».

Авторы [3] дают описание влияния звуков и их применение для коррекции состояния здоровья

человека. Приводим эту информацию ниже.

[i]. Долгое, протяжное пение на одной высоте стимулирует голосовые связки, гортань, уши, глаза, нос, головной мозг, гипофиз, шишковидную железу, все элементы черепа (восемь элементов черепа образуют две окружности: точка их соединения даёт переход творческой энергии левого, аналитического полушария мозга в энергию интуитивного правого, что способствует вдохновению). При этом возникает приятное ощущение радостного возбуждения, сопровождаемого (у некоторых людей) видением его цвета, ощущением его запаха.

[o]. Главный гармонизирующий звук, дающий подключение к универсальной гармонии вибраций. Вибрирует грудь, уменьшается глубина дыхания. Чем больше [o] в слове, тем больше в нём гармонии. Например, «болото» (в нем вырастают самые сильные лекарственные растения).

[e]. В народе используется для снятия порчи, сглаза, т.к. вибрирует [э]. в железах внутренней секреции. Даёт красоту.

[je]. «Е» чистит от энергоинформационной грязи, создавая энергобарьер вокруг человека, т.к. стимулирует паращитовидную железу, трахею. Старайтесь петь на высоких нотах, как поёт Олег Ануфриев в мультфильме «Бременские музыканты»: йэ-йэ-йэ.

[a]. Углубляется дыхание, увеличивается потребление кислорода верхней частью легких. Пойте его как при укачивании ребёнка.

[u]. Вибрации гортани, глотки, гипофиза дают уверенность в себе, т.к. гипофиз - центр воли. Этот звук наполняет человека Мудростью.

[ja] -Я. Многократное произношение избавляет от боли, усиливает биоэнергетику, гармонизирует работу всего организма.

[ju] - Ю. Чистит и наполняет энергией почки, мочевой пузырь.

[t's'] - показатель чистоты организма. Восстановление этой вибрации возвращает способность чувствовать.

[ch] - Изменения его вибраций говорят о том, что есть нарушения в Душе человека. Звуками [ХА], [ХЪ] по преданию Древних изгоняли духов болезней. Смейтесь чаще. Центр смеха находится в правом полушарии мозга. Смех это прерывистое дыхание. Вместо одного вдоха-выдоха за это время происходит 3-4 вдоха-выдоха, что очищает верхние дыхательные пути. Добавьте улыбку, т.к. даже искусственная улыбка вызывает обратную биохимическую связь - эндорфины.

[m]. Вибрации сосудов мозга. Нарушения вибраций этого звука говорят о нарушениях в отношениях матери и ребёнка.

[auoum]. Его надо произносить как звук колокола, с сильной артикуляцией. Он оживляет, очищает, наполняет энергией ментальное тело.

[n]. Активизация правого полушария. Гнусавость открывает евстахиевы трубы в голове, и человек начинает слышать музыку Небесных Сфер. Научитесь произносить носовой звук, похожий на русское сочетание НГ, касаясь задней частью языка мягкого нёба; добавляя к гласным, пойте его как можно дольше: [А]+[НГ]; [ИМНГ] и т.д.

[oj]. Дифтонг благотворно влияет на прямую кишку. Его можно подвывать. Лечит геморрой, как утверждают авторы [3].

Есть мнение, что наш мозг задействован только на 5% от своих возможностей. В Украине два языка — русский и украинский органично входят в наше сознание, память, культуру, сферу общения. Поскольку владение языками занимает какое-то количество нашей памяти и ячеек мозга, то, приятно осознавать, что у украинцев, владеющих двумя славянскими языками, больше ячеек памяти занято полезной информацией, чем у одноязычных.

Интерпретация каждой буквицы Древнесловенского Букваря как текста, дешифровка изначального смысла которого основана на синтезе фундаментальных знаний и озарений, даёт открытие образности и смысловой значимости буквиц.

Опираясь на интерпретацию буквиц [3], можно сделать расшифровку скрытого смысла, образности буквиц, входящих в название «Украина»:

**УК**- имя буквицы «У», образ: «Послание»;

**РА** - корневая форма, образ: «Сияние Божественной Мудрости», Солнце.

**И** - буквица «Иже», образ: «энергия»

**Н** - буквица «Нашъ», Высшие Знания наших Предков;

**А** — «Азъ», образ: «Изначальный Сеятель Жизни».

А теперь посмотрим значение названия Україна.

**«Ї»** - имя буквицы «ИНИТЬ»: И - буквица «Иже», образ: «энергия» плюс НИТЬ - корневая форма, образ: «Нить», связь**.**

В имени буквы «ї» содержится дополнительно к «И» образ — «Нить», связь, то есть расширение смысла, обогащение образа. Далее авторы приводят следующее:

Графический образ буквицы **«Ї»**: точки над вертикалью — являются символом эволюционных циклов перемен и трансформаций, происходящих в физических материях в результате творческих деяний Духа.

«Энергетическая Нить - коя суть Дух животворящий, направляет к Истоку стремление Человека уподобиться Богу в своих творческих созидательный деяниях, направленных на совершенствование своей Души».

Философское значение Буквицы «ї» - одухотворённое творчество в единении с Истоком [3].

То есть, при произношении «Україна» звучание обогащается смыслом, поло-жительными, творческими энергиями и целительным воздействием дифтонга [ji].

В украинском языке осталась буква **і** с точкой: **і** — это звук буквы «Ижеи», образ - «Вселенная».

В связи с положительным влиянием на здоровье народа употребления в речи как можно большего разнообразия звуков, можно приветствовать сохранение имеющейся в настоящий момент звуковой палитры и введение в современную украинскую грамматику звука [ґ].

Анализируя следствия языковых реформ, авторы [3] утверждают, что «в среде носителей русского языка растет языковое отчуждение, поскольку уровень нашего современного языка не позволяет нам адекватно отображать внешний мир и точно выражать свой внутренний мир. А отсутствие взаимопонимания, как известно, порождает междуусобные конфликты вплоть до войн, несущих смерть.

Нехватку взаимопонимания, так необходимого в наши дни, можно объяснить тем, что:

- у общающихся не срабатывает их единый языковой генетический код;
- нет доступа к их родовой памяти посредством исконных древних образов наших буквиц;
- искажено восприятие голографических картин, которые формируются тонкой материей звуков речи и которые, безпредельно распространяясь, становятся образами, знаками, символами, обладающими универсальной ёмкостью» [3].

В данной ситуации бодрую нотку можно найти в том, что у многих думающих людей приходит понимание необходимости возрождения лучших традиций наших Предков, применение оздоровительных технологий, осознанного — валеологического подхода к себе как к триединой сущности, обладающей физическим телом, душой и духом.

О смысле и образах букв и слогов русского языка в наше время даже в художественной литературе можно найти рассуждения. К таким писателям относится Сергей Алексеев, автор популярной серии произведений «Сокровища валькирии». В его произведении «Слово» есть следующие высказывания: «Физику с математикой изучаем, от Евклида и Демокрита, а язык свой, на котором говорим, думаем, - лишь самый его кончик». По его произведениям рассыпаны подобные мысли: «Наши ученые знают латынь и древнегреческий, современные иностранные языки, эсперанто, наши школьники зубрят чужую речь, но никто, кроме узких специалистов, и строчки не может прочитать на древнерусском». «Когда у человека беден словарный запас, ему не только говорить нечем, а и думать тоже». «Где же он нынче, гибкий, красочный, точный - богатейший русский язык?»

Мудрецы говорят: «кто не знает своего прошлого, не имеет будущего», поэтому современники должны осознавать свою причастность к высокой культуре своих предков, ценить, и уважать то духовное наследие, которое для нас было оставлено. К очень большому сожалению, дошло до нашего времени не так уж много проверенного тысячелетиями опыта наших Предков в сфере сохранения здоровья, культуры взаимоотношений в семье, навыков образного мышления, развития интуиции и телепатических способностей. И, как доказывают авторы [3], у нас отобран инструмент этих способностей, нам даже трудно представить себе, чего мы лишены. Стоит ли теперь удивляться нравственному и духовному убожеству некоторых представителей рода человеческого? Мы молчаливо соглашаемся с тем, что создателями славянской письменности называют двух византийских монахов Кирилла и Мефодия, что вера наших Предков, «то є поганська віра», язычество. Наш календарь начинается от рождения Иисусу Христа, а поселениям Триполья 6000лет, но мы скромно не настаиваем на том, чтоб весь мир об этом узнал. Нас оторвали от нашей славной истории, культуры, письменности, но многие ли наши современники знают о своих прабабушках и прадедушках, интересуются своей родословной? Прошлое столетие ознаменовано революциями, войнами, когда рвались родственные связи, люди покидали родные края, свои

дома, погибали родные и близкие, приходилось выживать в экстремальных условиях. Нынешнее тысячелетие преподнесло такие же испытания, хотя казалось, что мы уже живём в цивилизованном мире. Хотелось бы, чтобы эти испытания помогли возродиться патриотизму, объединить людей вокруг национальной идеи, возродить лучшие традиции, вернуть осознанность и духовность.

В конце прошлого века, когда появилась эзотерическая литература, стали открываться запрещенные и сакральные знания, многие начали знакомиться с духовными практиками, заниматься самосовершенствованием.

В результате анализа литературы и сложившейся в наше время ситуации можно сделать такие выводы: возрождение традиций наших Предков, поиски знаний, скрытых от нас за пеленой времени, правдивое освещение нашей истории, духовность и самосовершенствование каждого человека, позволят научиться создавать позитивные образы для того, чтобы осознанно творить счастливое будущее нашей замечательной страны, а также и прекрасной зелёной планеты.

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## Валеологічні аспекти мови, звуків, букв


У наш час про філософські переконання та віру древніх слов'ян, ми, їх нащадки, знаємо занадто мало й у цьому часто криється незбагненні проблеми, відсутність підтримки від Предків своїх, почуття зв'язку з корінням своїм, з віковими традиціями, які допомагали зберегти культуру, здоров'я, щастя та життя своїх славних Родів. У зв'язку з проявами прагнення до духовності та самовдосконалення в наших сучасників пробуджується інтерес до спадщини Предків. В останній час з'являються науково-дослідні роботы, присвячені дослідженню традицій, культури, писемності слов'ян, співставлення загальноприйнятих суджень з археологічними знахідками й з літературними джерелами, при цьому викривається система помилок і хибних уявлень про історію та культуру Предків. Ця стаття висвічує деякі аспекти впливу на здоров'я нації писемності та мови російськомовного населення.


**Ключові слова**: образне сприйняття, права та ліва півкулі мозку, символ.


## Valeological aspects of speech, sounds and letters


Currently about philosophical beliefs and the beliefs of ancient Slavs, we, their descendants, we know too little, and this often lay unconscious problems, lack of support from their Birth, the feelings of connection with their roots, with age-old traditions that helped to preserve the culture, health, happiness and the lives of his glorious Birth. In connection with the manifestation of the desire for spirituality and self-improvement among our contemporaries awakened interest in the heritage of their Ancestors. Recently research work devoted to the study of traditions, culture and literature of the Slavs, comparison of conventional judgments with archaeological and literary sources, detected system errors, misconceptions and false ideas about the history and culture of their Ancestors. This article sheds light on some aspects of the influence on health of the nation writing and speech of Russian-speaking population.


**Keywords**: imaginative perception, right and left hemisphere of the brain, symbol.

# Lingvopedagogical process as a part of spiritual development of a human

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**Abstract:** The main educational means is speech (language). The most important thing for a teenager is the ability to understand others, to feel the creative and destructive energy of speech and profanity. In fact, in the process of cognition of oneself and the world, comes awareness of the field interactions significance of the wave energy-information framework, because the child interacts with the energy-information fields of the people who surround him (teachers, parents, classmates, friends), and he also interacts with the environment that determines the area of human activity effects. Numerous scientific studies have revealed the effect of speech disorders, pronunciation on the quality of education and the state of children's health. So, for example, according to medical workers, the reproduction of neuroses is due to the lack of receptivity of information (speech) from the right hemisphere. Such disharmony produces a feeling of fear, anxiety, anger, guilt.
Language is the foundation of the nation. Language is the main means of spiritual development of human society. Language is the main channel of communication with the noosphere. In addition, all these statements fit into the modern concept of the wave nature of language. According to the current worldview, the presented scientific material should become a component of the linguistic competence of the teacher, which consists of the language feeling, the culture of speech, the knowledge of the features of interaction, the possession of valeo-ecological and pedagogical knowledge.
The health problems of children and adolescents today need close attention not only from health workers, but also teachers, parents, the public. A special place and responsibility in this healing process is assigned to the educational system, which can and should make the educational process health-saving.
Keywords: language, health, health care, pedagogic, education, school, upbringing, linguistics

According to the current post-nonclassical period of paradigmatic science development, our understanding of the structural organization of a human contains the physical, psychical and spiritual parts which are in harmonic interaction between each other and the surrounding world under hierarchical leading of the spirit (Pic. 1) The interaction with the environment is realized through seven energy centers-chakras and bioactive spots, which exchange information and energy with the "Human-Environment" system.

With the harmonious wave interaction of this system, the human condition is characterized by physical, mental and spiritual health, and development by physiological norms of the formation and functioning of various organs and tissues that provide the age stages of development and self-realization. A.A. Ukhtomsky wrote that the essential difference between a human and an animal is a new type of interaction with the environment, it is in consciousness (awareness), mediation of social, generic knowledge "through us" (consciousness). The Law of the "Honored Interlocutor", developed by A.A. Ukhtomsky, says that "knowing yourself through another person" and, "knowing the environment through another person" is the highest path of human's creative life. [18]

An important role in the development of this issue is given to the education system which has the function of teaching the right age development, depending on the ecological, pedagogical and social conditions of living. The higher is the level of human consciousness, the higher is information and energy levels of the Universe which interact with human’s consciousness, the deeper is the understanding of universal laws and processes.

The Universe manages not only the word, geometric form, number and sound, but also a human. [21, 23]

All things considered, it allows us to regard language and speech, both from the view of physiology, psychology and from the view of the bioenergy-information interaction mechanisms of the world.

Now 21st century is characterized by intensive development of technical production (progress) and by the fall of morality, spirituality and health. Is not it too expensive? Nature is on the verge of disaster, like human society. The problem of the relationship between human, nature and society has reached a peculiar acuteness and requires not only his own awareness but also his immediate actions.

Proceeding from the synergetic paradigm of the world organization, the energy-information (spiritual) and not the social essence of a human, can allow him to evolve and ensure survival. It is necessary to recall the words of V. Sukhomlinsky: "Who can provide the spiritual path of development for mankind? Who from the government can carry out a cardinal revolution in the minds of a new generation about the priority of spiritually harmonious development over economic enrichment? Only the education system!".

So, the hope is placed on "Pedagogy" or "Philosophy of Education", which will be able to train the army of a new ideology carriers, teachers of the future.

The positive and negative impact of the human psyche on health, lifestyle and social status is determined by the stream of thinking (i.e., wave radiation) that lifts up the human either to constructive self-organization, health, happiness, success in the case of positivity or to disharmony, diseases, premature aging and death in case of negative thoughts.

The urgency of the raised issues is realized on the basis of the bioethical educational process possibilities. The high culture of verbal communication on the background of post-nonclassical paradigmatic thinking is especially important for teachers who use the word as an instrument of their profession and are a model for imitation for students.

Overcoming of pedagogical risks is a priority direction of pedagogical researches and ways of modernization of modern school education for the purpose of its humanization and health care. [6]

An extremely important role is played by the conditions of the postnatal development period. So a person lives all his life with those organs that are formed from birth to changing teeth. This period is the crucial phase in the construction of the organism, its functions, the development of consciousness, the formation of its communicative culture. Unfortunately, this fact is not given enough attention in training programs of young teachers. In addition, attention must be given not only to the defects of physical development, but must be given to the development of mental and spiritual components. If the period of the feelings and character formation (crisis of childhood) is missed, then a subtle sense of justice and injustice, beauty and ugliness, cannot be developed.

"The child is moving psychically and spiritually in the area between agreement and disagreement, love and hate, which is reflected in the flow of linguistic erosion", writes the Ph.D., Assoc. Prof. L.G. Tatarnikova. “This development reaches its culmination during puberty”. [15, 16]

The main educational means is speech (language). For a teenager it is the passage of the Rubicon of Child Development by R. Steiner. The most important thing for a teenager is the ability to understand others, to feel the creative and destructive energy of speech and profanity. In fact, in the process of cognition of oneself and the world, comes awareness of the field interactions significance of the wave energy-information framework, because the child interacts with the energy-information fields of the people who surround him (teachers, parents, classmates, friends), and also interacts with the environment that determines the area of human activity effects.

Linguistics is the science of language as a means of human communication. Depending on the aspects of language learning, it is divided into: communication, descriptive linguistics, applied linguistics, structural linguistics. Also can be distinguished such branches of linguistics as psycholinguistics, linguistic geography, mathematical linguistics.

Linguistics is one of the most developed liberal arts.

The linguistic environment is the living language of its codified system, involved in the process of interaction with society and constituting the necessary condition for its existence. In modern conditions, a person has an impact on the linguistic environment, the same as it influences on a person.

Great merit in the formation of harmonious interaction is assigned to the teaching staff. Synthesis of natural science classical knowledge with new knowledge is manifested in voice, in language culture, in the organically tuned voice apparatus of a person, in his healthy life activity in society due to his ability to think, in his speaking skills, been free from rudeness, cruelty, aggression. In such a collective, with a harmonious interaction with each other, the general aura of space also changes, and the improving function of speech and voice is manifested, i.e. the voice reflects the general psychological state of a person "here and now", it is, the thermometer of health, as speech is an indicator of its steady balance [8, 13]. Therefore, the language diagnosis is used in pedagogy, speech therapy and valeology. In fact, it is the germination of a new worldview about the wave nature of everything that exists, since sound perception and sound emission as systemic processes normally ensure the consistency and synchronization of the vital functions of the human body and the development of higher mental functions. [4]

Voice is the vibrational spiral of life. L.N. Zasorina emphasizes that in bioenergy-information exchange with the environment, voice (speech) carries out a two-dominant interaction - feedback. Voice is a pass to the next stage of improvement: from a crisis with a non-discriminated perception of the "I" and the surrounding world, to the spiritualization of the crisis of youth, the need to be determined in the sense of life. The ability to distinguish melody and tonality of speech sound, its directivity, sonority and deafness, strength and lightness, sharpness and softness, distinctness are necessary for communication, all of them are the primary tasks of

educating and educating the educational system.

Unfortunately, today the social orientation of modern education and the quality of education is far from the high demands of the era of spirituality. Spirituality is connected, first of all, with word, language, speech as a way of self-expression of a person. Correctly used direct effects on the person are numerous: exhortation, persuasion, explanation, thanksgiving, plea, condemnation, reproach, forgiveness ... They help the teacher intuitively feel what words to choose to harmonize the student's internal status.

F. Iskander writes: "Language is given to people so that they, after understanding each other, can live together." [5]

The culture of the native language, the culture of the word appears as an indissoluble connection of many generations, including its health, a healthy surrounding speech environment of existence.

For the process of education, it is important to understand that the word is also the energy of thought (after all, we think in words!).

Man must learn positive thinking and this is also the vital task of the 21st century pedagogy. [7] Analyzing the current state of health of the current generation, both junior and senior, Ph.D., Assoc. Prof. Tatarnikova believes that the reason for a significant deterioration in health is the shift in the area of the words meaning - the concepts of human speech in the direction of negative meanings, corresponding to the energy of low, dark and gross vibrations. There was a break in the sign, meaning, and tone of the word. Human plunged into a semantic illusion, which caused a disconnect between objective and spiritual forms of existence, i.e. harmoniousness of the interaction between spiritual and physical areas was violated, so it contributed to the growth of diseases, mortality. [16]

Thus, the importance of understanding and knowledge of the bioenergy-information structural organization of a person in the pedagogical process is necessary:

- in the process of knowledge transfer / perception;
- In the process of intonation, goodwill;
- in the process of psychoemotional sphere forming;
- in the process of forming spirituality, i.e. health or anti-spirituality that means disease.

Nervous system of human functions as a complex system of rhythms that have a hierarchical character.

The reflection of reality in the human body is carried out at different levels:

- on the abstract-associative (with the help of sign systems);
- on the sensual;
- on the sensually instrumental (instrumental);
- on the sensually associative (taking into account past experience).

Voice determines the behavior of a person, his reactions to the development and self-development of a person. Voice is a sound wave that is perceived by the organs:

1) Hearing is for determining the musical tone;
2) Sound reproduction is with the help of voice, feeling and thought;
3) Voice ligaments.

In this process, the following are involved:

- energy system of breathing;
- larynx with vocal cords;
- sound-conducting and articulatory systems.

Function is the formation of emotional and sensual tint.

Ear is the main conductor to the heart and mind, it ensures the perception of motives, senses, feelings and beauty of speech. [16, 17]

Numerous scientific studies have revealed the effect of speech disorders, pronunciation on the quality of education and the state of children's health. So, for example, according to medical workers, the reproduction of neuroses is due to the lack of receptivity of information (speech) from the right hemisphere. Such disharmony produces a feeling of fear, anxiety, anger, guilt.

Language is the foundation of the nation. Language is the main means of spiritual development of human society. Language is the main channel of communication with the noosphere. In addition, all these statements fit into the modern concept of the wave nature of language.

According to the current worldview, the presented scientific material should become a component of the linguistic competence of the teacher which consists of the language feeling, the culture of speech, the knowledge of the features of interaction, the possession of valeo-ecological and pedagogical knowledge. [1, 8]

Unfortunately, now, a person is at the center of economical, political, social, and national contradictions, increasingly feels as if it is a subject of various manipulations and, increasingly, not a higher value. This process begins in the school with an authoritarian system of teaching.

The main trends of globalization processes, the calculations of scientists, political scientists, economists agree that only education can become a guarantor of the preservation and development of human civilization. From what kind of education will be, such will be the future of mankind.

Education and upbringing, as the main components of the education process, are mutually enriching and mutually influencing processes in pedagogical activity, in which a special role is assigned to motivation, that is correlated with the information interaction of people who control their emotions. Teaching profession on the frequency of neurotic, psychosomatic disorders and other diseases can be attributed to the risk group.

From the valeological point of view, pedagogical risks are considered as the price of education and means of communication.

The price of education is considered as an indicator of the state of health on which the future of any state (of Ukraine) depends.

Communication means are tested according to the level of the linguistic culture of the teacher and the level of his worldview and worldview.

Valeological safety is defined as:

- qualimetric category;
- an axiological reference point;
- the criterion of the quality (degree) of energy and information security of environmental conditions, including the assessment of the individual components impact of the pedagogical process safety: the quality criterion of the safety culture of pedagogical work, the safety of professional activities of a specialist.

The state of valeological safety depends on the person's adaptation to the educational environment, on the level of safety of the education conditions, providing security, protection from violence, threats, damage to health and well-being of the individual.

Specialists in the sphere of any kind of education as a scientific basis for a safety culture must be the bearers of valeological and pedagogical competence. [3, 9]

From the philosophical point of view (A. Schweitzer, Democritus), the basis of interaction should be based on love, gentleness, kindness. The followers of Pythagoras (Aristotle and Socrates) emphasized caution, restraint, and suggestion in mild terms (the main characteristics of effective pedagogical interaction). The teacher's duty is to sympathize with the students and treat them like their own children. In addition, the teacher must take care of the well-being of the students with the same degree of involvement as the father or mother takes care of their children. The teacher must always remember their weaknesses, but, as parents, be able to love them [13, 18].

However, unfortunately, we can not always say that the teacher fulfills this function. For example, we can observe this at the level of care and attention, but there is the most important function - the education and development of children, and here the teacher does not care about the child's health, because the learning process and methodology are not aimed at a specific child, but an average.

The interaction of the teacher and students without violence and coercion was given great importance by M. Montaigne, F. Frobel, such the remarkable teachers as N.I. Novikov, V.V. Izmailov, L.N. Tolstoy, S.T. Shatsky, V. Sukhomlinsky.

The same problem was paid much attention by K.D. Ushinsky. He stressed the decisive role of the teacher's personality in pedagogical interaction: "Only a person can influence on the development and definition of personality, only character can form character" [19].

V.A. Sukhomlinsky warned about the use of the teacher by the authorities, he considered such manifestations "to devastate the child's soul, engender distrust, even human hatred for man".

In the process of interaction, the teacher should be able to create such psychological comfort when, according to V.A. Sukhomlinsky, one sees in the person in 10, in 100 times more merits than demerits. For effective interaction, the teacher should strive to help the pupil in every possible way, to create better ideas about himself, to teach the child "self-knowledge of himself, which will allow him to understand better the nature, the laws of its development that affect human development."

In addition to upbringing and education, the purpose of the pedagogical system is determined by the requirements related to the health of schoolchildren as set forth in the Convention on the Rights of the Child.

In this regard, one of the main tasks of teachers is to create conditions for mastering knowledge and preserving,

and better strengthening, the physical and moral health of children. Therefore, "the health and emotional state of children pedagogical riskology refers to the priority areas of pedagogical systems actions.

The fact that the school thoroughly undermines the health of children, they knew already in the past centuries and beat the alarm activists and teachers. For example, as early as 1805, the great educator-educator G. Pestalozzi informed the world that, with traditional book forms of learning, there was a kind of "suffocation" of children's development, "killing" their health. Moreover, this discovery was made in an era when parents were healthy, gave birth to healthy children, when people ate clean food, drank absolutely pure water, breathed clean air.

Also N.I. Pirogov, a doctor, a teacher and a public figure, argued that upbringing should be given more vital importance than education. The modern school shifted the emphasis, expanding the educational field to the detriment of education and health, thereby creating conditions that not only destroy health, but also form vices [8, 12].

Our school today has become a school of disease. The most frequent diseases among schoolchildren are: school shortsightedness - in 55%, violation of posture, flat feet - in 62.4%. About 45% of teenagers have mental disabilities. According to official data, in the last 5 years, the number of musculoskeletal system diseases increased by 69.3%, circulatory system by 58.8%, endocrine system by 52.8%, genitourinary system by 42.7%, neoplasms ~ by 34.8%, congenital anomalies - by 31.6%. According to several studies, almost every high school graduate has at least one chronic illness. Only 14.4% are children who are mentally healthy, i.e. they do not have significant, moderate or functional mental abnormalities. Unfortunately, the health of children is seriously affected not only by biological factors, but also by social, cultural and purely pedagogical mechanisms, which makes any educational institution a "risk field" for many children.

The health problems of children and adolescents today need close attention not only from health workers, but also teachers, parents, the public. A special place and responsibility in this healing process is assigned to the educational system, which can and should make the educational process health-saving.

The stressful nature of the teacher's professional activity can not but affect the nature of pedagogical interaction, which in turn is manifested in the devastating consequences for the intellectual, psycho-emotional, physical development and spiritual well-being of children.

Studies of the Institute of Age Physiology RAE ranked school risk factors that adversely affect the health of children:

- stress pedagogical tactics;
- intensive educational process;
- inconsistenct between methods and technologies of teaching and the age and functional abilities of schoolchildren.

Modern pedagogical methods are mainly focused on left hemisphere perception. At the same time, the right hemisphere pupils find themselves in an impossible position, since they need a gentalt, a musical background, creative tasks [4, 10].

In the general educational context, the following conditions may violate:

- premature start of preschool system training;
- non-observance of elementary physiological and hygienic requirements to the organization of the educational process;
- functional illiteracy of the teacher in matters of health protection and promotion;
- mass illiteracy of parents in the issues of preserving and strengthening the health of children;
- partial destruction of school health monitoring services;
- shortcomings in the system of physical education;
- lack of a system that works on the formation values of health and a healthy lifestyle;
- any type of the nervous system is not taken into account, the specificity of sex, the organization of the cognitive processes of the child.

## Basic forms and methods of valeological support of the pedagogical system

A system of education that has a valeological basis is a that one, in which at each stage of maturation of the individual, the realization of its basic needs is provided, in this case the person most fully develops his abilities, knows his own uniqueness, resolutely self-determined in life, and in the process of self-actualization with him

involuntarily formed the main components of health, including linguo-ecological problems.

The organization of an educational process grounded on pedagogic now requires the following:

1) the creation of normal sanitary and hygienic conditions (air regime, sanitary condition class, lighting, etc.);

2) using health protection methods and training technologies;

3) conducting various forms of training sessions (lesson-play, lesson-hike, lesson-travel, etc.);

4) creating a positive emotional attitude to the lesson and internal motivation for learning activities;

5) creating nice psychological climate during the lesson (style, tone of communication, pedagogical tact, success situation, culture of speech, etc.);

6) making the level of complexity, difficulty, intensity of the lesson suitable for the level of children;

7) the ability of the teacher to assess the state of mental work performance of students during the lesson;

8) sufficient motor activity of the pupils during the lesson;

10) using training tools according to hygiene requirements.

It is known that one of the conditions for maintaining, restoring the child's health potential, is the success of his activity. The main activity of children in school is teaching. It is the success in teaching that contributes to the well-being of the child in school, and this is achieved through the creation for each opportunity to develop according to their individual characteristics. So, before the school is the task of searching for technologies, forms and methods that allow individualization of instruction taking into account modalities and holistic thinking.

In the structure of the lesson, physical exercise should be provided, the time interval for the removal of static tension, auto-training, relaxation. Students can freely move around the class, choose a workplace.

The formation of humane interpersonal relations between the teacher and the students is based on an atmosphere of cooperation, mutual understanding, mutual respect, and the use of jokes is welcomed. The priority subject in the lesson system is the student, for whom the individual selection of tasks provides a situation of success and positive emotions.

Based on valeology educational process requires the consideration of individual characteristics during the lesson (temperament, memory, attention, thinking, ability, health, etc.); reflexion as a form of control and assessment of students' knowledge in the lesson, changes in character, and the amount of homework.

The main requirement is the synchronization of educational programs, interdisciplinary integration of the content of education and the therapeutic and health-improving effect as a special organizational component and valeological control (audit). Realization of these cognitive tasks is carried out on the basis of the innovative organization of the educational process as a form of occupying a continuous system, which requires the structuring of the learning environment based on the valeological dominant. Features of the dominant organization include culturological, cognitive, information programs. The main activity of children in school is teaching. It is the success in teaching that contributes to the well-being of the child in school, which is achieved through the creation of the opportunity to develop according to their individual characteristics.

In this regard, before the school is the task of finding technologies, forms and methods that allow individualization of training.

In conclusion, we should dwell on the synchronized educational process, which allows to develop the potential of spiritual and physical health of children in the conditions of the modern school. [16, 22]

The implementation of this process depends on many conditions:

• First of all, the contradictions between the content of modern pedagogical techniques, technologies and the principle of naturalness were revealed.

• The main thing is the lack of special ecological and valeological knowledge of teachers, their inability to distinguish the valeological dominant in the teaching and upbringing process, as well as ignoring the results of scientific research in the field of neurophysiology about the occurrence of pedagogical risks in the language culture of the educational process.

• Bioethical opportunities of modern education based on the principles of: naturalness, cooperation, integration of linguistic competence, holistic process are grounded.

• On the basis of studying the psychophysiological characteristics of students, special algorithms of the educational process (integrated and binary lessons, the day of integrative immersion) that reduce pedagogical risks are developed.

• The possibility of changing the educational process on the basis of the ecological-valeological methodology is proved.

The results of the research showed that the teacher through the word, sound, speech realizes the way of thinking, the philosophy of the world, the philosophy of sensations. Dialogue between teacher and student is a

premise for socialization. Only through the continuous improvement of professional skills and the formation of a worldview in the valo-ecological direction can the teacher change his strategy of interaction with students, translating it into a valeo-pedagogical one.

Studies have shown that there are theoretical and practical opportunities to overcome pedagogical risks, but this requires new pedagogical technologies, valeological worldview, diagnostics based on the bioethical capabilities of modern education.

Change in the worldview at this stage of development with the help of declarations and propaganda is impossible.

Only the education of children from an early age new world outlook will allow an adult to become an aware and intelligent being.

The first step in developing a new understanding of the world, without which it is impossible to move, should be changes in the system of upbringing and education of children. It is preferably that such organizations as the United Nations, WHO, UNESCO, UNICEF and others join it. [11, 14, 23]

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# EEG rhythm correlates in the examination of state of inner prayer

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"Death and Life are in mercy of Language"
Holy Scripture

**Abstract**. This paper represents an exploration of untrained female person's EEG rhythms, during internal prayer "Oče naš" (internal speech) and during resting state, through assessment of subgroups of theta and beta EEG brain rhythms, which occur through constant and occasional activation of brain regions.
Recording of EEG rhythms was conducted on Nihon Kohden Corporation, EEG – 1200K Neurofax device, within monopolar longitudinal montage in a system of 10/20 electrodes in terms to determine peak frequency values of each explored location.
Results have shown that, during prayer, elements of both knowledge and beliefs are present, and that this appearance is plausible when we take into consideration insufficiently specified circumstances which followed the experiment and the subject itself, in terms of relative youngness and insufficient training for the prayer's depth. Types of region connections in relation to interhemispheric differences, as well as in relation to state of a prayer and resting state are discussed in the study. In comparison to findings in the literature and our previous findings, parts of the findings imply regions for "knowledge" and regions for "belief".
*Key words*: EEG, beta, cartographical regions, processing, internal speech, 69 Hz sound

## Introduction

From psychological point of view, when repeated daily, prayer develops attention and concentration capacities which conditions the arrangement of one's thoughts and feelings. From spiritual aspect, prayer is definite numerical and auditive code-signal for contact, which every person has to find and feel alone. Our words and toughts are capable to turn torsion fields into positive direction and in that way, informational field of prayer has an impact. Believers believe that, with appropriate prayer, they can connect with God directly.

Relation between prayer and heeling, changes in brain functioning during prayer by EEG research, influence of prayer on plants, structure of water etc. are being examined for a long period of years. Some research showed that the believing in one's prayer can stimulate healing of operational wounds, and that relaxational reaction during prayer gives feeling of self confidence and can improve imunological system. Numerous theories of operant mechanisms about apparent healings that are results of prayer are given by researchers. In spite of numerous explanations of mechanisms through which prayer leads to healing, aspect of prayer and healing still manages to slip away from rational explanation, and seems to implicate the existence of greater power (Hughes, 1997). Results on greater number of studies point out to the role of interpersonal faith in the efficiency of prayer and in accordance with that, recommend that this factor becomes subject of further investigations (Palmer, Katerndahl & Morgan-Kidd, 2004). Neuroimaging technologies development gives possibility of receiving more precise images of brain working during different tasks, including prayer, but researchers are getting different results because of the different methodological procedures, aims, and thus controlling factors etc. However, most of researchers indicate the necessity of research on religious experiences, in order to form precise protocols and to ease and equalize the findings interpretations (Ladd, Cook, Foreman & Ritter 2015).

Academic, P. Garjajev and his colleagues, realized a study of prayer influence on plants. Curses were spoken to plants. Results on the influence shocked researchers. Verbal treatment was similar to radiation of 40.000 X-rays, DNK chains and chromosomes were torn, genes were disperse and mixed. Most of the seeds died, and those who survived showed signs of monstrous mutation. Results did not depend on loudness

(whispering, shouting) and spoken words-in any case, destructive effect was the same. It wasn't the force of the sound which caused it, yet the meaning of what was spoken, namely, those torsion fields which showed when curses were spoken. According to the author, these results can be applied to animals and persons too.

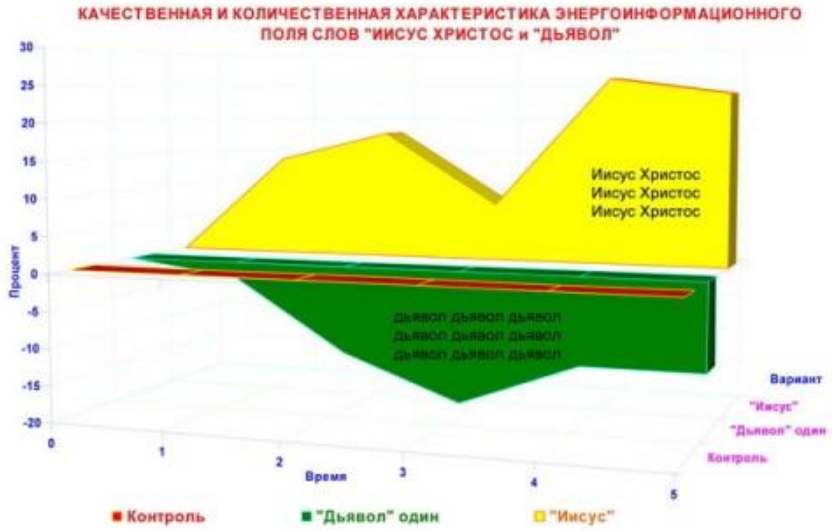



**Figure 1.** Qualitative and quantitative characteristics of energetic-informational field of words „Jesus Christ" and „Devil" (Picture was taken from site http://tainadiveevo.ru/)

Recently, researchers came to unexpected discovery-that the DNK molecule doesn't consist only from genes responsible for face shape: ear, eye colour etc., yet mostly from coded texts which take 95-99% of total chromosome content, and only 1 to 5% are notorious genes which syntethyse proteins. Most of the informations in chromosoms are still unknown. Garjajev claims that, with our words and thought, we set up informational programe into our cells, influencing them with positive or negative torsion fields. He printed out the text of prayer „Oče naš" in slovenian alphabet on laser printer and scaned it with biological laser. Received informations were transformed into picture and sound. Prayer danced with all of the rainbow colours, with a fantastic melody (Fig. 2).

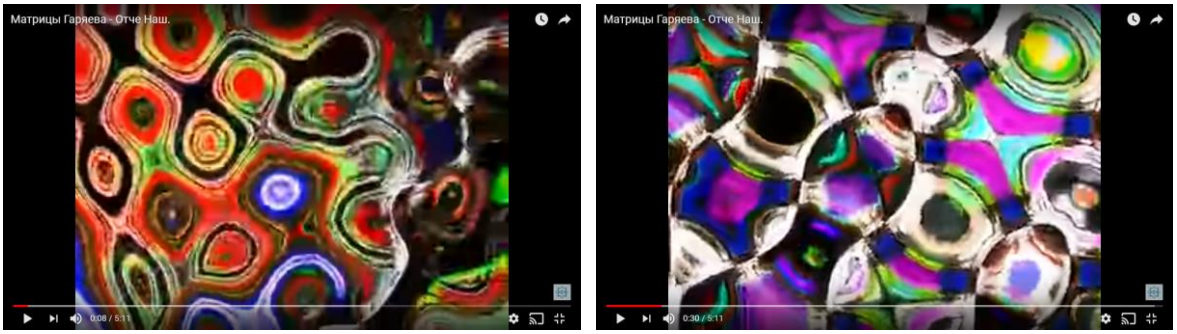



Figure 2. Representation of two fractals of „Oče naš" prayer's text, organized with Garjajev and Govorov method

A study (Slezin et al., 2013) showed that, during prayer, high frequency part of EEG spectre drops and it comes to domination of low frequency components of EEG without the increasement of apsolut level of their spectral power. At the same time, level of consciusness within subjects during prayer is normal (examination is conducted on monks) and it corresponds to a special psychophysiological state which is determined with activity of diencephalic level-emotional brain system. State of consciousness during prayer researchers consider as a manifestation of fourth physiological normal functioning state of brain which is not described yet, which authors note as "slow alertness". Three states of consciousness are known so far: alertness, slow and fast sleeping, which are differing one from another by nature of electrical impulses in cortex, and prayer is fourth state of electrical activity's full exclusion of brain cortex in full preserved consciousness.

Still, all prayer and meditative activities research that are available in literature so far, used various approaches, and didn't even manage to form a specific classification, and only touched the relation which we wanted to consider in this paper. That is, whether can we get clearer knowledge about differences between

prayer and resting state by examining EEG brain rhythm behaviors, and at which degree is present belief and in which degree is present knowledge in a state of inter prayer (Sovilj, Radičević & Jeličić, 2017)?

Basic form of comparison of brain regions interconnection activation through mutual frequency, in theta and bêta subgroups was chosen from our practical work conclusions, to prove lines of connections of brain regions in terms of knowledge, and in working with healthy individuals as well as patients with communication disorders and problems of subconsciousness and consciousness relationship related to behaviour disorders. Besides that, so far in silent speech (internal speech) literature, the role and meaning of connecting the auditory regions with rest of regions for estimation of knowledge versus belief was not pointed out. Bihemispheric connecting of regions into complex of knowledge and complex of beliefs did not cover emotional regions for input nor for emotional attitude. There is no clear illumination nor engagement of time and space engrams in research of this type. Maybe it is necessary to consider most basic beta activity behavior in relation to thetas, and via their subgroups which imply certain psychophysiological effect, which is not shown in newer literature.

## Aim

Aim of our paper is to determine the differences between resting state and prayer and to delimit belief and knowledge in internal prayer experience, by observing subgroups of theta and beta EEG brain rhythms which appear through constant and occasional activation of brain regions, in untrained person.

## Methodology

Young, healthy and mature female person, aged 22, highly educated, with academic diploma in Serbian mother language during internal „Oče naš“ prayer (silent speech) in a period of 3 minutes was examined. Examination was conducted during morning period, in comfortable conditions and sitting position. Quantitative EEG profile was measured with Nihon Kohden Corporation, EEG – 1200K Neurofax apparatus, with fixed cap with Ag/Ag Cl round electrodes filled with electro-conductive gel, which provides 19 EEG channels. Electrodes were placed according to 10/20 International system of electrode placement. Referent electrodes would be on A1 and A2 (lobulus of the earlobe) with the possibility of additional change of reference montage. The impedance would be kept below 5 kΩ, with not more than 1 kΩ difference between electrodes. The high-pass filter was set at 0.53 Hz, and the low-pass filter at 35 Hz. Before the examination, a standard EEG trace recording was made, in order to exclude EEG abnormalities in terms of wave morphology characteristics or frequency, respectively amplitude asymmetry.

According to the research goal, material for processing was obtained from the analysis of peak frequencies (peak frequencies in spectrum analysis table) expressed in the hertz (Hz) unit for the theta and beta rhythms. A total of 19 electrodes in monopolar and longitudinal montage were used: 8 electrodes on left (Fp1, F7, F3, C3, P3, T3, T5, O1), and corresponding right (Fp2, F8, F4, C4, P4, T4, T6, O2) cortical regions, with three midline (vertex) regions (Fz, Cz, Pz), and with one referent electrode on the corresponding ear of each side.

The 10 seconds samples without artifacts were taken from the beginning, middle, and end of the recording for RESTING STATE and PRAYER situations (lasting three minutes, respectively). For further analysis, the sample of 3 seconds, for both rhythms was takend from each sample of 10 seconds. Finally, within the period of 3 seconds, a window of 2 seconds was moving from the beginning till end of the period with 200-ms time lag. This resulted in six subsamples for each electrode and for each experimental situation (resting state, situation of prayer). In this way, the frequency of networking in the required closeness of each of the 19 regions within the subgroup of theta and beta in a constant and unstable relationship was obtained.

## Results

**Table 1.** Constant activity of engaged regions during resting state and prayer

| CONSTANT ACTIVITY OF SIGNIFICANTLY ENGAGED REGIONS DURING RESTING STATE AND PRAYER | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Left regions | | | | | | | | | Right regions | | | | | | | | | Medial regions | | | | |
| | Frequency subgroups | Fp 1 | F3 | F7 | C 3 | T3 | P3 | T5 | O1 | Σ | Fp 2 | F4 | F8 | C 4 | T4 | P4 | T6 | O 2 | Σ | Fz | Cz | Pz | Σ | L+ D |
| PRAYER | 4-6Hz | 18 | 18 | 16 | 18 | 17 | 18 | 18 | 18 | 142 | 17 | 18 | 16 | 18 | 18 | 16 | 17 | 18 | 139 | 18 | 17 | 16 | 51 | 281 |
| | 6-8Hz | 17 | 16 | 17 | 16 | 18 | 16 | 18 | 16 | 136 | 18 | 18 | 18 | 18 | 17 | 16 | 16 | 17 | 139 | 18 | 17 | 16 | 51 | 275 |
| | 13-15Hz | 18 | 16 | 16 | 18 | 16 | 18 | 14 | 18 | 134 | 18 | 15 | 17 | 17 | 18 | 16 | 15 | 18 | 134 | 18 | 18 | 17 | 54 | 268 |
| | 15-20 Hz | 16 | 15 | 16 | 16 | 16 | 16 | 17 | 15 | 124 | 17 | 15 | 16 | 16 | 18 | 17 | 15 | 15 | 129 | 18 | 16 | 15 | 49 | 253 |
| | 20-24 Hz | 0 | 0 | 0 | 15 | 17 | 18 | 0 | 17 | 67 | 0 | 16 | 17 | 17 | 18 | 17 | 0 | 17 | 102 | 0 | 18 | 16 | 34 | 169 |
| | 24-36Hz | 0 | 16 | 0 | 15 | 0 | 18 | 16 | 0 | 65 | 0 | 14 | 0 | 0 | 14 | 14 | 0 | 0 | 42 | 0 | 0 | 0 | 0 | 107 |
| | Total | 61 | 63 | 48 | 98 | 89 | 100 | 83 | 84 | 668 | 70 | 86 | 84 | 87 | 104 | 96 | 63 | 85 | 685 | 72 | 73 | 80 | 230 | 1358 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| RESTING | 4-6Hz | 17 | 18 | 18 | 18 | 17 | 18 | 18 | 18 | 143 | 18 | 17 | 17 | 17 | 17 | 18 | 17 | 17 | 139 | 18 | 18 | 17 | 51 | 282 |
| | 6-8Hz | 0 | 18 | 18 | 18 | 14 | 18 | 16 | 16 | 120 | 17 | 16 | 17 | 15 | 17 | 17 | 15 | 16 | 131 | 18 | 17 | 18 | 53 | 251 |
| | 13-15Hz | 18 | 13 | 18 | 16 | 16 | 17 | 15 | 0 | 113 | 16 | 13 | 17 | 17 | 18 | 0 | 14 | 15 | 108 | 15 | 15 | 15 | 46 | 221 |
| | 15-20 Hz | 0 | 18 | 12 | 0 | 0 | 0 | 15 | 0 | 45 | 13 | 13 | 0 | 16 | 0 | 16 | 15 | 0 | 73 | 18 | 16 | 14 | 48 | 118 |
| | 20-24 Hz | 15 | 15 | 17 | 0 | 0 | 14 | 16 | 0 | 77 | 0 | 14 | 15 | 0 | 16 | 15 | 15 | 17 | 92 | 16 | 15 | 15 | 46 | 169 |
| | 24-36Hz | 0 | 0 | 0 | 0 | 15 | 0 | 0 | 0 | 15 | 14 | 15 | 0 | 17 | 0 | 0 | 14 | 0 | 60 | 16 | 14 | 0 | 30 | 75 |
| | Total | 51 | 82 | 83 | 54 | 62 | 69 | 80 | 34 | 513 | 78 | 88 | 66 | 83 | 67 | 66 | 90 | 65 | 603 | 101 | 96 | 79 | 274 | 1116 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| DIFFERENCE | 4-6Hz | +1 | 0 | -2 | 0 | 0 | 0 | 0 | 0 | -1 | -1 | +1 | -1 | +1 | +1 | -2 | 0 | +1 | 0 | 0 | -1 | -1 | -2 | -1 |
| | 6-8Hz | +17 | -2 | -1 | -2 | +4 | -2 | +2 | 0 | +16 | +1 | -1 | 0 | +3 | 0 | -1 | +1 | +1 | +4 | 0 | 0 | -2 | -2 | +18 |
| | 13-15Hz | 0 | +3 | -2 | +2 | 0 | +1 | -1 | +15 | +21 | +2 | +2 | 0 | 0 | +2 | +17 | +1 | +3 | +27 | +3 | +3 | +2 | +8 | +56 |
| | 15-20 Hz | +16 | -3 | +4 | +16 | +16 | +16 | +2 | +15 | +86 | +4 | +2 | +16 | 0 | +18 | +1 | 0 | +15 | +56 | 0 | 0 | +1 | +1 | +143 |
| | 20-24 Hz | -15 | -15 | -17 | +15 | -17 | +4 | -16 | +17 | -10 | 0 | +2 | +2 | +17 | +2 | +2 | -15 | 0 | +10 | -16 | +3 | +1 | -12 | -12 |
| | 24-36Hz | 0 | +16 | 0 | +15 | -15 | +18 | +16 | 0 | +50 | -14 | 0 | 0 | -17 | +14 | +14 | -14 | 0 | -17 | -16 | -14 | 0 | -30 | +33 |
| | Total | +19 | -1 | -18 | +44 | +22 | +37 | +3 | +50 | +162 | -8 | +6 | +17 | +4 | +3 | +3 | -27 | +20 | +80 | -29 | -9 | +1 | -33 | +207 |

Table 1 shows constant engaged networked regions by theta and beta subgroups in situations of prayer and resting state in relation to the left and right hemisphere, medial regions, total as well as the difference in favour of prayer (+), respectively resting state (-). Appearance of differences between these two situations is noticeable, and it grows with the increase of EEG signal frequency. Brain regions engagement prevails significantly during prayer.

Table 2. Occasional activity in theta and beta subgroups during prayer and resting state

| OCCASIONAL ACTIVITY OF SIGNIFICANTLY ENGAGED REGIONS DURING RESTING STATE AND PRAYER | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Left regions | | | | | | | | | Right regions | | | | | | | | | Medial regions | | | | |
| | Frequency subgroups | Fp 1 | F 3 | F 7 | C 3 | T 3 | P 3 | T 5 | O 1 | Σ | Fp 2 | F 4 | F 8 | C 4 | T 4 | P 4 | T 6 | O 2 | Σ | Fz | C z | P z | Σ | Left + right regions |
| PRAYER | 4-6Hz | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 6-8Hz | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 13-15Hz | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 15-20 Hz | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 20-24 Hz | 11 | 14 | 0 | 14 | 12 | 0 | 13 | 0 | 74 | 12 | 0 | 0 | 0 | 0 | 0 | 13 | 0 | 25 | 10 | 0 | 0 | 10 | 99 |
| | 24-36Hz | 8 | 0 | 9 | 0 | 6 | 0 | 0 | 16 | 39 | 9 | 0 | 11 | 13 | 0 | 0 | 9 | 10 | 52 | 15 | 11 | 12 | 38 | 91 |
| | Total | 19 | 14 | 9 | 14 | 18 | 0 | 13 | 16 | 113 | 21 | 0 | 11 | 13 | 0 | 0 | 22 | 10 | 77 | 25 | 11 | 12 | 48 | 190 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| RESTING | 4-6Hz | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 6-8Hz | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 |
| | 13-15Hz | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 14 | 14 | 0 | 0 | 0 | 0 | 0 | 14 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 28 |
| | 15-20 Hz | 11 | 0 | 0 | 12 | 7 | 11 | 0 | 9 | 48 | 0 | 0 | 10 | 0 | 12 | 0 | 11 | 13 | 46 | 0 | 0 | 0 | 0 | 94 |
| | 20-24 Hz | 0 | 0 | 0 | 14 | 12 | 0 | 0 | 13 | 39 | 13 | 0 | 0 | 14 | 0 | 0 | 0 | 0 | 27 | 0 | 0 | 0 | 0 | 66 |
| | 24-36Hz | 8 | 13 | 11 | 12 | 0 | 11 | 5 | 7 | 67 | 0 | 0 | 13 | 0 | 11 | 14 | 0 | 9 | 47 | 0 | 0 | 9 | 9 | 114 |
| | Total | 33 | 13 | 11 | 38 | 19 | 22 | 5 | 43 | 182 | 13 | 0 | 23 | 14 | 23 | 25 | 11 | 22 | 134 | 0 | 0 | 9 | 9 | 316 |
| | | | | | | | | | | | | | | | | | | | | | | | | |
| DIFFERENCE | 4-6Hz | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| | 6-8Hz | -14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -14 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -14 |
| | 13-15Hz | 0 | 0 | 0 | 0 | 0 | 0 | 0 | -14 | -14 | 0 | 0 | 0 | 0 | 0 | -14 | 0 | 0 | -14 | 0 | 0 | 0 | 0 | -28 |
| | 15-20 Hz | -11 | 0 | 0 | -12 | -12 | -11 | 0 | -9 | -61 | 0 | 0 | -10 | 0 | -12 | 0 | -11 | -13 | -48 | 0 | 0 | 0 | 0 | -109 |
| | 20-24 Hz | +11 | +14 | +10 | 0 | 0 | 0 | +13 | 0 | +48 | -1 | 0 | 0 | -14 | 0 | 0 | +13 | 0 | -2 | +10 | 0 | 0 | +10 | +46 |
| | 24-36Hz | 0 | -13 | -2 | -12 | +6 | -11 | -5 | +9 | -30 | +9 | 0 | -2 | +13 | -11 | -14 | +9 | +1 | +5 | +15 | +11 | +3 | +29 | -21 |
| | Total | -14 | +1 | +8 | -24 | -6 | -22 | +8 | -14 | -43 | +8 | 0 | -12 | -11 | -33 | -28 | +11 | -12 | -71 | +25 | +11 | +3 | +39 | -75 |

Data shown in Table 2 indicate on significantly larger frequency of left hemisphere regions in both situations and significant prevailing of engagement during resting state situation.

**Table 3**. Differences in number of brain regions activations between situations of resting state and prayer

| CONSTANT ACTIVITY | | |
|---|---|---|
| Rhythm subgroups | Situations | |
| | PRAYER | RESTING STATE |
| Theta 4-6 HZ | 0 | 0 |
| Theta 6-8 Hz | Fp1, T3 | 0 |
| Beta 13-15 Hz | F3, O1, P4, O2 | 0 |
| Beta 15-20 Hz | Fp1, C3, T3, P3, O1, F7, F8, T4, O2 | 0 |
| Beta 20-24Hz | C3, T3, P3, O1, C4, O2 | Fp1, F3, F7, T5, T6, Fz |
| Beta 24-36HZ | F3, C3, P3, T5, O1, T4, P4, O2 | T3, Fp2, C4, T6 |
| | | |
| OCCASIONAL ACTIVITY | | |
| Theta 4-6 HZ | 0 | 0 |
| Theta 6-8 Hz | 0 | Fp1 |
| Beta 13-15 Hz | 0 | O1, P4 |
| Beta 15-20 Hz | 0 | Fp1, C3, T3, P3, O1, F8, T4, T6, O2 |
| Beta 20-24Hz | Fp1, F3, T5, T6, Fz | O1, C4 |
| Beta 24-36HZ | T3, O1, Fp2, C4, T6 | F3, C3, P3, T5, T4, P4, O2, Fz, Cz |

Our examination indicates the pronounced existence of an event occurring in an asymmetric left-sided activity in the PRAYER situation in the form of continuity, as opposed to the RESTING STATE situation in which, if an event exists, it occurs discontinuously with a significantly lower advantage of the left hemisphere.

Significantly larger number of regions engaged in PRAYER (connected in left hemisphere) we consider as a contribution to the examination of events in general. This paper showed that the advantage of networking. The advantage of networking of regions in such an event within shallow consciousness implied by 6–8 Hz theta of connected left auditory regions and those for attention, and speech language communication, as well as the plan of interpretation of the experience (happening), although within shallow subconsciousness, is associated with the light deviation from reality, which was insufficiently covered in literature (Travis et al., 2004). This, as well as the advantage of beta networking in favour of PRAYER, can indicate on a form of belief, especially because significantly larger engagement of regions in left hemisphere is expressed in PRAYER, in relation to the RESTING STATE situation. There are more symmetrical regions, namely higher level of synchronization of left and right hemisphere, in PRAYER situation in relation to RESTING STATE situation.

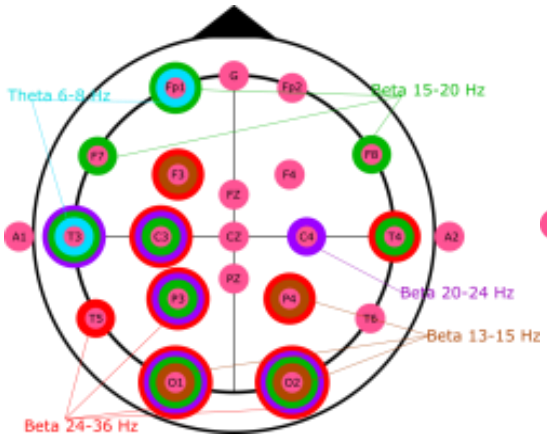



**Fig 3.** Number of regions activated during Prayer-Constant

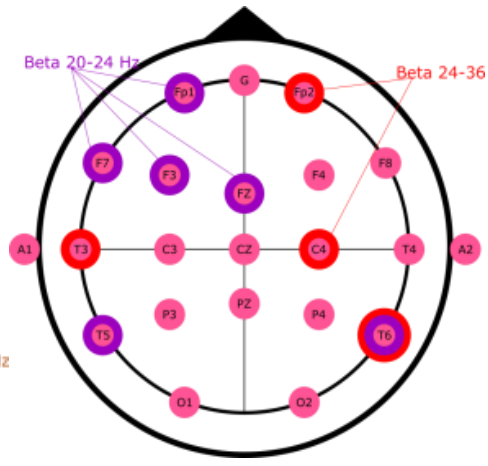



**Fig 4.** Number of regions activated during Resting State-Constant

;

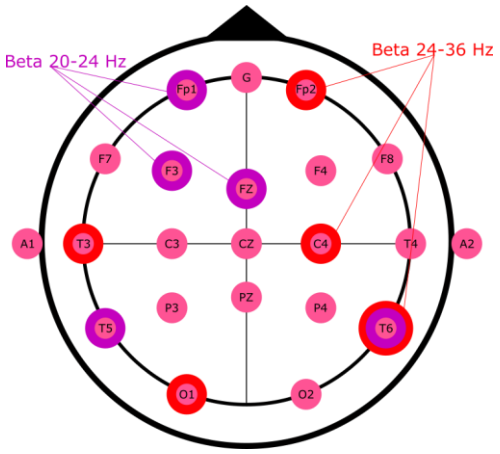



**Fig 5.** Number of regions activated during Prayer-occasional

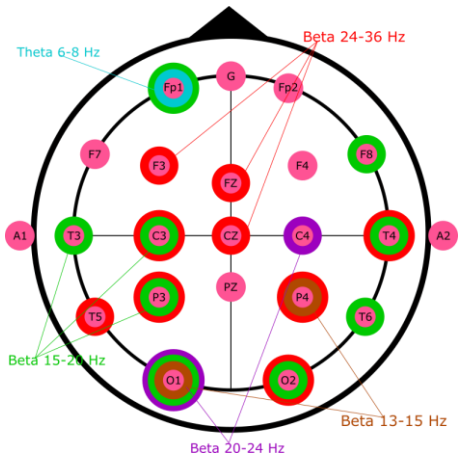
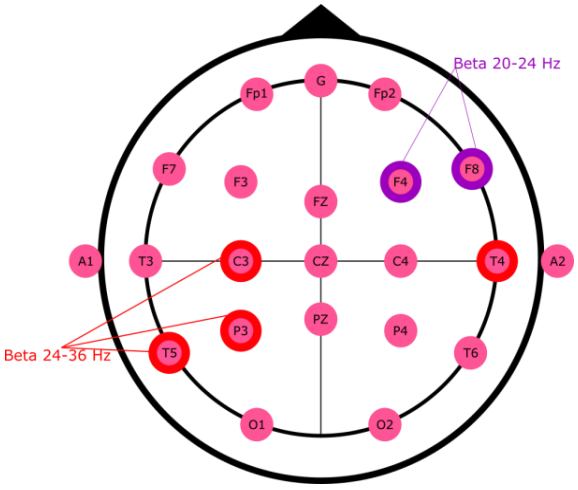


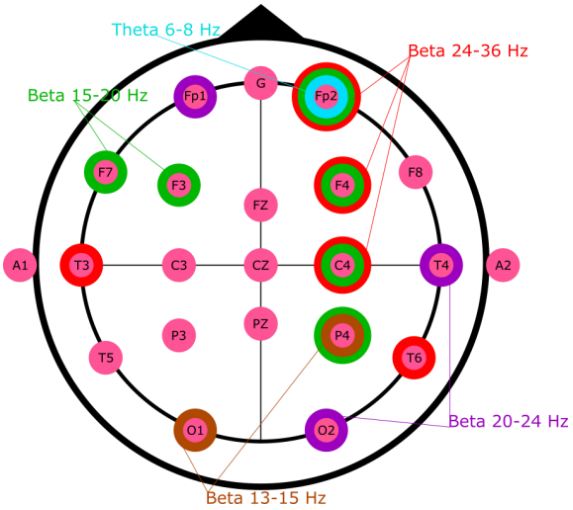

**Fig 6.** Number of regions activated during Resting state-occasional

**Table 4.** Difference between hemispheres in connecting brain region frequencies during prayer and resting state

| **CONSTANT ACTIVITY** | | |
|---|---|---|
| Rhythm subgroups | Situations | |
| | Prayer | Resting state |
| Theta 4-6 HZ | 0 | 0 |
| Theta 6-8 Hz | 0 | Fp2 |
| Beta 13-15 Hz | 0 | O1, P4 |
| Beta 15-20 Hz | 0 | F3, F7, Fp2, F4, C4, P4 |
| Beta 20-24Hz | F4, F8 | Fp1, T4, O2 |
| Beta 24-36HZ | C3, P3, T5, T4 | T3, Fp2, F4, C4, T6 |
| | | |
| **OCCASIONAL ACTIVITY** | | |
| Theta 4-6 HZ | 0 | 0 |
| Theta 6-8 Hz | 0 | Fp1 |
| Beta 13-15 Hz | 0 | O1, P4 |
| Beta 15-20 Hz | 0 | Fp1, F8, T4, P3, T6, O2 |
| Beta 20-24Hz | F3, C3, T3 | Fp2, T3, O1 |
| Beta 24-36HZ | O1, C4, T6 | Fp1, F3, C3, T4, T5 |

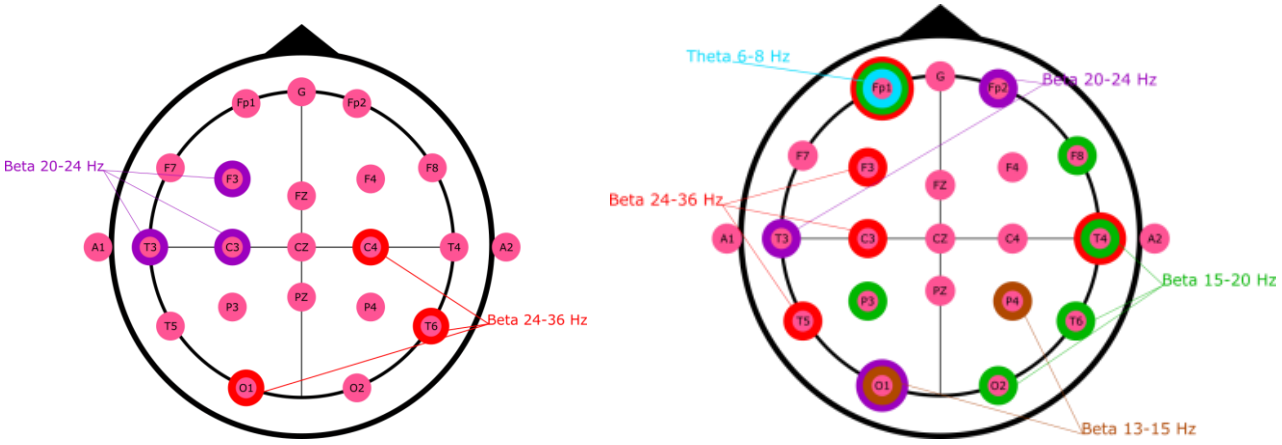



During PRAYER-constant activity




During RESTING STATE-constant activity

**Fig. 7.** Difference between hemispheres in connecting brain regions frequency-constant activity




During PRAYER-occasional activity

During RESTING STATE-occasional activity

**Fig. 8**. Difference between hemispheres in connecting brain regions frequency-occasional activity

Table 4 shows that total engagement of regions and correspondent regions during RESTING STATE is more numerous in relation to PRAYER situation, in constant and occasional situation for all theta and bêta subgroups. However, right-sided region higher frequency in constant form in 20-24 Hz beta, and left-sided in an occasional form was recorded only during PRAYER.

However, significant asymmetry between corresponding regions of left and right hemisphere in theta was not found during PRAYER, as well as total asymmetry. Asymmetry was not found in the RESTING STATE situation as well. This finding would diminish the value of subconscious event close to the situation of belief within our subject (Austin, 2000), and it confirms findings in the literature about reverse relations between consciousness and subconsciousness (subconsciousness supresses consciousness and vice versa) (Austin, 2000). In the confirmation about existence of difference between the two situations lies following finding: positive asymmetry exists in constant form in PRAYER situation as well as in occasional activity in RESTING STATE situation, but exclusively for Fp1 region and without connection to the auditory speech processing.

Positive asymmetry, prevalently left hemisphere, was found in 13-15, 15-20 and 24-36Hz beta subgroups in favour of constant form in PRAYER. Relatively neutral relationship was found in 20-24 Hz beta subgroup. Beta activity by subgroups is not explored enough (Fell et al., 2010), probably because research was referring to short transcendental prayer type states in trained persons and persons dedicated to belief, which was clearly not case in our subject. On the other side, our experiment also observed internal prayer speech as particular form of revision of learned text based on relatively stable system of connected auditory, temporal spatial regions, those for focused attention and especially motor regions.

Our findings about theta rhythm got closer to findings in the literature in terms of the increase of global theta activity in PRAYER situation, which implies significant deceleration of EEG activity, and thereby preservation of conscious operation (in contraire to sleeping). However, this paper showed that, the preserved conscious content has its profile in beta subgroups. In a certain way, it includes regions of conscious in a form of linkage of regions into systems that define some area of knowledge more precisely, like linkage of primary and complex auditory and spatial-time regions along with visual regions with primary (frontal) and executive (central) motor regions.

Findings also showed that mechanism of internal inhibition control during thought activities (implied by 13-15 Hz subgroups), expressed through connecting the regions O1-P4 in RESTING STATE, was significantly widened in PRAYER, by including visual right and frontal left regions, few times more expressed in constant activity in PRAYER situation, in relation to RESTING STATE situation. It disappears during occasional activity of PRAYER, while it continues to persist in same form of connecting, in occasional activity during RESTING STATE. Finally, it can be concluded that, for central inhibition during RESTING STATE, O1 P4 control is sufficient, while during PRAYER, additional activity of right visual and frontal left hemisphere is needed. It seems that it is logical for unhindered support of thematically oriented PRAYER speech, in contraire to plausible but occasional one in RESTING STATE (Thatcher et al., 2007). In constant activity, there are no

advantages of RESTING STATE over PRAYER situation, neither in terms of connecting the regions in 15-20 Hz subgroup which implies memory and elementary learning (Ivanovski & Malhi, 2007). In PRAYER situation, this advantage was provided by significantly numerous regions which include all parameters of speech and language communication left hemisphere, visual and temporal on both sides, with joined right sided emotional regions. Great support on both sided visual regions with moderate activity of emotional region on attitude and expression does not exclude the possibility that the subject had imagined (conscious) source of some picture (icon), which altogether differs from RESTING STATE situation. However, asymmetry in PRAYER situation was not expressed nor in this subgroup, nor in the 13-15 Hz subgroup.

Our examination showed significant difference between PRAYER and RESTING STATE situations in terms of number of engaged regions and their profile, in theta subgroup (Aftanas, Golocheikine, 2001), as well as beta subgroups (Fell et all., 2010; Thompson, 2003). It also showed that regions from left hemisphere are significantly more engaged in PRAYER situation. This difference is especially expressed in subgroup of theta, which implies shallow subconsciousness, and in subgroups of beta, which implies central motor inhibition (13-15 Hz) and learning, knowledge (15-20Hz). This kind of finding implies that knowledge is being used in PRAYER situation in relation to RESTING STATE situation.

Profile of significantly engaged regions in 20-24 Hz subgroup (so called combined beta) which primary implies decision making by processing learned text (Thompson, 2003; Martinović, 2009, Buzsaki , 2006) and believing in it, incluedes both sided motor and visual regions as time regions, and only left primary auditory regions during PRAYER. This indicates presence of some form of confidence in the experience of an image and motor activity, as well as the time, which is approximate to awareness of the moment of event, in contrast to the RESTING STATE, which is dominated by relying on emotional experience and auditory expectation, as well as the possible plan of action. In the situation of PRAYER, this decision, or the confirmation of this attitude, comes from the right interhemispheric asymmetry of emotional orbitofrontal structures. It is somewhat „new“, namely, it carries some kind of a discovery of a new experience and can denote belief together with the mentioned intersituational asymmetry (Thompson 2003).

For an assumption that the structure of 24–36 Hz beta response holds an actual answer to the goal of our research there are numerous reasons. This is the subgroup which implies doubt of what 20–24 Hz actually confirms (Thompson, 2003) and that the biggest part of the structure of the region of this response is represented in the PRAYER not only in situations but also in interhemispheric asymmetry on the left in the formula C3, P3, T5, and that time is a factor in the experience of the content of the prayer in the center of that doubt, dilemma, or distrust. Although the resting state shows asymmetry not only in the situation of prayer, but also interhemispherically, it is predominantly right hemispheric and comprises regions of planning and listening, therefore completely different compared to those during situation of prayer.

Generally speaking, the depth of diving into subconsciousness is significantly more present during Prayer. It is connected with regions of planning, which are connected with auditory region activation, which is most probably related to silent speech. The behavior of beta subgroup, which implies to learning, shows significantly larger involvement of regions during prayer. Once again, it refers to the relation with the activity of silent speech. If 20–24 Hz beta subgroup implies confirmation of the findings of prayer (decision making) that the participant in a way stood behind her words and that this was within rather determined emotional regions of the right hemisphere (Thatcher et al. 2007), then there is a possibility that this is a new belief which lies in the background with what is connected with learning and maybe the meaning of belief in the existence of another truth and not only the one directly connected with speech. Those responses that are higher than 24–36 Hz could be the confirmation for the doubt regarding to the learned text about a different truth (dualism). Localization of those doubts connected with parietal regions of the left hemisphere- responsible for understanding of time (Thatcher et al. 2007; Coan & Allen, 2004) could reflect the possibility that these two truths persist at the same time.

## Conclusion

Untrained young person during Prayer (internal prayer speech) showed a situation which differs from Resting state in terms of significant activation of regions responsible for learned knowledge, and only insufficiently reliable signs of belief. It seems that P3 region plays a significant role in the activity of belief. It is noticed that, in situations of PRAYER and RESTING STATE, greater number of right hemispheric regions

in constant theta-beta rhythm activity were included, in relation to occasional activity, in which left sided brain regions are more included. Results indicate that the prayer of untrained person establishes fourth physiological normal functioning state of brain, which Slezin named “slow alertness” state. It is noticed that, during Prayer, there is much greater number of activated symmetrical regions, which implies that Prayer has an effect on synchronization of left and right hemisphere.

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## Korelati EEG ritmova u ispitianju znanja i verovanja u stanju molitve


Rad predstavlja istraživanje EEG ritmova mlade, netrenirane ženske osobe, tokom unutrašnje molitve “Oče naš” (unutrašnji govor) i u stanju mira, ispitivanjem podgrupa teta i beta moždanih EEG ritmova koji se javljaju kroz stalnu i povremenu aktivaciju moždanih regija.

Snimanje EEG ritmova izvršeno je na Nihon Kohden Corporation, EEG – 1200K Neurofax aparatu, u monoploranoj longitudinalnoj montaži u sistemu 10/20 elektroda sa ciljem da se odredi pik frekventna vrednost svakog eksplorativnog mesta.

Rezultati su pokazali da tokom molitve postoje elementi i znanja i verovanja, a da je ovakva pojava moguća kada uzmemo u obzir nedovoljno specifikovane okolonosti koje su pratile eksperiment, kao i samog ispitanika, jer je ispitanik relativno mlad i nedovoljno treniran za dubinu molitve. U radu se diskutuju tipovi povezivanja

regija u odnosu na interhemisferne razlike, kao i u odnosu na stanje molitve i stanje mira. U poređenju sa rezultatima u literaturi i našim predašnjim nalazima, deo nalaza upućuje na regije za “znanje” i regije za “verovanje”.
*Ključne reči*: EEG, theta, beta, kartografske regije, procesiranje, govor u sebi, zvuk 69Hz

# On quantum-holographic and trans-generational implications for child developement

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**Abstract.** Our previously developed quantum-informational framework of psycho-somatics seems to provide theoretically fundamental understanding of the nature of psychosomatic diseases as well as limitations of their prevention and healing methods, by imposing new healing boundary conditions in the energy-state space of the EM quantum-field-related acupuncture system / (individual and collective) consciousness – suggesting three front lines of psychosomatic medicine: (i) collective consciousness, (ii) acupuncture system / individual consciousness, (iii) somatic level. It should be noted that the necessary activities in the second and third levels, with neglect of the first level, would result in further transfer of memory attractors on the level of individual and collective consciousness in this and future generations. This suggests necessity to focus on origins of many problems in child development on underlying prenatal trans-generational levels, and might be inspiring for wider applications of transpersonal holistic approaches and techniques in improvement of child development.

## 1 Introduction

In conclusions of the *First International Congress on Psychological Trauma: Prenatal, Perinatal and Postnatal aspects (PTPPPA 2015)* the following messages were outlined (Brekhman et al., 2015): (i) For understanding development of human consciousness, communication, behaviour and learning, we must apply a holistic approach from the prenatal period, from preconception, because a man is a unique expression of trans-generational characteristics of his ancestors and interactions with closer and wider environment; (ii) If in considering development of communication and behaviour we do not perceive this fact, we might consequently come into a situation of not being able to have substantial insight into our own situation and behaviour, and even less of the others; (iii) Experts who deal with child development, upbringing and education, should complement their knowledge with the art of composing and interpreting genealogic tree (somatic, psychological, spiritual), thus gaining holistic insight into the complete development of a person from the moment of conception, and being adequately prepared to support young generations properly.

This paper is fully in line with these conclusions. On the one hand, it provides theoretically fundamental understanding of our *quantum-holographic / quantum-gravitational theoretical framework for psychosomatics and spirituality* (cf. Section 2). On the other hand, it might have significant *quantum-holographic / quantum-gravitational implications for child development*, including *prenatal trans-generational aspects* (cf. Section 3).

## 2 On Quantum-Holographic Framework for Psychosomatics and Spirituality

Our previously developed generalized *Hopfield-like neural macroscopic quantum-holographic / quantum-gravitational* (HNMQHQG) *theoretical framework for psychosomatics and spirituality* provides better fundamental understanding of the *nature of psychosomatic diseases* as well as *limitations of their prevention and healing methods*, which might help in *developing strategies for psychosomatic integrative medicine in the 21st century*, with all holistic acupuncture-based and consciousness-based approaches and techniques treated as *quantum-informational therapies*, by *imposing new healing boundary conditions in the energy-state space* of the electromagnetic (EM) quantum-field-related *acupuncture system / (individual and collective) consciousness* – suggesting that *three front lines of psychosomatic integrative medicine* (Group of authors, 1999; http://www.dejanrakovicfund.org; Raković et al, 2004, 2009; 2011; Raković, 2008a, 2009; and refs. therein): (i) *spirituality & circular (psycho / energy) therapies* from all relevant meta-positions, with the possibility of a potential permanent removal of mutual memory attractors on the *level of collective consciousness*, (ii) *(quantum) holistic medicine and non-circular (psycho / energy) therapies*, which temporarily remove the memory attractors on the *level of acupuncture system / individual consciousness* and prevent or alleviate their somatization, as a result of negligence on the first level, and (iii)

*symptomatic conventional medicine*, which via immunology, pharmacology, biomedical diagnostics and surgery on the *somatic level* prevents or alleviates consequences of carelessness on the first two levels. It should be noted that the necessary activities in the second and third levels, with neglect of the first level, would result in further transfer of memory attractors on the level of individual and collective consciousness in this and future generations. This suggests necessity to focus on *origins of many problems* in child development on *underlying prenatal trans-generational levels*, as suggested by experiences of clients in *posthypnotic regressions* as well.

In this context, it should be also added that *psychosomatic healthy state* is the state of the *minimal entropy* while *psychosomatic disordered state* is the state of the *increased entropy* – and application of some *psychosomatic therapy* naturally *decreases entropy* (degradation) i.e. *increases information* (organization) of the (open) psychosomatic system (Raković, 2016a,b, 2017a).[1] Then, in the context of holistic acupuncture-based and consciousness-based approaches and techniques (see http://www.dejanrakovicfund.org; Raković et al., 2009, 2011; Raković, 2009, 2011a, 2013), their goal would be (external) bioresonant excitation of the target palpatory-painful / psychologically-traumatic attractors of the (open) acupuncture system / (individual) consciousness. This enables disordered initial attractors to be one-by-one bioresonantly excited (similar to annealing procedure in artificial neural networks (Hecht-Nielsen, 1990)), thus becoming shallower and wider on the account of deepening of (energy-dominating) attractor of the healthy quantum state (acupuncture palpatory painless or psychologically non-traumatic). However, when this process is hindered by transpersonal entangled blockages in the energy-state space of EM field of the (open) acupuncture system / (individual and collective) consciousness – then memory attractors of quantum-holographic network of the EM field-related collective consciousness should be removed as well, to disentangle energy-informationally all mental addresses included in the problem with final goal to achieve permanent healing i.e. spiritual integration of personality (see http://www.atpweb.org; Raković et al, 2009; Raković, 2009, 2013, 2014, 2015a,b,c, 2016a, 2017a,c; and refs. therein). This purified information of the healthy quantum state is then altogether quantum-holographically projected on lower quantum-holographic cellular levels, thus changing expression of genes in morphogenesis (so called downward causation!).

Also, our HNMQHQG theoretical framework for psyshosomatics and spirituality provides better understanding of the *two modes of knowledge*, according to the coupling strength mind-body-environment (see Raković and Dugić, 2005; Raković, 2007a,b, 2008a,b, 2009, 2011a,b, 2015a,b,c, 2016a, 2017a,b,c; http://www.dejanrakovicfund.org; and refs. therein): (i) *weakly-coupled quantum-entangled / quantum-coherent direct mode* (in the *out-of-body* spiritual-creative *non-stationary transitional states of consciousness / stationary altered states of consciousness*, like prayer, meditation, daydreams, lucid dreams, creative insights...) and (ii) *strongly-coupled classically-reduced indirect mode* (in *bodily* perceptively-rationally mediated *normal states of consciousness*, like sensory perception,

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[1] As Peruš (1996) showed that *any quantum system* has formal mathematical structure of *quantum-holographic Hopfield-like neural network* (within the Feynman propagator version of quantum mechanics; see also Raković, 2008a, 2009) – then it follows that *manifestly macroscopic quantum-like acupuncture system* (with *highly resonant microwave sensory response of the disordered organism, biologically effective non-thermal microwave radiation of extremely low intensity and energy, and neglecting microwave energy losses down acupuncture meridians*) and *consciousness* (with *in-deterministic properties of free will, non-local properties of consciousness pervading body, and altered and transitional states of consciousness*) – have fundamental (not model-dependent!) informational structure of *quantum-holographic Hopfield-like neural network* (see Raković, 2002, 2008a, 2009; Raković et al., 2004, 2009), with Hebb-like correlation matrix of memory synaptic connenctions corresponding to Green's function (quantum propagator) in Feynman's version of Schrodinger equation:

$$G(r_2,t_2;r_1,t_1)=\sum_{i=1}^{P}\phi^{k_i}(r_2,t_2)\phi^{k_i}{}^{*}(r_1,t_1)=\sum_{i=1}^{P}A_{k_i}(r_2,t_2)A_{k_i}{}^{*}(r_1,t_1)e^{\frac{i}{\hbar}(\alpha_{k_i}(r_2,t_2)-\alpha_{k_i}(r_1,t_1))}$$

whose memory attractors $\phi^{k_i}$ could be treated as psychosomatic states, representing biophysical basis of acupuncture-based and consciousness-based *quantum-holistic local psychosomatics*. Further on, by considering psychosomatic state in generally mixed quantum state of density matrix:

$$\hat{\rho}_S=\sum_i\left|c_{k_i}\right|^2\left|\phi^{k_i}\right\rangle_S\left\langle\phi^{k_i}\right|\equiv\sum_i p_{k_i}\left|\phi^{k_i}\right\rangle_S\left\langle\phi^{k_i}\right|$$

(where $p_{k_i}$ are probabilities of realization of the $k_i$-th quantum state), then von Neumann's quantum-mechanical entropy $S=-kTr(\hat{\rho}_S\ln\hat{\rho}_S)$ is reduced to classical Shannon's entropy $S=-k\sum_i p_{k_i}\ln p_{k_i}$ (Nielsen and Chuang, 2002; Dugić, 2004, 2009; Raković, 2008a, 2009). So, within our HNMQHQG theoretical framework, *entropy of pure-healthy state* of the psychosomatic system (described by the single $k_0$-th term in the superposition, of probability $p_{k_0}=1$), would be $S_{k_0}=0$ (as pure quantum state $\hat{\rho}_{S_{kv}}^{(k_0)}$ provides maximal possible information about the quantum psychosomatic system), while *entropy of mixed-disordered state* of the psychosomatic system (described by the full above superposition), would be $S_{\hat{\rho}}>0$ (as mixed stochastic state $\hat{\rho}_{S_{kv}}^{(k)}$ provides uncomplete information about the quantum psychosomatic system).

logic and scientific reasoning...) – and *conditions of mutual transformation*, with significant spiritual-epistemological implications. This explains the *generally poor informational rationalization* of any direct quantum-holographic spiritual / religious *mystical experience* (as the problem of quantum theory of measurement, related to the reduction of the implicate order of the quantum-entangled (quantum-holographic) superposition of states into the explicate order of measuring classically-reduced states). And can help us realize that all our *partial rationalizations* (classically-reduced mappings!) are still only an approximation of *fundamental holistic reality* (quantum-holographic territory!) – and that all *divisions are tragic misunderstanding* of spiritually immature (historical) epoch of civilization (as map is not the territory!) (see Raković, 1997, 2002, 2008b, 2015a,b,c, 2016a, 2017a,c). On the other hand, *the consensuses of the mystics of the same tradition on a similar partial rationalization of mystical experiences* could be understood as *part of the same dominant-channeling trans-generational contextual heritage of members of the same tradition* (Raković, 2017a,c; because we are not born as so-called *tabula rasa*, as being indicated by contemporary experiences of hypno-regressions (Newton, 1994, 2000, 2004, 2009) and experiences of different traditions as well (Eliade et al, 1991)).

In this context, it should be also added that *necessity of direct quantum-holographic coupling of individual and cosmic collective consciousness* in an observation of the implicate order might need *weak out-of-body quantum-communication consciousness-environment coupling*, i.e. previous *reprogramming of all psychosomatic loads* (cleansing of the possessive or hedonistic emotional-mental sinful / karmic connections with world – which as loading *mental addresses* would give rise to *quantum-gravitational projections* of the mentally-channelled tunnelled consciousness upon the *out-of-body environment*, and thus to classically-reduced *out-of-body stationary extrasensory observing* of the mentally-addressed environment (Raković, 1995, 2000, 2008a,b, 2009, 2015a,b,c, 2016a, 2017a,b,c; and refs. therein)).[2,3,4,5] Hence, the efforts of mystics of all traditions to *purify consciousness / soul via*

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[2] According to our previous proposals (see Raković, 1995, 2000, 2008a, 2009, and refs. therein), *transpersonal interactions* might be interpreted by *collapse-related consciousness-channeled quantum-gravitational tunneling of operator's individual consciousness* – mentally addressed on the target's content of the *collective consciousness / environment* in operator's *transitional states of consciousness* (short lasting and therefore not easily reproducible (Jahn, 1982)!) – thus *intentionally channeling state of operator's individual consciousness*, and *automatically influencing the complement collective consciousness / environment output in quantum-gravitationally-induced and consciousness-channeled decoherence (quantum collapse):*

$$\left|\Phi\right\rangle_S\left|\Psi\right\rangle_E = \sum_i c_i\left|\Phi_i\right\rangle_S\left|\Psi_i\right\rangle_E \xrightarrow{p_j = \left|c_j\right|^2 \approx 1} \left|\Phi_j\right\rangle_S\left|\Psi_j\right\rangle_E$$

Alternatively, this might be interpreted as *quantum entanglement between memory attractors of individual consciousness* $\left|\Phi_i\right\rangle_S$ *and collective consciousness* $\left|\Psi_i\right\rangle_E$ (*correlated via consciousness-based resonant recognition / interaction* (see Raković, 2014, 2017a,b,c, and refs. therein) *of associatively-related attractors of individual and collective consciousness*) *– followed by body-induced collapse-related stochastic process* (*with previously mentally enhanced* $\left|c_j\right| \approx 1$ *contribution, by focusing on corresponding j-th memory attractor* $\left|\Phi_j\right\rangle_S$ *in normal state of individual consciousness*). On this line, the *gauge quantum field theory and quantum gravity correspondence* (within string theory) of *any* quantum entangled system (i.e. Einstein-Podolsky-Rosen correlated quantum pair) and corresponding connected miniature (non-traversable) wormhole (i.e. quantum-gravitational Einstein-Rosen bridge) should be pointed out (Maldacena and Susskind, 2013). On its possible traversability in cosmological conditions see Thorne (1994), and in transpersonal conditions see (Raković, 1995, 2008a, 2009, 2017a,b,c; Raković and Dugić, 1998; Raković et al., 2004, 2009, 2011; and refs. therein). In the context of *Tesla-inspired holistic questions of creativity and education* (Raković, 2017b), the above formula might represent *mentally controlled-directed increasing* of macro-quantum correlations of individual and collective consciousness in *transpersonally-entangling creative phases* (with previous mental increase of the focused weight contribution $c_j$ and subsequent (practically non-stochastic) classically-reduced selection of this dominant weight contribution $c_j$) – while in the context of *Tesla-inspired holistic questions of psychosomatics and spirituality* (Raković, 2017c) the above formula might represent *mentally controlled-systemic decreasing* of macro-quantum correlations of individual and collective consciousness in *transpersonally-disentangling spiritual phases* (with previously systemic mental decreasing of all weight contributions $c_i$ and subsequent (stochastic) classically-reduced selection of the weight contribution $c_j$)! [Note that the above formula also describes a much more frequent, *constantly fluctuating*, spontaneous interaction of *individual consciousness with a closer environment*, making that with sensory-focused contents we have the experience of reality as in *normal states of consciousness* (Raković, 2017a)! This continuous fluctuation has its analogy in the *quantum biomolecular world*, between *continuously fluctuating* non-complementary $\left|\textit{states of biomolecular energy}\right\rangle_S$ and $\left|\textit{states of biomolecular conformation}\right\rangle_S$ (and entangling $\left|\textit{(complement) states of biomolecular environment}\right\rangle_E$) (Raković et al., 2014)!]

[3] It should be pointed out, that in the context of *necessary conditions for decoherence* described by the formula in the footnote above, defining of open quantum system and its environment is – *simultaneous process* – so that in the context of universal validity of quantum mechanics *consciousness is relative concept*, non-locally also influenced by farther parts of existing observing universe (and *vice versa*!), simultaneously creating conditions for the process of decoherence in the context of *existing relative borderline* (Dugić et al., 2002; Raković et al., 2004; and refs. therein):

$$\left|\Phi\right\rangle_S\left|\Psi\right\rangle_E \equiv \left|\textit{(partial) individual / collective consciousness}\right\rangle_S\left|\textit{(complement) environment}\right\rangle_E$$

This is fully in accordance with the idea of *collective consciousness* as a possible *ontological property of the physical field itself* (see Raković, 1995, 2000, 2002, 2007b, 2008a,b, 2009, 2014, 2015a,b,c; 2016a, 2017a,b,c; Raković et al., 2004, 2009; and refs. therein), with different micro-quantum and macro-quantum (both non-biological and biological, real and virtual) excitations. Then, as *cosmic collective consciousness* (coincident with the *field of Universe*) has its *complement particle cosmic environment*, their strong-interaction-coupling affects *decoherence of the field of cosmic collective consciousness* into stationary *classically-reduced (observing) stochastic state,* with probabilities of realizations of corresponding classically-reduced states of cosmic collective consciousness. [However, note that the *cosmic composite quantum state*:

$$\left|\Phi\right\rangle_S \left|\Psi\right\rangle_E \equiv \left|\textit{cosmic field collective consciousness}\right\rangle_S \left|\textit{(complement) cosmic particle environment}\right\rangle_E$$

*evolves without collapse* (due to absence of the complement outside-cosmic environment!), which implies that *Universe as a whole is presumably quantum hologram* subject to deterministic Schrödinger evolution (in the context of universal validity of quantum mechanics) (Raković, 2007b, 2017a)! This indicates that the *quantum information* (embedded by quantum-holographic boundary conditions in the very beginning of the Universe) *is fundamental physical property of the Universe* (and perhaps even more fundamental than particles, fields, and even the space-time, as briefly formulated by Wheeler's famous motto *'It from bit'*, motivated by *quantum-theoretical viewpoint* that we live in a *participatory Universe* (Wheeler, 1990; Vedral, 2010). In this context, the intriguing field-mediated experiments (Gariaev, 2009; Gariaev et al., 2011; Montagnier et al., 2010; Milovanovic et al., 2014) indicate that the *(quantum-holographic) field-encoded information* is presumably critically important even on the evolutionary scale to transfer appropriate boundary quantum-information conditions necessary for an explanation of the current *dynamics of biological evolution*, that cannot be explained on the basis of classical random laws described by the probability theory, as simply argued by Lennox (2007). On possibility of spiritual imposing new boundary conditions at the level of cosmic field / collective consciousness see the next footnote!]

[4] It should be noted that *spontaneous transpersonal communications*, with exchange of information in transitional states of consciousness, have *negative psychosomatic-spiritual effects*, as they neccessary give rise to *global trans-generational increase of psychosomatic loads* on the level of macroscopic quantum space-time network of c*ollective consciousness* – which might represent the *karmic / sin engine of history*. *The only phenomenon which decreases these loads is all-forgiving prayer to ourselves and others* (relatives, enemies, decised) – *probably via simultaneously purifying spiritually-excited vacuum-exotic new macro-quantum portions of vital energy* (similarly to spiritually-excited and mentally-channeled Ayurvedic, Qigong, Reiki and modern experiences of local and transpersonal healing (Swami Sada Shiva Tirtha, 2007; Cohen, 1999; Lee Rand, 1998; Brennan, 1987; Pearl, 2001; Stibal, 2006; Kinslow, 2008; Bartlett, 2009; Grabovoi et al., 2012)) *in prayer-related persons* – as *(decoherence-like) quantum-gravitational in-deterministic purifying interventions in (intrinsically-unitary) quantum-holographic evolution of collective consciousness*! This leaves most room for *free will and influence on future preferences* – making the *role of every person indispensable* due to influence and concern for *collective mental environment*! *As there is no out-of-cosmic environment that triggers* the non-unitary entanglement of the quantum-entangled state of the field-related cosmic collective consciousness and complementary particle cosmic environment – *the above proposed mechanism of prayer imposes (intrinsically, non-unitary!) necessary boundary conditions without mutually mentally-loaded addresses*. Hence it can be really said that *all-forgiving prayer* represents biophysical basis for optimization of (*quantum*) *holistic global psychosomatics of collective consciousness* (and complementary incoming individual and collective events) (Raković, 1995, 2000, 2002, 2008a,b, 2009, 2014, 2015a,b,c, 2016a, 2017a,c; Raković et al., 2004, 2009)! It should be added that aforementioned Ayurvedic, Qigong, Reiki, and modern experiences of local and transpersonal healings imply that *meditative visualization (intrinsically, non-unitary!) also imposes new (decoherence-like) quantum-gravitational boundary conditions*, by mentally-channeled transfer of purifying spiritually-excited vacuum-exotic new macro-quantum portions of vital energy. But contrary to prayer, *meditation balanses only practiotioner himself* while not removing simulateneously other mentally-loaded addresses (thus in these situations it is necessary to practice *circular meditatively-healing visualization from meta-position(s) of the other(s)* included in the existing conflict, in order to *remove simulateneously mentally-loaded addresses*). So, in the context of our quantum-holographic / quantum-gravitational theoretical framework, *spiritual prayer / meditation practices are non-unitary source of free will* at the level of *collective consciousness*, while *non-spiritual behaviour maintains* the trans-generationally-programed *unitary evolution of collective consciousness* – which evolutionary greatly increases *spiritual responsibility of each person and the entire human race*! [It should also be noted that *transpersonal vacuum-exotic aspect of energy-informational channels of vital energy* (i.e. their connection with exotic vacuum quantum fluctuations, necessary for anti-gravitational stabilization of these spatial-temporal miniature wormhole channels (see Footnote 2 and Raković, 1995, 2000, 2002, 2008a,b, 2009, 2015a,b,c; 2016a, 2017a; Raković and Dugić, 1998; Raković et al., 2004, 2009; and refs. therein)) might be *extended to energy-informational acupuncture channels* (Raković, 2014), of peculiar vacuum-like $n = 1$ refraction index (Sit'ko, 2012; Complete issue, 1998), *with vacuum-like outside inflow of vital energy / prana / qi* (Swami Sada Shiva Tirtha, 2007; Cohen, 1999; Lee Rand, 1998) – implying that such type of deeper exotic spatial-temporal communication enables *continuously-refreshing interaction* between the two mentally-addressed persons and *transpersonally stabilizes quantum-entanglement* of their acupuncture systems / consciousnesses i.e. *prevents dis-entanglement* of their macroscopic quantum-entangled non-stationary states by *decoherence-like* interaction with their local somatic environments!]

[5] It should also be added that *transpersonally-extended esoteric concepts* of various spiritual traditions of East and West (Wilber, 1980; Vujičin, 1995; Vlahos, 1998; http://en.wikipedia.org/ wiki/Soul; https://en.wikipedia.org/wiki/Spirit; https://en.wikipedia.org/wiki/Qi) could be biophysically accounted within our plausibly generalized HNMQHQG *theoretical framework* (http://www.dejanrakovicfund.org; Raković et al., 2004, 2009; Raković, 1995, 2000, 2007a,b, 2008a,b, 2009, 2011a, 2015a,b,c, 2016a, 2017a): (i) *astral body* (*manomaya, lingasarira, manovijnana, ka, psyche, nephesh, nafs, subtle body, psychic body, soul...*) **vs.** *ionic component of the out-of-body displaceable EM-ionic-exotic macro-quantum acupuncture system* (*connected with the body by miniature wormhole space-time tunnel, generated and stabilized in highly-noninertial transitional states of consciousness, as frequently observed in extrasensory near-death experiences*); (ii) *mental body* (*vijnanamaya, suksmasarira, manas, ba, thymos, ruach, ruh, noetic body, spiritual body, mind...*) **vs.** *EM component of the out-of-body displaceable EM-ionic-exotic macro-quantum acupuncture system* (embedded within *ionic component of the out-of-body displaceable EM-ionic-exotic macro-quantum acupuncture system*); (iii) *distributed centers of consciousness* (*chakras, acupuncture points, sephiroths, holy discs...*) **vs.** *EM-ionic condensations* in the *structured out-of-body displaceable EM-ionic-exotic macro-quantum acupuncture system*; (iv) *vital energy* (*chi / qi / ki, prana / akasha, mana, ka, pneuma / ether / natura medica / anima mundi, yesod, baraka, the Holy Spirit / Uncreated Light, bioenergy / biofield...*) **vs.** *EM-ionic-exotic macro-quantum condensates* (*unstructured / structured, virtual / real*) *within acupuncture channels* (with possible *generalization* from the *EM field* to the *unified field*, in line with the *broader traditional meaning* of vital energy, as all-pervasive

*spiritual practice* (prayer, meditation...) and thus to reach their *final eschatological goal* (Kingdom of God, nirvana...), i.e. *post-mortem salvation of soul* (non-bounded sin-free / karmic-free) by *re-union* (*re-ligare / yoga*) with the *supreme God* (Eliade et al, 1991; Wilber, 1980; Vlahos, 1998; Vujičin, 1995) might appear reasonable! [But it still would leave room for *personal love*, whose highest manifestation is ability and readiness for *permanent and unconditioned forgiving* (to loving person, and because of him / her to everybody else, including enemies!), in spiritual prayer and (subtly related quantum-holographic) living practice; the same refers to love for relatives and friends.]

The mentioned research is on the line of renewed interest in *consciousness studies*, with the indication of the *great synthesis of two modes of knowledge* – where the *role of each person becomes indispensable* due to the influence and concern of the *collective mental environment*, which is a *fundamental issue* of both spiritual and civic morality. Thus civilization, via *synthesis* of scientific knowledge in the field of *consciousness* and millennia experiences of the *spiritual traditions*, could contribute that new millennium would be characterized by *wisdom*. All this indicates the *full significance of holistic education and behavior*, suggesting necessity of *redefining* the global educational / informational / policy goals, with the shift towards *holistic gentle actions for solutions of the global risk society*. Decisive role in this process could play all *religious communities*, *cultivating* a true *spiritual moral* and absolute (not declarative, as so far in history!) inter-personal, inter-ethnic and inter-religious *tolerance*, as a measure of individual behavior from the *perspective of death*, i.e. amount of generated and non-reprogrammed psychosomatic conflicts until death, which determines the *spiritual evolution* of the soul of the deceased as well as the *preferences* of the individual and / or collective future of the descendants – that can be *significantly altered* only via *collective prayer* for our neighbors and enemies, and consequently *global reprogramming of collective consciousness*.

## 3 On Trans-Generational Implications for Child Development

Michael Newton, a famous American transpersonal hypno-regression-therapist, in his books talks about a number of psychotherapeutic experiences of post-hypnotic regressions, with systematized messages of his clients that our major life lessons and opportunities to optimize the otherwise predestined life-programs are lying in spiritual sphere of purification (Newton, 1994, 2000, 2004, 2009). Reading of Newton's books brought me a special pleasure, because of the many important *associations and implications* on correspondence of the *described experiences* and *theoretical predictions* of our HNMQHQG framework (cf. Raković, 2016a): (i) *transpersonal-spiritual tunneling as exclusive communications, without space-time barriers* (in accordance with our theoretical predictions); (ii) *soul transpersonally chooses a pair of prospective parents, among several offered alternatives previously carefully observed with all the details of a future life* (indicating that life is predestined on the physical level by existing boundary conditions at the level of cosmic field / collective consciousness); (iii) *by made choice of the parents, life is not completely fixed, but can be optimized by spiritual means, repenting and forgiving to ourselves and others* (bringing new boundary conditions at the level of cosmic field / collective consciousness, which points to the fundamental importance of spirituality as a source of the greatest freedom for optimizing otherwise predestined life-programs, and necessity of careful control of the reactions on current life-temptations in order to avoid further deepening of the existing conflicts); (iv) *although the aforementioned experiences evoke strong associations on reincarnation, some of the reported insights suggest the possibility of transmission of information of the same content into several persons during their overlapping lifetime periods* (implying a trans-generational transfer of accumulated information, with experiences that transferred contents leave a strong impression of the previously lived lives).

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cosmic quintessence). Additionally, if put in the *theoretical context of the holographic principle* (Susskind and Lindesay, 2005), according to which any 3D physical system is *isomorphic* to the holographic information embedded on its 2D surface, then *quantum-holographic informational content of a body* could also be contained in *corresponding surface layer of vital energy (aura)*, as has been stated in various traditions of East and West. [On the other hand, bearing in mind the *generally poor informational rationalization* of any direct quantum-holographic spiritual / religious mystical experience, it can help us understand that all our *partial rationalizations* (with different personalized pantheons) are only approximations of *fundamentally-holistic reality* (Prabhavananda and Isherwood, 1969; Castaneda, 1971; Talbot, 1991; Vujičin, 1995). In this context, *several-millennia controversy about post mortem evolution of the soul*, might be probably related to an *interpretative epistemological level* of rationalization of transpersonal transfer of mentally-addressed loads within the existing generation and further generations via network of collective consciousness, with possibility that particular strong conflicts transferred as *ego-states* leave a strong impression of previously lived lives (Raković, 2008a,b, 2009). But what is the *ontological spiritual reality* (implicate order of the very quantum-holographic territory!) – could remain *permanent controversy* of all these principally limited attempts (explicate orders of classically-reduced mappings of the quantum-holographic territory!) of *human rationalization* (Vujičin, 1995)!]

So, in the context of the aforementioned *trans-generationally-predestined quantum-holographic structure of collective consciousness* (as suggested by the experiences of tribal traditions, and traditions of the East and the West), *it seems irrational not only to be angry at life program* (previously freely chosen prenatally, *but it is also irrational not to optimize it* (spiritually-accepting and forgiving ourselves and our environment) – *contributing to both our own spiritual growth and catharsis of our trans-generational mental environment* (which is fundamental question of both mental hygiene and civil decency i.e. both spiritual and civil morality)!

Also, it is hereby instructive to mention Buddhist interpretation of *karma*, which occurs not as a *result of our spontaneous reaction* to the current situation in life, but as a result of the *latter justification of our conscious reactions against the others* in this situation (Panajotović, 2011)! In the context of the mentioned above *quantum-holographic predestined life programs*, this is fully justified because we all *(non-consciously) react to current conflicting-encoded life-situations* (several hundred milliseconds before we become aware (Dennett, 1991; Wegner, 2002; Hameroff and Penrose, 2014)!), but immediately afterwards we have a chance to (*consciously*) *permanently untangle the existing trans-generational conflict by penitent-all-forgiving prayer*. This is *quite fair spiritual opportunity – and up to each person is either to use it or not* – with accompanied *either unloading or overloading* trans-generational conflicts!

That might be possibly the reason for *Christianity* to insist on *repenting and forgiving* ('And forgive us our debts, as we forgive our debtors', Mt.6,12), which represents a level of *spiritual maturity of a person*. This implies an obligation of spiritually mature persons to help in reprogramming mental / emotional conflicts by praying, even when themselves being victims of the conflicts ('But I say unto you, love your enemies, bless them that curse you, do good to them that hate you, and pray for them which despitefully use you, and persecute you', Mt.5,44). *It is not even allowed to see evil in fellow-men and condemn them* (an old biblical commandment given to the man in paradise, forbidding to take food 'of the tree of the knowledge of good and evil' – in fellow-men – 'for in the day that you eat there-of you shall die' (Gen.2,17), whose violation has caused the *Adam's fall*, and sowed the seed of the growing *'terror of history'*), insisting only on *personal repenting and forgiving*, as the only way in *permanent reprogramming of psychic conflicts*. Anything else would enhance the existing mental / emotional personal loads and enlarge evil in the world, dismissing an individual and humankind from the final spiritual ideal of sinless state of consciousness!

Bearing in mind the role of a mentally burdensome contents in the *post-mortem spiritual evolution of the soul* of the dying (let us mention transpersonal collective levels of consciousness of *Bardo levels* in Tibetan tradition (Evans Wentz, 1968) or *aerial toll house* in Christian tradition (Father Seraphim Rose, 1988)) – this implies the importance of prayers for the soul of the deceased with ability not only to *influence its spiritual evolution*, but *also trans-generational preferences for individual and / or collective future offspring* (with possibility of even *retroactive-nonlocal trans-generational dis-entangling / un-binding of mental / emotional conflicts*, as suggested by *experiments with prayer* (McTaggart, 2007) – bearing resemblance to quantum delayed choice experiments (Wheeler, 1984; Jasquez et al., 2007; Kaiser, 2012) and pointing additionally to quantum roots of consciousness)!

We also mention some tribal traditions where initiated shamans ritually enter the altered states of consciousness and receive answers to the health problems of members of their tribe, and apply their healing methods based on reprogramming the loads on the level of tribe's collective consciousness (like in South America *Ayahuaska tradition* (Hadži-Nikolić, 2011), or Nigerian *Abiku tradition* (Tomšić Akengen, 2011), with fascinating spiritual diagnosis and subsequent extension of the predestined-short-life programs; or like in Hawaiian *Ho'oponopono tradition* (Vitale and Hew Len, 2007), based on the *participatory* concept of taking full *responsibility for any circumstance* in which we find ourselves and *repenting and forgiving ourselves* in the context of disturbing life situations, with fascinating successes in reprogramming *ourselves and our environment*). [In this context, I must mention an incredible experience of my cousin Milica, with (epi)genetically conditioned high-risk pregnancy of very low level of amniotic fluid, normalized in just a few days of ho'oponopono prayer practices, with subsequent normal delivery!]

On the same line, it is worth mentioning the *fascinating world bestseller confession of* Anita Moorjani (2012) *on spiritual changing her life program*, in which she decided to change her previous life program (and thus forgive herself and her grieving husband) and to continue to live – with return from clinical death and after a few weeks even *spontaneous healing of terminal phase of cancer*; this greatly contributes to our understanding that even *most difficult psychosomatic illness*, like cancer, *have their roots in the energy-information blockages* and that *healing begins by removing them* – first lovingly to ourselves, accepting ourselves and forgiving ourselves, which is then manifested by love to others and acceptance of others (e.g. by spiritually dis-entangling / un-binding repentant-forgiving prayer (Hay, 1984; Raković, 2008a,b, 2009))! [See link http://www.dejanrakovicfund.org/

2012_DRF_Stress_&_Anti_Stress.pdf with more details on recommended holistic anti-stress approaches and techniques!]

## 4 Conclusion

The outlined quantum-informational theoretical framework for psychosomatics and spirituality might have significant holistic implications, based on three front lines: (i) collective consciousness, (ii) acupuncture system / individual consciousness, and (iii) somatic level. This implies necessity to focus on *origins and treatment*s of many problems in child development on *underlying prenatal trans-generational levels of collective consciousness*, as confirmed by experiences of clients in post-hypnotic regressions too.

Everything considered might be of *fundamental importance* in understanding underlying quantum-informational acupuncture system / (individual and collective) consciousness *EM field-related biofeedback control mechanisms* of embryogenesis / ontogenesis and morphogenesis *via downward influence on the expression of genes* – shedding new light on the *long standing open problems of the nature and role* of acupuncture system and (individual and collective) consciousness as well.

All this might provide better understanding of the *nature of stress-induced psychosomatic diseases* as well as *limitations and methods of their prevention and healing*, which might help in *developing strategies for integrative psychosomatic medicine in the 21st century*. And might be inspiring for *wider applications of transpersonal holistic approaches and techniques in improvement* of development of children and their psycholinguistic functions, and of psychosomatic-cognitive status of adults as well.

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## O kvantno-holografskim i trans-generacijskim implikacijama za razvoj deteta

Čini se da naš prethodno razvijeni kvantno-informacioni okvir psiho-somatike pruža teorijski fundamentalno razumevanje prirode psihosomatskih bolesti, kao i ograničenja njihovih metoda prevencije i isceljenja, nametanjem novih graničnih uslova isceljivanja u prostoru energija-stanje EM kvantnog polja akupunkturnog sistema / (individualne i kolektivne) svesti – sugerišući tri linije fronta psihosomatske medicine: (i) kolektivna svest, (ii) akupunkturni sistem / individualna svest, (iii) somatski nivo. Treba napomenuti da bi neophodne aktivnosti na drugom i trećem nivou, uz zanemarivanje prvog nivoa, dovele do daljeg prenosa memorijskih atraktora na nivou individualne i kolektivne svesti u ovoj i budućim generacijama. Ovo sugeriše nužnost fokusiranja na poreklo mnogih problema u razvoju deteta na bazične prenatalne trans-generacijske nivoe, i može biti inspirativano za širu primenu transpersonalnih holističkih pristupa i tehnika u poboljšanju razvoja deteta.

# Language acquisition in infants raised in bilingual environments

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**Abstract.** Nowadays, more than half of the world's population is bilingual (Grosjean, 2010) and consequently a great majority of children are growing in bilingual families. Many parents, teachers and, by extension, societies see some types of bilingualism (those including "minor" languages) as a potential source of language learning problems. First, I will present recent studies showing that infants hearing two languages from birth, independently of the languages, pass the language development milestones at the same ages as their monolingual peers. Second, bilingual infants show linguistic and cognitive advantages compared to monolinguals. This point will be illustrated by recent studies on the acquisition of lexical stress in French monolingual and bilingual infants (Bijeljac-Babić, Serres, Höhle, & Nazzi, 2012; Bijeljac-Babić**,** Höhle, & Nazzi, 2016).

## 1 Introduction

It has been estimated that probably more than half of the world's population is bilingual (Grosjean, 2010), both adults and children who use two or more languages (or dialects) in everyday life. However, many parents, teachers and by extension societies, see some types of bilingualism (those including "minor" languages) as a potential source of language-learning problems. This is the case in all officially monolingual Western countries though its population is composed of immigrants speaking hundreds of different languages. It is in these countries that research on the acquisition of languages in young children has seen, these last several years, its greatest expansion. The aim of this presentation is to summarize recent research in language acquisition in bilingual infants over the course of the first year of life.

## 2. Bilingual environment

A child born into a bilingual milieu has a more complex task than does the monolingual child: they find themselves confronted with a larger number of different acoustic signals, without automatically knowing which language they belong to, or even if they belong to different languages. In addition, bilingual children must acquire certain capacities for which monolinguals have no need, such as quickly recognizing that the system of speech is entirely arbitrary (thus in order to designate identical objects do languages as close as Italian and French have entirely different words: the same vehicle will be "macchina" in Italian and "voiture" in French) and understanding that one can use more than one system in order to communicate.

Unlike monolinguals, bilingual children must always inhibit one language in order to avoid mixes and interferences. Differentiating language, learning to categorize the acoustic entries in two contrasted systems in order to avoid the interferences are tasks reserved to bilinguals. This poses several questions: does this demand the development of particular strategies, more cognitive load to switch from one language to another, etc..

### 2.1. .Differentiating languages

For the bilingual infant to be able to acquire the language, they must first be able to recognize that there are two languages that need to be differentiated. Even in families where the principle of "one language-one person" is adopted, the baby must discern in the speaking of the people around them the variations due to the individual characteristics of the different speakers and the variations due to the languages spoken by different people.

A recent study has shown that infants born to bilingual mothers (who spoke both languages regularly during pregnancy) exhibit different language preferences than infants born to mothers speaking only one language. Several groups of newborns, from different linguistic milieus, were tested during a task of preference and discrimination (Byen-Heinlein et al., 2010). In a first study, sentences in English and Tagalog (a language

spoken in the Philippines) were presented to newborns several days old from monolingual English and bilingual Tagalog-English families. Using nonnutritive high-amplitude sucking-preference procedure the authors measured the variations of sucking while the babies listened to the sentences spoken in English and in Tagalog. If the babies suck a lot while listening to the auditive stimulus, one deduces that they are interested and that their interest diminishes as their sucking rate lowers. The English monolinguals suck much more when hearing the maternal languages than when hearing Tagalog, while bilingual newborns show no preference, sucking their pacifier as much for English as for Tagalog. As we know about the last weeks of gestation, the child perceives the melody of utterances produced by their mother and is able at birth to recognize them and prefer them to the utterances in another language unknown to them. If the bilingual shows no preference, it is because they are attracted to both languages equally, or that the mix of two languages is too complex and they are unable to differentiate. The continuation of this work lends support to the first hypothesis: other English monolinguals and English-Tagalog bilinguals were able to distinguish the sentences in English from those in Tagalog. If bilinguals differentiate between the languages, this is because they are equally attracted to each one. In the study on discrimination between two rhythmically proximate languages such as Basque and Spanish, three-and-a half month old children whether monolingual or bilingual ground themselves on the acoustic indications that mark the rhythm and the melody of the sentence. The use of sentences filtered to preserve the rhythmicity and melody of the speech while suppressing their intelligibility show that both monolinguals and bilinguals succeed in doing so, but they do not behave in the same way: Spanish monolinguals, if they have first been familiarized with the Spanish phrases, recognize the Basque as being different during the first test phase, while the Basque monolinguals and Spanish-Basque bilinguals discriminate the two languages whatever the language of familiarization (Molnar et al., 2013). Very early on, bilingual babies are therefore sensitive to the rhythmic differences of their maternal language(s) even if the languages belong to the same rhythmic class.

The languages differentiate through the repertoire of phonemes which they use: certain are identical, others close and some very different. How do bilingual infants construct phonemic categories if the languages that they acquire are phonetically and rhythmically close? In Spanish, for example, there is only one /e/ sound and in Catalan there are two: an /e/ that is close but not identical to the Spanish one and another /ɛ/. Bilingual Spanish-Catalan adults with dominance in Spanish, who learned Catalan between 3 and 6 years of age, do not distinguish the /e/ from the /ɛ/ even though the Catalan monolinguals or bilinguals with a Catalan dominance do. For the Catalan-Spanish bilingual infants, this is a challenge when it is a matter of such subtle phonetic contrasts present in Catalan and absent from Spanish.

The perception of the contrast /e/ vs /ɛ/ at different ages was compared in three groups of infants, Catalan monolinguals, Spanish monolinguals and Catalan-Spanish bilinguals (Bosch and Sebastian- Galls, 2003). At four months of age, the three groups differentiate between /e/ and /ɛ/. At 8 months, as we already stated, Catalan monolinguals continue to differentiate them because the contrast exists in their language, but not Spanish monolinguals; even more surprising, bilinguals are unable to make the difference even though Catalan is one of the languages that these babies regularly hear. A supplementary group of bilingual babies 12 months old was tested in the same conditions and were able to make the difference. Thus bilingual infants showed a developmental trajectory in the shape of a U[6], in other words decrease in capacity of distinguishing those sounds between 4 and 8 months and a recuperation of it at 12 months. This U-shaped trajectory was also seen for Catalan-Spanish bilinguals in the discrimination of the contrast /s-z/, which exists in Catalan but not in Spanish (Bosch and Sebastian- Galls, 2003; Sebastian- Galls and Bosch, 2009).

It is possible that the babies calculate the frequency of sounds that they hear in their environment. When a sound is extremely frequent, it quickly gives way to the creation of a category: this is the case for the Spanish /e/, more frequent than the two vowels in Catalan. Foreign sounds, if they fall into proximity to this frequent category of sounds, are assimilated to it and therefore not distinguished among themselves: 8-month-old bilinguals show this behavior. At 12 months, after a more prolonged exposition and the beginning of the acquisition of words, the perception is more subtle and the phonetic[7] information has gradually transformed into more abstract phonological[8] information that is specific to the sound forms of the words: bilinguals then form

[6] The cognitive development of the child is not always linear. Certain capacities can appear at one age, disappear or diminish at another, only to later appear and stabilize. This gives the U-curve of development.

[7] Phonemic: related to the sounds of a language, where and how they are produced (for example: /b/ vs /p/)

[8] Phonological: explores the differences between sounds that change the meaning of the utterances (example: /ba/ vs. /pa/).

three categories for the /e/ vowels (Bosch and Sebastián-Gallés, 2005). The techniques for exposing the perceptive capacities being thus refined, we are now capable of measuring the anticipatory eye movements (AEM), even for infants only several months old. In this procedure, the children are sitting in front of a screen where an image disappears behind an obstacle to appear either to the left or to the right of the screen. When the image appears to the left, a sound is emitted, different from the one emitted when the image appears to the right. When hearing one of the two sounds, the child can through their gaze anticipate which side the image will appear on if they are able to discriminate the sounds from one another.

Thanks to this technique, it has been possible to show that 8-month- old Catalan-Spanish bilinguals discriminate the contrast of /e/ vs /ɛ/ as well as the Catalan monolinguals of the same age (Albareda-Castellot et al., 2011). Convergent results were given in a study where the French-English bilinguals had to discriminate two different realizations of the phoneme (d): in French (d) is a dental consonant (pronounced by putting the tongue against the teeth), whereas in English the ($d^h$) is alveolar (the tongue touches the palate) (Sundara et al., 2008). Ten-month-old French monolingual infants make no difference between these two sounds, while bilingual and monolingual English babies do. Apparently, bilingual children are not even momentarily late in the perception of phonetic contrasts in the languages to be acquired.

Clearly, bilingual children do not confuse their two maternal languages because they can differentiate them very early on. For the acquisition of the phonemes, consonants and vowels, one sometimes observes a slight tardiness in relation to monolinguals. This delay could simply be due to the fact that a bilingual child receives twice as little exposure to each of their maternal languages in comparison to a monolingual child. In addition, one of the languages is unavoidably more present than the other in the child's entourage. This dominance of one language over another is shown starting in the first weeks of life and influences the formation of phonological categories or the construction of phono-tactical rules (combination of phonemes in one language). Certain combinations will be more frequent in one language than in another, others are inexistent in one language and authorized in another—for example in Japanese words, there is a constant alternation of consonants and vowels, while in Serbo-Croatian, there are words where several consonants come one after the other(ex: "prst"). Thus, when we presented sounds whose combination was possible in Catalan ("tirk"), but not in Spanish to Catalan-Spanish bilinguals and to Spanish-Catalan bilinguals, the 10-month old Catalan-Spanish bilinguals for whom Catalan is dominant, showed a preference for "tirk" vs "tifk", this last combination existing neither in Catalan nor in Spanish. Bilinguals for whom Spanish was the dominant language, as for them, showed no preference (Sebastián-Gallés and Bosch 2002). There is therefore effectively no symmetry between a Catalan-Spanish bilingual and a Spanish-Catalan bilingual because of the fact that one language is always dominating the other, including for bilingually born babies.

### 2.2. The nonverbal identification of languages

The attraction produced by languages on bilingual babies and the incredible capacities that the baby sets to work in order to differentiate them does not rely exclusively on the acoustic, melodic or phonetic properties of the speaking but also on the visual information of the faces that speak these languages. In one study, researchers filmed three French-English bilinguals while they told a children's story in French or in English. The researchers presented monolingual and bilingual infants with silent video of these three women expressing themselves successively in French for one group of children or in English for another group. At the same time, they measured the time each child spent watching the videos (Weikum et al., 2007).

After several minutes of familiarization, the test phase started during which the children continued to watch the videos of the same women telling (still silently) new stories, either in the same language ("control" situation) or in the other language ("experimental" situation). If the infants can differentiate between the languages solely based on visual information, they would therefore watch videos in the "experimental" situation longer than in the "control" situation. In actuality, 4 to 6-month-old monolinguals differentiate the languages, but not 8 month olds, even though the French-English bilinguals continue to differentiate languages beyond 8 months. Here too, around 8 months, one observes a lowering of the interest of monolinguals for the foreign language. On the other hand, bilingual experience allows for this attraction to be maintained for languages, even if it is only a question of silent speech. The facial expressions during speech present a source of additional information that must play an important role in the discrimination of languages.

Which part of the face is the most attractive? Intuitively, it appears clear to us that it is the mouth. However, over the course of development, the baby's gaze does not see the same parts of the face as their interlocutor.

New techniques that precisely record eye movements have allowed for the discovery of important phenomena. When the video of a women speaking the maternal language (English) was presented to 4-month-old babies, they mostly look at the eyes, but at 6 months of age, when they start babbling, their attention is also drawn to the mouth and the eyes. At 8 months of age, they pay more attention to the mouth, whether the speaker is speaking in their maternal language or in a foreign language, and at 12 months they no longer look at the mouth as much as previously when the speaker speaks in their maternal language but stare at the mouth when it is a speaker of a foreign language (Lewkowicz and Hansen-Tift, 2012). In this study, it was concluded that when children start to have a preference for staring at the speaker's mouth, they differentiate the maternal language from the foreign language. The preference for the maternal language emerges between 8 and 12 months of age, a critical one in which the children use the audiovisual indications to acquire articulatory gestures. The same type of results were observed with monolingual children whose maternal language was Spanish (Pons et al., 2015). But, when these authors presented the videos to bilingual children, the behavior of these bilinguals was different from that of monolinguals: they practically do not stare at the speaker's eyes, whatever the language in which she speaks, whether maternal or foreign. Their attention is essentially paid to the mouth. Apparently, young bilinguals use different strategies for acquiring languages in relation to monolinguals. These not only make them no later in linguistic development but bring them to solicit other cognitive capacities earlier and better.

## 3. The advantages of bilingualism

Bilingual infants behave like monolinguals at the same age in many linguistic circumstances. However, this does not mean that language acquisition proceeds in exactly the same way in mono- and bilingual children. In the acquisition of certain subtle phonological properties, bilinguals can take a bit longer than monolinguals before their competencies in both languages stabilize. But, the vast majority of researchers firmly maintain that bilinguals do not progress any more slowly than monolinguals do. In addition, much recent research shows the advantages of bilingualism in linguistic and non-linguistic tasks that engage the cognitive processes implied in attention and inhibition (Kovács & Mehler, 2009; Singh et al., 2014). For example in some language-related tasks, the ability to distinguish between two /d/, one proper to French and the other proper to English, was studied in two groups of infants: a group of English-French bilinguals and two groups of French and English monolinguals (Sundara et al., 2008). At 6 to 8 months, it appears that the three groups are up to the task; however, at 12 months, the English monolinguals and bilinguals are able to, while the French monolinguals are not. Thus, the perceptive capacity of bilinguals exceeds that of French monolinguals and shows the presence of two languages maintains sensitivity to subtle phonetic differences.

Faced with the perception of the lexical accent, the one borne by words, bilinguals also show an advantage. Languages such as German or English place the accent on the beginning of disyllabic words (such as « **doc**tor » or « **ca**rrot »). These languages are called « trochaic ». On the other hand, in languages such as French, the accent is rather placed on the second syllable (« doc**teur** » « car**otte** ») or at the end of the phrase (iambic). This property is very important in the acquisition of English and German, for the accentual contrast between the two syllables is prominent and regular: the learner of these languages can base themselves on this property in order to segment the continuous flow of speech and detect the beginning of words that generally start with an accented syllable. In French, on the other hand, the stress contrast between the beginning and the end of the word is not as remarkable and French infants cannot use the regularity of the interval with which accentuated syllables appear. This lack of noticeable stress contrast in French explains why French adults have a lot of trouble detecting the accent of a foreign language, even if they have practiced it over long periods of time (Dupoux et al., 2008). Certain authors speak of «deafness» to accent in French adults, whether they are monolingual or late bilinguals.

### 3.1. Advantages of bilinguals over monolinguals in lexical stress processing

A series of studies realized in our laboratory at the Université de Paris-Descartes, in collaboration with researchers at the University of Potsdam in Germany allowed us to understand at what age French, German, and French bilinguals with other languages prefer to listen to words with an initial accent (trochaic accent) as in German, English, or Dutch, or with words with a final accent (iambic accent) as in French. In the first series of experiments with monolinguals, 6-month-old infants were presented with different tokens of a single item (e.g., /gaba/) recorded either with a stress-initial (trochaic) or stress-final (iambic) pattern. Using the headturn

preference paradigm (Hirsh-Pasek et al., 1987), we recorded the mean orientation times for each of the two stress patterns. German infants show a preference for trochaic words at 6 months, while French infants show no preference for any accents at that age. Does the fact that French monolinguals show no preference for the final accent of their maternal language signify that they are « deaf » to the nevertheless acoustically very noticeable variations of accent? No, when we tested another group of 6-month-old French babies in the discrimination task, the French, at 6 months, differentiate between the two accents (Höhle et al., 2009). However, French-learning infants' sensitivity to lexical stress declines between 6 and 10 months of age. While at 6 months, they could discriminate stress patterns at 10 months, French-learning infants require more time to identify stress patterns (Höhle et al., 2009; Skoruppa et al., 2009; Bijeljac-Babić et al., 2012). This developmental path is probably reflecting early language- specific reorganization leading to the "stress deafness" found in French adults (Dupoux et al., 1997, 2001; Bhatara et al., 2013, 2015; Boll-Avetisyan et al., 2016). Therefore, sensitivity to stress should be relevant for lexical access for infants learning a language with (variable) lexical stress but not for French-learning infants. How do bilingual infants learning both French and a language with variable lexical stress manage to learn two different prosodic systems? We studied how they discriminate lexical stress patterns at 10 months of age in comparison with French-learning monolinguals. We hypothesized those bilingual infants who are acquiring both French and another language that use stress contrasts at the lexical level would have better stress pattern discrimination performance than French-learning monolinguals.

A series of three experiments was realized with 10 month-old infants, French-learning monolinguals and French-other language bilinguals. Experiment 1 tested the stress pattern discrimination performance of 10-month-old French learning monolingual infants, in two experimental conditions: following a 2-minute familiarization, and following a 1-minute familiarization as done in Höhle et. al, (2009). In both cases, the stimuli were the same as those used previously, i.e. /gaba/, sequences, stressed either on the first or on the second syllable. Our prediction was that a 1-minute familiarization would not allow these infants to discriminate the stress patterns, whereas a 2-minute familiarization would. In Experiment 2, bilingual infants were tested, in short familiarization condition. All infants had been exposed to their two languages from birth, but varied in terms of the balance of their linguistic input. We distinguished two subgroups of bilinguals, those with a rather balanced input, who were hearing both languages 40–60% of the time, (subgroup 1: ''balanced'' bilinguals), and the others who were hearing the language other than French 70–80% of the time (subgroup 2: ''dominant other language'' bilinguals). In Experiment 2 all bilingual participants were familiarized only for 1 minute (short familiarization). At first, we hypothesized that the presence of a stress-contrasted language would maintain/enhance the bilinguals' sensitivity to stress contrasts at a higher level than French-learning monolinguals. Secondly, we predicted that if these bilinguals are more proficient at processing stress than French-learning monolinguals, a short familiarization should then be enough to elicit discrimination. Finally, we hypothesized that a discrimination effect would be found in these bilingual groups (''balanced'' bilinguals and: ''dominant other language'' bilinguals), or at least in subgroup 2.

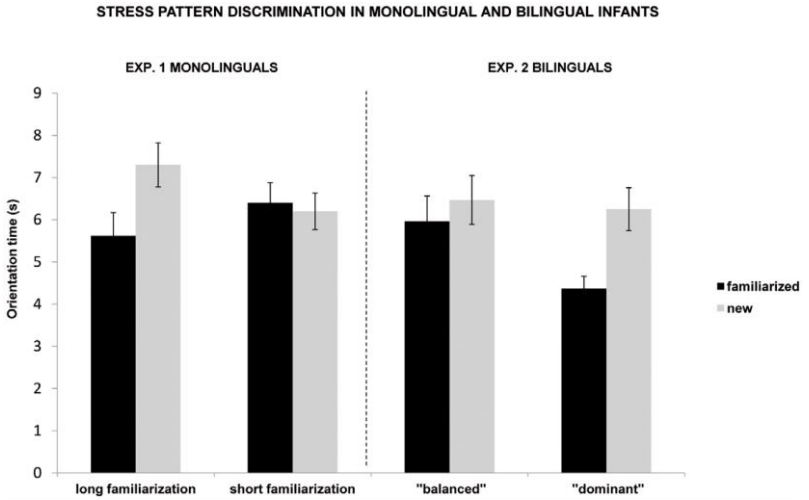


**Fig. 1**. Stress pattern discrimination in monolingual and bilingual infants. Mean orientation times to the familiarized and new stress patterns for 10-month-old infants. Experiment 1: monolinguals in short and long familiarization conditions. Experiment 2: bilinguals (''balanced'' and ''dominant other language'') in short familiarization condition. The error bars indicate the standard error of the mean. (Bijeljac-Babic et al, 2012, PLoS ONE)

The results with French-learning monolingual 10-month-olds, show that these infants can discriminate trochaic and iambic stress patterns following a long (2-minute) familiarization to one of the two patterns, as attested by a novelty preference, but not after a short (1-minute) familiarization. From the long familiarization discrimination result, we can conclude that by 10 months of age, French-learning infants are not ‘‘deaf’’ to lexical stress contrasts (even though such contrasts are absent in their native language). Regarding the effect of bilingualism, the comparison of the results of our two experiments clearly establishes that tested under the same conditions (1-minute familiarization time), bilinguals learning French together with a language that has lexical stress are more sensitive to stress pattern contrasts than monolinguals, but only if they are dominant in their stress-contrasted language, not if they received a balanced input of their two languages. Importantly for infants raised in a balanced bilingual environment, it is established that such infants are able to discriminate prosodic contrasts present in one of their native languages, even if these contrasts are not present in their other language, extending previous research conducted on a similar issue for the acquisition of the phonemic categories (Bijelac-Babić et al., 2012).

Would such abilities extend to contexts with segmental variability, in which infants need to detect a common prosodic pattern over different words, beyond segmental variability? In the next study, we examined lexical stress perception in the presence of segmental variation in 10-month-old French-learning monolinguals and bilinguals learning both French and a second language with variable lexical stress (Abboub et al., 2015). We used the same procedure as Bijeljac-Babić and colleagues (2012) to study discrimination in a difficult 1-min familiarization condition and the stimuli used by Skoruppa and colleagues (2009). The stimulus were the 8 CVCV pseudowords for familiarization recorded either with stress on the initial syllable (trochaic: /‘datu/, /‘sapi/, /‘kiba/, /‘nuki/, /‘latu/, /‘buki/, /‘luma/, /‘tiku/), to be used with half of the infants, or with stress on the final syllable (iambic: /da’tu/, /sa’pi/, /ki’ba/, /nu’ki/, /la’tu/, /bu’ki/, /lu’ma/, /ti’ku/), to be used with the other half. The 8 test phase stimuli (to be used with all infants) were recorded only once. Of these, 4 had initial stress (trochaic: /‘lapi/, /‘naku/, /‘nila/, /‘tuli/) and the other 4 had final stress (iambic: /ki’bu/, /lu’ta/, /pi’ma/, /pu’ki/).

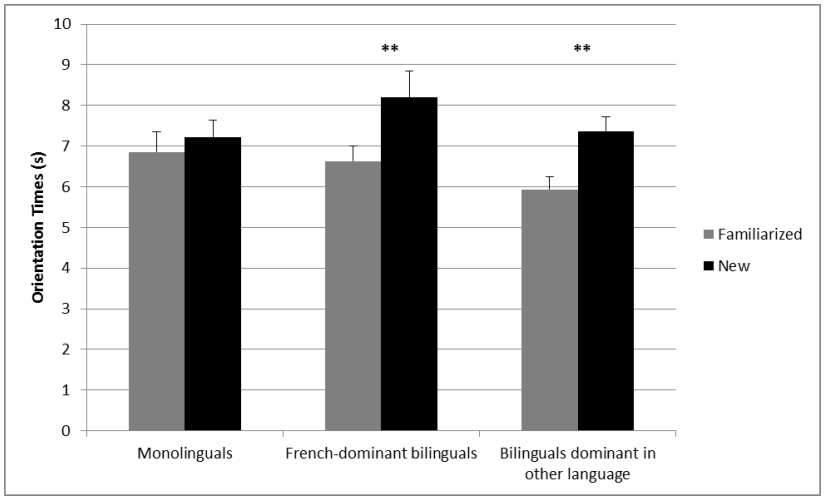


**Fig. 2.** Mean orientation times (and standard errors) to the familiarized versus new stress patterns, broken down by linguistic group: French-learning monolinguals, French-dominant bilinguals (60% to 70% French), and not-French-dominant bilinguals (30% to 50% French). **p < .01. (Abboub et al, 2015, J. Exp. Child Psycho.)

In this context of segmental variability, the monolingual infants failed to discriminate, whereas the bilingual infants succeeded. This suggests that these bilingual infants could perceive and adequately process cues for lexical stress even if they were not produced with exactly the same characteristics as in the languages with (variable) lexical stress that the bilingual infants were hearing in their environments. Furthermore, there was no difference between two groups of bilinguals; the performance was as good in the French-dominant subgroup as in the not-French-dominant subgroup. Our findings establish that even 30% of exposure to a language with variable lexical stress might be enough for bilingual infants to differentiate stress patterns in lists of segmentally varied pseudowords. This pattern of results differs from that found for stress contrast discrimination using a single item (/gaba/) in Bijeljac-Babić and colleagues (2012). In that study, only the not-

French-dominant 10-month-old bilinguals (30% to 40% exposure to French) performed better than French-learning monolinguals, with the subgroup of balanced bilinguals showing only a marginal effect. Among different explication to account for these differences across studies, one possibility is based on results in various studies showing that bilinguals have cognitive advantages over monolinguals, in particular for executive functions (for reviews, see Bialystok, Craik, & Luk, 2012; Kroll & Bialystok, 2013), and such effects can be found in infants as young as 7 or 12 months (Kovács & Mehler, 2009a; Kovács & Mehler, 2009b). Altogether, the current findings contribute to our understanding of early bilingual acquisition and demonstrate increased sensitivity to lexical stress patterns in French–other stress language bilinguals compared with French-learning monolinguals, as predicted by the prosodic characteristics of the infants' native languages.

## 4 Conclusion

If bilingual children go through the same phases at the same moments as the monolinguals over the course of the development of language during the first year, and this in almost exactly the same way for the two languages, one possible explanation would be that certain cognitive capacities (for attention, inhibition…) are developed more precociously than in monolinguals. The interest for novelty, more marked in bilingual infants than in monolinguals, might also be due to the bilingual's environment. In all these ways, this environment is more diversified and rich than that of monolinguals; it demands a more flexible mental activity more attentive to changes and sensitive to novelty.

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# The possibility of studying deeper levels of meaning in the most frequent verbs in Serbian language

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„If the thought is a prerequisite for creation, then the language is its indispensable condition"
*A. Margot*

**Abstract**. This paper represents a pilot study in which the deeper meaning and the legitimacy of mutual interactions of the first 10 most frequent verbs from the Serbian language corpus (SLC) are to be considered.
Taking into account the views of the new psychoneurolinguistics (NPNL), that each word has its external and internal value, i.e. that a word, besides its external communicational meanings, has also an internal value through the informational and energetic content, contained in its levels of spiritual, astral and material codes, we analyzed the codes of the first 10 most frequent verbs from SLC, which are encoded by NPNL method. Then, they were presented according to the frequency of occurrence in the Serbian language, by the code size (levels: intentions, primacy and executions) and level of degree of freedom of word code. Observing the codes and the degree of freedom, the attributive analysis of the "informational-energy-material flow" of the verb by NPNL approach has been carried out.
*Key words*: language, word, verbs, Serbian language corpus, word code, NPNL

## Introduction

### About Serbian language corpus

Serbian language corpus (SLC), among other things, enabled the acquisition of insight into the dynamics of frequencies in Serbian language words. SLC is an unique corpus in the world, which was developed in the Institute for Experimental Phonetics and Speech Pathology under the management of Đorđe Kostić and around 300 professors of Serbian and Old Serbian language, in period from 1954-1961. SLC is the biggest corpus in the world, grammatically processed by hand, and it has over 11 million words. It is the only diachronic language corpus in the world, because it is consisted from sampled texts of everything that is written in Old Serbian and Serbian language from 12$^{th}$ to 20$^{th}$ century. Content is formed out of few subsamples: files from 12$^{th}$ to15$^{th}$ century; subsample of literature from 15$^{th}$ to 18$^{th}$ century; subsample of Vuk Karadžić's language; and subsample of contemporary language which is consisted of 5 subsamples: daily press, contemporary poetry, literary prose, political texts and scientific texts. Đorđe Kostić was working with his associates on the development of SLC. His aim was realization of automatic recognition of speech, a project of machine translating, and the development of analyzer and synthesizer of voice and a phonetic machine. Quantitative description of Serbian language's phonetic structure with produced realistic frequency of Serbian language speech sounds, depending from position in the word, as well as the probability of speech sounds joins was conducted. Also, they also worked on syntax in verbs. For its aim, diachronic vocabulary not only has the detection of patterns in Serbian language's dynamics of development, but also it has to enable the mathematical approach to language changes in the function of time. SLC is transferred to electronic shape.

In the second half of 20$^{th}$ century, as Kostić said "all research has been directed to communication with machines through the language, so that machines can communicate by language, and so that they could communicate with human beings, and as a solution, especially in the United States, the need arises to reduce the language to formal logic as far as possible, by classifying linguistic phenomena, and by determining their relationships to find the laws by which words are interconnected in sentences. Normative grammar is created in such a climate". Kostić considered that the reduction of language to formal logic is impossible, and that this direction in language research would neglect the research of language nature, language comprehension, its development and tracking its changes, and that it would disable planning of its future. In his attitude and his

research, Kostić insists on the research of language nature, indicating that it is necessary to get into the core deep "complexities of language phenomena, from phonology to lexicon, up to the systems of shapes which are being connected to the higher grammatical system of meanings". If we would accept the division of language tools and classification of grammatical forms in the way that it is represented in contemporary grammar, then we would not be able to enter the language nature.

In his research, he mostly relies on the frequency of appearing of grammatical forms, published in „ Structure of the usable value of forms in the Serbian language "(IEFP, 1966). His intentions were to release the language science from classification approach, and to indicate to the direction of deeper research of complex language structure. So, in his research, he begins with „the noun which is the only independent word in language and it represents the basic core in every comprehension", with the intention to break free from division of grammar from semantics and grammar from syntax, in aim of forming the comprehensive view on language, without the division, which was mostly caused by formal approach in language research. He published his direction in research of language comprehensiveness in the book „Operational grammar" (1987), where he pointed out that „in every lexical determinant, its whole grammar exist virtually, and he clearly indicated what is the difference between sign-symbol on one side, and the word-which is capable to enter into the language game... when boundaries between lexicon and grammar, and grammar and syntax were eliminated, the syntax itself had to be changed, and by that it pulled with itself the changes of comprehension of word division into types".

The important thing for our research is Kostić's attitude expressed in „Operational grammar", that „the language research would move in the direction of application of technology on language phenomena, primarily on the improvement of realization system and on the transmission of thoughts, and on the detection of central nervous system functions because the human behavior in life depends on better understanding of these functions (and language could serve as one of the approaches to that better understanding)". Also, for the approach in our research, Kostić's attitude towards verbs as dependent words is very important „Verb word can't be observed as simple sign, as simple denominator of action, process, state of motion etc., but he has meanings in itself, which could be derived from global verb meaning and could be observed as relatively independent. It would mean that the verb is not closed in itself, but it is a syndrome of meanings, which by its functions, makes so much possibilities that its organs could be observed in the realization of meaning as relatively independent phenomenon".

## About NPNL

NPNL is a field in informational technologies which is based on automatic processing of data, through using the highly sophisticated NPNL computer program with specially developed algorithms for coding words and sentences, as well as „infiltration" of one word through different languages (JAA, patent reg. No. S79/91, S47/94, S5/97, S65/98).

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|---|---|---|---|---|---|---|---|---|
| **А 1** | **Б 2** | **В 3** | **Г 4** | **Д 5** | **Ђ 6** | **Е 7** | **Ж 8** | **З 9** | **И 10** |
| **Ј 11** | **К 12** | **Л 13** | **Љ 14** | **М 15** | **Н 16** | **Њ 17** | **О 18** | **П 19** | **Р 20** |
| **С 21** | **Т 22** | **Ћ 23** | **У 24** | **Ф 25** | **Н 26** | **Ц 27** | **Ч 28** | **Џ 29** | **Ш 30** |

**Graph 1.** SERBIAN CYRILLIC SCRIPT-SPIRITUAL LEVEL-level of intention

The base for coding is sequence number of letters in: Serbian Cyrillic script-gives informational word code (Graph 1) (spiritual level-level of intention), English Alphabet-gives energetic word code (Graph 2) (astral level-level of handover) and Serbocroatian Alphabet-gives physical word code (Graph 3) (material level-level of execution). NPNL informational technology system in its theoretic and computer program unified knowledge, not only from different scientific disciplines (linguistics, psycholinguistics, neurolinguistics,

epistemology, phonetics etc.), but also from ancient knowledges: gematria (the substitution of word positions who have the same code in text), notarikon (reading of words as anagrams) and temurah (speculative technique of finding the deeper meaning), kabala, kazodama, kotodama etc. The results of processing are numbers-codes, so that the words which have the same code belong to same measured level. It discovers the deeper levels, words and their essential interconnection, cause-consequence interaction and material manifestation (Margot, 2010).

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **A 1** | **B 2** | **C 3** | **D 4** | **E 5** | **F 6** | **G 7** | **H 8** | **I 9** | **J 10** |
| **K 11** | **L 12** | **M 13** | **N 14** | **O 15** | **P 16** | **Q 17** | **R 18** | **S 19** | **T 20** |
| **U 21** | **V 22** | **W 23** | **X 24** | **Y 25** | **Z 26** | | | | |

**Graph 2.** WEST ALPHABET-ASTRAL LEVEL-level of handover

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **A 1** | **B 2** | **C 3** | **Č 4** | **Ć 5** | **D 6** | **DŽ 7** | **Đ 8** | **E 9** | **F 10** |
| **G 11** | **H 12** | **I 13** | **J 14** | **K 15** | **L 16** | **LJ 17** | **M 18** | **N 19** | **NJ 20** |
| **O 21** | **P 22** | **R 23** | **S 24** | **Š 25** | **T 26** | **U 27** | **V 28** | **Z 29** | **Ž 30** |

**Graph 3.** SERBOCROATIAN LATIN SCRIPT-MATERIAL LEVEL-Level of execution

In The Old Testament it is written „In the beginning was the Word, and the Word was with God, and the Word was God. The same was in the beginning with God. All things were made by him; and without him was not anything made that was made. In him was Life, and the Life was the light of men". By that, Word originated before Men. By NPNL learning (New Psycho Neural Linguistic), language is the God-Creator-Maker-Author-Lord, the purpose of language is the creation-materialization of imagined concept, which is still being realized, namely, the language is the mediator-catalyst. It means that language-word originated before us and that we gradually "revealed" it by time, and that it "revealed" to us, by the Creator's will.

Word is simultaneously, an instrument for creation and the top creation, and the Lord gave it only to Man, to create with it. Man finally has to find out that he, himself creates his life with thoughts and words, and by that, he influences on the lives of others, he is joint creator in cosmic creation. Taking into account that the verb TO BE is the most frequent word and, at the same time, the most frequent verb in Serbian language (frequency 94498), we will present the short display of TO BE as: phonological sequence, word, and as the meaning of sentence TO BE TO BEE (noun) TO BEEE (noun) TO BE (verb), through NPNL prism. If we observe this sentence through three levels of creation, by NPNL, we will notice that it reveals to us the line of creation from the quantum point - the source (informational-spiritual level) through astral-energetic, to physical-material level. It is very difficult to understand the essence and meaning of this sentence if you don't speak Serbian language, namely, it is nearly impossible to translate this sentence on any other language, and to keep the essential meaning (words with vocal E repetitions should be read with different durations of vocal E). BE BEE BEEE BE on informational level (spiritual) comes with the word BE-on energetic-handover level is BE BEE BEEE, and on physical-material level is BE BEE BEEE BE. Is it an accident that the verb TO BE is the most

frequent word in Serbian language? Starting from all previous premises, the need for modern research to focus on the study of the possibility of objectively measuring the force, power, and depth of meaning of the word is inevitable.

Taking into account these aspects, the aim of our research was to code and analyze the first ten most frequent verbs in Serbian language, from SLC, on informational-energetic-material level, in aim of comparison of their codes by NPNL system, and to explore deeper meanings and patterns of their mutual interactions.

## Methodology

In the accordance with the study aim, coding of the first ten most frequent verbs from SLC was conducted, by the application of NPNL computer program. Obtained codes, with the degrees of freedom of codes, served for the estimation and redistribution of verbs by the size of codes and degrees of freedom of codes. Results are shown in tables and graphs.

## Results

**Table 1.**First 10 verbs by the frequency of appearing in Serbian language (SLC)

| Verbs | Frequency | P | log2(p) |
|---|---|---|---|
| **To Be** | **94498** | **,047592** | **4,3931** |
| **To Want** | **12854** | **,006474** | **7,2711** |
| **To Can** | **4766** | **,002400** | **8,7027** |
| **To Know** | **4123** | **,002076** | **8,9120** |
| **To Have** | **3905** | **,001967** | **8,9898** |
| **To See** | **2720** | **,001370** | **9,5116** |
| **Not to Have** | **2645** | **,001332** | **9,5522** |
| **To Say** | **2224** | **,001120** | **9,8023** |
| **To Need** | **2179** | **,001097** | **9,8322** |
| **To Come** | **2118** | **,001067** | **9,8722** |

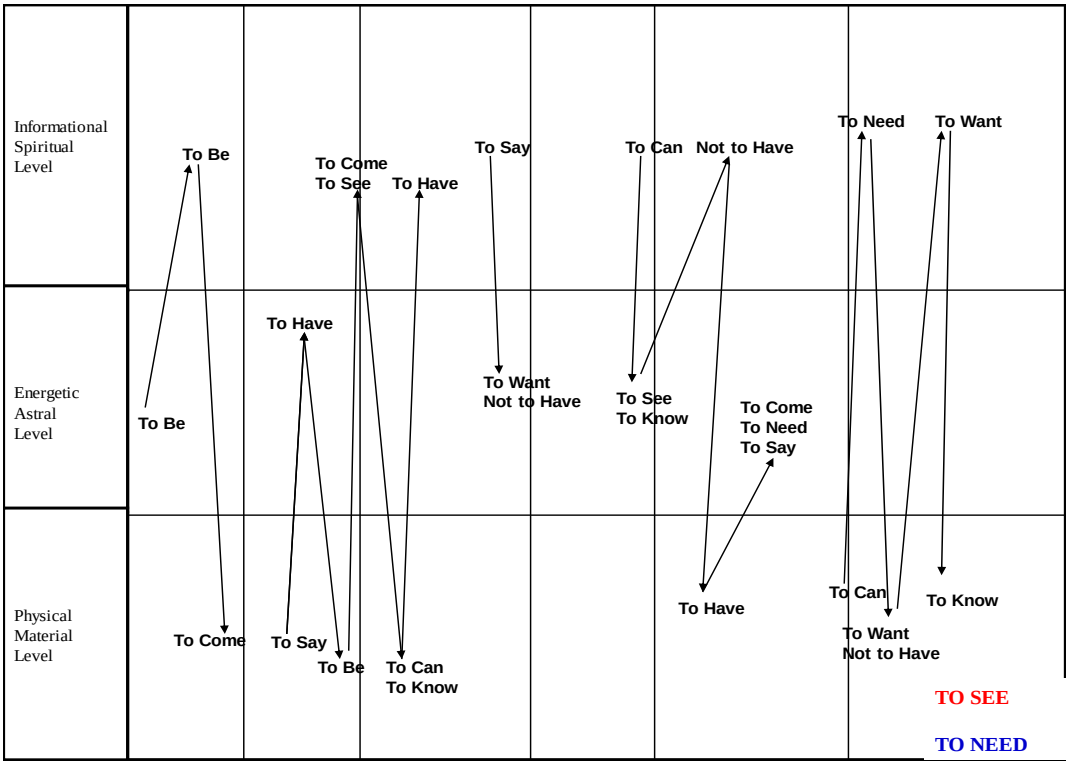
First ten most frequent verbs from SLC with calculated probability of appearing and logarithmic probability are shown in Table 1.

In table 2, verbs and their codes on all three levels and specified degrees of codes freedom are shown. By tracking them, we can notice the informational-energetic-material flow (IEMF) of verbs. In our opinion, it can indicate on one of the creation models, from providence to words/object/event. Codes that indicate through which common codes the verbs can be linked are marked with stars (Margot, 2010).

**Table 2**.The order of verbs in terms of code size in three examined levels

| | | | |
|---|---|---|---|
| To Be | A | $40^{2}$ | 38 39 40 41 42 |
| To Be | S | $44^{0}$ | |
| To Come | M | $45^{1}$ | 44* 45 46 |
| To Say | M | $50^{2}$ | 48 49 50 51 52 |
| To Have | A | $52^{2}$ | 50* 51* 52* 53 54 |
| To Be | M | $54^{1*}$ | 55 56 57 |
| To Come | S | $56^{1}$ | 55* 56* 57* |
| To See | S | $57^{1}$ | 56* 57 *58* |
| To Can | M | $57^{1}$ | 56* 57 *58* |
| To Know | M | $58^{1}$ | 57* 58* 59 |
| To Have | S | $58^{0*}$ | |
| To Say | S | $60^{1}$ | 59** 60 61 |
| To Want | A | $62^{2}$ | 60* 61* 62 63 64 |
| Not to Have | A | $62^{2}$ | 60 61* 62* 63* 64* |
| To Can | S | $66^{1}$ | 65 66 67 |
| To See | A | $69^{2}$ | 67* 68 69 70 71 |
| To Know | A | $70^{2}$ | 68* 69*70* 71* 72 |
| Not to Have | S | $71^{2}$ | 69* 70* 71* 72* 73 |
| To Have | M | $71^{2}$ | 69* 70* 71* 72* 73* |
| To Come | A | $73^{2}$ | 71* 72* 73* 74 75 |
| To Need | A | $75^{2}$ | 73* 74* 75* 76* 77 |
| To Say | A | $77^{2}$ | 75* 76* 77* 78 79 |
| To can | A | $82^{2}$ | 80 81 82 83 84 |
| To Need | S | $84^{1}$ | 83* 84* 85 |
| To Want | M | $86^{2}$ | 84* 85* 86 87 88 |
| Not to Have | M | $86^{3}$ | 83 84* 85* 86* 87* 88* 89 |
| To Want | S | $87^{1}$ | 86* 87* 88* |
| To Know | M | $88^{2}$ | 86 87 88* 89 90 |
| To See | M | $95^{3}$ | 92 93 94 95 96 97 98 |
| To Need | M | $100^{3}$ | 97* 98* 99 100 101 102 103 |

Legend: S-spiritual-informational; A-astral-energetic-transmitting-handover; M-material-physical




**Graph 4**. IEMF of verbs in the process of creation-schematic display

## Conclusion

Our results in the examination of deeper meanings in mentioned verbs, by applying only the elementary level of NPNL through the coding program for three code levels and their degrees of freedom (Table 1, Table 2, Graph 4), indicate that it is possible to „ENTER“ into deeper levels of meanings in verbs, to perceive their inter correlations, interrelations, and interactions on all three examined levels and that Kostić was right by claiming that: „it would mean that the verb is not closed in oneself, but it is a syndrome of meanings which, by its functions, makes possibilities so that its organs can be perceived in the fulfilment of meaning as relatively independent phenomenon“. On Graph 4, simplified IEMF of most frequent 10 verbs in Serbian language could be seen. TO BE (to exist) on I level simultaneously is TO COME on M level. TO SAY (something) on M level is TO HAVE (transferred signal) on E level and TO BE (to exist) on M level, but simultaneously TO COME and TO SEE on S level, simultaneously TO CAN TO KNOW on M level, which is simultaneously TO HAVE on S level. TO SAY on S level (an idea) on E level is TO WANT and NOT TO HAVE which means having a desire, but maybe not having: possibilities, courage, knowledge etc. TO CAN on S level provides TO SEE and TO KNOW (insight and knowledge) on E level, but also NOT TO HAVE on S level, because TO CAN from S level on E level had INSIGHT and KNOWLEDGE which provides TO HAVE on M level and simultaneously TO COME TO NEED and TO SAY on E level. However, when TO CAN (something) comes from M level TO NEED on S level, it conditions TO WANT and NOT TO HAVE (powerful but disrupted desire) simultaneously launches TO WANT on I level (power of beliefs, faith and desire) which on M level provides TO KNOW. The cycle of creation with these verbs (IEMT of verbs) ends with TO SEE and TO NEED on M level, in order to continue process of movement and creation. **With the application of NPNL program, it is possible to enter into deeper connections, interdependencies and interrelations of words, and to apply obtained results into different activities and scientific fields.**

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## Могућност изучавања дубљих нивоа значења најфреквентнијих глагола у српском језику

„Ако је мисао предуслов стварања, онда је језик његов неизоставни услов“

А. Маргот


Рад представља пилот истраживање у коме се жели сагледати дубље значење, и закономерности међусобних интеракција првих 10 најфреквентнијих глагола из Корпуса српског језика (КСЈ).
Имајући у виду ставове нове психонеуролингвистике (НПНЛ), да свака реч има своју спољашњу и своју унутрашњу вредност тј.,да реч поред својих спољашњих комуникативних значења, има и унутрашњу вредност кроз информациони и енергетски садржај који се налази у њеним нивоима духовних, астралних и материјалних кодова, извршили смо анализу кодова првих 10 најфреквентнијих глагола из КСЈ, који су кодирани методом НПНЛ. Затим је извршена њихова презентација по фреквенци јављања у српском језику, по величини кодова (нивои: намере, примо-предаје и извршења) и степену слободе кода речи. Посматрајући кодове и степен слободе кодова извршена је атрибутивна анализа „информационо-енергетско-материјалног тока“ глагола по НПНЛ приступу.


*Кључне речи*: језик ,реч, глаголи, Корпус српског језика, код речи, НПНЛ

# **“To be or not to be?” What a question!**©2017

J. R. G. Turner, T. G. N. Turner

Co-Founders/Co-Directors: Whole-Self Discovery & Development Institute, Inc. International

**Abstract:** This question by William Shakespeare articulates a conundrum which has perplexed humanity for hundreds of years. In this paper, we find Hamlet descending the ramparts of Castle Elsinore and wandering in the graveyard coming upon the skull of his once Court Jester, Yoric. His words help us to uncover clues about language to be discovered. The authors explore some profound Philosophical thoughts about speech and language. They also share an important discovery about language in Whole-Self Therapy Practice by Sigrid Westermann.

## Introduction

Recently, Olga Gouni suggested that at the age of 83 and a half I needed to consider writing something Philosophical. As many of you know, Troya & I have written and spoken extensively about Whole-Self Prebirth Psychology confirmed by Brekhman. How we discovered and for some 50 years traveled the globe to share our hypothesis that the evolutionary way that nature transfers thoughts and emotions to the next generation is through mother during her pregnancy. The Whole-Self Prebirth Psychology discovery in 1970 is, that when mother has a trauma during her pregnancy, her baby is born - and lives all through life - with the thoughts, the words and feelings that the trauma is its own until resolved through Whole-Self Prebirth Psychology Therapy. We call this a *trauma trance* encoding the evolutionary *Whole-Self Emotional DNA.*

So with that said, donning my Philosophical Cap I will now attempt to, as the English idiom says “wax philosophical.” Even in the early 1950s when I was attending the College of the Holy Cross in Worcester, Massachusetts, I was still challenged to speak or write. We have spoken about this at earlier Speech and Language Congresses under the titles *My Brain Just Did Not Give Me Anything to Say* and *Now Our Brains Give Us Something To Say*! Holy Cross is a Jesuit College offering intense development and precision of logic and expression. I had a roommate who with a photographic memory could flip through all the homework in minutes while I had to spend hours repeating a sentence ten times to glean any understanding of the meaning of the sentence.

Now, I reveal a secret to you. The only subject I had complete understanding of was the *Plays of William Shakespeare*. We had to read and be able to discuss a complete play of a Shakespearian every class. Somehow, I knew the meaning of every Elizabethan word and phrase. It was inevitable that I wrote my graduation thesis on Shakespeare’s Theater.

## Hamlet, the Prince of Denmark

In the annuls of human communication in the English language, perhaps the most profound words of Elizabethan playwright William Shakespeare were spoken by Hamlet, the Prince of Denmark, in the play ***The Tragedy of Hamlet, Prince of Denmark***. Wandering the graveyard of Castle Elsinore, Prince Hamlet comes upon an open grave where he spies the bare skull of his once Court Jester and friend, Yoric. His already befuddled brain asks the question which since 1604 has echoed through human consciousness these hundreds of years.

**“To Be or Not To Be? That is the Question!”**

Let us eavesdrop on his profound inner thoughts of the *Soliloquy*, the random explorations of Hamlet, the depressed Dane, as he tenderly holding Yoric’s skull, speaks thoughts which have reverberated through human consciousness every since. Here is Hamlet’s monologue with Yoric, his decapitated mentor. Just listen to the cadence, sensing, not necessarily needing to understand every word of Hamlet’s meaningful musings as he bares his heart and soul:

***The Tragedy of Hamlet, Prince of Denmark*** Act III, Scene 1

To be, or not to be? That is the question!
Whether 'tis nobler in the mind
to suffer the slings and arrows of outrageous fortune,
or to take arms against a sea of troubles,
and by opposing end them?

To die: to sleep no more; and by a sleep
to say we end the heart-ache
and the thousand natural shocks that flesh is heir to.

'tis a consummation devoutly to be wish'd.
To die, to sleep; to sleep:
perchance to dream: ay, there's the rub;
For in that sleep of death what dreams may come
when we have shuffled off this mortal coil
must give us pause:

There's the respect that makes calamity of so long life;
for who would bear the whips and scorns of time,
the oppressor's wrong, the proud man's contumely,
the pangs of despis'd love, the law's delay,
the insolence of office and the spurns
that patient merit of the unworthy takes,
when he himself might his quietus make
with a bare bodkin?

Who would fardels bear,
to grunt and sweat under a weary life,
but that the dread of something after death,
the undiscover'd country from whose bourn
no traveler returns, puzzles the will
and makes us rather bear those ills we have
than fly to others that we know not of?

Thus conscience does make cowards of us all;
and thus the native hue of resolution
is sicklied o'er with the pale cast of thought.
And enterprises of great pitch and moment
with this regard their currents turn awry,
and lose the name of action.—

What Shakespeare has done is to delve into the depth of human consciousness few authors before, or few after, have dared to explore. Through Prince Hamlet, aggrieved by the murder of his father by the conspiracy of

his feckless mother and his uncle, we are presented with a priceless gift – a sacred offering of astounding words - speech and language so beautifully able to share what some might consider to be even unthinkable domains.

Ideas and concepts gifted from one mind – Hamlet's to Joric's, and through Shakespeare's quill to my mind, to your mind – sometimes directly, sometimes indirectly; sometimes clearly, sometimes obtusely; transfers of insights, philosophies, beliefs, desires, fantasies; unspeakable fears, doubts, and dreads.

Phantoms of thought can flit past the mind's eye in an amorphous, hardly recognized form. And, there can be secrets, unutterable pictures hidden in cloudy vistas but still propelling behaviors and actions - consciously or non-consciously. All these dimensions explored in such brevity and conciseness, they can literally be breathtaking.

While we have shared some philosophical thoughts with you we want to share a very practical Whole-Self Prebirth Psychology discovery about Speech and Language by Sigrid Westermann (Whole-Self Co-Director for Germany) in Hamburg, Germany. Here is a summary of a W-S Session with Maren.

Maren, a Danish native, asked Sigrid for a Whole-Self Coaching Session. Maren has been living in Germany for 40 years and speaks the German language perfectly. She even thinks and dreams in German.

About 10 years ago, Maren had done the complete Whole-Self Prebirth Psychology Session for 8 hours and also had some other separate hours with Sigrid. Sigrid prefaces by saying that Maren is a very unique woman. She is advanced with an open heart and a quick analytical, mind. In addition, she paints unusual, impressive pictures that appeal to even the most discerning and critical viewers. She has an office job where she is head of a small department. Maren has a high school diploma; although she was able to reap great success in school and international competitions. She has not been to University,

Maren is now almost 60 years old yet looks about 15 years younger and is very healthy and graceful. Maren lives alone, having been divorced for many, many years. All her relationships which she entered after her divorce were unsatisfactory. She presented that in most of those relationships the men, even in her presence, gazed at other women and gave her the feeling of not being attractive enough for them. This extraordinary woman is admired and envied by all her female friends for her warmth, her friendly manner, her appearance, her beauty, her interest in art and culture, her material wealth, all women admire her, even envy her. Yet she has met one man after another who seemingly did not value her.

Meren shared with Sigrid about what happened when she and Johannes, her current partner, where on holiday. Again, he showed little respect for her by staring at women young enough to have been his granddaughters. When he could not turn his gaze from beauties on the beach or at supper, Maren, decided to visit Sigrid's office again.

Sigrid had observed that Johannes seemed to radiate sympathy. He appeared to be eight to ten years older than Maren, with a fat, jolly, wobbly belly. A retired Engineer he lived again in his motther's house. Sigrid had wondered why this man had apparently not recognized the jewel Maren is, and why he seemingly directed his desires to women who were 40 years younger than him. And, Sigrid wondered why he did not try to hide his apparent desires even in Maren‘s presence. In the Whole- Self Therapy Work with Maren it came out that Johannes was impotent. Sigrid knew that Maren had worked on her self-esteem problem years ago & thought it was resolved. I seemed evident that this lack of self-esteem was reflected to her by her chioce of partners.

So Sigrid said she decided to find out the truth of this reality. In a new Whole-Self Coaching Session with Maren, Sigrid asked her why the Whole-Self Work which in the past apparently had been so effective seemed to have failed. Maren surprised herself with the answer her Whole-Self gave her:

**"Because we have been working in German language and not in my mother tongue."**

So, from that point onwards Sigrid asked Maren to write down all the questions and answers they did in their W-S Session and then translate and repeat them at home in Danish.

In the next W-S Coaching Session, Maren was very enthusiastic about the results of their plan. She told Sigrid that she had discovered when they had worked in German, she understood and felt the memories correspondingly and connected with them. However, Maren said that when she repeated the exercises in Danish, she not only felt the feelings but was instantly put into the situation in which these feelings first came into her consciousness. When she then allowed herself to sense the stressful feelings in Danish as she passed through them again, they clarified the traumatizing situation in which the emotions had arisen and they subsequently dissolved. For instance, her very strict, rejecting mother now reappeared to her as a loving mother who had done everything for her that she was able to do.

Through the use of both languages during Sigrird's W-S Coachings, German and the translation into Danish, Maren was able to detect some changes in everyday life after only a few coaching hours.[1] For the first time, she experienced that her professional career was running stress-free with her subordinates. She was able to give clear instructions, even if she has to express criticism; the employees listened to her; they no longer had unpleasant discussions with Maren.

And Maren now faces her own superiors without complexes. In the meantime, the staff meetings, which had often been a torment for her, she now completed with serenity. Finally, she can shine with her competence; does not have to try to hide herself because she no longer has an authority problem; can express her self-esteem and competence quite naturally.

Maren was very grateful for this change in her professional life. Now she would also like to be able to make use of these changes in personal relations. Johannes has not developed and he still hopes that it is okay if he fantasizes about other, younger sexy women, as long as he does not act out gazing as unfaithfullness. And, Maren can now have her own eyes out for a partner who is attracted to her and wants her.

## Conclusion

When it comes to a preference of language in therapies and coachings, most authors mention the need to use the mother tongue in case of insufficient language skills of the client. However, the fact that the mother tongue allows deeper access to people even above a very well-spoken foreign language, should be given more attention in any psychological counseling/treatment/coachings.

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# Хармонијски језички код ДНК у историји светске цивилизације

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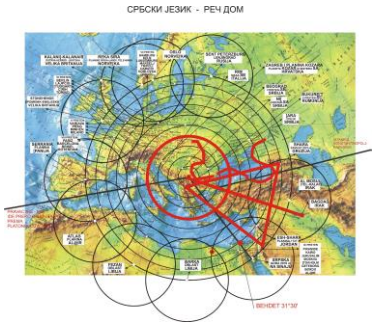
**Абстракт**: Ширење знања настало преузимањем кодова српског језика постало је саставни део свих делатности Др. Мирјана Совиљ је испитивала цео систем склопа фреквенција које су битне за нашу унутар чулну перцепију и које су постављене као реплика стварања самог Универзума. Адела Маргот је нумерички, путем језичких математичких вредности, успела да дефинише улогу српског језика у историји. Приказ Велике Пирамиде као симбол хармонијског склопа 9/8 одговара географском приказу Србије као броја 9/8. Перјана змија је и ликовна представа Сунчевих циклуса од 11,5 година. Тако имамо 11,5 x 365=4.197,5 дана : 518=8,103 или број **8.** И ето разлога постојања слова "Е" у Делфима. Ето разлога постојања разлога календара од 518 дана који сам назвао ДАЖ БОГ. Перјана змија у Мајанском храму у Чичен-Ици, Мексико. је његов преставник. Њен број је број 8 или ОКТАГОН, или оне ДВЕ РИБЕ највеће на планети Земљи. Милош Гроздановић је спајајући фонетски склоп српског језика са хармонским склопом гитаре са 24 прагова и 144 поља, успео да стилизира слово "Е" у Делфима. и да га проучи као подлога за изучавање Перјане змије. Људски ДНК је склоп који излази из система 52:21 и долази до Апсолута 118. Држач је Хексагон, а Обнављач је Октагон, а на Земљи време преко календан ДАЖ БОГА.
*Кључне речи:* српско ћирилично писмо, гитара, хармоније, ДНК, шестоугаоник, октагон, догони, маје, риба, ка, перјана змија, број 8.

## 1 Реч "дом" - прва земља равна плоча




**Слика 01**. Прва Земља равна плоча

Прва Земља равна плоча са пречником од 4000км и првом речју ДОМ написаном као рељефно писмо су први почеци стварања из БОЖИЈЕ РЕЧИ.

Зехарија Сичин у књизи "Дванаеста планета" каже:"..."Еп о постању" нас информише да су "Богови" дошли на Земљу после промишљене одлуке свог вође..:"У дубини Горе, тамо где боравите, "Краљевску кућу Горњу" направио сам. Сада ћу исту да направим Доле". Земља, према томе, није била само предмет посете или краткотрајног боравка; она је имала да буде трајан "ДОМ далеко од куће", стр. 245,246.. Спој три Шар планине – Шара на Кавказу, Русија, Шар палнина, Србија и Еш Шара у Јордану формирају ТРОУГАО, линија Ниш – Константинопоље – Багдад формирају ПРАВУ линију, прстен Ниш – Рим формирају КРУГ. Тако спојени систем формира реч ДОМ. Реч ДОМ се тако показује као ПРВИ доказ да је језик криптован на Земљи као неки ЛЕНДСКЕЈП или Уметност огромних простора. Е, ето реч ДОМ нам је полазна тачка са којом Адела Маргот улази у језик као СИСТЕМ НАРЕДБЕ

| | |
|---|---|
| Д О М | А Н = 60 |
| 5 18 15 = 38/1 | 1 16 = 17 |

## 2 Систем Аделе Маргот

Духовни ниво – српски језик, ПРЕНОСА – Астрални ниво – западна абецеда, и ИЗВРШЕЊА – Материјални ниво – Српскохрватска абецеда. Сиситеми којима то обрађује су стари Библијски системи проучавања – Гематрија, Нотарикон и Темура.

### 1. ГЕМАТРИЈА

**Гематрија је замењивање места у тексту појединим речима које имају исти збир.**

*Будући да је у јеврејском језику свако слово истовремено и број, што свака реч, кад се саберу бројчане вредности њених појединих слова, има одређену збирну бројчану вредност.*

*По Кабали, све речи које имају исту бројчану вредност су истоветне (будући да су те речи у дубини заједничког корена једнаке) и у тексту им се могу мењати места, јер је то само један од начина за боље разумевање значења текста.*

***Уместо бројчаних стања слова хебрејског језика служим се са три наведена писма и бројчаним стањима њихових слова.***

### 2. НОТАРИКОН

**Нотарикон је техника читања појединих речи као да су анаграм.**

*"Тако се свако слово у одређеној речи узима као почетно слово неке друге речи и на тај начин се од једне речи добија нова реченица. У ствари, реченица није нова, она је стара колико и реч из које је настала.*

*Ово значење је и Сам Бог имао на уму (између многих других) када је ту реченицу давао народу Израела.*

*Овај смисао је стајао у њој (самој Речи) заједно са 69 других скривених сми-слова те исте Речи."*

| Реч | = | 1 | + | 69 | = | 70 | смисловa. |
|---|---|---|---|---|---|---|---|

пример:

| "- РАЂА - М | -М - АЂАР": |
|---|---|

### 3. ТЕМУРА

**Темура је спекулативна техника тражења дубљег смисла текста.**

### БРОЈЧАНА СТАЊА ТРИ ПИСМА

***Духовно,*** *тј. тананo, невидљиво, или унутрашње стање, се објашњава кроз српскоцрногорско ћирилично писмо од тридесет (30) сл.*

*Рачунарско-комп'ютерским језиком речено ово је улаз (input) -ин-пут-невидно-(не-ви-дно) = дух стање*

СРПСКОЦРНОГОРСКА (СРПСКА) ЋИРИЛИЦА

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| А. 1. | Б. 2. | В. 3. | Г. 4. | Д. 5. | Ђ. 6 | Е. 7. | Ж. 8. | З. 9. | И. 10. |
| Ј. 11. | К. 12. | Л. 13. | Љ. 14. | М. 15. | Н. 16. | Њ. 17. | О. 18. | П. 19. | Р. 20. |
| С. 21. | Т. 22. | Ћ. 23. | У. 24. | Ф. 25. | Х. 26. | Ц. 27. | Ч. 28. | Џ. 29. | Ш. 30. |

*Astralno, тј. стање предака или силазак на ниже нивое, потпање, објашњавам кроз западноевропску абецеду која има двадесет шест (26) сл.*

*Рачунарско-комп'ютерским језиком речено ово је AOP (automatska obrada podataka) = душа стање.*

ZAPADNOEVROPSKA ABECEDA.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *A. 1.* | *B. 2.* | *C. 3.* | *D. 4.* | *E. 5.* | *F. 6* | *G. 7.* | *H. 8.* | *I. 9.* | *J. 10.* |
| *K. 11.* | *L. 12.* | *M. 13.* | *N. 14.* | *O. 15.* | *P. 16.* | *Q. 17.* | *R. 18.* | *S. 19.* | *T. 20.* |
| | | *U. 21.* | *V. 22.* | *W. 23.* | *X. 24.* | *Y. 25.* | *Z. 26.* | | |

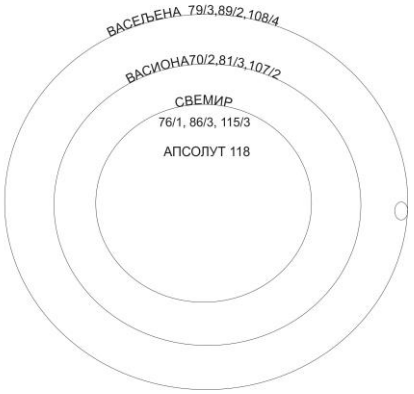
***Materijalno,*** *тј. чврсто стање објашњавам кроз српско-hrvatski abecedu, која као и српскоцрногорска азбука, има тридесет (30) звукова, али се служи са (27) сл.*

*Рачунарско-комп'ютерским језиком речено, ово је izlaz-(**output**)-оут-пут. **vidno'(vi-dno),= materijalno stanje,***

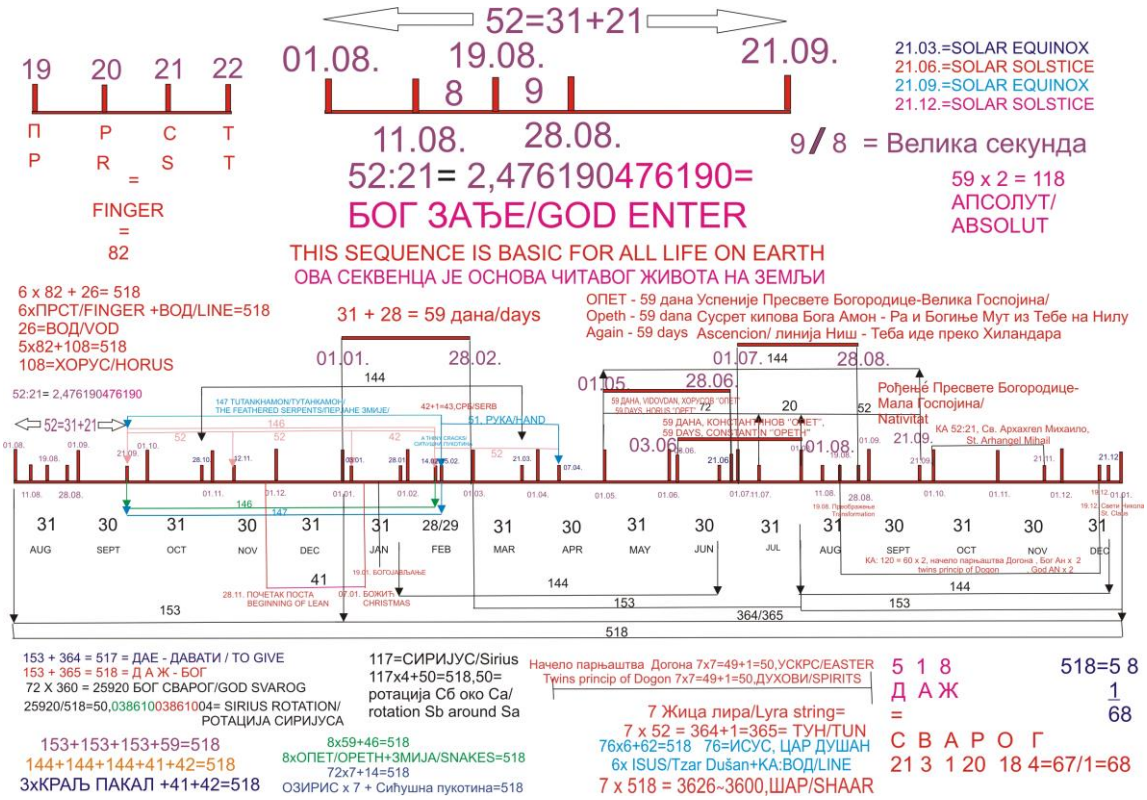
SRPSKOHRVATSKA (HRVATSKA) ABECEDA.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A. 1. | B. 2. | C. 3. | Č. 4. | Ć. 5. | D. 6 | Dž. 7. | Đ. 8. | E. 9. | F. 10. |
| G. 11. | H. 12. | I. 13. | J. 14. | K. 15. | L. 16. | Lj. 17. | M. 18. | N. 19. | Nj. 20. |
| O. 21. | P. 22. | R. 23. | S. 24. | Š. 25. | T. 26. | U. 27. | V. 28. | Z. 29. | Ž. 30. |

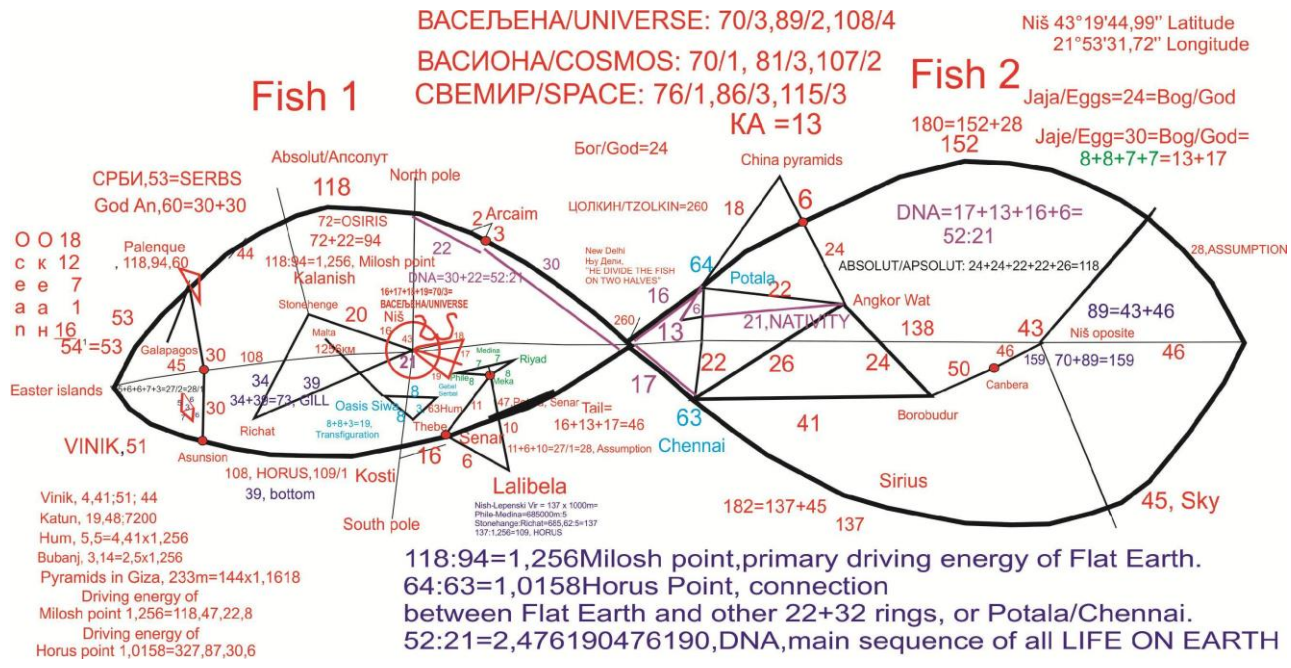
Српско ћирилично писмо, западно европска абецеда и српскохрватска абецеда су три основна писма која нам пружају увид у одређена стања. Њихове бројчане вредности нам дају могућност математичког промишљања и прилагођавања у израчунавању стања одређених појмова који тако долазе у корелацију један са другим, ван својих веза у језику, времену и простору.




**Слика 02.** Васељена79/3, васиона 70/2, свемир 76/1, апсолут 118




**Слика 03**. Права Српска година која садржи 518 дана представља време Бога ДАЖ или Бога СВАРОГА




**Слика 04.** Приказ двеју риба као систем светих места које представљају заправо ОКТАГОН, или како смо представили у прошлом раду, као систем који садржи два ХЕКСАГОНА.

Овај временски систем је управо приказивање тих Хексагона као временски ток. Чувено Хи-Ро је временско приказивање времена као симбола Сумерског Бога АНА, са правим именом РАНКА.

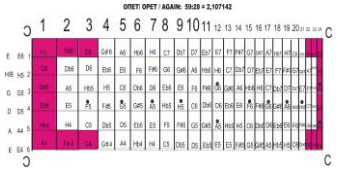
Српски православни календар садржи два система датума: један је у званичној употреби, Грегоријански, и други, Јулијански, као црквени. У употреби су нормална слова, слова *италик*, слова

црно болдирана и црвена слова. Горња мапа датума је настала након мог истраживања планине Ртња. Тада сам открио да постоји распоред датума према распореду месеца у години. Наиме, испоставило да је централни датум заправо 1. август. А онда сам увидео да распоред црвених слова одговара веома значајним догађајима који нису везани само за нас Србе. Наиме, овде се појављују поједини циклуси који одговаварају нумеричким вредностима личностима и појмовима који су везани за целу планету Земљу. Рецимо, 144 као коефицијент Краља Пакала, 72 као број Цара Душана.

Међутим, цела прича са Сиријусом А и Б и њиховим ротацијама, није само астрономски догађај. То је заправо цела прича која у себе убацује све познате математичке и хармонске и ДНК односе. Наиме горња слика је и време, али и хармонски однос 9/8 или однос слова "Е" као доказ да су Делфи као пророчиште заиста, а не случајно радила управо оно што је заправо остало као доказ да је српски језик био основа почетка добијања знања.

ОПЕТ је време од 59 дана и то је време од 01. јануара до 28. фебруара. Јавља се опет, као ритаул у Египту, као ОПЕТ и то је време од 01. јула до 28. августа, црвеног слова, када је време прославе ВЕЛИКЕ ГОСПОЈИНЕ, или Одлазак Пресвете Богородице на Небо.

Мала Госпојина је време 21. септембра када се слави Рођење Пресвете Богородице, црвеног слова. Оба датума су везана за звезде Сиријус А и Б.

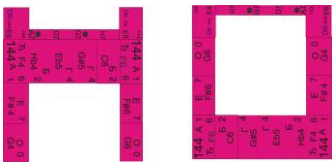


**Слика 05.** Слово "С" као хармонијски склоп појма "ОПЕТ"

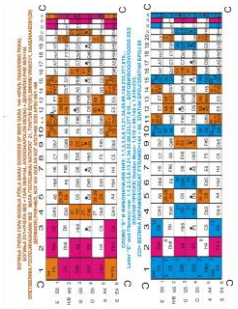
**Слика 06.** Слово "Е" као склоп слова "Е" и појма ритуала "ОПЕТ"

**Слика 07**. Догони из Малија носе маске са стилизованим двоструким "Е" које представљају ЖИВОТ и КА слова "Е"

**Слика 08.** Слово "Е" ротацијом формира слово, ћирилично "Ш", а комбинацијом системом КА формира слово "Ж" системом "леђа у леђа"и број ОСАМ као сложену форму системом "лице у лице"

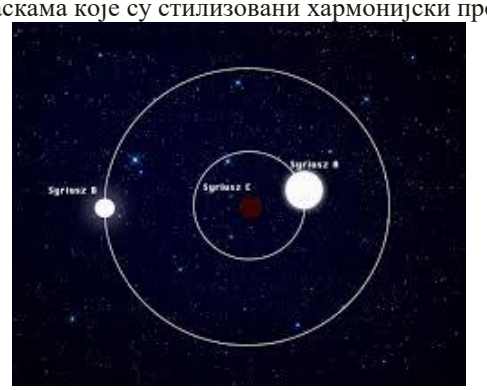


**Слика 09.** Слово "С" хармонијског појма "ОПЕТ" формира системом КА слово, ћирилично "Н" или латинично "Х", као и слово "О"



**Слика 10.** Слова "Е" као хармонијски склопови појмова. Видимо слова "Е", број "8"

**Слика 11.** Наши Догони са маскама које су стилизовани хармонијски процеси са горње слике

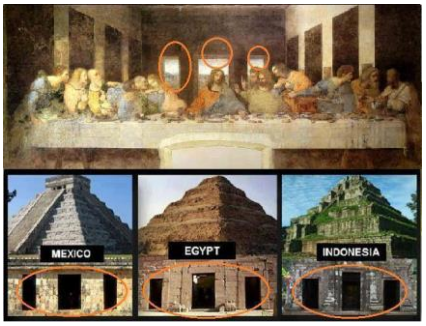



**Слика 12.** Ротација Сиријуса Б око Сиријуса А. Њихова ротација дате приказ броја 8. Могуће је да је Сиријус А = А, а Сиријус Б = Е, као самогласнички склоп.

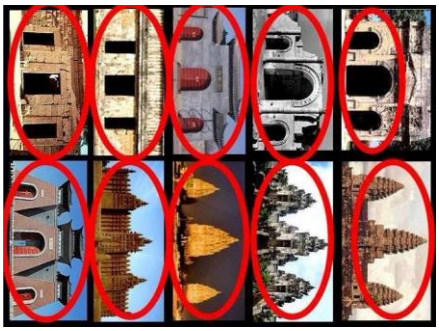
С И Р И Ј У С А Б
21 10 20 10 11 24 21=117 1 =118 АПСОЛУТ 2 = 119 АПСОЛУТ

**Слика 13.** Положај Слова "Е" у Делфима, указује на утицај који има на сву духовност данашњих религијских – светих грађевина. На свим континентима се одржава исти образац троструких улаза у храмове или олтар, или купола на грађевинама.

**Слика 14.** Слика иконостаса где се виде троја врата као стилизација слова "Е"




**Слика 15.** Слово "Е" као узор Леонарду Да Винчију у осликавању "Тајне вечере". Доле се виде храмови у Мексику, Египту и Индонезији као идентичном преслику хармонског слова "Е".



**Слика 16.** Улази у храмове преко система слова "Е" и систем кула формиран на исти начин.

X P A M
26 20 1 15=62/1

**Слика 17.** Кецалкоатл код Астека, или Кукулкан код Маја, или Виракоча код Инка је Перјана Змија која је заправо ликовни приказ хармонског склопа "Е" у Делфима, са бројем осам и словом М

**Слика 18.** Бог Вишну лежи на својим змијама и одржава цео познати свет. Бог Вишну је и стваралац јер има океан воде у коме се он јавља као стваралац и као Бог у својим инкарнацијама као Аватар.

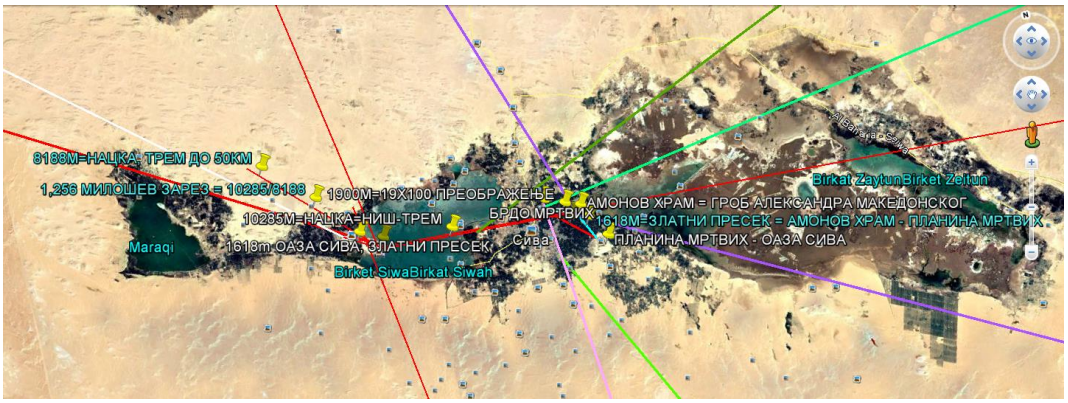
В И Ш Н У О В Е З М И Ј Е В И Ш Н У
3 10 30 16 24 18 3 7 114/2 =116 9 15 10 11 7 52/1 = 53 = СРБИ 3 10 30 16 24
83/1=82 ПРСТ

**Слика 19.** Шива Лингам

Б Р А М А З М И Ј А Л И Н Г А М
2 20 1 15 1 39 + 9 15 10 11 1 46/1 + 13 10 16 4 1 15 59/1 = 144 КРАЉ ПАКАЛ
Ш И В А К Р Ш Н А
30 10 3 1 = 44 + 12 20 30 16 1 = 79, Свемир = 123/1
К Р Ш Н А + Б Р А М А А П С О Л У Т
12 20 30 16 1 79 2 20 1 15 1 39 = 1 19 21 18 13 24 22 =118/2

**Слика 20.** Кукулкан – Перјана Змија код Маја

К У К У Л К А Н П Е Р Ј А Н А З М И Ј А
12 24 12 2 4 13 12 1 16 114/2=116=АПСОЛУТ 19 7 20 11 1 16 1 =75/2 9 15 10 11 1
А П С О Л У Т =46/1
19 21 18 13 24 22 118/2 =116 75/2 + 46/1 = 121/1=120 = АПСОЛУТ




**Слика 21.** Оаза Сива – или Оаза Бога ЖИВАНА и Богиње ЖИВАНЕ

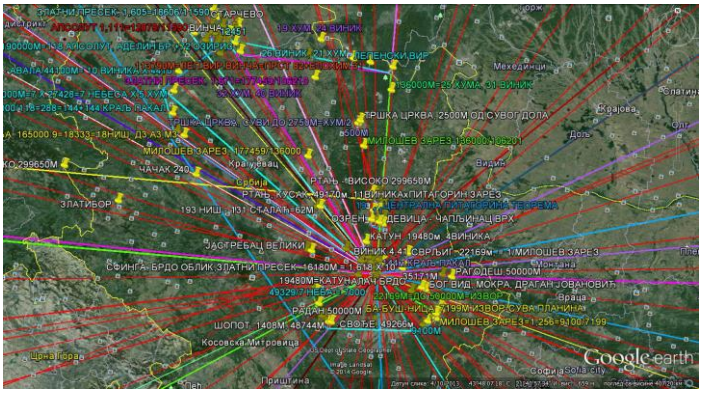
Оаза Сива је место на 800км од Гебел Сербал и који је на 2000км од Ниша, и представља тачку која је на 2,5 пута краћој путањи од припадајућег прстена. Ту се налази храм Бога Амон Ра, који се црта са овнујским роговима. Међутим, Оаза Сива је добила име по правом имену Амон Ра = ЖИВАН. Реч ДОМ је исте вредности 38/1 као име ЖИВАН.

Ж И В А Н + Ж И В А Н А = С В Е М И Р
8 10 3 1 16 38/1 8 10 3 1 16 1 39/1 21 3 7 15 10 20= 76/1

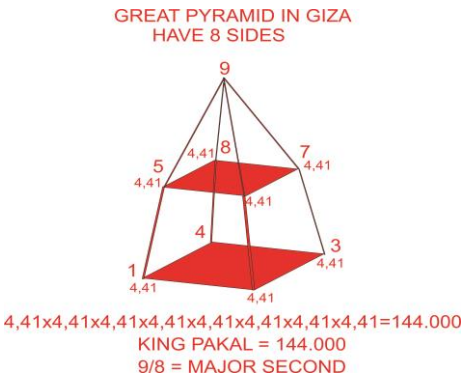
**Слика 22.** Краљевска породица: планина Ртањ, планина Радан и Сува планина .

Све се налазе на 50 км од Ниша. Број 50 представља растојање као ротацију Сиријуса Б око Сиријуса А за 50 година. Право име Суве планине је АЛКАИДА. То значи Вођа, Мудрац, али је право значење "АЛКА их ДА" или "АЛКА их чува". Ради се о томе да ове три планине чине држач који држи целу планету Земљу, односно, то је АЛКА или ВЕРИГЕ СВЕТА како се звала у време Римљана, као КАТЕНА МУНДИ. То је заправо наш **ХЕКСАГОН** који држи све познато на Земљи и држе слово "Е" Делфима. То су 6 празних тонова на гитари **Е6,Б(Х)5,Г5,Д4,А4,Е4**

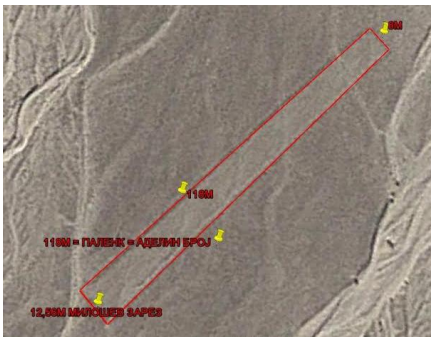
СУВА ПЛАНИНА – А Л К А И Д А
1 13 12 1 10 5 1 43/1 СРБИ
Р А Д А Н Р Т А Њ
20 1 5 1 16=43/1 СРБИ 20 22 1 17=60/1
АЛКА-И-ДА +РАДАН + РТАЊ = 146/3=144 КРАЉ ПАКАЛ
К Р Ш Н А + Б Р А М А А П С О Л У Т
12 20 30 16 1 79 2 20 1 15 1 39 = 1 19 21 18 13 24 22 =118/2
О Д И Н Т О Р В О Т А Н
18 5 10 16 = 49/1 Сб око Са + 22 18 20=60=Бог АН + 3 18 22 1 16= 60/2 Бог АН = 169/4
П Р В С И Р Н **Б Р С** Т А В = ОЗИРИС КА: **С Р Б**
19 20 3 21 10 20 16 2 20 21 22 1 3 =178/2 = 177= 59 Х 3 = 177 = 3 ОПЕТ



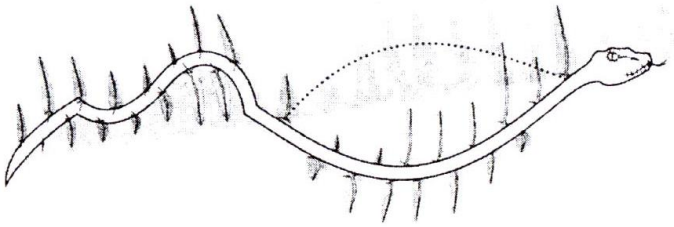

**Слика 23.** Приказ Србије као симбол хармонијског склопа 9/**8**.




**Слика 24.** Представа хармонијског склопа 9/**8** је и Велика пирамида у Гизи

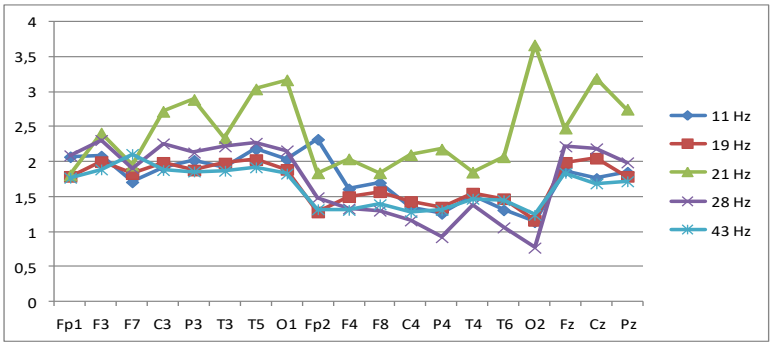



**Слика 25.** Приказ пустиње НАЦКА у Перуу, где се виде правоугаоник са димензијама 118м = АПСОЛУТ, **8 = Србија,** 12,56м=Милошев зарез



**Слика 26.** Перјана змија као ликовна представа Сунчевих циклуса од 11,5 година. Тако имамо 11,5 x 365=4.197,5 дана : 518=8,103 или број **8.** И ето разлога постојања слова "Е" у Делфима. Ето разлога постојања разлога календара од 518 дана који сам назвао ДАЖ БОГ.

## Др Сци Мирјана Совиљ




**Слика 27.** Графикон 14б) СНАГА ТЕТА ПОСТСТИМУЛУС РАЗЛИКА. овај графиком представља дословно ухваћену перјану змију

Овај графикон је начињен у ИЕФПГ на енцефалографу који је за сигнале имао вредности 11, 19,21, 28 и 43Хз.

**Слика 28.** Симбол Трибала је била глава дивље свиње прободена стрелом у устима

**Слика 29.** Перјана змија у Мајанском храму у Чичен-Ици, Мексико. Њен број је број 8 или ОКТАГОН, или оне ДВЕ РИБЕ највеће на планети Земљи.

## Закључак

Грчка филозофија и грчка религија су два нераздвојива чиниоца развоја људске мисли и чине незаобилазну станицу развоја цивилизацијског помака.

Међутим, они су само једни од оних који ми називамо "старим цивилизацијама" као део великог ланца преноса знања од праискона до данас.

Ми данас имамо на располагању могућност синтетичког односа и система којим можемо да то знање представимо као не "случајним процесом", него сталним "намерним процесима".

Тако једино можемо да математику употребимо као "модуларни систем размишљања", и да целу религијску мисао сведемо на математичко – исповедну причу о реалним догађајима који су дешавали, а остали су записани као митолошки догађај или стара филозофска скаска о нечему што наизглед не изгледа тачно, или у најмању руку чудно.

Основу нашег рада чини систем поставке Прве Земље Равне плоче (***слика 01***), систем Аделе Маргот (***слика 02***) и рада др Мирјане Совиљ (***слика 28***), која је показала да је систем стабилан и то показује математичким анализама.

Милошев зарез, 1,256 указује на систем Прве Земље равне плоче са десет прстенова од по 200км, као њен основни коефицијент.

Хорусов зарез, 1,0158, као коефицијент постања Планете Земље, коју чине 64 прстенова, са уклапањима, и то показује велики религијски симбол Хорусовог ока, за који се показало да је разломак 63/64.

Питагорин зарез, 1,0136 указује на хармонију света измерену кроз лире – гитаре. Два тона одсвирана након седам октава и дванаест квинти нису иста, већ се разликују за износ 1,0136. Тај број указује на свеукупност повезаног кретања целог Универзума, и који указује да је хармонија саставни део свих органских процеса на Земљи.

Време и простор утичу на ротацију Земље и на њен хармонски склоп који се очитује преко језика. Показали смо већ у књигама "Српски еталони језика, времена и простора у историји светске цивилизације", "Нова космогонија света" и "Периодни систем гитаре Краља Пакала и Цара Душана", да постоји апсолутно јединство у представљању ових коефицијената кроз сва главна религијска средишта целе планете. Свуда налазимо њихову присутност, а потврда за све наше ставове дошла је анализа сигнала из сазвежђа Сагитаријус.

Свуда налазимо да су језик, време и простор нераскидиво везани за анализу српског језика. Показује се да он има динамичну енергију која се резултира као хармонски раложив и сложени ликовни приказ.

Ликовно приказивање језика представља посебан систем анализе које указује на вишеструку модуларност и могућност представљања појединачног гласа као и сложених појмова.

Ти појмови се могу анализирати на три нивоа: духовном, астралном и материјалном. Српски језик са духовног нивоа представља главни фокус нашег рада. Установили смо да су све главне мере управо вредности тих прорачунатих коефијицијената. Пример је, рецимо, пророчко и астрономско место Аркаим у Русији, који се налази на удаљености од Паленка у Мексику, тачно на 11800км, или коефицијент 118 који представља духовну вредност појма АПСОЛУТ (***слика 05***).

Управо из наших анализа, појам АПСОЛУТ је место почетног исходишта наше цивилизације.

У Делфима је постојао симбол слова "Е", који је симетричан, и показује на сличност са словом Х или словом Н. Претпоставка је била да је то због друге позиције у односу на Додону. Саме гласове А,Е,И,О,У су формирале три Суђаје: Клота, Лахеса и Атропа. У нашем језику постоји реч КЛОТ и односи се на предиво и плетење, или на нешто као празно, као "клот пасуљ", јер Три Суђаје плету мрежу живота људима. Реч Тропа је од Атропе која сече маказама нит од Богова према нама. Постоје још и меко "Е" и меко "О". Сходно томе, постоји и интрумент ЛИРА која има седам жица, по једна за сваки самогласник. Аполон држи међу ногама управо тај инструмент.

Када се вредност ритуала ОПЕТ који износи 59/28= 2,1071542 стави на хармонску подлогу гитаре добијамо облик слова "С" (***слика 06***). Смисао који добијамо гласи: БОГ ЕА. То је Сумерски Бог Во-де, интелигенције, стваоц људи. Има и име ЕНКИ. По рангу је одмах испод Бога АНА. Спомиње се и као Бог АПСУ. То је Бог затвореног простора. Ми га спомињемо као **апсану**, или затвор, или **апсу место** када играмо кликере.

Кад се вредност 52/21 = 2,476190 стави у хармонску подлогу гитаре добијамо савршени изглед слова "**Е**" (***слика 07***). Шта нам то казује? Казује нам да је време ротације Земље у идеалном хармонском поретку. То је време као простор поретка броја 144.

Слово "Е" је симетрично само себи по Х оси по средини осе слова, и чини КА – паралелност, дуалност самом себи, као лик човека у огледалу.

Управо такву маску као КА слова "Е" носе маске припадници племена ДОГОН-а из Републике МАЛИ (***слика 08***). Реч Догон је из српског корпуса и значи **догонити**, **јурити**. Тај народ још увек има ритуале, за које је др Роберт Темпл у књизи "Тајна звезде Сиријус", рекао, да су добили од Мисираца. Значи, речи **догон** и **опет** су и данас у употреби код Срба, и указују на чињеницу да ови графикони нису случајни.

Систем слова "С" спојени леђима, дају нам слово "Н" ћирилично, или "Х" латинично. Спојени напред, дају нам слово "О". Рецимо да је то наше "ОПЕТ".

Међутим, машта Догона ради свашта, и прави нову маску сложених шара, али то је поредак који одговара вертикалном хармонском поретку слова "Е" и "С". Он у стварности одговара поретку звезда Сиријус А и Сиријус Б на небу као звезде које су надређене нама. Наиме Сиријус А је 2,5 пута већи од нашег Сунца, а Сиријус Б је приближно 0,9 масе нашег Сунца. То су односи 2,5 и 1 којим се дефинише Прва Земља равна плоча (***слика 13***).

У Мисиру, постоји један ритуал ОПЕТ, који се односи на појаву кипова Богиње Мут и Бога Амон-Ра, који излазе из Мисирске Тебе, и срећу се на средини Нила . Догађај је везан за август месец. Ми тада славимо Велику Госпојину, 28. августа. Линија Теба – Ниш пролази преко нашег манастира ХИЛАНДАР

Значи, Делфи и Теба су директно повезани са Србијом и налазе се на 3. и 11. прстену. Они су КА тачке Истанбулу и Багдаду који су такође на 3. и 11. прстену. Значи, појам КА се јавља и у простору и као словни знак.

Када се споје слова "Е" и "С" добијамо слику слова "Е". Када се слово "Е" које има своје КА премести у простору, добијамо, системе слова "Ж" и "Ш", и броја 8. Слово "Ж" у српској азбуци има вредност 8 (***слика 09***).

Време од 518 дана је ВРЕМЕ ДАЖ БОГА (***слика 03***). Појам ДАЖ је 518 (Д=5,А=1, Ж=8). То је време у коме су укључени сви нумерички представници старих цивилизација – Сумера, Маја, Мисираца, Словена итд.

На Земљи постоји систем пророчких места ван Грчке, Сумера итд. који су дали целој планети Земљи један потпуно нови дух и рухо. Захваљујући Гуглу, имамо прилике да их повежемо, и да их премеримо. Детаљније смо их описали у нашим књигама, и показали смо да је то систем заснован на вредностима које су дужински одређене коефицијентима духовних вредности појмова као Апсолут, Срб, Милошев зарез, Хорусов зарез и Питагорин зарез, Океан, итд.

Добили смо тако изглед двају риба појединачно, или заједно положену осмицу, или ОКТАГОН.

То је заправо прави светски ДНК систем. Све вредности су пажљиво премерене, и спајањем се добија облик, који је и тестиран једним сигналом који је стигао из космоса 15. августа 1975. године из сазвежђа Сагитаријус или Стрелац.

Тај сигнал смо обрадили и анализирали преко система нотног записа и видели да се он може анализирати и преко словног записа, преко система нота, али и да се може сабирати по колонама, по декадном принципу. Све наше тачке су заправо добиле сигнал провере и мерења хармоснског одзива. На крају, тај се сигнал и свира, како на елетричној, тако и на класичној гитари, само са 24 прага.

И видите да се та стрела види код Аполона који узима одмах по рођењу Лук и Стрелу. Али Са – гитар указује да је појам гитаре која има изглед стреле, управо најпогоднији да покаже хармонску сложеност система ДНК. Овде не улазимо нити у хемију нити физику ДНК. Овде указујемо да је систем ДНК који имамо данас дат од Вотсона и Крика непотпун, и да смо указали на чињеницу да је гђа Розалин Франклин урадила њену потпуно другачију структуру.

Овај Октагон је заправо систем два ХЕКСАГОНА, тј. свака Риба је по један Хексагон или Шестоугаоник изгледа пчелињег саћа. То је у грчкој митологији записано као дело Богиње Гара, Богиње пчела којој је припао симбол Хексагона. У нотама, то значи да су то она 6 тона на нултом прагу.

Али, хоризонтални положај слова "С" и "Е" даје још једну визуелну упадљиву сличност са иконостасом и олтаром наше цркве. Наиме, распоред вратију са стране и врата за улазак у олтар одговарају визуелној слици слова (***слика 15***).

Међутим и ренесансни уметници, попут Леонарда да Винчија, на "Тајној вечери" су користили исту стилизацију, и визуелно се такође подударају са улазним вратима храмова на три континента (***слика 16***).

Иста визуелна стилизација се користила код улазних прочеља храмова и купола истих такође на свим континентима (***слика 17***).

Све Змија Кецалкоатл код Астека и Маја представља систем слова "Е", "С", "М" и двеју осмица (***слика 18***) и (***слика 21***). КУКУЛКАН =116 = АПСОЛУТ = ПЕРЈАН ЗМИЈА. Међутим, и Врховни Бог у Индији, ВИШНУ седи на змијама (***слика 19***). Осим хармонског значења, мислим да су то електромагнетни таласи. Наиме, откривено је пре неколико година да електромагнетни таласи путују са краја на крај Универзума са таквом застрашујућом енергијом, и да су они његови одржаваоци, што Вишну по вокацији и јесте, одржаваоц и стваралоц. Његов лингам је основно градивно везиво одакле све материјално исходи (***слика 20***). Змије су по израчунавању СРБИ 053, а ВИШНУОВЕ је АПСОЛУТ 116, а ВИШНУ је Бог = 82 = ПРСТ.

БРАМА + ЗМИЈА + ЛИНГАМ = 144 = КРАЉ ПАКАЛ. ОВО ЈЕ ЈЕДАН ОД ПОТПУНИХ ДОКАЗА ДА СУ СВЕ РЕЛИГИЈСКЕ ВЕЗЕ ЗАСНОВАНЕ НА ПОТПУНОМ ХАРМОНСКОМ ПОДУДАРАЊУ ХАРМОНСКОГ ДНК.

Оаза Сива је Оаза Бога Живана или Бога Амон Ра где је сахрањен Александар Македонски (слика 22). Садржи комплетан систем мера – ХАРМОНСКОГ ДНК ЦЕЛОГ СВЕТА.

И Краљевска породица Ртањ, Радан и Сува планина су на 50 км од Ниша и представљају време ротације Сб око Са (***слика 23***).

Али, када то слово окренемо на доле, добијамо слово "М" (***слика 09***). И то слово управо видимо на Змији Кецалкоатл или Кукулкан или Виракоча. Поред њега видимо и две осмице.

Па добро. Шта је онда ЗМИЈА (***слика 30***)? Змија јесте представа слова "Е", са отвореним устима и са језиком који палаца и СИКЋЕ. Дакле слово "С" је сиктање Змије. Али то је и представа главе Дивљег вепра са стрелом у устима (***слика 29***). То симбол ТРИБАЛА.

Цар Душан јесте био АРХОНТ СВИХ ТРИБАЛА, односно свих Срба.

И стрела и лук су ПРЕДСТАВА СЛОВА "Е".

Значи, Аполон у Делфима описује објаву слова "Е".

И снимак Перјане Змије на енцефалографу (***слика 28***) доказ да је заправо слово "Е" функционисало као ПРИХВАТНИ ЦЕНТАР СВИХ СИГНАЛА И ПОДАТАКА КОЈИ НАМ ДОЛАЗЕ ИЗ СПОЉЊЕГ ПРОСТОРА.

Зато је и служио Аполонов храм у Делфима.

ПРОСТОР СРБИЈА ПРЕДСТАВЉА СИСТЕМ 9/8 (***Слика 24***).

ПИРАМИДА ЈЕ СИСТЕМ МАТЕМАТИЧКОГ МОДЕЛИРАЊА ПРОСТОРА 9/8 КАО КАЛЕНДАРСКОГ И ПРОСТОРНОГ ХАРМОНСКОГ ДНК (***слика 25***).

ПУСТИЊА НАЦКА У ПЕРУУ ЈЕ ПРОСТОРНИ ДНК АПСОЛУТА 118 ПОВЕЗАН СА СТВАРАЊЕМ ЗЕМЉЕ ПРЕКО МИЛОШЕВОГ ЗАРЕЗА 1,256 И ОКТАГОНА (***слика 26***).

СУНЧЕВО ЗРАЧЕЊЕ И ПЕРИОДА ЈЕ 11,6 ГОДИНА ИП РЕДСТАВЉА СЕ СИСТЕМОМ КОЈИ ЛИЧИ НА ПЕРЈАНУ ЗМИЈУ (***слика 27***).

И СИМБОЛ ТРИБАЛА ЈЕ ПЕРЈАНА ЗМИЈА У ОБЛИКУ ГЛАВЕ ДИВЉЕ СВИЊЕ СА СТРЕЛОМ У УСТИМА (***слика 29***).

И НАШ МОЗАК ЈЕ ЗАПРАВО СПРЕМИШТЕ ПЕРЈАНЕ ЗМИЈЕ (***слика 28***). Заиста изгледа као Перјана змија у Чичен – Ици. (***слика 30***).

ЗАПРАВО, ЛУК И СТРЕЛА ИЛИ ЗЕМЉА СУ ПЕРЈАНЕ ЗМИЈЕ, МИ СМО ПЕРЈАНЕ ЗМИЈЕ, СУНЦЕ ЈЕ ПЕРЈАНА ЗМИЈА, СИРИЈУС А И СИРИЈУС Б СУ ПЕРЈАНЕ ЗМИЈЕ.

## Укратко

Хармонијски језички кôд ДНК је нови појам који дефинише хармонске, временске, религијске, географске, језичке и архитектонске сличности које видимо на свим континентима планете Земље. Знаци као језичке поруке духовног кôда српског језика дефинишу КА – начело парњаштва трансформације, где записи долазе до нас преко електромагнетних таласа огромних и суптилних енергија стилизиваних преко симбола Перјаних змија. Видимо их кроз симболе Вишнуових змија и

Шива лингама. Оне представљају синхронизовани систем ротације Сиријуса А и Сиријуса Б, и нашег Сунца. Њихови периоди ротација су представљени стилизацијом простора бројем 144, и словним симболима "Е" и "С". Излазак кодова иде преко хармонске структуре броја 8 и 9 и представља се географски територијом Србије и симболично преко пирамиде у Гизи, а преко хармоније 9/8. Записи хармонске структуре кодова језика, времена и простора налазимо у Пустињи Нацка, кроз маске Догона у Републици Мали, кроз системе религијских светилишта Маја, Мисираца, Ангкор Вата, Леонарда Да Винчија, нашег иконостаса и олтара, и много других ствари у свим осталим нацијама.

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# Harmony of languages code of DNA in the history of world civilization

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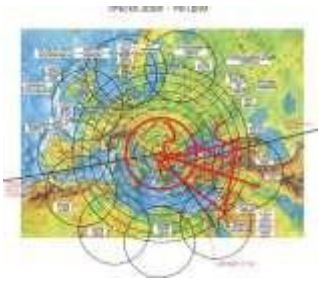
**Abstract**: The spread of knowledge created by downloading the Serbian language codes has become an integral part of all the activities of mankind. Dr. Mirjana Sovilj examined the whole system of frequency assemblies that are important to our within sensory perception and which are set as replicas of the creation of the Universe itself. Adela Margot has numerically, through linguistic mathematical values, managed to define the role of the Serbian language in history. The display of the Great Pyramid as a symbol of the harmonic structure 9/8 corresponds to the geographical representation of Serbia as number 9/8. The feathered snake is also a visual representation of the Sun's cycles of 11.5 years. So we have 11.5 hours 365 = 4,197.5 days: 518 = 8,103 or number 8. And that's the reason for the existence of the letters "E" in Delphi. This is the reason for the existence of the calendar day of 518 days that I called DAJ GOD. Feathered snake in the Mayan temple in Chichen-Ica, Mexico. is his representative. Its number is No. 8 or OCTAGON, or those are the highest in the planet Earth. Miloš Grozdanović combining the phonetic assembly of the Serbian language with a harmonic guitar set with 24 thresholds and 144 fields, managed to stylize the letter "E" in Delphi. and to study it as a basis for studying the Perry's snake. Human DNA is a circuit that comes out of the system 52:21 and comes to Absolute 118. The holder is Hexagon, and the Reconnector is Octagon, and on Earth the time is over the calendar of DAJ GOD
*Keywords***:** serbian, circular, letter, guitars, harmonies, dnk, sestoughonik, oktagon, dogoni, maja, fish, ka, perjana zmija, number 8.

## 1 The word "DOM" - THE FIRST EARTH FLAT DISC



**Picture 01.** The First Earth Flat Panel

The first Earth is a plane with a diameter of 4000km and the first word of the DOM written as a relief letter is the first beginning of creation from the Word of God.

Zechariah Sichin in the book Twelfth Planet says: "..." "Epic on Post" informs us that the "Gods" came to Earth after the thoughtful decision of their leader .. "In the depths of the Mountains, where you're staying, I made the Royal House of Gorge. Now I'll do the same to make Dole. " The country, therefore, was not only the subject of a visit or short stay; she had to be a permanent "DOM away from home", p. 245,246 .. The combination of three Shar Mountains - Shara in the Caucasus, Russia, Shar palnina, Serbia and Ash Shara in Jordan form the TRIANGLE, the line Nis - Konstantinopolj - Bagdad form the RIGHT line, the Nis-Rim ring form the CIRCLE. The so- formed system forms the word DOM. The word DOM thus appears as FIRST proof that the language is encrypted on Earth as some LENDSKEJP or the Art of enormous space. E, that's the word DOM-home in engl. is our starting point with Adela Margot entering the language as a SYSTEM OF ORDER

Д О М 5 18 15 = 38/1 A H = 601 16 = 17

## 2 Adele Margot System

Spiritual level - Serbian, TRANSFER - Astral level - Western alphabet, and EXECUTIONS - Material level - Serbian-Croatian alphabet. The systems they handle are old Biblical systems of study - Gematri, Notarikon and Temura.

1. ТЕМАТРИЈА

**Гематрија је замењивање места у тексту појединим речима које имају исти збир.**

*Будући да је у јеврејском језику свако слово истовремено и број, што свака реч, кад се саберу бројчане вредности њених појединих слова, има одређену збирну бројчану вредност.*

*По Кабали, све речи које имају исту бројчану вредност су истоветне (будући да су те речи у дубини заједничког корена једнаке) и у тексту им се могу мењати места, јер је то само један од начина за боље разумевање значења текста.*

**БРОЈЧАНА СТАЊА ТРИ ПИСМА**

*Српско, тј. тачно, нетачно, или упутрашње стање, се објашњава кроз српскоцрногорско ћирилично писмо од тридесет (30) сл.*

*Рачунарско-компјутерским језиком речено ово је улаз (input) -интуиција-нетачно-(не-ја-ово) = дух стање*

СРПСКОЦРНОГОРСКА (СРПСКА) ЋИРИЛИЦА

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| А. 1. | Б. 2. | В. 3. | Г. 4. | Д. 5. | Ђ. 6 | Е. 7. | Ж. 8. | З. 9. | И. 10. |
| Ј. 11. | К. 12. | Л. 13. | Љ. 14. | М. 15. | Н. 16. | Њ. 17. | О. 18. | П. 19. | Р. 20. |
| С. 21. | Т. 22. | Ћ. 23. | У. 24. | Ф. 25. | Х. 26. | Ц. 27. | Ч. 28. | Џ. 29. | Ш. 30. |

*Анално, тј. стање предака или силазак на ниже нивое, објашњавање, објашњавам кроз западноевропску абецеду која има двадесет шест (26) сл.*

*Рачунарско-компјутерским језиком речено ово је ПОР (аналитичку обилазну радњу) = доле пауза.*

ZAPADNOEVROPSKA ABECEDA.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *A. 1.* | *B. 2.* | *C. 3.* | *D. 4.* | *E. 5.* | *F. 6* | *G. 7.* | *H. 8.* | *I. 9.* | *J. 10.* |
| *K. 11.* | *L. 12.* | *M. 13.* | *N. 14.* | *O. 15.* | *P. 16.* | *Q. 17.* | *R. 18.* | *S. 19.* | *T. 20.* |
| | | *U. 21.* | *V. 22.* | *W. 23.* | *X. 24.* | *Y. 25.* | *Z. 26.* | | |

***Материјално, тј. чврсто стање обухватамо кроз српско-хрватску абецеду, која као и српскоцрногорска азбука, има тридесет (30) гласова, али се служи са (27) сл.***

*Рачунарско-компјутерским језиком речено, ово је излаз-**(output)**-интуиција **видео'ни-дво)-материјално стање,***

SRPSKOHRVATSKA (HRVATSKA) ABECEDA.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A. 1. | B. 2. | C. 3. | Č. 4. | Ć. 5. | D. 6 | Dž. 7. | Đ. 8. | E. 9. | F. 10. |
| G. 11. | H. 12. | I. 13. | J. 14. | K. 15. | L. 16. | Lj. 17. | M. 18. | N. 19. | Nj. 20. |
| O. 21. | P. 22. | R. 23. | S. 24. | Š. 25. | T. 26. | U. 27. | V. 28. | Z. 29. | Ž. 30. |

*Уместо бројчаних стања слова хебрејског језика служим се са ћири наведена писма и бројчаним стањима њихових слова.*

2. НОТАРИКОН

**Нотарикон је техника читања појединих речи као да су анаграм.**

*"Тако се свако слово у одређеној речи узима као почетно слово неке друге речи и на тај начин се од једне речи добија нова реченица. У ствари, реченица није нова, она је стара колико и реч из које је настала.*

*Ово значење је и Сам Бог имао на уму (између многих других) када је ту реченицу давао народу Израела.*

*Овај смисао је стајао у њој (самој Речи) заједно са 69 других скривених сми-слова те исте Речи."*

| Реч | = | 1 | + | 69 | = | 70 | смислова. |
|---|---|---|---|---|---|---|---|

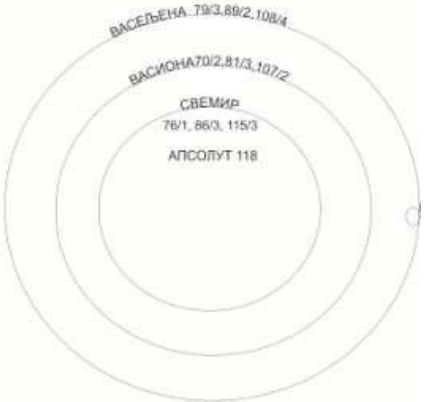
Пример:

| "- РАЂА - М | - М - АЂАР": |
|---|---|

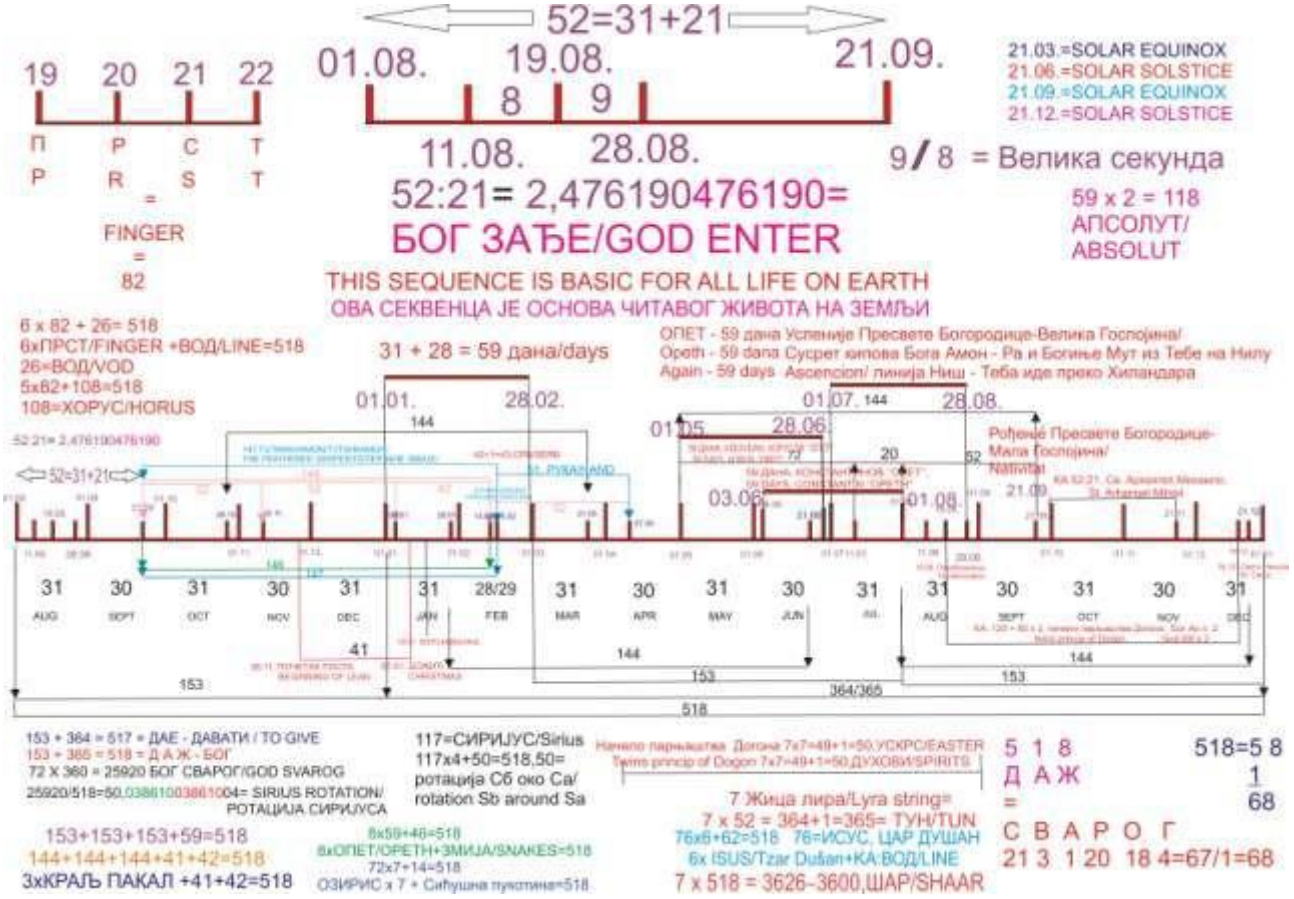
3. ТЕМУРА

**Темура је спекулативна техника тражења дубљег смисла текста.**

The Serbian Cyrillic Letter, the Western European Alphabet and the Serbian Serbo-Croatian alphabet are three basic letters that give us insight into certain conditions. Their numerical values give us the possibility of mathematical reasoning and adjustment in calculating the state of certain concepts that thus come in correlation with each other, beyond their relationships in language, time, and space.




**Picture 02**. VASELJENA79 / 3, VASIONA 70/2, SVEMIR 76/1, ABSOLUT 118




**Picture 03.** The real Serbian year, which contains 518 days, represents the time of God DAJ or God SVAROG

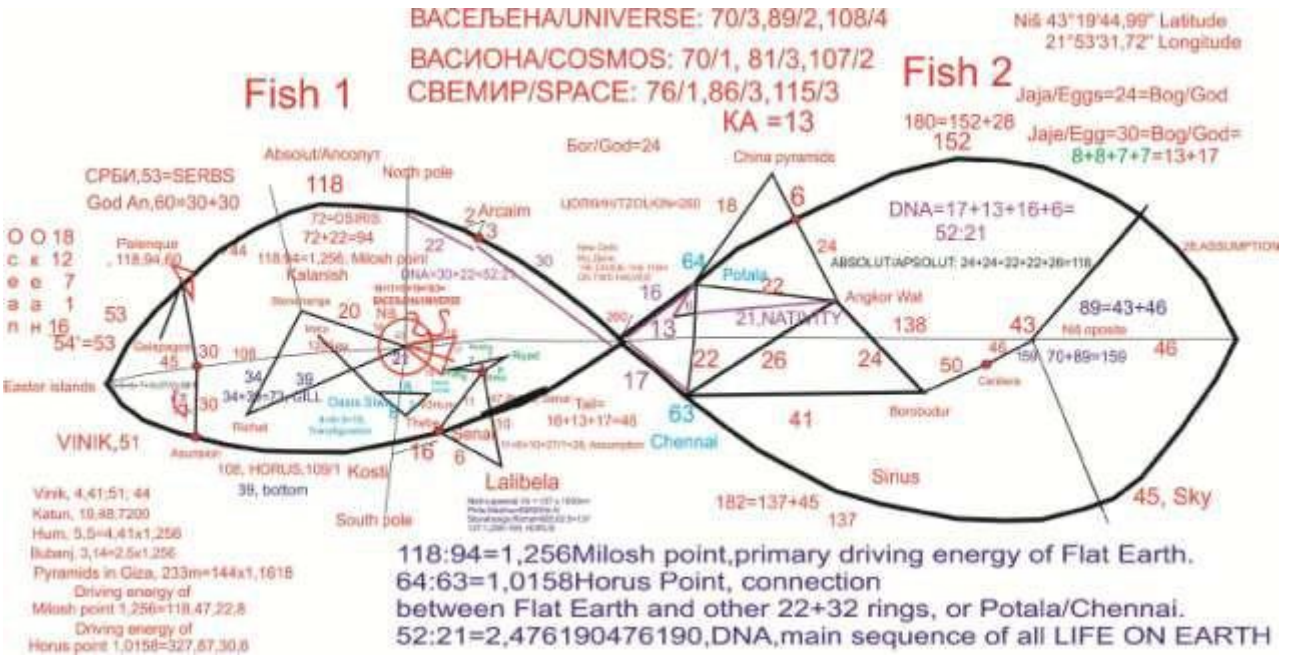



**Figure 04.** Display of two fish as a system of sacred sites that are actually OKTAGON, or as we presented in the previous paper, as a system containing two HEXAGONA.

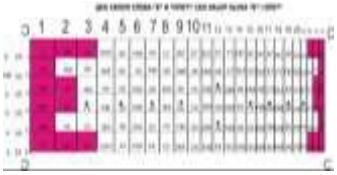
This time system is just showing these hexagons as a time stream. Well known

Hi-Ro is a time display of time as the symbol of Sumera God ANA, with the real name RANKA.

The Serbian Orthodox calendar contains two system dates: one is in official use, Gregorian, and the other, Julian, as a church. Normal letters, italics, letters in black and bold and red letters are in use. The top date map was created after my exploration of Mount Rtanj. Then I discovered that there is a schedule of dates according to the schedule of the month of the year. Namely, it turned out that the central date was August 1st. And then I realized that the layout of the red letters corresponded to very important events that are not related only to us Serbs. Specifically, here are some cycles that correspond to the numerical values of personages and terms related to the whole planet Earth. Let's say, 144 as the coefficient of King Pakal, 72 as the number of Tzar Dušan.

However, the whole story with Sirius A and B and their rotations is not just an astronomical event. It's actually a whole story that incorporates all known mathematical and harmonic and DNA relationships into itself. Namely, the above picture is also time, but also the harmonic ratio 9/8 or the relation of the letters "E" as evidence that the Delphi as a prophet really, and not accidentally did exactly what actually remained as evidence that the Serbian language was the basis of the beginning acquiring knowledge. OPETH is a 59-day period and it's time from January 1st to February 28th. It appears again, as a ritual in Egypt, as OPETH and it is the period from July 1 to August 28, in red letters, when it is the time of the celebration of ASCENSION, or the Departure of the Holy Virgin to Heaven.The NATIVIATE is the time of the 21st of September when the birth of the Most Holy Mother of God we celebrated in red letters. Both dates are related to the stars of Sirius A and B

**Picture 05.** The letter "S" as the harmonic set of the term "OPETH"

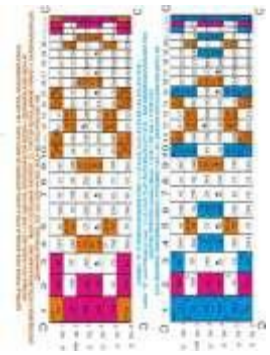


**Picture 06**. The word "E" as a set of letters "E" and the notion of ritual "OPETH"

**Picture 07**. Dogoni from Malia wear masks with stylized double "E" representing LIFE and KA of letters "E"

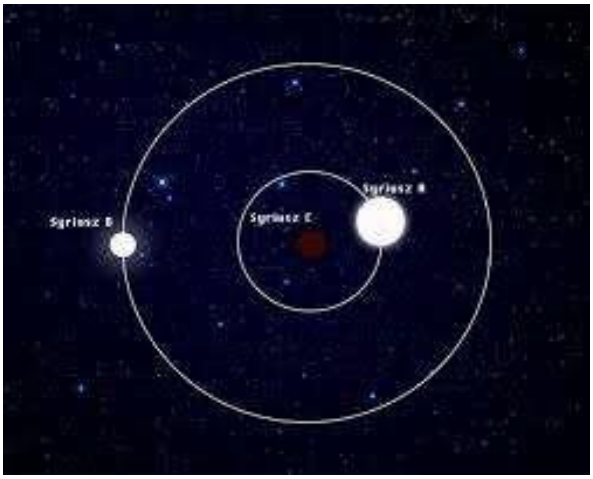
**Picture 08.** The word " E " rotates the letter, the Cyrillic " Š ", and with the combination of the KA system, it forms the letter " Ž " in the back " and the OSAM number as a complex face-to-face system "

**Picture 09.** The word "S" of the harmonic term "OPETH" forms with the KA letter system, Cyrillic "N" or Latin "H", and the letter "O"



**Picture 10**. The words "E" as harmonic concepts. We see the letters "E", and number "8",

**Picture 11.** Our Dogons that have stylized masks with harmonic processes from the upper picture



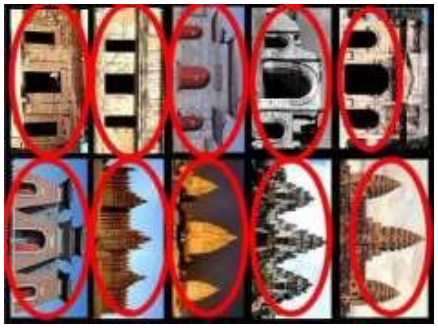

**Picture 12.** Rotation of Sirius B around Sirius A. Their rotation is given in figure 8. It is possible that Sirius A = A, and Sirius B = E, as a vowel.

С И Р И Ј У С А Б
21 10 20 10 11 24 21=117 1 =118 АПСОЛУТ 2 = 119 АПСОЛУТ

**Picture 13.** The position of the Letter "E" in Delphi points to the impact that the spirituality of today's religious and sacred buildings has on the whole. The same pattern of triple entrances to temples or altars, or dome on buildings, is maintained on all continents.

**Picture 14.** Picture of the iconostasis where the three doors are seen as the stylization of the letters "E"

**Picture 15.** Letter "E" as a model for Leonardo da Vinci in painting the "Secret of the Dinner". Below are the temples in Mexico, Egypt and Indonesia as an identical copy of the harmonic letter "E"..



**Picture 16.** It enters the temples through the letter system "E" and the tower system is formed in the same way.

Х Р А М
26 20 1 15=62/1

**Picture 17**. Kecalkoatl near Asteka, or Kukulkan near May, or Virakoča at Ink is Perjan Zmija, which is actually a visual representation of the harmonic circuit "E" in Delfi, with the number eight and the letter M

**Picture 18**. God Vishnu lies on his snakes and maintains the whole known world. God is the supreme creator because he has an ocean of water in which he appears as a creator and as God in his incarnations as Avatar

*VISHNU* *SNAKES* *VISHNU*

В И Ш Н У О В Е З М И Ј Е В И Ш Н У

3 10 30 16 24 18 3 7 114/2 =116 9 15 10 11 7 52/1 = 53 = СРБИ 3 10 30 16 24

83/1=82 ПРСТ

**Picture 19**. .Shiva Lingam

Б Р А М А Brahma З М И Ј А Snake Л И Н Г А М Lingam King Pakal

2 20 1 15 1 39 + 9 15 10 11 1 46/1 + 13 10 16 4 1 15 59/1=144 КРАЉ ПАКАЛ

Ш И В А Shiva К Р Ш Н А Krshna

30 10 3 1 = 44 + 12 20 30 16 1 = 79, Свемир = 123/1

К Р Ш Н А + Б Р А М А А П С О Л У Т

12 20 30 16 1 79 2 20 1 15 1 39 = 1 19 21 18 13 24 22 =118/2

**Picture 20.** Kukulkan – Feathered Snake in Maya

К У К У Л К А Н Kukulkan П Е Р Ј А Н А З М И Ј А

12 24 12 2 4 13 12 1 16 114/2=116=АПСОЛУТ 19 7 20 11 1 16 1 =75/2 9 15 10 11 1

А П С О Л У Т =46/1

19 21 18 13 24 22 118/2 =116 75/2 + 46/1 = 121/1=120 = АПСОЛУТ

**Picture 21.** Oasis of theSIWA - or the Oasis of God Living and the Goddes Živana

The Oasis of Siva is a place 800km from Gebel Serbal and is at 2000km from Niš, and represents a point which is 2.5 times shorter than the corresponding ring. There is the temple of God Amon Ra, which is drawn with the ram horns. However, Oasis Gray was named after the real name Amon Ra = ŽIVAN. The word DOM – HOME is the same value of 38/1 as the name ŽIVAN. Ж И В А Н + Ж И В А Н А = С В Е М И Р

8 10 3 1 16 38/1 8 10 3 1 16 1 39/1 21 3 7 15 10 20= 76/1

**Picture 22.** Royal Family: Rtanj Mountain, Radan Mountain and Suva planina.

Everything is 50 km from Nis. Number 50 represents the distance as the rotation of Sirius B around Sirius A for 50 years. The real name of Suva planina is ALKAIDA. That means the Leader, the Sage, but the true meaning is "ALKA give them" or "ALKA keeps them". The facts is that these three mountains that make up the holder holding the whole planet Earth, that is, ALKA or CHAIN OF THE WORLD as it was called at the time of the Romans, as Katena Mundi. It's actually our HEKSAGON that keeps everything known on Earth and keeps the word "E" to the Delphi. These are 6 empty tones on guitar E6, B (H) 5, G5, D4, A4, E4

СУВА ПЛАНИНА – А Л К А И Д А

1 13 12 1 10 5 1 43/1 СРБИ

Р А Д А Н Р Т А Њ

20 1 5 1 16=43/1 СРБИ 20 22 1 17=60/1

АЛКА-И-ДА +РАДАН + РТАЊ = 146/3=144 КРАЉ ПАКАЛ

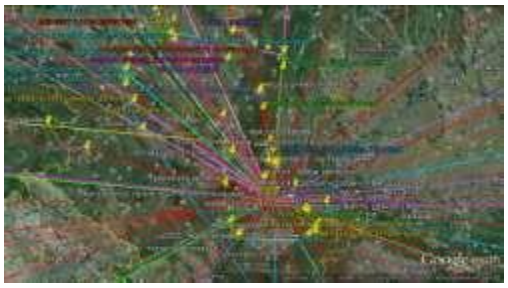
К Р Ш Н А + Б Р А М А А П С О Л У Т

12 20 30 16 1 79 2 20 1 15 1 39 = 1 19 21 18 13 24 22 =118/2

О Д И Н Т О Р В О Т А Н

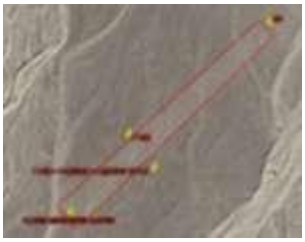
18 5 10 16 = 49/1 Сб око Са + 22 18 20=60=Бог АН + 3 18 22 1 16= 60/2 Бог АН = 169/4 П Р В С И Р Н **Б Р С** Т А В = ОЗИРИС КА: **С Р Б**

19 20 3 21 10 20 16 2 20 21 22 1 3 =178/2 = 177= 59 X 3 = 177 = 3 ОПЕТ



**Picture 24.** Serbia's display as a symbol of the harmonic assembly 9/8.

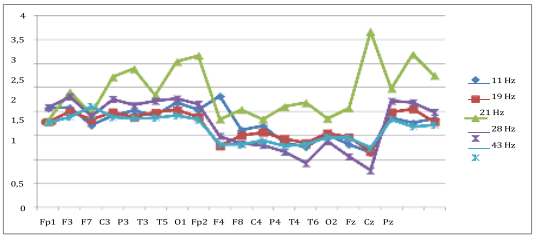
**Picture 25.** The performance of the harmonic circuit 9/8 is also the Great Pyramid in Giza



**Picture 26.** NACKA Desert Descent in Peru, where you see a rectangle with dimensions of 118m = APSOLUT, **8 = Serbia,** 12.56m = Miloš's comma

**Picture 27:** Flying Snake as a visual representation of the Sun's cycles of 11.5 years. So we have 11.5 hours 365 = 4,197.5 days: 518 = 8,103 or number 8. And that's the reason for the existence of the letters "E" in Delphi. This is the reason for the existence of the calendar day of 518 days that I called DAJ GOD.

## 3 Dr Sci Mirjana Sovilj




**Picture 28.** Chart 14b) POWER OF A TETA POSTSTIMULUS DIFFERENCE. this graphic represents a literally caught feathered snake. This graph was made in the IEFPG on the encephalograph which had a value of 11, 19.21, 28 and 43Hz for the signals

**Picture 29.** The Tribal symbol was the head of a wild boar pierced with a shot in the mouth

**Picture 30.** Feathered snake in the Mayan temple in Chichen-Itza, Mexico. Its number is No. 8 or OCTAGON, or those TWO FISHES which are the highest in the planet Earth

## Conclusion

Greek philosophy and Greek religion are two inseparable factors in the development of human thought and make it an inevitable station for the development of a civilization movement.

However, they are just one of the those we call "old civilizations" as part of a large chain of knowledge transferring from the primordial time up to today.

Today we have at our disposal the possibility of a synthetic relationship and a system by which we can present this knowledge as a "random process", rather than a continuous "deliberate process".

So we can only use mathematics as a "modular system of thinking", and to put all religious thought on a mathematical - confessional story of real events that have taken place, while others are recorded as a mythological event or an old philosophical sketch about something that does not seem to look right, or at least strange.

The basis of our work is the system of the setting of the First Earth of the Flat Panel (***Figure 01***), the Adela Margot system (***Figure 02***) and the work of Dr. Mirjana Sovilj (***Figure 28***), which showed that the system is stable and it shows with mathematical analyzes.

Miloš's point, 1,256 points to the system of the First Earth flat disc with ten rings of 200km, as its basic coefficient.

Horus point, 1,0158, as the coefficient of the formation of Planet Earth, consisting of 64 rings, with fittings, and this is shown by the great religious symbol of the Horus Eye, which proved to be a fraction 63/64.

Pythagoras point, 1,0136 points to the harmony of the world measured through lire - guitars. Two tonnes played after seven octaves and twelve quintas are not the same, but differ for 1,0136. This number points to the universality of the connected movement of the entire Universe, which indicates that harmony is an integral part of all the organic processes on Earth.

Time and space influence on the rotation of the Earth and its harmonic assembly, which is expressed through language. We have already shown in the books "Serbian Ethalones of Language, Time and Space in the History of World Civilization", "New Cosmogony of the World" and "Periodic Guitar System of King Pakal and Cara Dusan", that there is absolute unity in presenting these coefficients through all the major religious centers of the whole planet. Everywhere we find their presence, and the confirmation for all our attitudes has been analyzed by the signal from the constellation Sagittarius.

Everywhere we find that language, time and space are inextricably linked to the analysis of the Serbian language. It is shown that it has a dynamic energy that results in a harmoniously vigorous and complex visual representation.

Visual representation of the language represent system of analysis which indicates the multiple modularity and the possibility of presenting a single voice as well as complex concepts.

These terms can be analyzed on three levels: spiritual, astral, and material. Serbian language from the spiritual level is the main focus of our work. We have established that all major measures are precisely the values of these calculated coefficients. An example is, for example, the prophetic and astronomical city Arkaim in Russia, located at the distance from Palenque in Mexico, exactly 11800km, or a coefficient of 118 that represents the spiritual value of the term APSOLUT – ABSOLUTE (***Figure 05***).

From our analysis, the term APSOLUT – ABSOLUTE is the starting point of our civilization.

In Delfi there was a symbol of the letter "E", which is symmetrical, and shows similarity to the letter H or the letter N. The assumption was that it was the second position in relation to Dodon. The very voices A, E, I, O, U formed three Fates = Clotho, Lachesis and Atropos. In our language, there is the word KLOT and refers to yarn and knitting, or to something as empty, as "clot of beans", because the Three Dukes are knitting the network of people's lives. The word of the Tropa is from Atropa, which cuts the scissors from the gods to us. There are still soft "E" and soft "O". Accordingly, there is also a LIRA instrument with seven wires, one for each vowel. Apollo is holding that instrument between his legs.

When the value of ritual OPETH of 59/28 = 2.1071542 is placed on the harmonic base of the guitar, we get the letter "S" (***figure 06***). The meaning we get is: BOG EA. It's the Sumerian god Vo-de, intelligence, creator of people. It also has the name ENKI. At the rank is just below God AN. It is also remembered as the God of the APSU. It is the God of the enclosure. We refer to him as an **abscess**, or a prison, or an **''apsu place''** when we play marbles.

When the value 52/21 = 2.476190 is placed in the harmonic base of the guitar, we get the perfect appearance of the letter "E" (***Figure 07***). What does that tell us? It tells us that the time of rotation of the Earth is in an ideal harmonic order. It's time as the area of order number 144.

The letter "E" is symmetrical to itself in terms of the H axis in the middle of the axis of the letter, and makes KA - parallel, duality to itself, as the figure of the man in the mirror.

It is exactly such a mask as KA letters "E" wearing masked members of the DOGON tribe from the Republic of Mali (***Figure 08***). The word Dogon is from the Serbian Corps and means to go down, run. That nation still has rituals, which Dr. Robert Templ said in the book, "The Secret Star of Sirius," said that they got it from Misirka. So, the word Dogon is still in use today in the Serbs, and they point to the fact that these charts are not random.

The "S" backbone system gives us the letter "N" in Cyrillic, or "H" in Latin. Joining forward, they give us the letter " O ". Let's say it's our "OPETH".

However, Dogon's imagination does everything, and creates a new mask of complex patterns, but this is the order that corresponds to the vertical harmonic order of the letters "E" and "S". He corresponds in reality to the order of stars Sirius A and Sirius B in the sky as stars that are superior to us. Namely, Sirius A is 2.5 times larger than our Sun, and Sirius B is about 0.9 mass of our Sun. These are relations 2.5 and 1, which defines the First Earth Flat Panel (***Figure 13***).

In Misir, there is one OPETH ritual, which refers to the appearance of the sculptures of the Goddess Mut and God Amon-Ra, who emerge from the Egyptian Heaven (***Figure 08***), and meet in the middle of the Nile (***Figure 07***). The event is tied in August. We then celebrate the Great Lady, August 28th. The Teba - Niš line passes through our HILANDAR monastery (***Figure 09***).

So, Delphi and Thebes are directly linked to Serbia and are on the 3rd and 11th rings. They are KA points to Istanbul and Baghdad who are also on the 3rd and 11th rings. So, the term KA occurs both in space and as a sign of the letter.

When the letters "E" and "S" are joined, we get the picture of the letter "E". When the letter "E" having its KA moved in the space, we get the letters "Ž" and "Š" and the number 8. The letter "Ž" in Serbian alphabet has a value of 8 (***picture 09***).

The time of 518 days is TIME OF GOD (***Picture 03***). The term DAŽ is 518 (D = 5, A = 1, F = 8). It is a time that includes all numerical representatives of old civilizations - Sumer, Maya, Misir, Slovene, etc.

On Earth there is a system of prophetic places outside of Greece, Sumera, etc. who gave the whole planet Earth a brand new spirit and robe. Thanks to Gugl, we have the opportunity to connect them and to measure them. We have described them in more detail in our books, and we have shown that this

system is based on values that are determined by the coefficients of spiritual values of concepts like Apsolut, Srb, Miloš's comma, Horus comma and Pythagoras comma, Ocean, etc.

We have thus obtained the appearance of two fish individually, or together a laid eight, or OKTAGON.

This is actually the true world-wide DNA system. All values are carefully measured, and a merger takes shape, which was tested with a signal that came from the cosmos on August 15, 1975 from constellation Sagittarius or Sagittarius.

We processed and analyzed this signal through the notation system and saw that it can be analyzed through the writing of the notation, through the notation system, but also that it can be summarized by columns, using the decimal principle. All of our points actually received a signal of measurement and measurement of the harmony response. In the end, this signal is played, both on the eletrical and the classical guitar, only with 24 thresholds.

And you see that this arrow is seen by Apollo who takes it immediately after the birth of Luke and Strela. But Sagittarius points out that the notion of a guitar that has the appearance of lightning is precisely the most suitable to show the harmonic complexity of the DNA system. We do not enter either chemistry or DNA physics here. Here we point out that the DNA system we have today given from Watson and Chris is incomplete, and that we pointed to the fact that Ms. Rozalin Franklin did her completely different structure.

This Octagon is actually a system of two HEXAGONA, i.e. each fish is one hexagon or a hexagon that looks like a bee honeycomb. It is written in Greek mythology as the work of the Goddess Gara, the Goddess of Bees to which the symbol of Hexagon was attached. In notes, it means that it's 6 tonnes at the zero fret.

But the horizontal position of the letters "S" and "E" gives another visual striking similarity to the iconostasis and altar of our church. Namely, the arrangement of the door on the side and the door to enter the altar corresponds to the visual image of the letters (***Figure 15***).

However, Renaissance artists, such as Leonardo da Vinci, used the same styling at the "Secret Evening", and visually also coincide with the entrance doors of temples on three continents (***Figure 16***).

The same visual stylization was used at the entrance facades of temples and domes of the same on all continents (***Figure 17***).

All Snake Kecalkoatl in the Aster and Maya systems is a system of letters "E", "S", "M" and two eight (***Figure 18***) and (***Figure 21***). KUKULKAN = 116 = APSOLUT = PERJAN ZMIJA.

However, the Supreme God in India, MUCH seated on snakes (***Figure 19***). Apart from the harmonic meaning, I think that these are electromagnetic waves. Namely, it was discovered several years ago that electromagnetic waves travel from the end to the end of the Universe with such terrifying energy, and that they are its keepers, which is Višna po vokaciji and is, the maintenance and creator. His lingam is the basic building material from where all the material outcomes are (***Figure 20***). They are snakes after calculating SRBI 053, and VIŠNU'S is APSOLUT 116, and VIŠNU is God = 82 = PRST (Finger).

BRAMA + ZMIJA + LINGAM = 144 = KRALJ PAKAL. THIS IS ONE OF THE FULFILLING EVIDENCE THAT ALL RELIGION LINKS ARE BASED ON THE COMPLETE HARMONICAL DERIVATION OF HARMONIC DNA.

The Oasis SIWA is the Oasis of the Living God or God of Amon Ra, where Alexander the Great was buried (***Figure 22***). It contains a complete system of measures - HARMONICAL DOCUMENT OF THE WORLD OF THE WORLD.

The Royal Family Rtanj, Radan and Suva planina are 50 km from Niš and represent the rotation time of Sb around Sa (***Figure 23***).

But when we turn that letter down, we get the letter "M". And we see that letter just on Snake Kecalkoatl or Kukulkan or Virakoča. Next to him, we see two eights.

Well OK. What then is SNAKE (***Figure 21***)? Snake is a play of the letters " E ", with its mouth open and with the tongue that thumbs and SIKE. So the letter "S" is the scepter of the Snake. But this is also the performance of the Wild Boar head with a shot in the mouth. This is TRIBAL symbol.

Tzar Dušan was ARHONT OF ALL TRIBALS, or all Serbs.

And the arrows and the bow are the PRESENTATION OF LETTER "E".

So, Apollo describes the letter "E" in Delphi.

And the image of Feathered Snakes on the encephalograph (***Figure 20***) shows that the letter "E" actually functioned as an ACCEPTING CENTER OF ALL THE SIGNALS AND DATA THAT COME FROM THE OUTER SPACE.

That's why Apollo's temple served in Delphi.

THE SPACE OF SERBIA PRESENTS SYSTEM 9/8 (***Figure 24***).

PIRAMYD IS A MATHEMATICAL SPACE MODELING SYSTEM 9/8 AS A CALENDAR AND SPHERE HARMONIC DNA (***Fig. 25***).

THE PASSENGER OF THE NACKA IN THE PERU IS A SPACIOUS DNA OF THE ABSOLUTE 118 CONNECTED WITH THE CREATION OF THE COUNTRY THROUGH THE MILOSE SURFACE 1,256 AND OTTAGONA (***Figure 26***).

THE SOLE RADIATION AND PERIOD IS 11,6 YEARS IP IS REDUCED BY A SYSTEM WHICH WOULD LIKE THE FOAM OF MASS (***Fig. 27***).

AND THE SYMBOL TRIBAL IS FEATHERED SNAKE IN THE FORM OF THE WILD BOAR WITH THE ARROW IN HIS HEAD (***Figure 29***).

AND OUR BRAIN IS REALLY STORAGE OF FEATHERED SNAKES (***Figure 28***).

THEREFORE, BOW AND ARROW OR FLAT EARTH ARE FEATHERED SNAKES. WE ARE FEATHERED SNAKES, SUN IS FETHERED SNAKE, SIRIJUS A I SIRIJUS B ARE FETHERED SNAKES.

## In short

The Harmonious Language Code of DNA is a new term that defines harmonic, temporal, religious, geographical, linguistic and architectural similarities that we see on all continents of the planet Earth. Signs like the linguistic messages of the spiritual code of the Serbian language define KA - the principle of parity of transformation, where the records come to us through the electromagnetic waves of huge and subtle energies of the stylized ones through the symbol of the Perry Serpent. We see them through the simbols of the Vishnu's snakes and the Shiva Lingam. They represent a synchronized system of rotation of Sirius A and Sirius B, and our Sun. Their rotation periods are represented by the stylization of spaces with the number 144, and the letter symbols "E" and "S". The output of the codes goes through the harmonic structure of numbers 8 and 9 and is represented by the geographical territory of Serbia and symbolically over the pyramid in Giza, and through harmony 9/8. The records of the harmonic structure of the codes of language, time and space are found in the desert Natzka, through masks of Dogon's in the Republic of Mali, through the systems of religious shrines of Maya, Misirian, Angkor Wat, Leonard Da Vinci, our iconostasis and altar and many other things in all other nations.

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# Слово Е у Делфима и "опет" времена и хармоније српског језика

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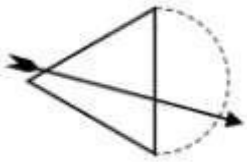
**Абстракт**: Језик, Време и Простор су три међусобно повезана еталона која заједно чине целу људску цивилизацију међусобно повезаним. Ови еталони бришу границу међу народима и континентима. Из ових еталона је произишла цела људска духовност, и почевши од храмова у Додони, Делфима и другим, добијамо нова синтетичка знања попут математике, филозофије, хармоније, етике, религије итд. Појава људи попут Питагоре чини да се спајају наизглед неспојива стања, и хармонију стављају и као математичку и као етичку збиљу. Спајајући наша данашња знања са њиме достигли смо знање о чувеном слову "Е" које стоји у Делфима и које се односи као ликовно – хармонски предложак сложеном као ритуал "ОПЕТ" у Мисиру – Египту. Тако Античка Грчка и Антички Мисир добијају хармонску слику јединствености знања и порекла примања тог знања. Тако долазимо до појма Перјане Змије код Маја и коначног решења слова "Е" у Делфима, а то је да наш мозак заправо садржи сигнал Перјане Змије.
**Кључне речи:** слово "е" у делфима, делфи, ритуал "опет", српско ћирилично писмо, гитара, хармонија, аполон, ка, перјана змија

## Увод

**Слика. 01** Аполонов храм у Делфима

Бог **Аполон** је син Бога Зевса и Богиње Лете, рођен у седмом месецу трудноће. Одмах по рођењу, по четвртом дану, затражио је **лук и стрелу** (Р.Грејвс, стр. 70).

**Слика 02** Прва Земља Равна плоча



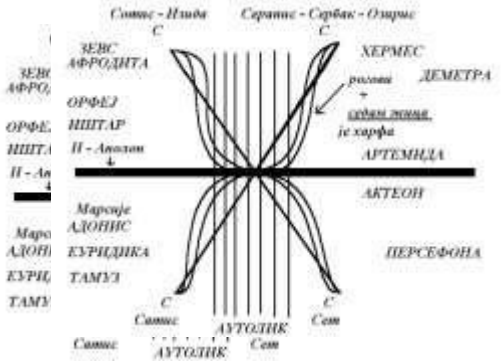
**Слика 03** Лук и стрела су спојени троугао као З Шар планине (Србија, Кавказ и Јордан) и стрела као линија Ниш – Истанбул - Багдад

Аполон иде на Парнас, где се скривала змија Питон, непријатељ његове мајке, и рани је његовим стрелама. **Питон** бежи до пророчишта у Делфима, које је добило име по његовом другу, чудовишту Делфину. Аполон га прати до светилишта и убија на ивици самог светог понора.

Бог Зевс се наљути на сина Аполона, јер је мајка Земља пријавила овај догађај њему. Аполон мора да иде у Темпе ради очишћења од греха. Бог Зевс установљава Питонске игре, а за казну поставља Аполона да председава њиме. Али Бог Аполон се није осећао кривим и одлази у Ајгијалају на очишћење од греха, у пратњу Артемиде. Одлази затим на Тару, на Крети, где је краљ Карманор приређивао свечаност.

Враћа се у Грчку, тражи Бога Пана, старог Бога Аркадије са јарећим ногама, добија тајну предсказивања, одлази у Делфе и натера свештенице зване Питомке да му служе.Аполонов храм у Делфима је посвећен Мајци Земљи, и оставштина за будућност која нам је остављена као сећање, визуелно и текстуално и археолошки и уметнички, као пример свих духовних и физичких сила која су се дешавала у потрази за питањима пророштва будућности тадашњих житеља. Будућност или ЗНАЊЕ је могло бити виђено захваљујући знању свештеника и сила са висине.

Седам самогласника грког алфабета су били:А,Е,И,О,У. Њих су измислиле Три Суђаје, а неки кажу да је то урадила Ија, сестра Форонејева, а уз то су измислиле и два сугласника Б и Т. Осталих једанаест сугласника је измислио Пакамед, Науплијев син. Бог Хермес је све то уобличио у карактеристичне знаке преко клинастих облика и пренео га из Грчке у Египат. Р.Г. 161




**Слика 04**. Шема Прве Земље Равне плоче кроз приказ Божанских парњака – КА.

Равна плоча која Н-А ПОЛА дели рогове ЗМИЈОЛИКОГ изгледа је заправо н – А - ПОЛ – ОН. Мајка Земља је заправо н-А-ПОЛ-ОН. АУТОЛИК је то чувено КА или пресликавање.

**Слика 05** Две Змије или два Рога на Земљи данас као рељеф у облику планинских масива АЛПА и КАРПАТА и СТАРЕ ПЛАНИНЕ

Два самогласника, дуго "О" и кратко "Е", увели су Аполонови свештеници, тако да отада Аполонова света лира има по један самогласник за сваку од седам струна. Р.Г. 161

Слово А је прво у алфабету јер *alphe* значи *част,* а *alphainein* значи *измислити*. Али **aleph**

на феничанском значи **ВО**. А Бојотија је земља **Волова**. Р.Г. 161

Сваки самогласник је имао неко значење. И биљку и неки период године, као:

**А** – јела или палма, дрво рођења, зимска краткодневница, **Е** – топола, јесења равнодневница, **И** – тисовина, дрво умирања, зимска краткодневница, **О** – штипавац, пролећна равнодневница, **У** – врес, летња дугодневница,

**Б** и **Т** – измислила је Богиња Кармента, јер су означавали по једну половину њене године, која је била подељена између светог краља и његовог заменика. Р.Г. стр. 162

"У Египту – Мисиру свештеници певају химне боговима изговарајући седам самогласника један за другим, а њихови звуци производе снажан музички доживљај, као да употебљавају фрулу или лиру". Р.Г.стр.163

"Плутарх, древни биограф и филозоф из Черонеа у Бејотији (46-127 АД), који је служио као господар Делфи, бавиће се са појмом "Делфи Е", међутим, постајући посебно илустративан. Опис чувеног натписа у Делфију, према традицији, долазио је из дрвеног постоља у праисторијском храму Аполона, а приликом снимања и читања потребан је Палаиограмски систем писања и читања и искуства измене слова и, евентуално, ништа што није значено за трисекцију.

- Замислите тада триангуларни педимент са симетричним, десним и левим, а "Е" или "Х", "предсједавајућим те" на врху са "Знај себе" и "ништа више". Индекс сумње у, писмени посјетилац без "Е" имао је испред њега некомплетан палиндромски натпис!
- ΓΝΘ ΣΤ ΜΔΝ Γ - са недостајућом тачком: "Т"! Завршен натпис: ΓΝΘ ΣΤ Τ1 ΜΔΝ Γ
- ΓΝωΘι ΣαυΤον οΤι ΜηΔεΝ αΓαν - У слободном преводу: Научи га! Упознајте га! Реците себи да чак ни "ништа" није "превише"!"

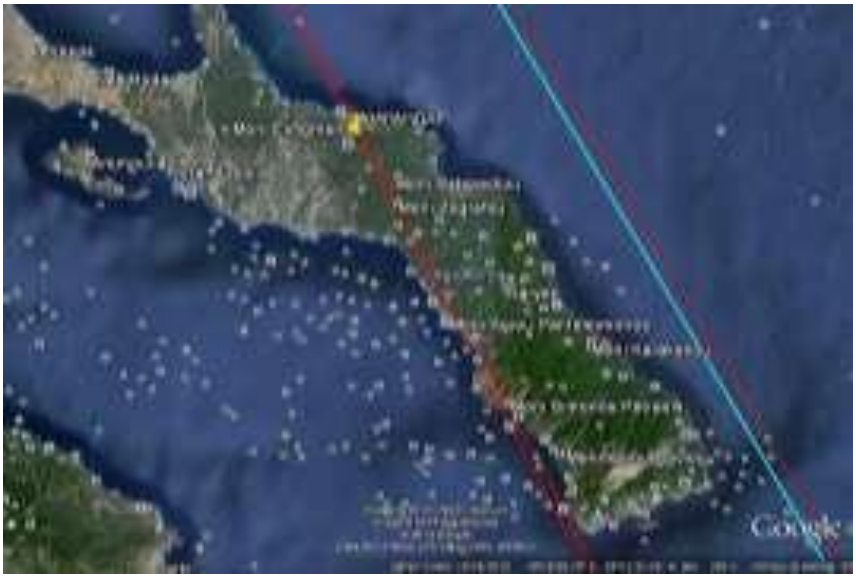
Додона је у Грчкој носила титулу првог храма, јер је био посвећен Богу Зевсу, а свето дрво је био храст.

**Слика 06** Делфи се налазе на 3. прстену на 600км од Ниша, Додона и Олимп на 2. прстену од Ниша

**Слика 07** 28. августа сваке године износио се кип Бога Амона Ра. Карнак је храм где се налазио кип Бога Амон Ра, сједињавали су се на средини пута у Нилу

Ритуал ОПЕТ у Мисиру је јединствени циклус који указује на вечито спајање мушког и женског принципа. Луксор и Карнак у Теби су чували њихове кипове. Међутим, ОПЕТ на српском има још једно значење. То је заправо ОПЕТ и ОПЕТ понављани неки циклус времена. У овом случају је то везано за понављање времена од 01. јануара до 28. фебруара. То је време од 59 дана. Међутим, ми Срби имамо и празник ВИДОВДАН, црвено слово, који славимо 28. јуна. И то јесте ОПЕТ који износи 59 дана. И имамо још један ОПЕТ, црвено слово, СВЕТИ ЦАР КОНСТАНТИН И ЦАРИЈА ЈЕЛЕНА, дана 03. јуни и то даје 59 дана до првог авуста. Међутим овде ћемо сада само обрађивати Велику Госпојину јер је други датум 21. септембар који је Рођење Пресвете Богородице.

**Слика 08:** Луксор је храм у коме се налазио кип Богиње МУТ. Ознака 53м по Адели Маргот додељује се речи "СРБИ"



**Слика 09:** Линија Ниш – Теба иде право преко ХИЛАНДАРА и Горе Атонске

МАЈАНСКИ КАЛЕНДАР почиње са бројањем 11. августа 3314. године старе ере. код нас постоји датум 19. август као црвено слово празника Преображење.

28. август је празник ВЕЛИКЕ ГОСПОЈИНЕ, а код Мисираца је то био празник ОПЕТ.

21. септембар је празник МАЛА ГОСПОЈИНА

Линија НИШ-ЛУКСОР- КАРНАК пролази кроз манастире ХИЛАНДАР, ЗОГРАФ и СИМОНО ПЕТАР. Тако сада можемо СХВАТИТИ ЗАШТО ЈЕ ПРЕСВЕТА

БОГОРОДИЦА ИГУМАНИЈА МАНАСТИРА ХИЛАНДАР. Највећи број манастира на Светој Гори се налази између ове линије и линије Ниш – Бехдет. УПРАВО ЈЕ ОВО ДОКАЗ ДА ЈЕ ХАРМОНИЈА ТА КОЈА ПОВЕЗУЈЕ СРБЕ И МИСИР = МИ СИР- БИ

**Систем Аделе Маргот**

Духовни ниво – српски језик, ПРЕНОСА – Астрални ниво – западна абецеда, и ИЗВРШЕЊА – Материјални ниво – Српскохрватска абецеда. Сиситеми којима то обрађује су стари Библијски системи проучавања – Гематрија, Нотарикон и Темура.

1. ГЕМАТРИЈА

**Гематрија је замењивање места у тексту појединим речима које имају исти збир.**

*Будући да је у јеврејском језику свако слово истовремено и број, што свака реч, кад се саберу бројчане вредности њених појединих слова, има одређену збирну бројчану вредност.*

*По Кабали, све речи које имају исту бројчану вредност су истоветне (будући да су те речи у дубини заједничког корена једнаке) и у тексту им се могу мењати места, јер је то само један од начина за боље разумевање значења текста.*

***Уместо бројчаних стања слова хебрејског језика служим се са три наведена писма и бројчаним стањима њихових слова.***

2. НОТАРИКОН

**Нотарикон је техника читања појединих речи као да су анаграм.**

*"Тако се свако слово у одређеној речи узима као почетно слово неке друге речи и на тај начин се од једне речи добија нова реченица. У ствари, реченица није нова, она је стара колико и реч из које је настала.*

*Ово значење је и Сам Бог имао на уму (између многих других) када је ту реченицу давао народу Израела.*

*Овај смисао је стајао у њој (самој Речи) заједно са 69 других скривених сми-слова те исте Речи."*

| Реч | = | 1 | + | 69 | = | 70 | смислова. |
|---|---|---|---|---|---|---|---|

пример:

| "- РАЂА - М | - М - АЂАР ": |
|---|---|

3. ТЕМУРА

**Темура је спекулативна техника тражења дубљег смисла текста.**

Српско ћирилично писмо, западно европска абецеда и српскохрватска абецеда су три основна писма која нам пружају увид у одређена стања. Њихове бројчане вредности нам дају могућност математичког промишљања и прилагођавања у израчунавању стања одређених појмова који тако долазе у корелацију један са другим, ван својих веза у језику, времену и простору.

БРОЈЧАНА СТАЉА ТРИ ПИСМА

*Духовно, ћ. шапто, невидљиво, или умућљиво сйање, се обрашњава кроз срйскоцрноборско ћирилично йисмо од ћрнаесеш (30) сл.*

*Рачунарско-комйућерском језиком речено ово је улаз (input) -шифрић-невидљиво-(не-ви-дио) = духовно сйање*

СРПСКОЦРНОГОРСКА (СРПСКА) ЋИРИЛИЦА

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| А. 1. | Б. 2. | В. 3. | Г. 4. | Д. 5. | Ђ. 6. | Е. 7. | Ж. 8. | З. 9. | И. 10. |
| Ј. 11. | К. 12. | Л. 13. | Љ. 14. | М. 15. | Н. 16. | Њ. 17. | О. 18. | П. 19. | Р. 20. |
| С. 21. | Т. 22. | Ћ. 23. | У. 24. | Ф. 25. | Х. 26. | Ц. 27. | Ч. 28. | Џ. 29. | Ш. 30. |

*Видљиво, ћ. сйање йредмеш или сшварносш на неком месшу, йосйављање, обрашњавање кроз лайинословенску абецеду коју има двадесеш месшо (26) сл.*

*Рачунарско-комйућерском језићу речено ово је ЈОШ (излазна обавезна реченица) = дала слика.*

ЗАПАДНОЕВРОПСКА АБЕЦЕДА

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| *A. 1.* | *B. 2.* | *C. 3.* | *D. 4.* | *E. 5.* | *F. 6* | *G. 7.* | *H. 8.* | *I. 9.* | *J. 10.* |
| *K. 11.* | *L. 12.* | *M. 13.* | *N. 14.* | *O. 15.* | *P. 16.* | *Q. 17.* | *R. 18.* | *S. 19.* | *T. 20.* |
| | | *U. 21.* | *V. 22.* | *W. 23.* | *X. 24.* | *Y. 25.* | *Z. 26.* | | |

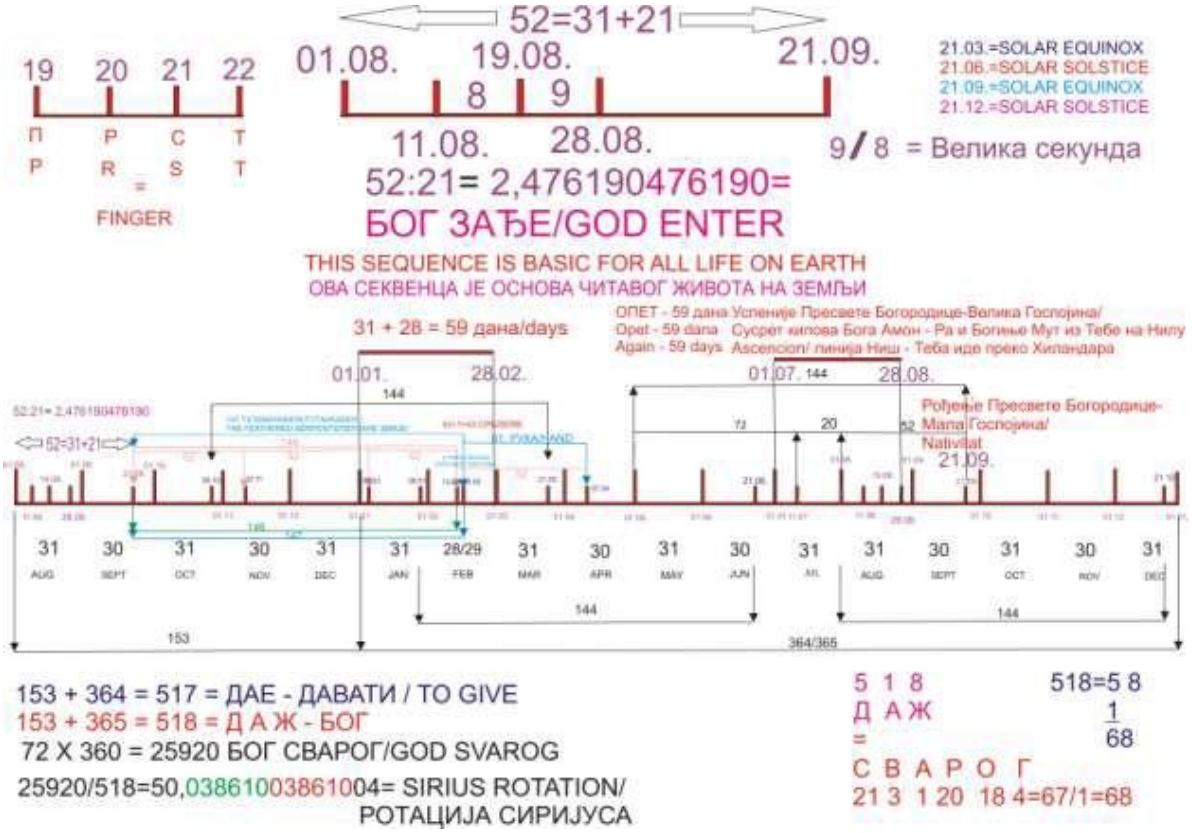
***Материјално, ћ. чврсйо сйање обрашњавам кроз срйско-хрвайску абецеду, која као и срйскоцрноборска азбука, има ћрнаесеш (30) звукова, или се служи са (27) сл.***

*Рачунарско-комйућерском језићу речено, ово је улаз-**output**,-оуййуйй. **видио(ví-dio)**,= **материјално сшање.***

SRPSKOHRVATSKA (HRVATSKA) ABECĒDA.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A. 1. | B. 2. | C. 3. | Č. 4. | Ć. 5. | D. 6 | Dž. 7. | Đ. 8. | E. 9. | F. 10. |
| G. 11. | H. 12. | I. 13. | J. 14 | K. 15. | L. 16. | Lj. 17. | M. 18. | N. 19. | Nj. 20. |
| O. 21. | P. 22. | R. 23. | S. 24 | Š. 25. | T. 26. | U. 27. | V. 28. | Z. 29. | Ž. 30. |

**Слика 10**: ВАСЕЉЕНА, ВАСИОНА, СВЕМИР, 2. ниво 86/3=89 и АПСОЛУТ = 118




**Слика 11 :** Главни ДНК простора и свег живота на Земљи почива на коду 2,476190. То је матични код који спаја време од 01.августа до 21. септембра и износи 52 дана. Време ОПЕТ је 59 дана и са првим временом од 01. јануара до 28. фебруара даје број 118 или АПСОЛУТ.

## Главно Време

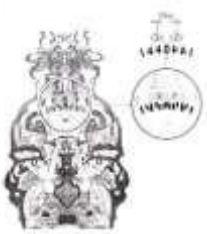
То је време од 1. августа до 21. септембра и главни је генетски код живота.

То је ПРОСТОР ЗЕМЉЕ која ротира. И то је ЈЕЗИК јер 2,476190 значи ДОСЛОВНО на СРБСКОМ ЈЕЗИКУ : БОГ ЗАЂЕ или код Мисираца је то Бог Хорус или Бог УЂА ОБРАДА ЈЕ

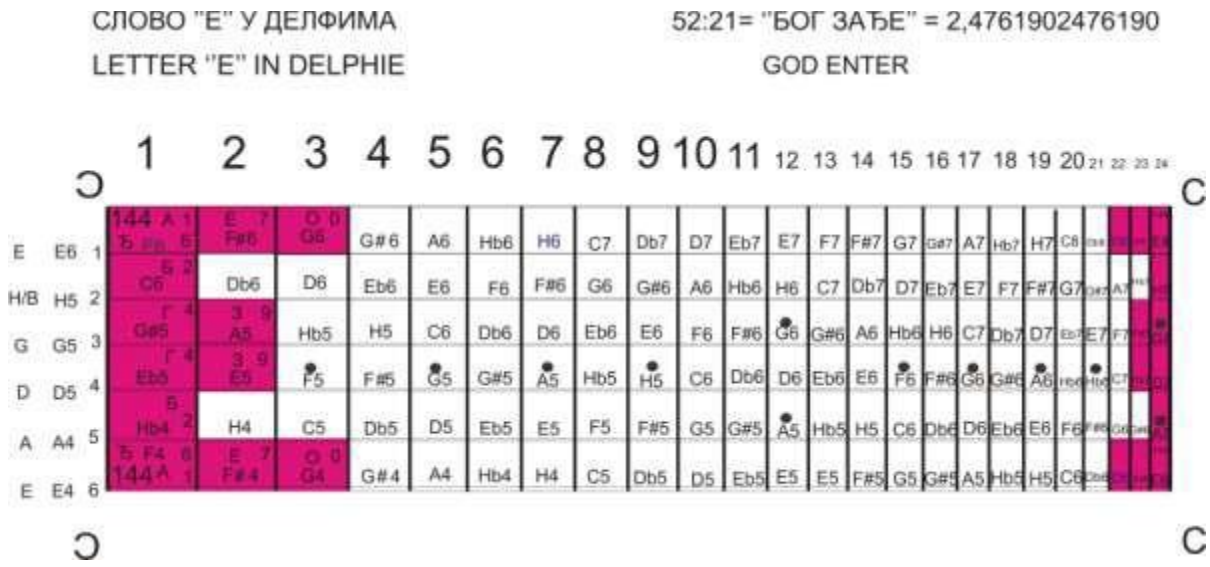
2, 4 7 6 1 9 0

Б Г Е Ђ А З О = БОГ ЗАЂЕ ДУПЛА СЕКВЕНЦА 4, 9 5 2 8 0

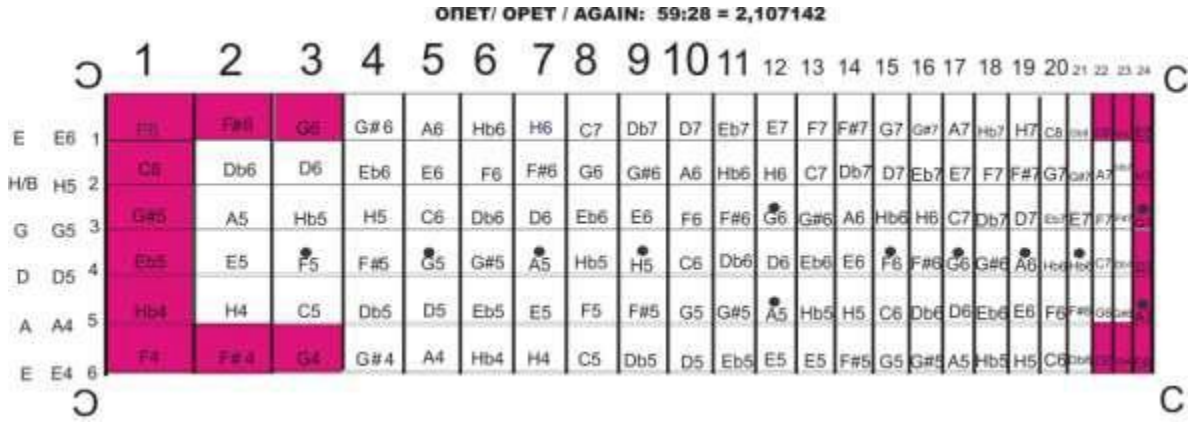
Г З Д Б В Ж О = ГОД ВО, или БОГ ВО или ГОД на енглеском, што асполутно указује на истинитост поставке Аделе Маргот СВЕМИР ЈЕ НАШЕ ПОЛАЗИШТЕ.



**Слика 12:** Краљ Пакал, Мајански краљ на челу има бројеве 144 0 0 0 441.

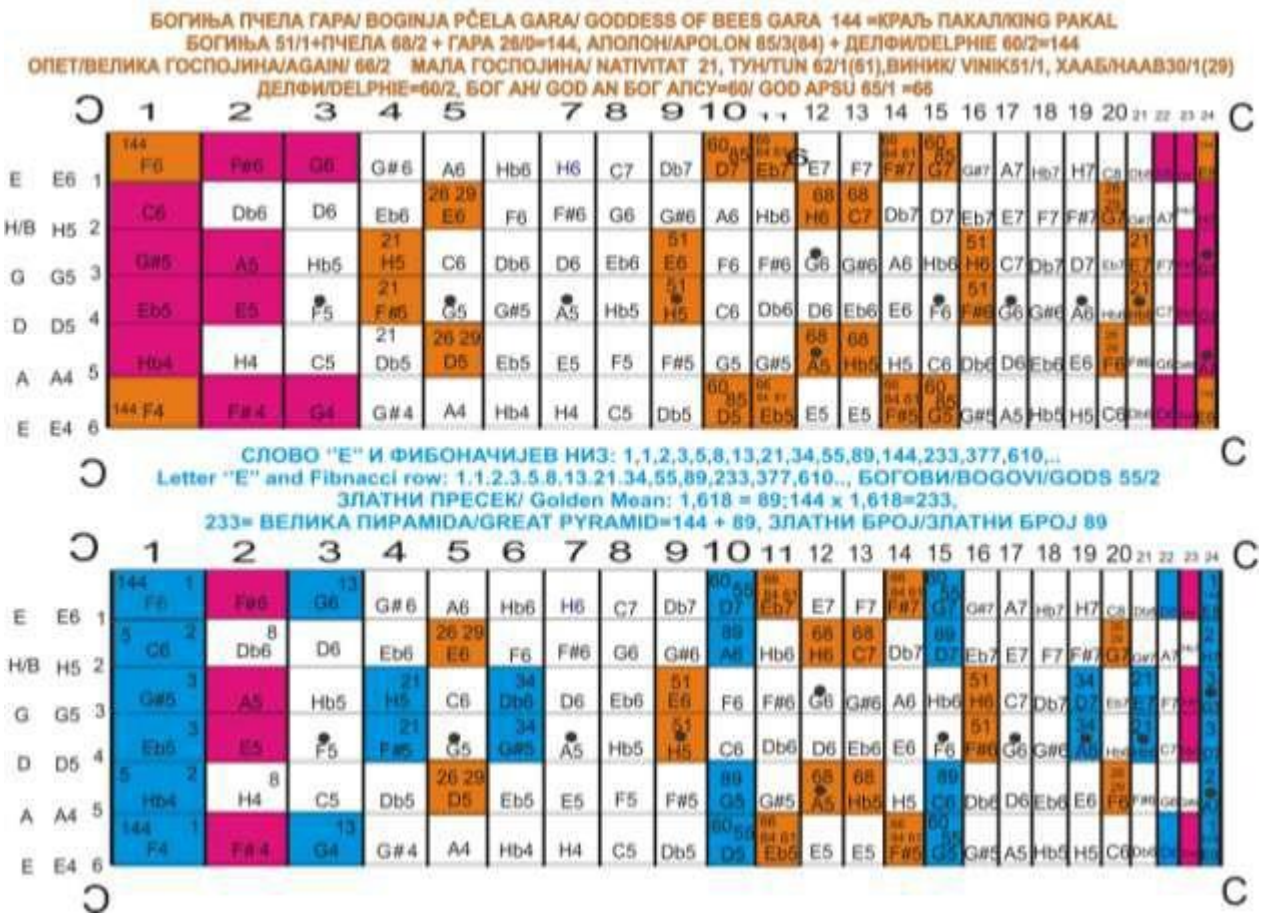



**Слика 13** ОВО ЈЕ ХАРМОНСКО СЛОВО "Е" У ДЕЛФИМА, ГДЕ СЕ КОД 2,476190 ПРЕТВАРА У СЛОВО "Е"




**Слика 14:** Код ОПЕТ је 2,107142 и добијамо хармонско решење као слово "С"

**Слика 15**: Код ОПЕТ се спаја са кодом слова "Е" и добијамо хармонско решење као слово "Е"




**Слике 16 и 17:** Богиња Пчела Гара има број 144 и представља простор као и Краљ Пакал, а Аполон и Дели исто дају број 144. Златни број је 89. То је број Свемира на примо – предајном нивоу86/3=89

**Слика 18:** Перјана Змија као носилац знања БОГОВА који преносе знање људима. Гледано овако видимо слово М од њеног тела. Гледано са стране имамо две ОСМИЦЕ.

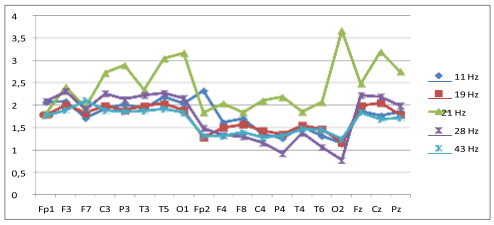
Слово Е у хармонској анализи показује да апстрактно приказивање има много предности. Једна од њих је сажимање ликовног израза. Наиме, коцкасто приказивање код Мисираца и Маја и осталих народа није било само условљено поставком камења таквог облика. Имало је утицај да стоје два слова "Е" као ЛУК И СТРЕЛА, али и лик ПЕРЈАНЕ ЗМИЈЕ. То је заправо ПИТОН који је боравио у ДЕЛФИМА. Средњи део је ЈЕЗИК, а лик слова С из фигурације ОПЕТ је чељуст или глава ЗМИЈЕ

**Слика 19:** Када се оба слова "Е" као КА систем ставе у међусобни однос добијамо потребан и довољан доказ да је хармонска анализа исправна.

Позиција Ш = позиција слова Ш и има редни број 30. Е је број 7 у српској ћирилици. Позиција спајања као слово Ж даје ликовни приказ из Мисира који представља појам спајања Лотоса и Папируса као спајање Горњег и Доњег Нила. Када се та два слова "Е" ставе једно према другом "лицем у лице" добијамо број 8.

Редни број слова Ж у српској ћирилици је 8. Реч ЖИВОТ означава животну силу коју добијамо од две Змије које имамо у себи. По Јога знању, то су две главне струје ИДА и ПИНГАЛА

## Др сци Мирјана Совиљ




**Слика 20:** Графикон 14б) СНАГА ТЕТА ПОСТСТИМУЛУС РАЗЛИКА ( Снаге овај графиком представља дословно ухваћену перјану змију

Овај графикон је начињен у ИЕФПГ на енцефалографу који је за сигнале имао вредности 11Hz, 19 Hz, 21 Hz, 28 Hz и 43Hz.

**Слика 21**. ПЕРЈАНА ЗМИЈА У МАЈАНСКОМ ХРАМУ У ЧИЧЕН-ИЦИ, МЕКСИКО

## Закључак

Грчка филозофија и грчка религија су два нераздвојива чиниоца развоја људске мисли и чине незаобилазну станицу развоја цивилизацијског помака.

Међутим, они су само једни од оних који ми називамо "старим цивилизацијама" као део великог ланца преноса знања од праискона до данас.

Ми данас имамо на располагању могућност синтетичког односа и система којим можемо да то знање представимо као не "случајним процесом", него сталним "намерним процесима".

Тако једино можемо да математику употребимо као "модуларни систем размишљања", и да целу религијску мисао сведемо на математичко – исповедну причу о реалним догађајима који су дешавали, а остали су записани као митолошки догађај или стара филозофска скаска о нечему што наизглед не изгледа тачно, или у најмању руку чудно.

Основу нашег рада чини систем поставке Прве Земље Равне плоче (***слика 02***), систем Аделе Маргот (***слика 10***) и рада др Мирјане Совиљ (***слика 20***), која је показала да је систем стабилан и то показује математичким анализама.

Милошев зарез, 1,256 указује на систем Прве Земље равне плоче са десет прстенова од по 200км, као њен основни коефицијент.

Хорусов зарез, 1,0158, као коефицијент постања Планете Земље, коју чине 64 прстенова, са уклапањима, и то показује велики религијски симбол Хорусовог ока, за који се показало да је разломак 63/64.

Питагорин зарез, 1,0136 указује на хармонију света измерену кроз лире – гитаре. Два тона одсвирана након седам октава и дванаест квинти нису иста, већ се разликују за износ 1,0136. Тај број указује на свеукупност повезаног кретања целог Универзума, и који указује да је хармонија саставни део свих органских процеса на Земљи.

Време и простор утичу на ротацију Земље и на њен хармонски склоп који се очитује преко језика. Показали смо већ у књигама "Српски еталони језика, времена и простора у историји светске цивилизације", "Нова космогонија света" и "Периодни систем гитаре Краља Пакала и Цара Душана", да постоји апсолутно јединство у представљању ових коефицијената кроз сва главна религијска средишта целе планете. Свуда налазимо њихову присутност, а потврда за све наше ставове дошла је анализа сигнала из сазвежђа Сагитаријус.

Свуда налазимо да су језик, време и простор нераскидиво везани за анализу српског језика. Показује се да он има динамичну енергију која се резултира као хармонски раложив и сложени ликовни приказ.

Ликовно приказивање језика представља посебан систем анализе које указује на вишеструку модуларност и могућност представљања појединачног гласа као и сложених појмова.

Ти појмови се могу анализирати на три нивоа: духовном, астралном и материјалном. Српски језик са духовног нивоа представља главни фокус нашег рада. Установили смо да су све главне мере управо вредности тих прорачунатих коефијицијената. Пример је, рецимо, пророчко и астрономско место Аркаим у Русији, који се налази на удаљености од Паленка у Мексику, тачно на 11800км, или коефицијент 118 који представља духовну вредност појма АПСОЛУТ.

Управо из наших анализа, појам АПСОЛУТ је место почетног исходишта наше цивилизације.

Аполонов храм у Делфима (***слика 01***), је други храм по значењу у Грчкој. Први храм је Додона, који је посвећен његовом оцу Богу Зевсу. Додона је на другом прстену, а Делфи на трећем прстену (***слика 06***). Аполон добија одмах лук и стрелу (***слика 03***), и тиме потврђује да је његов Отац – Зевс, онај који је направио Земљу, и да је он Врховни Бог са троуглом као својим знаком. Троугао чине три Шар планине – У Србији – Шар планина, , Русији, Кавказ - Шара, и у Јордану – Еш Шара. Права линија је линија коју чине Ниш – Истанбул

– Багдад. Аполон је заправо та равна плоча од 4000км ширине. На горњем делу се налази један систем симбола 4С и доле други систем 4С. Тако добијамо право име Аполона. Он је Н – А пол он. Он их дели на пола = Н-Аполон. Али у Делфима се налазила јама којој се није знала дубина, јер је то била тачка до које је тада дошло до прављења трећег прстена. Питон, змија чија је то место боравка била, има заправо слику 4С и змијоликих рогова (*слика 04*).

То се пресликавало у религији као двоструко божанство – као Змија и као ВО = БИК = БАК. Пара која је излазила је давала знаке Питонкама – свештеницама, на основу чега су оне послепрорицале.

Рупе или јаме непознате дубине су представљале рупе – отвори између прстенова од силицијума. су били намењени за постављање учвршћивача – клинова или нечега што је било везиво за прстенове. Имамо пример наше планине РТАЊ који је заправо ЗАВ-РТАЊ. Главни град Пољске је Варшава, или ВАР – ШАВА јер се налази на 6. прстену од Ниша. Град Милано у Италији је на петом прстену и он значи НАГО-МИЛАНО камење, којим је попуњена рупа. Главни град Аустрије је Беч како га ми зовемо, али је право име Вијена или НА-ВИЈЕНА, у смислу окретања неког навоја.

Када су змијолике антене пале уз огромну рику, касније претвореног у Бога Пана, претвориле су се у данашње масиве АЛПЕ и КАРПАТЕ и СТАРУ ПЛАНИНЕ (***слика 05***).

У Делфима је постојао симбол слова "Е", који је симетричан, и показује на сличност са словом Х или словом Н. Претпоставка је била да је то због друге позиције у односу на Додону. Саме гласове А,Е,И,О,У су формирале три Суђаје, Клота, Лахеса и Атропа. У нашем језику постоји реч КЛОТ и односи се на прediво и плетење, или на нешто као празно, као "клот пасуљ", јер Три Суђаје плету мрежу живота људима. Реч Тропа је од Атропе која сече маказама нит од Богова према нама. Постоје још и меко "Е" и меко "О". Сходно томе, постоји и интрумент ЛИРА која има седам жица, по једна за сваки самогласник. Аполон држи међу ногама управо тај инструмент.

Слово "Е" је симетрично само себи по Х оси по средини осе слова, и чини КА – паралелност, дуалност самом себи, као лик човека у огледалу.

У Мисиру, постоји један ритуал ОПЕТ, који се односи на појаву кипова Богиње Мут и Бога Амон-Ра, који излазе из Мисирске Тебе (***слика 08***), и срећу се на средини Нила (***слика 07***). Догађај је везан за август месец. Ми тада славимо Велику Госпојину, 28. августа. Линија Теба – Ниш пролази преко нашег манастира ХИЛАНДАР (***слика 09***).

Значи, Делфи и Теба су директно повезани са Србијом и налазе се на 3. и 11. прстену. Они су КА тачке Истанбулу и Багдаду који су такође на 3. и 11. прстену. Значи, појам КА се јавља и у простору и као словни знак.

Ротација Земље је 365,25...дана. Многи сматрају да је то велика грешка, али ради се о правилном и смишљеним системом који треба у сваком тренутку да обезбеди системе мерења и сталне провере појма КА. Наиме, постоје временске координате као број 59 који чине време од 01. јула до 28.августа. То чини 59 дана. Исто толико чини и време од 01. јануара до 28. фебруара. Значи ОПЕТ је поновљени циклус који се односи на број 28. То је и 4 х 7 = 28. ОПЕТ је тако КА времена од 59 дана.

Појам АПСОЛУТ је вредности 118. Значи, ОПЕТ х 2 = 59 х 2 = 118. Ово је доказ повезаности времена и Апсолута преко српског језика.

Време од 518 дана је ВРЕМЕ ДАЖ БОГА (***слика 11***). Појам ДАЖ је 518 (Д=5,А=1, Ж=8). То је време у коме су укључени сви нумерички представници старих цивилизација – Сумера, Маја, Мисираца, Словена итд.

Проблем поставке гитаре као хармонског инструмента даје могућност да се на 144 прагова исписује вредност појединих гласова или појмова. Иначе број 144 је уписан мајанском Крају Пакалу на челу. Тако добијамо појединачне слике које нам указују на одређене слике и могућнопст да се ти исти појмови ОДСВИРАЈУ. Појам основног кода живота који је однос 52:21=2,476190476190. Када то ставимо на врат гитаре, добијамо слово "Е". Повезали смо тако Филозофију Питагоре, српски језик, и Аполонов храм у Делфима. Тај код у српском језику дословно значи: БОГ ЗАЂЕ. Значи, да је Аполонов храм у Делфима био временско – хармонско – језичка машина која директно одговара вредностима српског језика.

И појам ОПЕТ када се стави на врат гитаре даје нам слику слова "С" и то је вредност 59:28

=2,107142. То је БОГ ЕА. Он је иначе Ануов брат, познат и као ЕНКИ. Он је сумерски Бог Воде, КРЕАЦИЈЕ, интелигенције, мудрости и магије. Спомиње се и као Бог АПСУ, бога подземног света. Његови симболи су гуска и РИБА. Планета је Меркур. Он никада не лаже, не вара и не шали се. На предлог овог БОГА СТВОРЕНО ЈЕ ЧОВЕЧАНСТВО СА СВРХОМ ДА СЛУЖИ БОГОВИМА.

Богиња Гара је Богиња затвореног простора и Богиња ПЧЕЛА (***слика 16***). Њен број је 144. Њен симбол су саће са 6 углова или ХЕКСАГОН. На гитари су то 6 празних жица на нултом прагу.

Календари Виник, Хааб и Тун код Маја су такође чиниоци хармонског склопа српског језика.

Значи, слово "С " које смо добили представља ЧИН СТВАРАЊА. И тако смо повезали и Сумер преко српског језика.

Златни пресек је такође кључ броја 144. Тако добијамо вредност златног броја као број 89, као збир са бројем 144 када добијамо број 233, или дужине странице Велике пирамиде у Гизи. Када се све то стави као слика у хармонском домену, добијамо слике слова "М", слику броја "8" (***слика 17***), слику слова "С", и слику слова "Е". Ту су и два симбола Крста. И Перјана змија (***слика 18)*** је показатељ слова "М", броја 8 и слова "Е"

Када се споје слова "Е" и "С" добијамо слику слова "Е". Када се слово "Е" које има своје КА премести у простору, добијамо, системе слова "Ж" и "Ш", и броја 8. Слово "Ж" у српској азбуци има вредност 8 (***слика 19***).

Али, када то слово окренемо на доле, добијамо слово "М". И то слово управо видимо на Змији Кецалкоатл или Кукулкан или Виракоча. Поред њега видимо и две осмице.

Па добро. Шта је онда ЗМИЈА (***слика 21***)? Змија јесте представа слова "Е", са отвореним устима и са језиком који палаца и СИКЋЕ. Дакле слово "С" је сиктање Змије. Али то је и представа главе Дивљег вепра са стрелом у устима. То симбол ТРИБАЛА.

Цар Душан јесте био АРХОНТ СВИХ ТРИБАЛА, односно свих Срба.

И стрела и лук су ПРЕДСТАВА СЛОВА "Е". Значи, Аполон у Делфима описује објаву слова "Е".

И снимак Перјане Змије на енцефалографу (***слика 20***) доказ да је заправо слово "Е" функционисало као ПРИХВАТНИ ЦЕНТАР СВИХ СИГНАЛА И ПОДАТАКА КОЈИ НАМ ДОЛАЗЕ ИЗ СПОЉЊЕГ ПРОСТОРА.

Зато је и служио Аполонов храм у Делфима.

## Укратко

Дакле, хармонски код ДНК је директно зависан од ротације Сиријуса Б око Сиријуса А, и формирања Прве земље равне плоче преко Милошевог зареза = 1,256, формирања планете Земље преко Хорусовог зареза = 1,0158, и јавља се преко српског језика као духовно – наредбодавног кода Васељене, Космоса и Свемира, и појма АПСОЛУТ. Слово "Е" у Делфима и мисирски ритуал "ОПЕТ" су два чиниоца која су спојила језик, време и простор кроз форму КА – начела парњаштва, и формирања простора кроз систем броја 144 који је представљен кроз лик Краља Пакала, и директног улазка на свет кроз "Сићушну пукотину" коју смо представили кроз ликове Бога Озириса и броја 72 и Цара Душана као броја 76. Цео систем човека је заснован на форми примања енергије и знања путем система Перјане змије који је представљен снимљеним графиконом и религијским знамењима.

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# Letter "E" in Delphie, "opeth" - "again" of time and harmonies of serbian language

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**Abstract**: Language, Time, and Space are three interrelated etalons that together make the whole human civilization interconnected. These standards are erasing the boundary between nations and continents. From these standards, the whole human spirituality emerged, and starting from the temples of Dodona, Delphi and others, we receive new synthetic knowledge such as mathematics, philosophy, harmony, ethics, religion, etc. The emergence of people like Pythagoras seems to combine seemingly incompatible states, and they place harmony both as mathematical and as ethical. By merging our present knowledge with him, we have reached the knowledge of the famous letter "E" in Delphi, which is referred to as the artistic - harmonic template complexed as the "OPETH" – AGAIN, ritual in Misirt - Egypt. Both the Ancient Greece and the Ancient Misir receive a harmonious picture of the uniqueness of the knowledge and the origin of receiving this knowledge. So we come to the concept of Feathered Snakes near Maya and the final solution of the letters "E" in Delfi, which is that our brain actually contains the signal of Feathered Snakes.
**Key Words:** Letter "E" in Delphie, Delhie, Ritual "OPETH" - AGAIN, Serbian Cirilic letter, guitar, Harmonie, Apolon, KA, Feathered Snakes.

## Introduction

**Figure 01.** Apolon temple in Delphie

God **Apolon** is son of God Zeus and Goddess Leta, born in seventh month of pregnancy. Immediately after his birth, on the fourth day, he requested the **bow** and **arrow** (R. Graves, page 70).

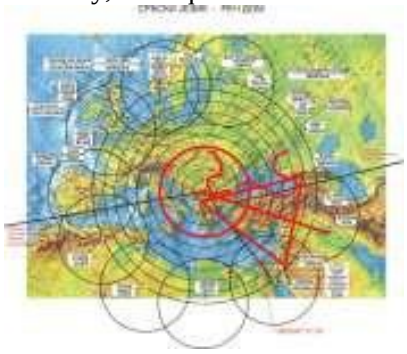

**Figure 02.** First Earth Flat Disc

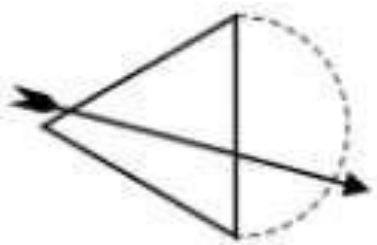

**Figure 03.** Bow is triangle with 3 Shar mountains (Serbia, Caucasus and Jordan) and arrow is line Niš – Istanbul - Bagdad

Apollo goes to Parnas, where snake Piton, the enemy of his mother, is hiding, and wounded by his arrows. **Python** flees to the prophecy in Delphi, which was named after his other, the monster Delfin. Apollo traces him to the sanctuary and kills him on the edge of the Holy Abyss.

God Zevs feels angry at the son Apollo because Mother Earth reported this event to him. Apollo must go to Tempe for the sake of cleansing of sin. God Zevs establishes Python Games, and for the punishment he appoints Apollo to preside over him. But God Apollo did not feel guilty and went to Eggalia to purify himself from sin, accompanied by Artemis. Then he went to Tara, in Crete, where King Karmanor organized the ceremony.

He returns to Greece, searches for God Pane, the old God of Arkady with his goat knees, receives the secret of foretelling, goes to Delphi and forsakes the priests called Pitomkies to serve him. The Alfonso's temple in Delphi is dedicated to the Mother Earth, and the legacy for the future that has been left to us memory, visual and textual, archaeological and artistic, as an example of all the spiritual and physical forces that were going on in search of the prophecies of the future of the inhabitants of that time. The future or KNOWLEDGE could be seen thanks to the knowledge of the priest and the force from the height.

The seven vowels of the Greek alphabet were: **A**, **E**, **I**, **O**, **U**. They were invented by the Three Fates, and some say that it was done by Hugh, sister of Forone, and also made up by two consonants **B** and **T**. The other eleven consonants were invented by Pakamed, the son of Naupli. God Hermes made all this into characteristic signs through wedge shapes and transferred him from Greece to Egypt. R.G. 161.

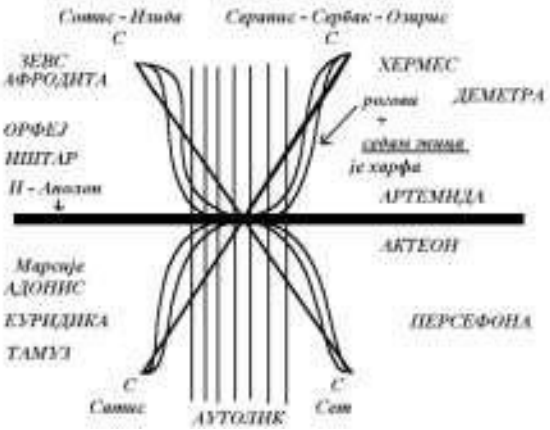


**Figure 04.** Scheme of the First Earth The straight plates through the representation of Divine Parables - KA.

The flat slab that N-A POLA divides into the horns of the SNAKE look is actually n-A- POL-ON. Mother Earth is actually n-A-POL-ON. AUTOLIK is a famous KA or a mapping.

**Figure 05.** Two Snakes or Two Rows on the Earth today as a relief in the form of mountain massifs ALPE and KARPATIES and Old – STARA Mountain - PLANINE

Two vowels, long "**O**" and short "**E**" were introduced by Apollo's priests, so that from there Apollo's holy lyrus has one vowel for each of seven strings. R.G. 161

Letter **A** is first in the alphabet because alpha means honor, and alphainein means to make up. But aleph on Phoenician means BULL. And Booyotia is the land of the BULLS. R.G. 161

Each vowel had some meaning. Both the plant and some period of the year, such as:

**A** - meals or palm trees, tree of birth, winter midsummer, **E** - poplar, autumn equinox, **I** - thrush, dying tree, winter midsize, **O** - scorpion, spring equinox, **U** - spring, summer long

**B** and **T** - came up with the Goddess of Carment, because they marked one half of her age, which was divided between the holy king and his deputy. R.G. p. 162

"In Egypt, the priests of the Holy Prophet sing the hymns to the gods by pronouncing the seven vowels one by one, and their sounds produce a powerful musical experience, as if they used a flute or a lyre." R.G.str.163

"Plutarch, an ancient biographer and philosopher from Cherônia, Beyotia (46-127 BC), who served as the master of Delphi, will deal with the term " Delphi **E** ", however, becoming particularly illustrative. The description of the famous inscription in Delphi, according to tradition, came from a wooden stand in the prehistoric temple of Apollo, and during the recording and reading it is necessary to have the Palaiogram system of writing and reading and the experience of altering the letters and, possibly, nothing that is not significant for the tricection.

- Imagine then a triangular pediment with symmetrical, right and left, and "**E**" or "**H**", "chairing you" at the top with "Know yourself" and "nothing more." The index of suspicion in a written visitor without "E" had an incomplete palindromic inscription in front of him!
- ΓΝΘ ΣΤ ΜΔΝ Γ - with the missing point: "Τ"! Completed inscription: ΓΝΘ ΣΤ Τ1 ΜΔΝ Γ
- ΓΝωΘι ΣαυΤον οΤι ΜηΔεΝ αΓαν - In free translation: Learn it! Meet him! Tell yourself that even "nothing" is not "too"! "

Dodona was the first temple in Greece because she was dedicated to God Zevs, and the holy tree was oak

**Figure 06.** Delphi are located on 3rd Ring at 600km from Nis, Dodon and Olympus on the 2nd Ring of Nis

**Figure 07.** On August 28, each year, the statue of God Amona Ra was made. Karnak is the temple where the statue of God Amon Ra was located, were united in the middle of the road in Nile

The OPETH ritual in Misir is a unique syllable that indicates the eternal connection of the male and female principles. Luxor and Karnak in Thebes guarded their statues. However, OPETH in Serbian has another meaning. It's actually OPETH and OPETH repeated a cycle of time. In this case, this is related to the repetition of the period from January 1st to February 28th. It's 59 days. However, we Serbs have a holiday VIDOVDAN – ST. VITUS, a red letter, which we celebrate on June 28th. And this is OPETH which is 59 days. And we have another OPETH, a red letter, SVETI CAR KONSTANTIN AND CARE JELENA – HOLLY TZAR KONSTANTIN AND

TZARITZA HELEN, on June 3, and that gives 59 days to the first August. However, here we will now only process the Great Lady because the second date is September 21, which is the Birth of the Most Holy Theotokos.

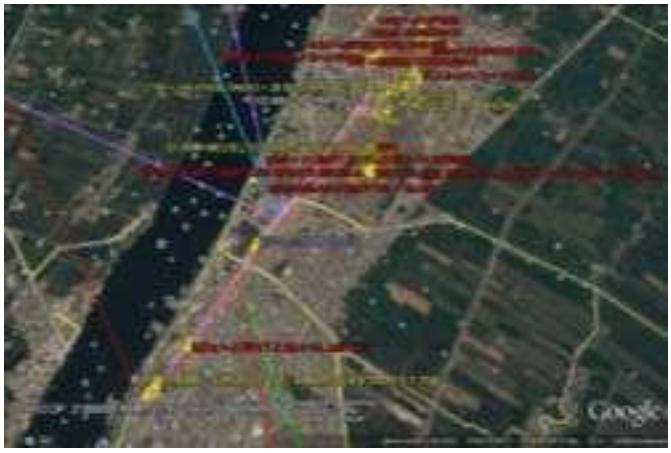

**Figure 08.** Luxor is the temple where the statue of the Boginja MUT was located. The mark of 53m by Adela Margot is given the word "SRBI - SERBS"

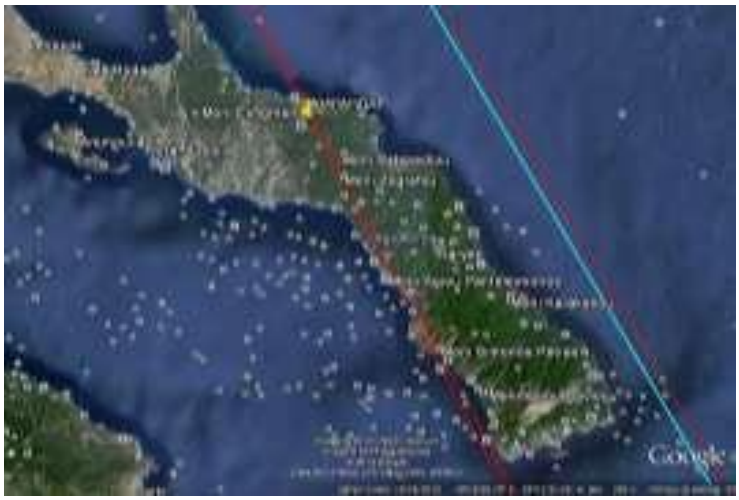

**Figure 09**. Line Niš - Thebus is going straight over HILANDAR and Mountain Athos

MAJOR CALENDAR begins with the count on August 11, 3314, of the old era. In our country there is a date August 19 as a red letter to the Transfiguration. August 28th is a holiday of BIG MEMORY, and with Misirac it was a feast of OPETH.
September 21 is the holiday of NATIVITAT - MALA GOSPODINA

The NIS-LUXOR-KARNAK line runs through the HILANDAR, ZOGRAF and SIMONO PETAR monasteries. Thus, we can now REQUEST WHY THE BOGORODICA IGUMANIJA MANASTIRA HILANDAR IS RESOLVED. The largest number of monasteries on Sveta Gora lies between this line and the line Niš - Behdet. THE MANAGEMENT IS THAT EVIDENCE THAT THE HARMONY IS CONTRIBUTED BY THE SERBS AND THE MISSION = MI SIR- BI

## Adele Margot System

Spiritual level - Serbian, TRANSFER - Astral level - Western alphabet, and EXECUTIONS - Material level - Serbian-Croatian alphabet. The systems they handle are old Biblical systems of study - Gematri, Notarikon and Temura.

1. ГЕМАТРИЈА

**Гематрија је замењивање места у тексту појединим речима које имају исти збир.**

*Будући да је у јеврејском језику свако слово истовремено и број, што свака реч, кад се саберу бројчане вредности њених појединих слова, има одређену збирну бројчану вредност.*

*По Кабали, све речи које имају исту бројчану вредност су истоветне (будући да су те речи у дубини заједничког корена једнаке) и у тексту им се могу мењати места, јер је то само један од начина за боље разумевање значења текста.*

***Уместо бројчаних стања слова хебрејског језика служим се са три наведена писма и бројчаним стањима њихових слова.***

2. НОТАРИКОН

**Нотарикон је техника читања појединих речи као да су анаграм.**

*"Тако се свако слово у одређеној речи узима као почетно слово неке друге речи и на тај начин се од једне речи добија нова реченица. У ствари, реченица није нова, она је стара колико и реч из које је настала.*

*Ово значење је и Сам Бог имао на уму (између многих других) када је ту реченицу давао народу Израела.*

*Овај смисао је стајао у њој (самој Речи) заједно са 69 других скривених сми-слова те исте Речи."*

| | | | | | | |
|---|---|---|---|---|---|---|
| Реч | = | 1 | + | 69 | = | 70 смисловa. |

пример:

| | |
|---|---|
| "- РАЂА - М | -М - АЂАР": |

The Serbian Cyrillic Letter, the Western European Alphabet and the Serbian Serbo-Croatian alphabet are three basic letters that give us insight into certain conditions. Their numerical values give us the possibility of mathematical reasoning and adjustment in calculating the state of certain concepts that thus come in correlation with each other, beyond their relationships in language, time, and space.

**БРОЧАНА СТАЊА ТРИ ПИСМА**

*Здравље, ср. стање, нешкодљиво, или унутрашње стање, се објашњава кроз српскохрватско ћирилично писмо од тридесеш (30) сл.*

*Рачунарско-компјутерском језиком речено ово је улаз (input) -нутрашњи-мождано-(не-ви-рно) = дух стање*

СРПСКОХРВАТСКА (СРПСКА) ЋИРИЛИЦА

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| А. 1. | Б. 2. | В. 3. | Г. 4. | Д. 5. | Ђ. 6 | Е. 7. | Ж. 8. | З. 9. | И. 10. |
| Ј. 11. | К. 12. | Л. 13. | Љ. 14. | М. 15. | Н. 16. | Њ. 17. | О. 18. | П. 19. | Р. 20. |
| С. 21. | Т. 22. | Ћ. 23. | У. 24. | Ф. 25. | Х. 26. | Ц. 27. | Ч. 28. | Џ. 29. | Ш. 30. |

*Abrádoc, ср. стање бродске или сплавске на њима нипе, пољашњи, објашњавам кроз западноевропску абецеду која има двадесеш шесш (26) сл.*

*Рачунарско-компјутерском језиком речено ово је BOP (autostrada obrade podataka) = bela linija.*

ZAPADNOEVROPSKA ABECEDA.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| ***A. 1.*** | ***B. 2.*** | ***C. 3.*** | ***D. 4.*** | ***E. 5.*** | ***F. 6*** | ***G. 7.*** | ***H. 8.*** | ***I. 9.*** | ***J. 10.*** |
| ***K. 11.*** | ***L. 12.*** | ***M. 13.*** | ***N. 14.*** | ***O. 15.*** | ***P. 16.*** | ***Q. 17.*** | ***R. 18.*** | ***S. 19.*** | ***T. 20.*** |
| | | ***U. 21.*** | ***V. 22.*** | ***W. 23.*** | ***X. 24.*** | ***Y. 25.*** | ***Z. 26.*** | | |

***Материјално, ср. чврсто стање објашњавам кроз српско-хрватску абецеду, која као и српскохрватска азбука, има тридесеш (30) знакова, али се служи са (27) сл.***

*Рачунарско-компјутерском језиком речено, ово је излаз-**output**,-отпутни **video(vi-deo)**,= **материјално стање.***

SRPSKOHRVATSKA (HRVATSKA) ABECĒDA.

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| A. 1. | B. 2. | C. 3. | Č. 4. | Ć. 5. | D. 6 | Dž. 7. | Đ. 8. | E. 9. | F. 10. |
| G. 11. | H. 12. | I. 13. | J. 14. | K. 15. | L. 16. | Lj. 17. | M. 18. | N. 19. | Nj. 20. |
| O. 21. | P. 22. | R. 23. | S. 24. | Š. 25. | T. 26. | U. 27. | V. 28. | Z. 29. | Ž. 30. |




**Figure 10.** VASELJENA, VASIONA, SVEMIR, 2. nivo 86/3 = 89 i APSOLUT = 118

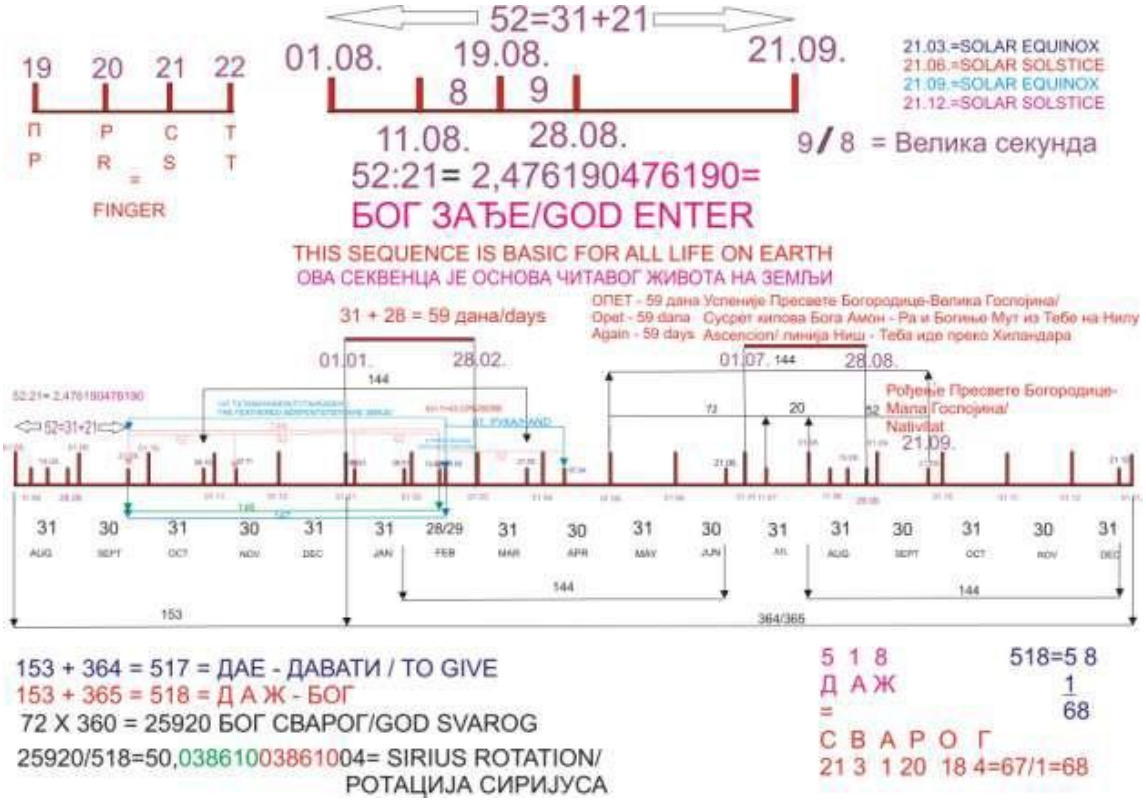


**Figure 11.** The main DNA of space and all life on Earth rests on the code 2,476190.

## Main Time

It is a master code that connects the time from August 1st to September 21st and is 52 days. The time of OPET is 59 days and the first time from January 1st to February 28th is number 118 or APSOLUT. That's the time from August 1st to September 21st and the main genetic code of life. It is the EARTH ROOM that rotates. And that's LANGUAGE because 2,476,190 means ALLOWANCE ON SERBIAN : БОГ ЗАЂЕ or in the case of Misirin, this is God Horus or God UDJA. Education is: 2, 4 7 6 1 9 0

Б Г Е Ђ А З О = БОГ ЗАЂЕ

Double sequence 4, 9 5 2 3 8 0

Г З Д Б В Ж О = ГОД ВО – GOD BULL, or БОГ ВО or GOD

in english, which completely indicates the truthfulness of the Adela Margot item that SPACE IS OUR HOME FROM THE BEGINING

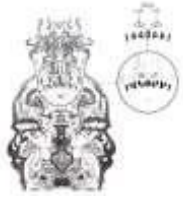

**Figure 12.** King Pakal, the king of the Mayans at its head has the numbers 144 0 0 0 441.

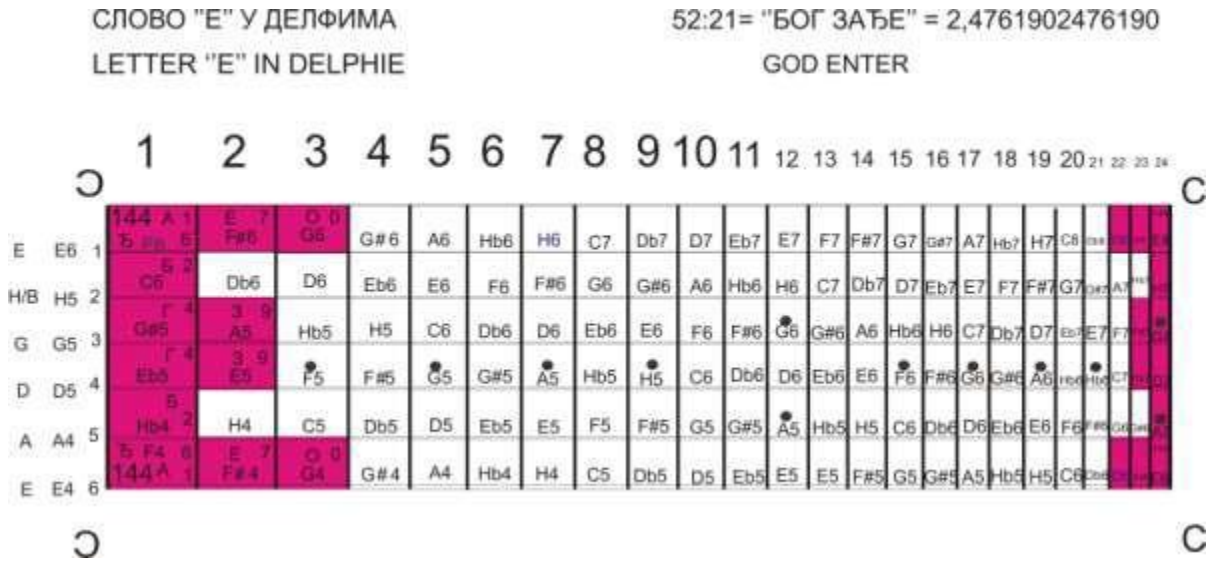


**Figure 13.** THIS IS THE HARMONICAL SLOVE " E " IN DOLPHIN, WHERE CODE 2,876190 IS CONFIRMED IN LETTER " E "

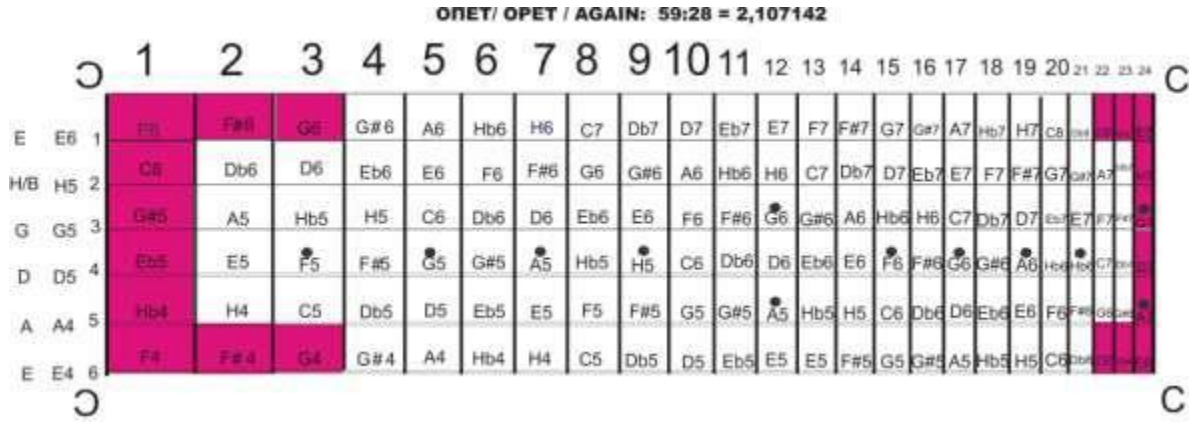


**Figure 14.** Code OPETH is 2,107142 and get harmonical solution as letter "C"

**Figure 15**. Code OPETH connected with code of letter "E" and get harmonical solution as letter "E"

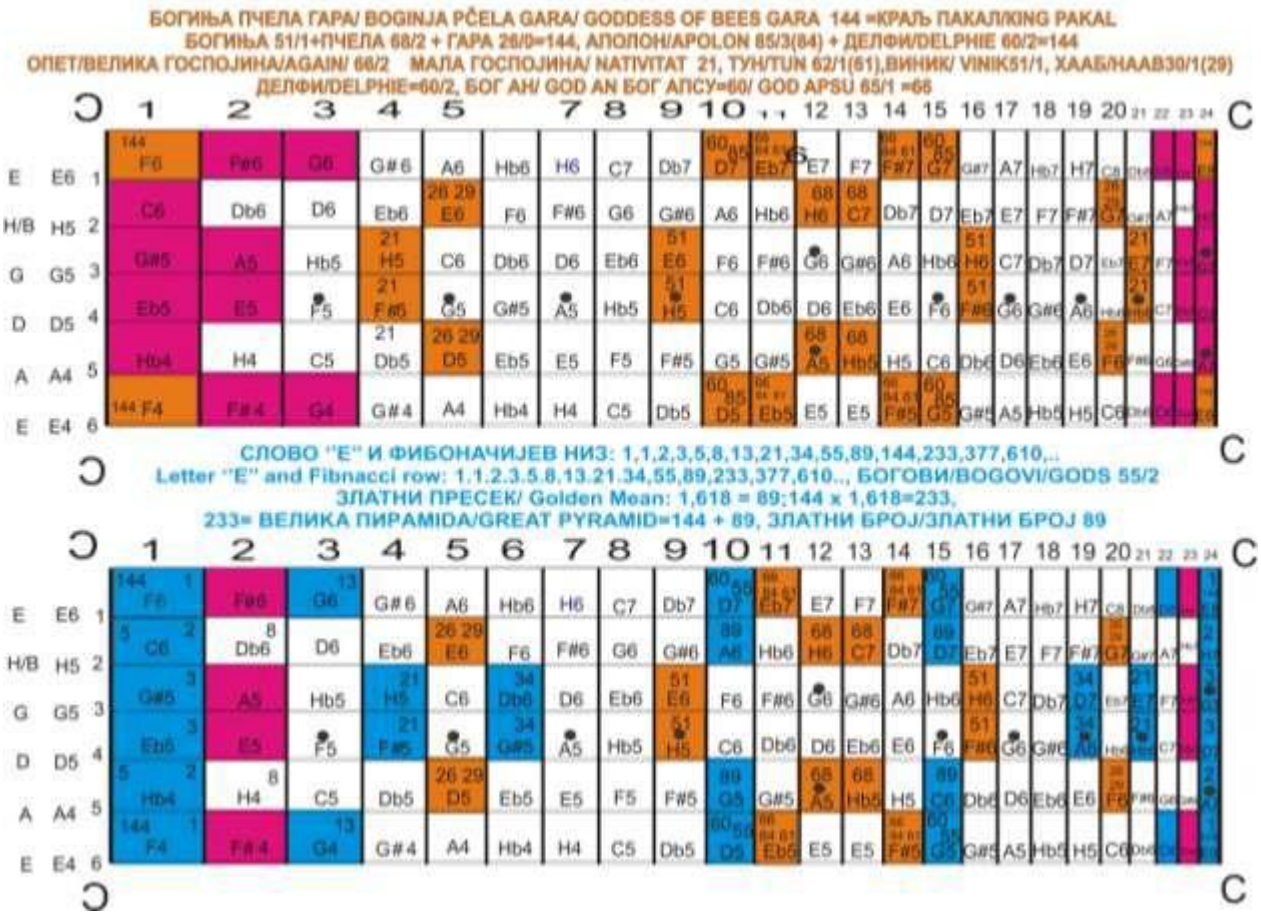


**Figure 16 and 17.** The goddess of Bee GARA has number 144 and represents space as the King PAKAL, and Apollo and Delfi also give the number 144. The golden number is 89. This is the number of the Universe on the primordial level 86 / 3 = 89

**Figure 18.** Feathered Snakes as the bearer of the knowledge of Gods who transfer knowledge to people. In this way, we see the letter M from her body. Viewed from the side we have two eights

.

The letter E in harmonic analysis shows that abstract display has many advantages. One of them is the compression of artistic expression. Namely, the staging with the Misirians and Mayans and other peoples was not only conditioned by the setting of stones of this form. It had the effect that there are two letters "E" as BOW and ARROW, but also the figure of the FEATHERED SNAKES. That's actually PITON who was staying at DELPHIES. The middle part is TONGUE, and the figure of letters S from the OPETH figure is the jaw or the head of SNAKE.

**Figure 19.** When both letters "E" as the KA system are put into mutual relation, we get the necessary and sufficient proof that the harmonic analysis is correct.

Position Ш = Position of the letter Š and has a serial number 30. E is number 7 in Serbian Cyrillic. The position of joining as a letter is given by the visual representation of Misir, which is the notion of joining Lotus and Papyrus as a connection between the Upper and the Lower Nile. When these two letters "E" are put to each other "face to face", we get number 8.

The regular number of letters Ж = Ž in the Serbian Cyrillic is 8. The word LIFE begin with Ж andindicates the life force that we receive from the two Snakes we have in ourselves. According to Yoga knowledge, these are the two main currents of IDA and PINGALA

## Dr Sci Mirjana Sovilj

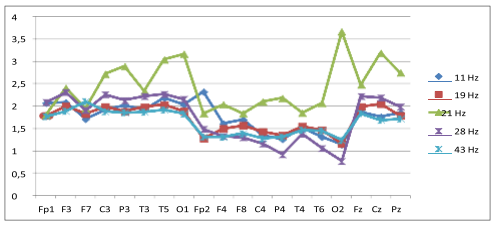


**Figure 20**. Chart 14b) POWER OF A DAMAGE POSTSTIMULUS DIFFERENCE (The strength of this graphic represents a literally caught feathered snake

This graph was made in the IEFPG on the encephalograph which had a value of 11, 19.21, 28 and 43Hz for the signals.

**Figure 21.** FEATHERED SNAKES IN MAYAN TEMPLE IN PALENQUE, MEXICO

## Conclusion

Greek philosophy and Greek religion are two inseparable factors in the development of human thought and make it an inevitable station for the development of a civilization movement.

However, they are just one of the those we call "old civilizations" as part of a large chain of knowledge transferring from the primordial time up to today.

Today we have at our disposal the possibility of a synthetic relationship and a system by which we can present this knowledge as a "random process", rather than a continuous "deliberate process".

So we can only use mathematics as a "modular system of thinking", and to put all religious thought on a mathematical - confessional story of real events that have taken place, while others are recorded as a mythological event or an old philosophical sketch about something that does not seem to look right, or at least strange.

The basis of our work is the system of the setting of the First Earth of the Flat Panel (***Figure 02***), the Adela Margot system (***Figure 10***) and the work of Dr. Mirjana Sovilj (***Figure 20***), which showed that the system is stable and it shows with mathematical analyzes.

Miloš's point, 1,256 points to the system of the First Earth flat disc with ten rings of 200km, as its basic coefficient.

Horus point, 1,0158, as the coefficient of the formation of Planet Earth, consisting of 64 rings, with fittings, and this is shown by the great religious symbol of the Horus Eye, which proved to be a fraction 63/64.

Pythagoras point, 1,0136 points to the harmony of the world measured through lire - guitars. Two tonnes played after seven octaves and twelve quintas are not the same, but differ for 1,0136. This number points to the universality of the connected movement of the entire Universe, which indicates that harmony is an integral part of all the organic processes on Earth.

Time and space influence on the rotation of the Earth and its harmonic assembly, which is expressed through language. We have already shown in the books "Serbian Ethalones of Language, Time and Space in the History of World Civilization", "New Cosmogony of the World" and "Periodic Guitar System of King Pakal and Cara Dusan", that there is absolute unity in presenting these coefficients through all the major religious centers of the whole planet. Everywhere we find their presence, and the confirmation for all our attitudes has been analyzed by the signal from the constellation Sagittarius.

Everywhere we find that language, time and space are inextricably linked to the analysis of the Serbian language. It is shown that it has a dynamic energy that results in a harmoniously vigorous and complex visual representation.

Visual representation of the language represent system of analysis which indicates the multiple modularity and the possibility of presenting a single voice as well as complex concepts.

These terms can be analyzed on three levels: spiritual, astral, and material. Serbian language from the spiritual level is the main focus of our work. We have established that all major measures are precisely the values of these calculated coefficients. An example is, for example, the prophetic and astronomical city Arkaim in Russia, located at the distance from Palenque in Mexico, exactly 11800km, or a coefficient of 118 that represents the spiritual value of the term APSOLUT - ABSOLUTE.

From our analysis, the term APSOLUT – ABSOLUTE is the starting point of our civilization.

Apollo's Temple in Delphi (***Figure 01***) is the second temple of importance in Greece. The first temple is Dodone, which is dedicated to his father, God Zeus. Dodone is on the second ring and Delphi on the third ring (***Figure 06***). Apollo immediately receives an arc and arrow (***Figure 03***), thereby confirming that his Father is the Zeus, the one who made the Earth, and that he is the Supreme God with a triangle as his own sign. The triangle consists of three Shar Mountains - in Serbia - Shar Mountain,, Russia, Caucasus - Shara, and Jordan - Esh Shara. The right line is the line made by Nis - Istanbul - Baghdad. Apollo is actually a flat panel of 4000km wide. On the upper part there is a system of symbols 4S and below another system 4S. So we get the real name of Apollo***. He is N - A half of Him.*** He shares them in half = N-Apollo. But in Delphi there was a cave which did not know the depth, because it was the point at which the third ring was then

made. Piton, the snake whose place of stay was, actually has a picture of 4S and snake horns (***Figure 04***). It was mapped in religion as a double deity - like Snake and as VO (BULL) = BIK = BAK. The outgoing vapour gave signs to Pitonks - priests, on the basis of which they were postprocessed.

Holes or caves of unknown depth were holes - the openings between the silicon rings were designed for setting up a fastener - pins or something that was a binder for rings. We have an example of our mountain RTANJ, which is actually ZAV-RTANJ (SCREW). The capital of Poland is Warsaw, or VAR - SAVA because it is located on the 6th ring of Nis. The city of Milan in Italy is on the fifth ring and it means NAGO-MILANO (PILED) rocks, which is filled with holes. The capital of Austria is Vienna as we call it, but the real name is Vienna or NA-VIJEN, in the sense of turning a thread.

When snake - like antennas fell with a huge rik, later transformed into God Pan, they turned into today's massifs of ALPE and CARPATE and OLD MOUNTAIN (***Fig. 05***).

In Delfi there was a symbol of the letter "E", which is symmetrical, and shows similarity to the letter H or the letter N. The assumption was that it was the second position in relation to Dodon. The very voices A, E, I, O, U formed three Fates = Clotho, Lachesis and Atropos. In our language, there is the word KLOT and refers to yarn and knitting, or to something as empty, as "clot of beans", because the Three Dukes are knitting the network of people's lives. The word of the Tropa is from Atropa, which cuts the scissors from the gods to us. There are still soft "E" and soft "O". Accordingly, there is also a LIRA instrument with seven wires, one for each vowel. Apollo is holding that instrument between his legs.

The letter " E " is symmetrical to itself in terms of the H axis in the middle of the axis of the letter, and makes KA - parallel, duality to itself, as the figure of the man in the mirror.

In Misir, there is one OPETH ritual, which refers to the appearance of the sculptures of the Goddess Mut and God Amon-Ra, who emerge from the Egyptian Heaven (***Figure 08***), and meet in the middle of the Nile (***Figure 07***). The event is tied in August. We then celebrate the Great Lady, August 28th. The Teba - Niš line passes through our HILANDAR monastery (***Figure 09***).

So, Delphi and Thebes are directly linked to Serbia and are on the 3rd and 11th rings. They are KA points to Istanbul and Baghdad who are also on the 3rd and 11th rings. So, the term KA occurs both in space and as a sign of the letter.

The Earth's rotation is 365.25 ... days. Many believe that this is a big mistake, but it is a proper and thoughtful system that needs to be provided at all times for measurement systems and constant checks of the concept of KA. Namely, there are time coordinates as number 59 which make up the time from July 1st to August 28th. That's 59 days. Time is also the same from January 1st to February 28th. So OPETH is a repeat cycle that refers to number 28. That's 4 x 7 = 28. OPETH is so KA time of 59 days.

The term APSOLUT is 118. Therefore, OPETH x 2 = 59 h 2 = 118. This is a proof of the connection between time and Absolute through the Serbian language.

The time of 518 days is TIME OF GOD (***Figure 11***). The term DAŽ is 518 (D = 5, A = 1, F = 8). It is a time that includes all numerical representatives of old civilizations - Sumer, Maya, Misir, Slovene, etc.

The problem of setting the guitar as a harmonic instrument gives the ability to print the value of individual voices or concepts at 144 thresholds. Otherwise the number 144 was entered by the Mayan King Pakal headed. So we get individual images that point us to specific images and it is possible that these same concepts are RESOLVED. The notion of the basic code of life, which is a ratio of 52: 21 = 2.476190476190. When we put it on the guitar neck, we get the letter "E". We connected the Philosophy of Pythagoras, the Serbian language, and the Apollo temple in Delphi. This code in the Serbian language literally means: GOD OF JEWELRY. It means that the Apollo temple in Delphi was a weather - harmonic - language machine that directly corresponds to the values of the Serbian language.

When notion OPETH where placed on the guitar door gives us a picture of the letter " S " and this is a value of 59:28 = 2.107142. It's God EA. He is usually Anu's brother, also known as ENKI. He is the Sumerian God of Wisdom, Creation, intelligence, wisdom, and magic. It is also remembered as the God of the APSU, the god of the underworld. His symbols are goose and

FISH. The planet is Merkur. He never lies, does not cheat and does not joke. At the suggestion of this God, humanity has been devised with the help of gods.

Goddess Gara is the Goddess of the enclosure and the Goddess of the Bee (***Figure 16***). Its number is 144. Its symbol is a honeycomb with 6 angles or HEKSAGON. On the guitar there are 6 empty strings on the zero threshold. The calendar of Vinik, Haab and Tun in Mayan culture are also elements of the harmonic language of the Serbian language.

So the letter "S" that we get is a ACT OF CREATION. And so we connected Sumer through the Serbian language.

The gold cross-section is also the key number 144. Thus, we get the value of the golden number as number 89, as the sum with the number 144 when we get the number 233, or the length of the page of the Great Pyramid in Giza. When all this is put as an image in the Harmonic domain, we get the letters of the letter "M", the figure "8" (***Figure 17***), the image of the letter "S", and the image of the letter "E". There are also two symbols of the Cross. And Perry Snake (***Figure 18***) is an indicator of the letters "M", number 8 and the letters "E"

When the letters "E" and "S" are joined, we get the picture of the letter "E". When the letter "E" having its KA moved in the space, we get the letters "Ž" and "Š" and the number 8. The letter "Ž" in Serbian alphabet has a value of 8 (***Figure 19***).

But when we turn that letter down, we get the letter " M ". And we see that letter just on Snake Kecalkoatl or Kukulkan or Virakoča. Next to him, we see two eights.

Well OK. What then is SNAKE (***Figure 21***)? Snake is a play of the letters " E ", with its mouth open and with the tongue that thumbs and SIKE. So the letter "S" is the scepter of the Snake. But this is also the performance of the Wild Boar head with a shot in the mouth. This is TRIBAL symbol. Tzar Dušan was ARHONT OF ALL TRIBALS, or all Serbs.

And the arrows and the bow are the PRESENTATION OF LETTER "E".So, Apollo describes the letter "E" in Delphi.And the image of Feathered Snakes on the encephalograph (Figure 20) shows that the letter "E" actually functioned as an ACCEPTING CENTER OF ALL THE SIGNALS AND DATA THAT COME FROM THE OUTER SPACE.

That's why Apollo's temple served in Delphi.

## In Short

Hence, the harmonic code of the DNA is directly dependent on the rotation of Sirijus B around Sirius A, and the formation of the First earth of a flat disc across Miloš's point = 1,256, the formation of the Earth's planet through the Horus point = 1,0158, and appears via the Serbian language as a spiritual-command code of Universes, Cosmos and Space, and the term APSOLUT

- ABSOLUTE. The word "E" in Delphi and the Misirian - Egyptian ritual "OPETH" are two factors that combined language, time and space through the form of KA - parity principle, and the formation of space through the system number 144 represented by the figure of King Pakal, and a direct entry into the world through the "Tiny Crack" that we presented through the figures of God Osiris and number 72 and Tzar Dušan as number 76. The whole system of man is based on the form of receiving energy and knowledge through the system of the Feathered snake which is represented by a recorded chart and religious signs.

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# EMA measures for representation of articulatory movements

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**Abstract.** Electromagnetic Articulography is one of the methods that is being increasingly used to record and measure the movement of speech organs (the articulators), especially the tongue. The possibility of tracking a large number of articulator flesh-points in real time, in addition to the obvious advantages, is burdened with certain issues such as the segmentation methods, the selection of the appropriate measures that quantify the movements of the articulators, spatial normalization, etc. This paper represents a review of the measures used in characterization of the articulatory movements and approaches in segmentation with a reference to their advantages and disadvantages.

## 1 Introduction

The possibility of tracking the movements of articulatory organs such as lips, jaw and tongue is crucial from the aspect of studying the speech production at the articulatory level. The main obstacle for reliable tracking of the articulatory movements is the fact that they are mostly hidden inside the mouth and therefore inaccessible to visual observation. Researchers have used a variety of technologies in order to record articulatory movements. As a result, the articulators were recorded using the x-rays (Munhall, Vatikiotis-Bateson & Tohkura, 1995; Westbury1994; Weismer, Yunuvosa & Westbury, 2003), MRI (Masaki, 1999; Narayanan, Nayak, Lee, Sethy & Byrd, 2004), ultrasound (Stone, 2005; Bressmann, 2007; Stone, Sonies, Shawker, Weiss & Nadel, 1983; Kaburagi & Honda, 1994), electropalatography (Dagenais, 1995) etc. The drawbacks of these techniques was that they were either prone to errors, expensive or even carried a certain health risks. With the development of electromagnetic articulography (EMA), and the devices that are capable to measure, record and store 3D data that originate from multiple flesh points associated with the speech articulators, in real time, these shortcomings are mitigated and EMA method is successfully used for recording of speech movements from its first introduction into the scientific community (Schönle, Gräbe, Wenig, Höhne, Schrader & Conrad, 1987; Perkell, Cohen, Svirsky, Matthies, Garabieta & Jackson, 1992). Since then, a large number of studies that investigate the movements of the speech organs are based on the EMA data which means that EMA is inevitably becoming one of the most important technologies used to study articulatory movement. Nowadays, EMA data is used as a part of various data basis (MOCHA-TIMIT, Torgo Database of Dysartic Articulation, Emotional Electromagnetic Articulography Database), in phonetic research (Cho et al., 2014, Gafos et al., 2014, Beňuš, 2012, Jaeger & Hoole, 2011), speech pathology (van Lieshout et al., 2014, Bose & van Lieshout, 2008), aspects of physiology of tongue, jaw and swallowing (Badin et al., 2010, Bolter et al., 2012, Serrurier et al., 2012, Henriques & van Lieshout, 2013), in therapy purposes (Wang et al., 2012, Katz et al., 2007), coarticulation research (Lindblom & Sussman, 2012, Zharkova & Hewlett, 2009). In the last couple of years EMA principle is in the large number of clinical applications including articulator movement control devices (Huo, Wang & Ghovanloo, 2008) biofeedback (Katz, McNeil & Garst, 2010), speech recognition with articulatory information (King, Frankel, Livescu, McDermott, Richmond & Wester, 2007; Rudzicz, Hirst & Van Lieshout, 2012), and silent speech interfaces (Denby, Schultz, Honda, Hueber, Gilbert & Brumberg, 2010; Wang, Samal, Green & Rudzicz, 2012; Wang, Samal, Green & Rudzicz, 2012).

## 2 Principles of Electromagnetic Articulography

The basic principle used in EMA devices is the electromagnetic induction. Multiple transmitter coils that are generating alternating electromagnetic fields at different frequencies induce currents of varying intensity in small coils (sensors) placed inside the measurement area. The strength of the induced current at the sensors varies as a function of the distance and the angle between the axis of the sensor and the axis of each of the transmitters. The location, orientation, and tilt of the sensors can therefore be obtained from the intensities of the induced currents and the known model of the magnetic field using thee iterative non-linear optimisation method (Hoole & Zierdt, 2010; Kaburagi, Wakamiya & Honda, 2005; Perkell, Cohen, Svirsky, Matthies, Garabieta & Jackson,1992; Zierdt, Hoole & Tillmann, 1999).

Currently, there are only two manufactures of articulographs. One, Cartens (Carstens Medizinelektronik GmbH, Bovenden, Germany) and the other NDI (NDI, Waterloo, Ontario, Canada). The latest models manufactured by Carstens are the 3D articulographs AG500 and AG501, that were preceded by 2D models AG100 and AG200 and the EMMA device developed at MIT (Perkell, Cohen, Svirsky, Matthies, Garabieta & Jackson, 1992). The spatial accuracy of the AG500 device was reported to be approximately 0.5 mm at a 200 Hz sampling rate (Yunusova, Green & Mefferd, 2009). The accuracy of the NDI Wave system has been reported to have the similar accuracy level as that of the Carstens AG500. The accuracy of the recently released AG501 was reported by the manufacture to be 0.3 mm using a 250 Hz sampling (Carstens ,2012). These characteristics guarantee good spatial and temporal resolution. Also, the known issues of the AG500 (Kroos, 2012; Kroos, Sock, Fuchs & Laprie, 2008; Yunusova et al., 2009) are proven to be solved with completely redesigned AG501 model (Stella, Stella, Sigona, Bernardini, Grimaldi & Gili Fivela, 2013).The most recent comparative study of the precision of Articulographs (Savariaux, Badin, Samson & Gerbera, 2017) which included Northern Digital Instruments' Wave and Carstens' AG200, AG500, and AG501 systems concluded, after the series of extensive tests, that the AG501 (Fig. 1.) produced by far the lowest errors compared to his counterparts.

This measuring equipment is now enabling a researchers to collect articulatory data originating from large group of speakers (including the children and medical patients) to study the movements of speech organs in systematic and extensive manner. Besides that, the state of the art electromagnetic articulographs allow the simultaneous recording of up to 24 sensors at sampling frequencies ranging from 100 to 1250 Hz. Each sensor is characterised with three spatial coordinates (*x*,*y*,*z*) and two angular coordinates (*phi, theta*). The system does not record the rotations about the main axis of the sensor, since this does not cause any change in the electromagnetic induction. The versatility of the EMA equipment and the amount of available data are introducing challenges associated with the methodology of the research, data acquisition, analysis and interpretation.

In the following pages, sensor placement, some of the measures used in characterization of the articulatory movements and approaches in segmentation of recorded data are reviewed.

## 3 Sensor placement

Based on the previously described principles of the 3D-EMA to obtain the articulograph records - electromagnetic sensors are attached (using the physiological glue) to the target places on the articulators. Typical placement of the sensors is shown on the Fig. 2.

Five sensors (T1, T2, T3, T4 and T5) are placed on the tongue, where three of them are placed on the midline of the tongue. The sensors on the lips are attached midline to the vermilion borders of the upper (UL) and lower (LL) lips and at the corners of the mouth, left (LM) and right (RM). In some cases, when jaw sensors are used, they are attached to the mandibular teeth rather than externally on the chin to avoid skin movement artefact (Green, Wilson, Wang & Moore, 2007). These sensors are attached just above the mandibular gum line.

**Fig. 1**. Articulograph AG501

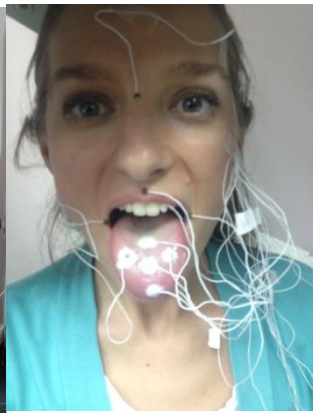

**Fig. 2**. Placement of the sensors

One of the characteristic of the articulography recording is that the movement of the head is initially incorporated in the recordings of articulatory organs. This means that movement of the head needs to be recorded during data acquisition in order to derive head-independent articulatory movements, or head corrected data. Minimum of two sensors is needed in order to reliably track translation and rotation of the head. For the Carstens AG501, head correction sensors are usually attached at the upper incisors, behind the ears or at the bridge of the nose, in other words, at the places on the head inside the measuring area that are not affected by the movement of articulators. In some cases, head correction sensors are attached on a pair of glasses or goggles to avoid skin motion artefacts (Green, Wilson, Wang & Moore, 2007; Mefferd & Jordan, 2010) and the glasses are securely positioned on the subject's head.

Number and position of the sensors varies depending on the requirements and the purpose of the study. Nevertheless, some redundancy needs to be present, especially in the case of head correction sensors, because, it is virtually impossible to reattach sensor at the exact location after it becomes detached. On the other hand, too many sensors could negatively affect subject's articulation and additionally, cause interference. Sensors need to be placed at the certain distance, to avoid interference which would be hard to control in cases when there are too many sensors placed in the mouth for example. There are other constraints regarding the placement and number of sensors. Often young children and medical patients cannot tolerate more than two sensors (Wang, Green & Samal, 2013). This doesn't necessarily needs to be an obstacle, since research showed that tracking of four articulators (i.e., tongue tip, tongue body back, upper lip, and lower lip) may be sufficient for distinguishing major English phonemes based on articulatory movements (Wang, Samal, Rong & Greene, 2016). This is the minimal number of sensors that still encodes enough information that is statistically equivalent to that encoded by a full set of sensors. They used a support-vector machine (SVM) to classify vowels, consonants, words, and phrase samples on the basis of the movement of individual sensors and groups of sensors.

## 4 Review of EMA measures

Depending on the objectives and methodology of the research, the measures used to quantify the movements of the speech organs are either obtained directly from the articulograph e.g. spatial coordinates and angular coordinates or their derivations.

For example, authors in (Carignan, 2014) performed an articulatory (EMA) and acoustic study of the realizations of three oral–nasal vowel pairs in French language. Sensors were located at the tip, middle and the back of the tongue, and at the upper and lower lip. Measures dealt with the superior-inferior dimension and the anterior-posterior dimension of the tongue sensors. Labial measures involved the anterior-posterior dimension of sensors, as well as the Euclidean distance between them defined as:

$$d = \sqrt{(x_{LL} - x_{UL})^2 + (y_{LL} - y_{UL})^2} \quad (1)$$

where $x_{LL}$ and $x_{UL}$ represent anterior-posterior dimension of lower and upper lip, respectively, and $y_{LL}$ and $y_{LL}$ represent superior-inferior dimension of lower and upper lip, respectively. Anterior-posterior dimension was used to characterize the degree of labial protrusion, while the distance between labial sensors defined with equation (1) described the degree of labial aperture. All lingual and labial measures were calculated and logged for the midpoint of each vowel, in order to correspond with the formant measures. Statistical analyses performed on the acquired data give strong support to the view that the goal of speech acts is acoustic, by showing that speakers use a variety of articulatory combinations in order to achieve a similar acoustic output.

In another study (Brunner, Fuchs, Perrier & Kim, Hyeon-Zoo, 2003), where the aim was to set up a catalogue of parameters which are involved in the distinction of Korean velar stops in intervocalic position, authors used parameters derived from the basic set of EMA parameters. They used Euclidean distance between coordinates of the starting and ending point, and the *movement amplitude* defined as :

$$A_m = \int_t \frac{v_t}{f_s} dt \quad (2)$$

where $v_t$ represents tangential velocity of the sensors and $f_s$ sampling rate. To find out the degree of the path curvature the quotient of Euclidean distance and movement amplitude has been calculated. If this ratio is near 1 this means that the tongue is taking a nearly direct way, whereas if the number is very small the tongue moves in a big loop. Beside these, authors used tangential velocity measures (peak and minimal tangential velocities). The difference between peak velocity and minimal velocity was the measure that characterized the abruption of the movement.

The angular parameters obtained from the articulograph are offering the useful information, since they characterize the important features of the shape of the tongue. Apart from the statistic analysis of the tongue, jaw, and lip movements that were recorded using the sensors close to the tongue tip, the blade and the back of the tongue, below the lower incisors, and on the external extremities of the lips authors use angular parameters in (Zeroual, Hoole, Fuchs & Esling, 2007) to characterize the differences at the front part of the tongue, between the emphatic (coronal) and the non-emphatic consonants in Moroccan Arabic.

In the (Mefferd & Jordan, 2010), beside the distance measures between EMA sensors, authors used principal component analysis (PCA) to determine the strength of association between tongue kinematic and speech acoustics changes in response to speaking rate and loudness manipulations. The three dimensional distance signal between the posterior tongue sensor and nose bridge sensor is calculated and then filtered with 10-Hz low-pass filter. Additionally, the first principal component of the posterior tongue sensor trajectory was derived from the filtered movements in the x, y, and z dimension. The distance signal was used to determine phonetic specification; the principal component signal was used to determine phonetic variability. A significant positive linear association was found for kinematic and acoustic specification but not for kinematic and acoustic variability.

In order to quantify the articulatory distinctiveness of 8 major English vowels and 11 English consonants based on tongue and lip movement authors in (Wang, Green, Samal & Yunusova, 2013) used articulatory data from the sensors located at the upper and lower lip, and for sensors located along the midline of the tongue. They considered only vertical and anterior–posterior coordinates of the sensors because the movement along the lateral axis is not significant during speech of healthy talkers (Westbury, 1994). Two classification methods were used: procrustes analysis and a support vector machine (SVM). Procrustes analysis gave the better classification result. Same authors in (Wang, Samal, Green & Carrell, 2009) showed that SVM outperformed other approaches, such as neural networks and decision trees, for this same application.

Another method used to analyze EMA data is Functional data analysis (FDA). In (Lucero & Löfqvist 2005) FDA is used to examine articulatory variability across repetitions in normal speech, under different movement constraints. This temporal normalization technique is applied to align trajectories of lips, jaw, and tongue in vowel-consonant-vowel sequences. An index of amplitude

variability that is used is defined as the mean standard deviation between peak velocities of the consonantal closure by the active articulator, in each VCV sequence. The results show that articulatory variability varies as function of both the phonetic requirements of the consonant and the biomechanical characteristics of the articulatory structures involved. FDA is used for aligning of EMA signals in (Lee, Bresch & Narayanan, 2006) in order to study emotional speech production.

Another frequently used time aligning technique, Dynamic Time Warping (DTW) is used in (*Katz, Mehta, Wood* & *Wang,* 2017), a study that examined the contributions of the tongue tip, tongue body, and tongue lateral positions in distinction of American English alveolar consonants. The data were analyzed using two quantitative approaches, including statistical analyzis of positional changes of lingual sensors and a time series pattern analysis of lingual sensor movement using DTW.

The important issue regarding the EMA data collection is the choice of cut-off frequency for lowpass-filtering of articulatory data. Namely, EMA data needs to be filtered in order to obtain smooth trajectories of the sensors. Since the amount of smoothing that is introduces mainly depends on the experience of researcher, there is always the risk of over smoothing. The excessive smoothing of the EMA data introduces distortion, and the smoothed data will no longer reliably reflect the fast changes in the EMA data that correspond to the actual articulatory movements. Some researchers when dealing with the simple vowels and consonants use low pass filter with cut-off frequency of 10 Hz since the trajectory of the tongue and lower lip sensor contain only very low frequency components (Wang et al., 2013). Depending on the linguistic unit different cut-off frequencies for phonemes (10Hz), words (20Hz) and phrases (30Hz) are used (Wang et al., 2016). Velocities and accelerations of the lingual and labial sensors were also low pass filtered with a band width of 15 Hz (Fuchs, 2005). Some other researchers prefer using the filters with higher cut-off frequencies for tongue tip sensors and lower for the remaining sensors (Beňuš & Šimko, 2014).

Data parsing, or segmentation of the signal in the EMA research is usually performed manually, based on the segmentation of the audio signal which is performed using the audio recordings and the spectrographic view (Zeroual et al., 2007; Wang et.al., 2016), as shown in Fig. 3.

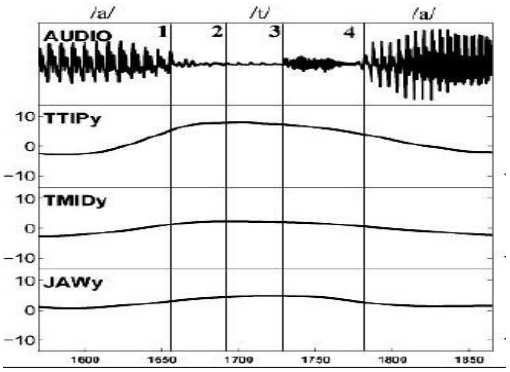


**Fig. 3.** Segmentation based on the acoustic data, adopted from (Zeroual et al., 2007)

In some cases, segments are located based on both acoustic and kinematic cues (Lee et al., 2006; *Katz et al., 2017)*. On the other hand, EMA data could be parsed based on the articulatory data and audio cue. In (Fuchs, 2005) EMA data is segmented based on the tangential velocity as shown in Fig. 4. A 20% tangential velocity threshold criteria proposed in (Kroos, Hoole, Kühnert & Tillmann, 1997) is used in order to define onset and offset of tongue tip and jaw closing movements.

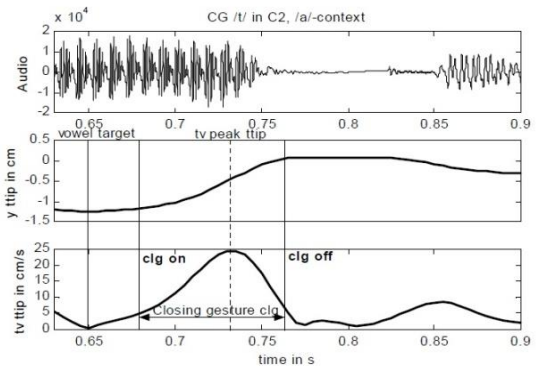


**Fig. 4.** Example of time points defined on the tongue tip tangential velocity signal, adopted from (Fuchs, 2005)

## 5 Conclusion

Modern 3D articulographs are instruments that are increasingly used for tracking and recording of the articulatory movements. Despite the fact that they are able to reliably track the articulators, a certain amount of caution is required in order to properly perform the sensor placement and data capture, processing and classification. In this paper we give an overview of the measures and data processing methods used in the research practice in order to successfully characterize the movements of the speech organs using the electromagnetic articulography.

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## EMA mere za karakterizaciju artikulacionih pokreta

EMA je jedna od metoda koja se sve česce koristi u merenju pokreta artikulacionih organa, pogotovo jezika. Mogućnost praćenja većeg broja tačaka u realnom vremenu pored očiglednih prednosti nosi sa sobom i određene nedoumice kao što su nacin segmentacije, odabir odgovarajućih veličina za merenje kretanja artikulatora, prostorna normalizacija itd. U radu će biti opisane velicine koje se koriste u karakterizaciji pokreta govornih organa i pristupi u segmentaciji sa osvrtom na njihove prednosti i mane.

# Negative influence of hyperventilation to phonation

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**Abstract.** During the phonatory process, or voicing, the certain changeable level of pressure across the larynx has been created by the air expelled from the lungs through the glottis. Strictly speaking, the process of exhalation does not require muscular activity, but the articulation process of speech voices completely depends on subtle activity of phonatory neck muscles. The process of hyperventilation firstly leads to the state of hypocapnia, reduced blood level of $CO_2$ and consequently to the process of hypoxia in human cells. The original Muscular breathing equation (MBE) depicts muscles with the lack of $PCO_2$ as prone to stiffness what gives clue that muscles who are supporting phonation would have positive spectrum shift, what practically means the inability to produce exact voice frequencies, especially lower ones. The pilot EPG measuring completely supports this statement. Thus elimination of HV might be both the first and mandatory step in treating patients with speech disorders.
*Keywords***:** phonatory process, voicing, hyperventilation, hypocapnia, muscular breathing equation, MBE, treating patients, muscular activity, spectrum shift, yoga breathing technique, speech disorders.

In normal tissue cell, the level of $CO_2$ is higher than in alveoli, so there is the high affinity of exchanging the $O_2$ molecule with the $CO_2$. This is known as the Bohr effect [9], and it's main consequences are shown at the Figure 1 [1].

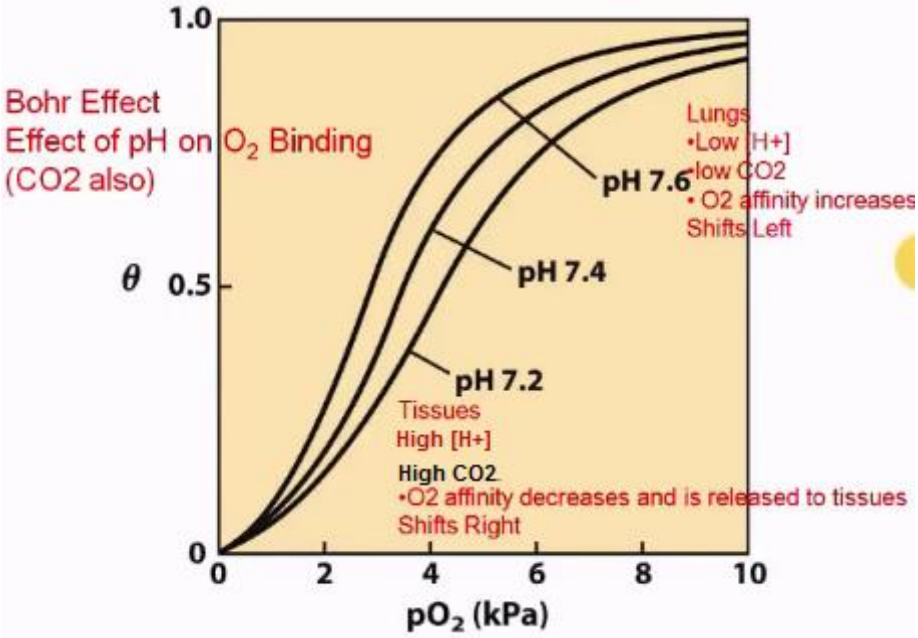


**Figure 1:** Bohr Effect depicting the affinity of hemoglobin binding and releasing $O_2/CO_2$ as function of pH value.

In tissues with lack of $CO_2$ this process will be slowed down, aiming to a tissue hypoxia. [2]. All cells are sensitive to tissue hypoxia. Beside neurons, muscle tissues have a short response to this process.

[9] Also called Bohr-Hasselbach effect

It is well known that $PCO_2$ is the main control variable of breathing [3]. On the other hand, this parameter still cannot be measured directly[10]. The speed of $CO_2$ producing in human organism can vary few hundreds of times – the whole human physiology could be observed through the eyes of organism strains to keep the cell $PCO_2$ in exact range intact, roughly not less than 2% and not more than 6%. Any spill of this region can be disastrous for the organism. Prolonged tissue hypoxia will lead to the death of cell[11] [4]

Figure 2 shows three zones [5]. The red zone depicts excess of $PCO_2$ and cannot be prolonged forever. The blue zone depicts lack of $CO_2$ and will cause the hyperventilation. Residing in this area for prolonged period of time will cause tissue hypoxia. The middle zone should be ensured all the time. The practical tool for achieving this is above all the activity degree of breathing musculature.

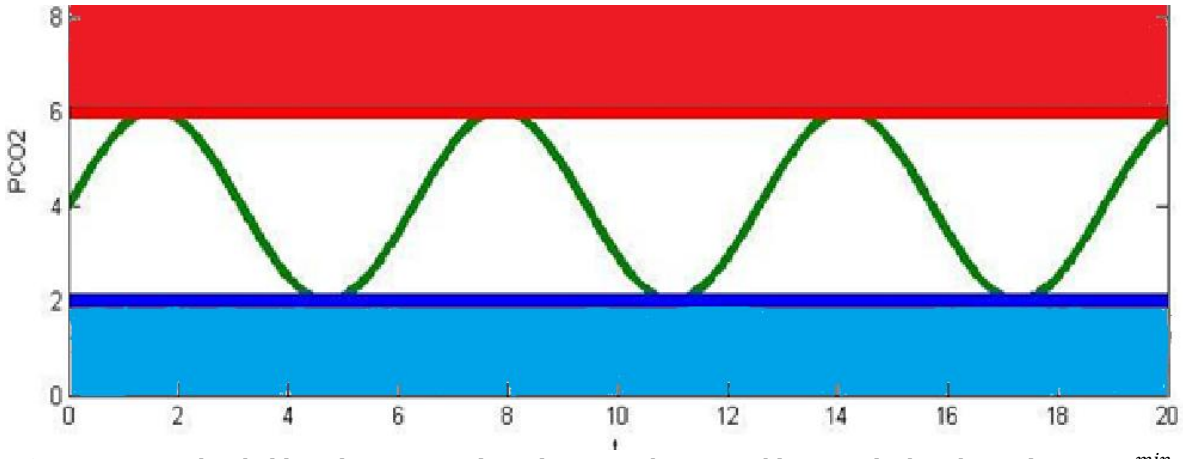


**Figure 2:** $PCO_2$ thresholds and respirational regulation: as the reasonable example the taken values are $P_{CO_2}^{min} =$ 2%, and $P_{CO_2}^{max} = 6\%$.

If we define a threshold constant as

$$T_{CO_2} = \frac{3P_{\mathrm{CO}_2}^{min} + P_{\mathrm{CO}_2}^{max}}{4}$$

and the effective value of partial pressure of carbon-dioxide as

$$P_{CO_2}^{eff} = P_{CO_2} - 2T_{CO_2}$$

the equation on demand may have a quite compact form:

$$\left|\boldsymbol{P_{CO_2}^{eff}}\right| < \boldsymbol{T_{CO_2}}$$

Although quite precise the above equation is currently of no practical importance due to a lack of measuring potential of $PCO_2$, so a different approach has been made at this point.

The breathing process requires the certain muscle group activity, called breathing musculature. Its contribution to the total energy consumption can vary from 3-53% [Guyton]. The ground idea of MBE is the optimal middle part zone 3 of a $CO_2$ (in contrast to lack zone and surplus zone of $CO_2$).

However, MBE nowhere uses $PCO_2$ as the variable, but quotient between total and breathing musculature energy consumption[12].

$A = \sum_{i=1}^{n} A_i = A_p + A_{heart} + A_{gastro} + A_{neuro} + A_{renal} + \cdots$

where $A$ is total muscular energy consumption, $A_p$ energy of pulmonic supporting muscles.

[10] For that purpose physiology uses Henderson's equation [Guyton]

[11] couple minutes for neurons to up for a week for bone cells

[12] Generally this variable can include overall energy consumption of all cells. In the case of sick patients in must include the influence of number of patogenic processes, e.g. different infections caused either by viruses, bacteria or fungi that can both reduce or enlarge blood level of $CO_2$.

$$P_{CO_2} \sim e^{\frac{A-A_p}{A_p}} - 1 = e^{(C_p - 1)} - 1$$

$C_p$ is the ratio between total and breathing (pulmonic) energy consumption in time.

Even the simple MBE linearization denotes two extremums that should be avoided in practice. [5] *Figure 2* possess three zones: blue, white and red. During excess musculature activity it can be noticed the constant surplus of $PCO_2$ and cannot last indefinitely due to the terminal acidosis. Hence the locomotor musculature portion must not exceed certain level during prolonged period of time.

On the opposite side, during the rest and especially during the sleep, the breathing musculature activity should not surpass surprisingly low level, since it can reduce $aCO_2$ depot below the minimum level, which during prolonged period of time would cause tissue hypoxia. This extremely harmful process is known as hyperventilation, and to the most of population has remained totally unknown [6]!

A quick overview on the phonatory apparatus's anathomy shows that beside the cartilage tissue (Figure 3), the muscles take part it's largest volume [2].

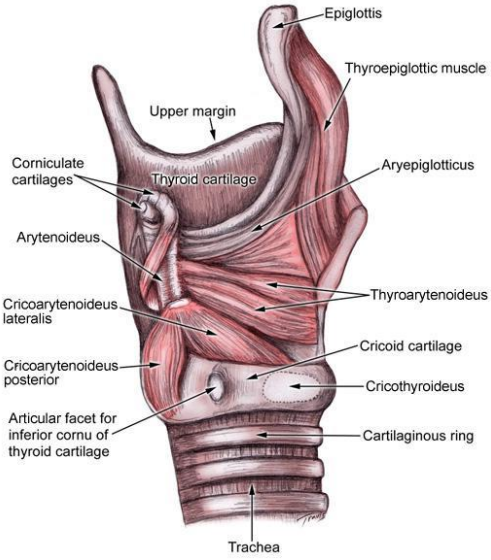


**Figure 3:** beside the cartilage tissue, the tissue of the muscles take place the largest volume of the phonatory apparatus**.**

Laryngeal muscles are a distinct allotype, differing from other muscles with respect to embryological origin and initiators (upstream activators) of myogenesis. They are endowed with a capacity to express a wider range of myosin heavy chains than limb muscles [7]. All general HV influence on musculature are valid for the phonatory muscles as well.

*Han & Stegen* from Katholieke Universtet Leuven in Belgium measured HV effect in 1995. on different aspects including speech abilities. After retraining period they conclude that ' *(3) explaining the rationale of therapy—reduction of hyperventilation by acquiring an abdominal breathing pattern, with slowing down of expiration; and (4) breathing retraining for 2 to 3 months by a physiotherapist. After breathing therapy, the sum scores of the Nijmegen Questionnaire were markedly reduced. Improvements were registered in 10 of the 16 complaints of the questionnaire*.' [8].

In 1958 *Robinson* conducted longterm experiments with top trained aviation pilots and radio mechanics. The main concern was to investigate personal ability to recognize voices under HV. This robust experiment (being classified for 50 years) could be gathered into 2x2 grid of ability to articulate correct voices and also to recognize them. The ability to recognize long sentences during HV, with the experiments on the ground, was halved to the level below 50 % of the initial one, while conducting in high altitudes could have detrimental consequencies. [9].

As the most direct influence appears the negative HV effect on muscle stiffness leading to inability to produce lower speech frequencis of phonatory apparatus. The neurological and psychological effects [10] are also presented but they are not the part of this study.

As a practical advice, it is very important to conclude that every solid speech disorder treatment in childhood should include the quick physical observation of HV signs. It is indicated that the treatment

success for the patient with HV syndrome wouldn't be even tackled without initial stopping of the process of hyperventillation! [11]

Our MBE completely corroborates with the above findings extending to new capabilities. The process of recovering from HV could be individualized, so new frames for the comfort recovery zones may be controlled.

For further scientific experiments MBE might be very useful for checking the degree of breathing training against HV syndrome.

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# Probabilistic approach to the nearest neighbor classifiers in the characterization of the phonemes

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**Abstract.** This paper presents a probabilistic approach to interpreting the results of the k NN (k Nearest Neigbors) classifier in the classification of the speech signals that are related to the phonemes of the Serbian language. Solving the speech recognition problem, or the articulation quality assessment, is finally reduced to the accuracy of classification, or pattern recognition. Therefore, in this paper, attention is focused on the comparative interpretation of the results of the kNN classifiers. These classifiers decide on the principle of majority voting of the closest neighbors, thereby causing the probability of membership of an instance to a certain class to be approximated by the Boolean variables (0,1). The amount of information lost in this way is the subject of this research. We use the kNN classifier as the generator of the probability of membership of the tested instances to one of the predefined classes. Obtained set of probabilities served as a training set for the Neural Network in order to improve the performance of the classifier. The hybrid classifier shown in the work in its performance exceeds regular k NN classifiers, which was the starting hypothesis of this research.

## 1 Introduction

The paper presents a new approach to interpreting the results of the NN classifier in the classification of segments of the speech signal that are related to the phonemes of the Serbian language. The key to solving speech recognition problems or articulation quality assessment is ultimately reduced to the accuracy of classifying or identifying patterns. Therefore, in this paper attention is focused on the comparative interpretation of the results of the kNN classifiers. These classifiers decide on the basis of the majority voting of the nearest neighbors, which approximates the probability values of the membership status of instances to a particular class by a discrete binary Boolean variables. The amount of information lost in this way is the subject of this research. In this paper, we use the kNN classifier as a generator of the probability of membership of instances of test samples to the certain class. In this way formed probability set served as a training sample for the neural network in order to improve the classification performance. A comparison of the performance of classifiers created in this way is presented, using both the standard databases and laboratory data in the field of speech pathology. The biggest problem in the characterization of the segments of the speech signal belonging to certain phonemes is their discrimination in relation to other segments, ie classification into an adequate class, whether it is the classification of normal phonemes in different classes or the classification of phonemes in two categories, typical and atypical, in the sense quality of articulation. The efficiency of the classifier is in a causal relation with the representativity of the semplers which, through their features (predictors), represents the population from which it is compiled, and with the nature of the classifier algorithm that interacts with the pattern during the modeling process (training or parameter determination) of the classifier. It is known that classifiers are exposed to the stochastic component of the impact of the selection of sample training, the imbalance in the number of opposing classes, and the impact of the initial state of the parameters, for which they are a good example of the Neural Network. However, regardless of the stochastic effect of the initial parameters of the neural networks, they exhibit extraordinary flexibility in the formation of boundary hypersurfaces for separating classes. On the other hand, by moderating the results of the ensemble of neural networks, their determinism is accompanied by a high degree of flexibility. Classifiers based on measuring the distance of the nearest neighbors in the n-dimensional feature space show general deterministic behavior and the only stochastic component comes from the selection of a training sample that can somewhat alter the classification outcome, which is not the result of their internal structure. The usual approach of the kNN classifier is the decision based on the

majority voting principle, where the class of the instance is determined on the basis of majority class membership of a set of its closest neighbors (an odd number of suitably selected neighbors). In this type of classification, an approximation of the state of probability of belonging to a class is approximated in the final discrete value of the class indicators (0,1). For example, if three of the five nearest neighbors of the tested instance $x_i$ belong to class C1 then the tested instance is also considered to belong to class C1 (xi $\epsilon$ C1) although its membership is essentially defined by the probability P($x_i \epsilon C_1$)=3/5. We explored how much this approximation affects the validity of the decision of the classifier, and decided to examine the approach of assessing the class membership of instances on the basis of the true probability values of a different number of nearest neighbors. For this purpose, we have generaerd a sample of probability vectors using the k NN ensemble (1 NN, 3 NN, 5 NN, 7 NN and 9 NN) and then we used this vector sample to train the MLP structure in order to compare the results obtained by this hybrid classifier with classical k NN classifiers. As an initial sample, we used the standard available databases on the Internet addresses and our database with acoustic signal segments of several charactristic phonemes of the Serbian language. Prior to the classification of instances of a given sample, the preparation of a sample is carried out through adequate preprocessing and extraction of characteristic independent features. After standard procedures of preprocessing the acoustic signal and the extraction of characteristics, special attention should be paid to the unequal representation of classes in the available sample, as a cause of favoring the dominant class and neglecting the minor class by the classifier. During training, the classifier develops a tendency to adapt to instances of the dominant class and classifies the minor class class sample into the dominant class on a test class. In order to avoid this situation, different methods of balancing the existing imbalance in the representation of classes in the available sample have been developed (Furundzic et al. 2017). The most common case of class imbalance is the occurrence of a large number of normal instances (negative class) and a much smaller number of pathological (positive class) instances so that classifiers tend to declare all instances to a negative class. In the case of a very prominent imbalance, the classification of all instances into the negative class will imply a result with a formally minor error but practically unusable. Therefore, an appropriate metric should be used to evaluate the validity of the classifier, so we used the confusion matrix for this purpose.

## 2 Classification based on the k nearest neighbors algorithm

One of the simplest classification methods is the k nearest neighbors classifier. It classifies an unknown instance to the class determined by the majority among its k nearest neighbours, based on a distance metric, in the training data (Cover and Hart 1967; Guvenir and Akkus 1997). Despite inherent simplicity, k NN produces competitive results to other complex learning algorithms. Some attempts have been made to improve the performance of individual nearest neighbors classifiers using ensemble techniques: (Grabowski 2002, Domeniconi and Yan 2004, Zhou and Yu 2005, Hall and Samworth 2005 and Samworth 2012). An ensemble of k NN classifiers, where the responses of these multiple classifiers are combined for final outcome is presented in Bay (1998)

The classifier based on the k NN (k nearest neighbors) uses the distance between the instances of the training set and the sample test in the nD feature space to evaluate the class of unknown instances of the test set. Depending on the type of space of the mark (numerical and categorical), the distance can be counted over the Euclidean distance, Manhattan, Hamming and other distances. The formula for the numerical determination of the Euclidean distance between the instances $x_i = \{f_{i1}, f_{i2}, \dots, f_{in}\}$ i $x_k = \{f_{k1}, f_{k2}, \dots, f_{kn}\}$ defined by the set of the feature vectors $f$ of length $n$ in the features space is represented by the following equation:

$$d(x_i, x_k) = \sqrt{\sum_{j=1}^{n} (f_{i,j} - f_{k,j})^2} .$$

The distances between categorical features are defined as follows:

$d(x_i, x_k) = \sum_{j=1}^{n} (f_{i,j} - f_{k,j})$, gde je $f_{i,j} - f_{k,j} = 0$ if $f_{i,j} = f_{k,j}$, ie $f_{i,j} - f_{k,j} = 1$, if $f_{i,j} \neq f_{k,j}$.

The basic idea of NN is finding the observations (instances) from a training session that are most similar to the observation we want to classify. The similarity criterion is based on the values of the distance d between the comparable instances, so that the degree of similarity is in reverse

correlation with the distances of the current instances. The number of selected closest neighbors (k) from the training session assessing the test case belonging can range from 1 to N, where N represents the cardinality of the training session, or the total number of observations. In the case of k = 1, the classifier has great flexibility and sensitivity followed by a lack of incorporation of noise into the classification process. The other extreme in the definition of the model is k = N, which leads to the fact that each test instance is declared a member of the class that is dominant in the training session. Usually the majority class is less interesting to the user because it represents normal (negative) cases (findings) and its majorization unacceptably increases the Falce Negative (FN) category of results. That is why a strategy is needed to define the number to the nearest neighbors in order to increase the credibility of these classifiers. For this purpose, in addition to the training session, a validation set is formed to determine the efficiency of the model in the function of the number k. The criterion is the minimization of the error to the test set in the function of k and k as the relative number k is accepted with the least error in the NN classifier. In order to achieve the flexibility and reliability of these classifiers, an ensemble of several to the NN classifier can be used, whose response is defined as the response composition of individual classifiers (Gul et al., 2016, Furundzic et al., 2017). Combination of multiple classifiers, well known as ensemble of classifiers are promising algorithms for improvement of the classification performance of weak learners. These classifiers are explored in the last twenty years (Barandela et al. 2013; Bauer and Kohavi 1999; Maclin and Opitz 2011). Mentioned algorithms lead to obvious reduction in classification error in many applications and, are very resistant to irrelevant features in the data than individual models (Khoshgoftaar et al. 2011; Melville et al. 2004). One of the widespread ensemble techniques is bagging, that combines the outputs of classifiers constructed on randomly-generated bootstrap training sets (Breiman 1996a). The block diagram for the k NN ensemble is shown in Fig. 2. which will be analysed in detail for the purpose of describing the proposed procedure. The input data are defined by the matrix $U = \{u_{ij}, i = 1,2, \dots, n,\ j = 1,2, \dots m\}$, which can also be represented by the set of *n* row vectors $\boldsymbol{u}_i = \{u_{i1}, u_{i2}, \dots, u_{im}\}$ whose components represent *m* features of training or test samples. Complete training procedure for individual k NN classifiers consist only in the selection of sample training from the entire available set of realizations. The training pattern serves as a paradigm for determining the class of unknown (test) instances according to the criterion of similarity (the difference *d* between the values of the features) in relation to the predefined set of *k* nearest neighbors. In hybrid MLP + k NN classifier (Fig. 1), the training set composed of probabilities of similarity, is used to train the MLP classifier, which generalises the acquired knowledge during the classification of test samples.

## 3 Data preparation

In addition to experimental data that include phonemes, š /ʃ/, s, ž/ʒ/ and z, as characteristic representatives of the category with an emphasized articulation pathology, data from the standard databases of the UCI Machine Learning Repository have been used. The characteristics of the databases with phonemes are shown in rows 6, 7, 8 and 9 of Table 1. In the preparation of data for the classification process, a mandatory procedure was performed to normalize all the values of the selected features on the domain [0,1] in order to avoid majorization in the calculation of the features with a large range of values and marginalized the impact of no less relevant attributes with a smaller range of values. Table 1 shows the databases used for the comparative assesment of the classifiers peerformances. In addition to the database names given in the first column, there are also informations on the total number of instances N (second column), the number of instances of negative and positive classes (N0 and N+) in columns 3 and 4, data on the degree of imbalance (IR), (column 5) and number of attributes (column 6). The process of forming the predictors (attributes) for the base of speech recordings of the listed phonemes, which implies the reduction of dimensions and the extraction of characteristic qualities, is shown in the form of a block diagram in Figure 1, and the detailed procedure is presented in Furundzic et al. 2017. It should be noted that in all training cases we used the following sample distribution: 50% of the randomly selected data was used for training classifiers, the other 50% was used to test the performance of the NN classifier. The training and test

samples consisted of randomly selected 50% of the majority sample and 50% of minority examples for each database, maintaining the original imbalance rate. Classifier training samples were then subjected to a balancing process using selected algorithms. The problem of balancing is not an actual topic here, so we will only emphasize that it increases the performance of classifiers in sets with prominent imbalance in the number of instances of different classes. In any case, the testing of new instances was done on the original imbalanced test samples.

**Table 1.** Summary descriptions of data sets.

| | Data set | N | $N^o$ | $N^+$ | IR | #Atr. |
|---|---|---|---|---|---|---|
| 1 | Br. Cancer | 699 | 458 | 241 | 1.9004 | 9 |
| 2 | Heart | 294 | 188 | 106 | 1.7736 | 13 |
| 3 | Letter A | 20000 | 19211 | 789 | 24.3480 | 16 |
| 4 | Magic | 19020 | 12332 | 6688 | 1.8439 | 10 |
| 5 | Phoneme | 5404 | 3818 | 1586 | 2.4073 | 6 |
| 6 | Phon. sh/ʃ/ | 314 | 218 | 96 | 2.7080 | 19 |
| 7 | Phoneme s | 185 | 121 | 64 | 1.8906 | 19 |
| 8 | Phon. zh/ʒ/ | 279 | 188 | 91 | 2.0659 | 19 |
| 9 | Phoneme z | 189 | 117 | 72 | 1.6250 | 19 |
| 10 | Pima | 768 | 500 | 268 | 2.1194 | 8 |

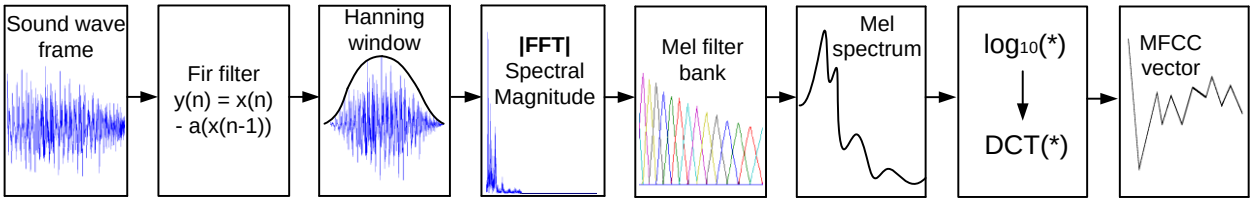


**Fig. 1**. Selection of predictor variables of the listed phonemes.

As shown in Fig. 2, each instance of $\boldsymbol{u}_i$ goes through the classification procedure in the classifier set with k1, k2, k3, ..., and kq of the nearest neighbors. An envelope of the p classifier in response to the input vector $\boldsymbol{u}_i$ at the output determines the output vector variable $\boldsymbol{x}_i = \{x_{i1}, x_{i2}, \dots, x_{ip}\}$ whose values represent the probability of belonging to an instance $\boldsymbol{u}_i$ to one class, for example C1. $x_{i1} = P_1(\boldsymbol{u}_i \epsilon C_1), x_{i2} = P_2(\boldsymbol{u}_i \epsilon C_1), \dots, x_{ip} = P_p(\boldsymbol{u}_i \epsilon C_1)$. The probability values of P are conditioned by the number to the nearest neighbors. In our case the numbers of the nearest neighbors of the ensemble were: k1 = 1, k2 = 3, k3 = 5, k4 = 7 and k5 = 9. The odd values were chosen so that the classifier always has an unambiguous conclusion based on the majority decision of the nearest neighbors in determining the class of an unknown instance.

In the case of k1 = 1 in the binary classifier (classes $C_1$ i $C_2$), $x_{i1}$ can have values of 1 or 0, respectively $x_{i1} = P_1(\boldsymbol{u}_i \epsilon C_1) \epsilon \{0, 1\}$, in the case k2 = 3, $x_{i2} = P_2(\boldsymbol{u}_i \epsilon C_1) \epsilon \{0, 1/3, 2/3, 1\}$, for k3=5 is $x_{i3} = P_3(\boldsymbol{u}_i \epsilon C_1) \epsilon \{0, 1/5, 2/5, 3/5, 4/5, 1\}$, and generally for kq=r $x_{ir} = P_p(\boldsymbol{u}_i \epsilon C_1) \epsilon \{0, 1/r, 2/r, 3/r, \dots, (r-1)/r, 1\}$. A regular k NN classifier, all values of the probability P discretizes to the binary values 0 and 1, taking as a criterion the threshold value of 0.5. In this procedure large amount of information is lost. It also often happens that the decisions of the classifier with different numbers of k nearest neighbors are contradictory, so the amount of information lost during the binarization of the probability could have a decisive importance for the valid decision of the classifier. These reasons are the motivation for our approach in which the probability vectors of all the classifiers of the ensemble $\boldsymbol{x}_i = \{x_{i1}, x_{i2}, \dots, x_{ip}\}$ are used as input training patterns for the neural network (multilayer perceptron), whereby the target output vector $\boldsymbol{y}_i$ uses the binary values of the indicator class $\boldsymbol{c}_i \epsilon \{0, 1\}$, which belong to the actual instances of the training session $\boldsymbol{u}_i$ (Figure 2). After training or during the exploitation of the trained neural networks its original output values are finally rounded to the binary values that are the indicators of the class in which the tested instances are classified.

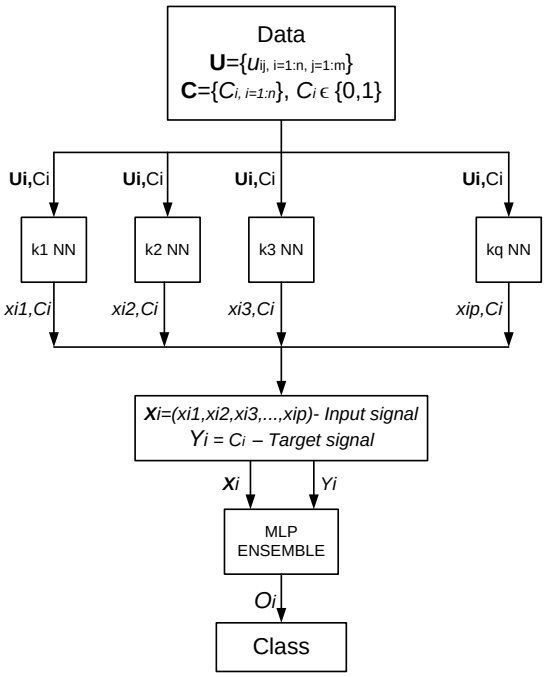


**Fig. 2**. Hybrid classifier MLP + Ensemble of k NN.

## 4 Experimental results - classifier performance

The results of the classification of the bases shown in Table 1 are shown in Table 2. The used metric is based on the values of the condensed derivative of the confusion matrix (the area below the ROC curve known as AUC (Area Under the Curve), (Kubat et al., 1998, Favcett, 2003). The values for the AUC belong to the domain [0,1], where the unit value represents the exact classification of all instances (FP=0, FN=0). The classification results are presented on all 10 databases using selected classifiers where MLP means Multylayer Perceptron, 1 NN relates to 1 Nearest Neighbor, Ens. NN means Ensemble of NN classifiers (1 NN, 3 NN, 5 NN, 7 NN and 9 NN) and MLP + Ens. NN refers to a hybrid classifier (MLP trained on values of probabilities obtained by Enseble of k NN). The results show a certain advantage of the hybrid classifier both in relation to the Ensemble of the NN classifier and the individual regular k NN classifiers. Our goal was to show that the amount of information lost during the abstraction of the value of the membership probability, taking place when using the individual k NN classifier, has a major impact on their performance as evidenced by the results of Table 2. It has also been confirmed that Ensemble of the NN classifiers also have advantage over individual NN classifiers. Since the ultimate objective of the classification process is the reliability and accuracy of the classification, attention must be paid not only to the choice of a representative training model but also to the type of classifier that interacts with the data during the process. Boldface values presented in Table 2 represent the best results obtained. Obviously, the best results are concentrated in the sixth column of Table 2., which means that the hybrid classifier MLP + Ens. NN is superior to regular NN classifiers. This result confirms the assumptions about the benefits of a hybrid classifier based on complete information on the probability of class membership of training instances in relation to discretized probabilities used by a regular kNN classifier.

verovatnoći klasne pripadnosti trening instanci u odnosu na diskretizovane vrednosti verovatnoća kojima se služi regularni kNN klasifikator.

**Table 2**. Classification results (AUC) for the set of classifiers.

| Data Set | | Used Classifiers | | | | | | |
|---|---|---|---|---|---|---|---|---|
| | | 1 NN | 3 NN | 5 NN | 7 NN | 9 NN | Ens. NN | MLP + Ens. NN |
| 1 | Br. Cancer | 0.9628 | 0.9785 | 0.9789 | 0.9592 | 0.9173 | 0.9688 | **0.9823** |
| 2 | Heart | 0.6720 | 0.6568 | 0.6857 | 0.6382 | **0.6934** | 0.6831 | 0.6868 |
| 3 | Letter A | 0.9824 | 0.9835 | 0.9791 | 0.9644 | 0.9861 | 0.9796 | **0.9906** |
| 4 | Magic | 0.8013 | 0.7703 | 0.7957 | 0.7552 | 0.7253 | 0.8081 | **0.8271** |
| 5 | Phoneme | 0.7909 | 0.8697 | **0.8729** | 0.8243 | 0.8295 | 0.8361 | 0.8215 |
| 6 | Phon. sh/ʃ/ | 0.9030 | 0.8750 | 0.9060 | 0.9068 | 0.8955 | **0.9583** | 0.9477 |
| 7 | Phoneme s | 0.8660 | 0.8645 | 0.8653 | **0.8992** | 0.8796 | 0.8904 | 0.8801 |
| 8 | Phon. zh/ʒ/ | 0.7818 | 0.7761 | 0.7692 | 0.7939 | 0.8135 | 0.7929 | **0.8033** |
| 9 | Phoneme z | 0.9607 | 0.9385 | 0.9105 | 0.9628 | 0.9712 | 0.9501 | **0.9743** |
| 10 | Pima | 0.7024 | 0.7523 | 0.7462 | 0.7205 | 0.7510 | **0.7533** | 0.7403 |

## 5 Conclusion

This paper presents a new probabilistic approach to interpreting the results of the k NN classifier in the classification of segments of the speech signal that are related to the phonemes of the Serbian language. We have assumed that the amount of information, lost when using a regular NN classifier, has an impact on the accuracy of these classifiers in classification of phonemes. The loss of information arises by approximating the value of the calculated probability of class membership of the tested instance $[P(\boldsymbol{x}_i \epsilon C_j) \leq 1]$ with the values $[P'(\boldsymbol{x}_i \epsilon C_j) \in \{0,1\}]$ obtained by majority decision of the nearest neighbors of that instance. We constructed a hybrid classifier that uses the original probability values of $P(\boldsymbol{x}_i \epsilon C_j)$ and the original indication of the class training sample $I(C_j)$ as a new teching sample for the MLP classifier, which generalizes the learned mapping of pairs to an unknown sample of the target population. Based on the obtained results, we found that the hybrid classifier has better performances than regular k NN classifiers, thus proving the starting assumption.

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## Probabilistički pristup klasifikatoru k najbližih suseda pri characterizaciji phonema

U ovom radu je predstavljen nov probabilistički pristup interpretacije rezultata k NN klasifikatora pri klasifikaciji segmenata govornog signala koji se odnose na foneme Srpskog jezika. Ključ rešavanje problema prepoznavanja govora ili ocene kvaliteta artikulacije se na kraju svodi na tačnost klasifikacije ili rekognicije uzoraka. Zato je u ovom radu pažnja usmerena na komparativnu interpretaciju rezultata k NN klasifikatora. Ovi klasifikatori odlučuju na većinskom principu (majority votting) najbližih suseda, čime se nebinarne (realne) vrednosti varovatnoća pripadnosti instanci određenoj klasi [$P(\boldsymbol{x}_i \epsilon C_j) \leq 1$], aproksimiraju binarnim vrednostima [$P'(\boldsymbol{x}_i \epsilon C_j) \in \{0,1\}$]. Količina informacije izgubljena na ovaj način je predmet ovog istraživanja. Dakle kNN klasifikator koristimo kao generator verovatnoća pripadnosti instanci testieranih uzoraka. Ovako formiran skup verovatnoća u formi vektora koristimo kao trening skup za neuronsku mrežu u cilju poboljšanja klasifikacije. U radu je prikayana komparacija performansi novog klasifikatora sa regularnim k NN klasifikatorima, kako na standardnim bazama podataka tako i na laboratorijskim podacima iz oblasti govorne patologije. Novi hibridni klasifikator prikazan u radu po svojim performansama prevazilazi regularne k NN klasifikatore čime je dokazana polazna pretpostavka ovog istraživanja.

# Identificational probability functions of the perceptual recognition of africates' and fricatives' duration

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**Abstract.** The acoustic feature of the duration is phonetic system's inherent feature. The duration of each speech sound has its own variation field within which its realizations are perceived as typical. The results related to the analysis of the duration in the domain of the pathology of speech sounds, on a typical / atypical characteristic, were not found in the literature for the Serbian language.
The objectives of this study were to determine the boundaries of the typical / atypical basis of the identification functions of the probability of perceptual recognition of the duration and their comparison between voicing and voiceless speech sounds in the group of affricate and fricatives.
Based on the analysis of the selected speech sounds: /c/, /č/, /dž/, /š/, /ž / the boundaries of typical and atypical were defined, and they served for the synthesis of stimuli used in perceptive experiments. According to the given procedure, 6300 stimuli were formed and then presented to the listeners who were asked to identify and mark the stimulus based on typical and atypical (extended / shortened) duration. The analysis of the data found the identification functions of the probability of perceptual recognition of the typical / atypical duration for the examined speech sounds, at initial position in words, by which the limits of the typical / atypical duration of the stated speech sounds.
The results have shown the existence of categorical perception through the emergence of a higher sensitivity of the perceptive mechanism to a reduction in duration (a greater inclination of the identification function of the probability of perceptual recognition of typical / atypical duration) than of prolonging the duration of the voice, which demonstrated that the label of duration can be a good indicator of deviation in articulation. In addition, it has been shown that there have been differences in the function of the probability of perceptual recognition of the duration of voicing and voiceless speech sounds, which explanation requires further research. Apart from the importance in theory of speech and language pathology and practice, these results can be useful in speech technologies.
*Key words*: perception, typical/atypical pronunciation, acoustic features, duration of pronounced speech sounds, variation field

## 1 Introduction

The base of speech process realization is the presence of two participants, one who is articulating /producing, and the other one, who listens/perceives. It is being realized by defined order, starting with message formulation, speech organs innervation, articulation, through sound waves vibrations with corresponding frequencies and amplitudes through air environment, vibration transfer through middle and inner ear, transfer by auditory nerve to the brain, and understanding the message at the end. In this complex communication chain, basic unit of speech process is a phoneme, which is realized as an articulated sound or speech voice in speech. Basic acoustic features of speech sound are: duration, frequency and intensity. They appear as a result of coordinated effect of speech organs system, and they are significant for perceptive identification of singular phoneme and for inter phonemic discrimination. In the first step, perception process implies recognition of basic message meaning which is contained in speech. Process of auditory perception takes certain time during which two key processes are being enacted: a) detection of acoustic characteristics in speech signal and b) their accumulation and integration in perceptive unit (Jovičić, 1999).

Appearance of acoustic features in different relations enables variations of acoustic quality. Duration, as a subject of interest in this study, is an inherent characteristic of phonetic system and a constant companion of all acoustic speech manifestations. In order to use speech expression in comprehension, speech sounds, as its bearing segments, must take certain time to achieve function of

differentiation. Examination of general acoustic features of speech sounds showed that upper and lower limits could be set in area od duration in individual speech sound (Ispitivanje opštih akustičkih osobina glasa pokazalo je da se na području trajanja jednog glasa može postaviti donja i gornja granica). If the duration of speech sound is less than 20 ms, person can't perceive it; upper limit is not strictly determined, and it is linked to the expirium limit and emphatic accentuation, but in every case, it exists as the limit of distortion-when speech sounds become unrecognizable (Kašić, 2000). Some previous studies showed that the duration of fricatives can change the perception of articulation's location (Hughes and Halle, 1956), and that, the shortest duration of friction so that a listener could precisely and naturally identify /s/ and /š/ is about 50 ms (Jongman, 1989).

Duration is a speech sound's feature. Its variability is influenced by series of factors: speaker's features, requests of communication situation, phonetic context, position of phoneme in a word, influence of accentuated syllable in word, position before or after the break, suprasegment organization etc. (Lehiste and Ivić, 1986).

Variations in pronunciation, conditioned by factors of linguistic and paralinguistic origins, must stay in the speech sound's articulation field, namely, in the field of given limits for specific speech sound-typical realization. If the realization of speech sound comes out of limits set by speech standard, we are talking about atypical realization. Deviation can be noticeable on one or on set of articulation and/or acoustic features. The oldest technique in the assessment and analysis of speech sound duration (typical and atypical), which is applied today, is assessment by hearing (auditory-perceptive identification). This technique is known by the name of expert or trained listening. It provides „setting up" the discrimination line between typical and atypical speech sound pronunciation (Vasić, 1971; Golubović, 1997; Sovilj, 1988; Subotić and Pantelić, 2002; Punišić and Čabarkapa, 2003). Expert uses his auditory-perceptive system for speech processing, which is based on the experience in field of standard articulation and acoustic characteristics of pronounced speech sounds in given language, by which he diagnoses, characterizes and classifies pronunciation. Speech therapists are experts, trained to classify speech in terms of typical and atypical, respectively, normal and pathological expression.

For speech disorders assessment, besides other procedures, tests based on perceptive evaluation of examiner are being used (Lippke et al., 1987; Smit and Hand, 1997; Gruber, 1999; Goldman and Fristoe, 2000; Ase et al., 2000). Speech therapist, besides that he detects atypically pronounced speech sound by trained listening, is capable to characterize it by certain features and classify it in appropriate pathological group.

Methods of expert listening should not be underestimated, but an objectification of pathological pronunciation assessment would enable procedures' uniformity and availability. It is especially important because for Serbian language, there are no standardized bases of atypical pronunciation, so speech therapists can't „train" their auditory perception during education. Additional aggravating circumstance, results in relation to analysis of duration in pathology domain, on relation typical/atypical feature were not found in Serbian language literature. Even though the tradition in examination of this dimension is very long, it is predominantly linked to typical pronunciation aspect (Lehiste, 1970; Crystal and House, 1988; Whitehead et al., 1995). From perceptual aspect, the influence of basic frequency of $F_0$ on the perception of vowel duration was analyzed (Wang et al., 1976); the influence of surrounding by vowels on consonant duration in continuous speech (Whitehead et al., 2000); the influence of vowel reduction on consonant duration in inter vowel surrounding in reading speech (Son and Pols, 1996); influence of consonant duration and vowels in stimuli of consonant-vowel type (CV) on the voicing-voiceless distinction, in English pairs of fricatives and affricates: /s/-/z/, /f/-/v/ and /č/-/dž/ (Cole and Cooper 1975) etc. In perceptive experiment for Croatian language (Horga, 1988), the level of recognition in individual frequency ranges was examined for spoken speech sounds.

With the development of contemporary speech technologies, examinations of durations gain in significance, in domains like speech and speaker recognition, speech synthesis and natural language processing (Huang et al., 2001). Duration of occlusion of phoneme /p/ was analyzed by measuring the JND (*just noticeable difference*) parameter, in a sentence pronounced by normal and accelerated tempo. Normally pronounced sentence was accelerated by 8%, 16% and 24%, while the accelerated sentence was slowed down by same percentages (Huggins, 1970); time characteristics of speech in simultaneous communication were analyzed (Whitehead et al., 1999); durations of phonemic and sub

phonemic segments of different speech sounds in children with neat verbal status, average age of 10 years and 6 months in Croatian language were analyzed (Heđever, 1996) etc. The complexity of this feature made examinations specific for each language, so we are going to mention duration examinations for American English (Umeda, 1975; 1977), Dutch (Heuvel et al., 1994), Spanish (Mendoza et al., 2003), German (Braunschweiler, 1997), French (O'Shaughnessy, 1981), but also comparisons between some of the mentioned languages (Delattre, 1965; Laeufer, 1992). Studies exploring the fricative duration in phonetic context showed that voiceless fricatives in initial and final position are longer by duration than voicing fricatives (Baum and Blumstein, 1987; Crystal and House, 1988). We should mention some of the examinations dealing with duration characteristics in speech after esophagectomy (Christensen and Weinberg., 1976; Christensen and Weinberg, 1981), after the correction of broken palate and expressed hypernasality (Leder et al., 1988), in aphasia (Ryalls, 1986).

In Serbian language, speech sound examinations were conducted in phonetic domain (Mihajlović, 1953; Kašić et al., 1987; Kašić, Ivanović, 2011), in domain of technological examinations for TTS (*text-to-speech*) optimization of synthesizers in Serbian language (Sovilj-Nikić et al., 2007), while Jovičić and colleagues (Jovičić et al., 2008) conducted the study in which they analyzed the duration of fricative /š/, in isolated words, at initial, medial and final position, and the effect of word's duration, syllable accent and co-articulation of fricatives duration. Last examination showed that fricative /š/ has the shortest duration at medial position, and the longest and most stable in final position; also, it has been shown that the duration of speech sound /š/ is longer for shorter words in the number of phonemes and in syllables of short accent. Research of atypical pronunciation in speech sound duration (Jovičić and Punišić, 2007; Jovičić et al., 2010; Punišić et al., 2007; Punišić et al., 2009; Punišić et al. 2011; Punišić, 2012; Punišić et al., 2016) are small and mostly linked to certain speech sounds, speech sound groups, for durations in terms of certain distortion (Bilibajkić et al., 2016) or using neural networks (Furundžić et al., 2009).

This research, as a part of an extensive study whose aim was to determine precise articulation-acoustic indicators of deviation in speech sounds' pronunciation, has a dimension of duration precisely in terms of determining the boundaries typical/atypical duration for its subject of research. Discrimination of typical from atypical duration was conducted based on identificational probability functions of the perceptual recognition of duration. Research was realized on voicing and voiceless speech sounds from groups of affricates and fricatives, and the detected values were aligned between voicing and voiceless speech sounds. One of the motives for this kind of research concept was the contribution to a more reliable classification, categorization and the assessment of pathological pronunciation in speech and language therapy. This is the reason why we first conducted experiments whose aim was to define variation fields of duration, based on the analysis of chosen speech sounds (/c/, /č/, /dž/, /š/, /ž/), as they served for synthesis of stimuli used in following perceptive experiments.

## 2 Study aim

The aim of this research was to determine the boundaries between typical/atypical duration, based on identificational probability functions of the perceptual recognition of duration and the comparison between voicing and voiceless speech sounds in a group of affricates and fricatives. Examination was realized on 5 speech sounds from two mentioned groups: /c/, /č/, /dž/, /š/, /ž/.

With the introduction of identificational functions, quantitative indicators of typicality and atypicality of duration in analyzed speech sounds during production were enabled, which is very significant for speech and language practice, and it opened the door for further research on this subject.

## 3 Methodology and methodological procedures in this research

Research sample was consisted from two groups: group of speakers whose pronunciation formed a set of speech sound stimuli and a group of listeners for the perceptive experiment needs-for determining the boundaries typical/atypical duration.

Ten and eleven year olds were chosen for speakers, because they are in speech phase in which they are approaching adult speakers, namely, the system of automatized articulatory habits is achieved, and they are in a process of adopting of standard orthoepy. The group of listeners was conducted from experts (speech therapists).

### 3.1 Description of I experiment

For formation of speech stimuli set Global articulation test (GAT) and Analytic evaluation of Serbian language speech sounds test (AT) were used (Kostić et al., 1983).

Sample for articulation and acoustic research was formed out from 410 ten year olds (eleven year olds), for whom it was assumed that they automatized articulation base of Serbian language as a mother tongue. Speakers had: average intellectual abilities, neat anatomic-functional status of speech organs, neat hearing status, they were monolingual, born and living in Belgrade.

As an articulation standard, existing one was taken, namely, description of acoustic-articulation characteristics of Serbian language speech sound (Miletić, 1952; Stevanović, 1981; Kostić et al., 1964 Simić and Ostojić, 1996).

From given set of pronunciations, we separated typically pronounced speech sounds /c/, /č/, /dž/, /š/, /ž/ from the same group of speech sounds differing from typical pronunciation only by duration. The sample of total 381 speech sounds was obtained, namely 381 pronounced words: /cica/, /čelo/, /džep/, /šuma/, /žaba/ in which examined speech sounds /c/, /č/, /dž/, /š/, /ž/ were at the initial position. Number of pronunciations is: for /c/ - 86 pronunciations, by which 45 typically and 41 atypically articulated; for /č/ - 81 pronunciations, by which 36 typically and 45 atypically articulated; for /dž/ - 67 pronunciations, by which 40 typically and 27 atypically articulated; for /š/ - 77 pronunciations, by which 43 typically and 34 atypically articulated; for /ž/ - 70 pronunciations, by which 42 typically and 28 atypically articulated.

For the duration feature role, in the identification and discrimination of phonemes in Serbian language, it is important to know objective criteria which define boundaries of its typical/atypical value. Because of that, in first experiment, for each selected speech sound, certain boundary of typicality/atypicality of duration, based on characteristics of their duration distribution was determined.

### 3.2 Description of II experiment

Within the second experiment, research of experts' perceptive mechanism sensibility on change in duration of selected speech sounds was conducted. Deviation in duration was analyzed with the help of identificational probability function of perceptual recognition.

In the analysis of speech sounds duration deviation, with the help of perceptive identification, the same methodology as in classic experiments of perception and discrimination was applied, e.g. plosive in function of transition of second F2 formant (Stevens et al., 1969), and the recognition and identification of typicality/atypicality in production was requested from listeners.

Function of identification for speech sounds durations was determined on three levels: shortened (reduced), typical and elongated (enlarged). Shortened and elongated durations, which belong to the deviations from distortion category, were achieved by a process of synthesis of speech sounds based on experiment demands, respectively, by computer manipulation of duration dimension, with complete preservation of its naturalness.

Speech sounds were segmented and modified by the duration dimension, through shortening and extending, while the rest of the word /_ica/, /_elo/, /_ep/, /_uma/, /_aba/, stayed with unchanged duration. The change in duration length of each initial speech sound was conducted with the help of *Praat* software package (Boersma and Weenink, 2010). For each of the 5 stimuli-words one word was chosen as a starter word, in which the duration of analyzed speech sound corresponds to average typical value (referent word). The duration of initial speech sound of that stimuli was modified, namely, shortened in 8 steps and elongated in 8 steps to the value of completely clearly recognizable shortening/elongation of duration. In that way, 17 stimuli (including starting stimuli too) were formed out, from which the last stimuli corresponded to atypical durations-first stimulus corresponded to completely recognizable shortened duration, and seventeenth to completely recognizable elongated

duration. Stimuli were divided into two groups: the first group was consisted from all 8 shortened stimuli, plus starting stimuli, while the other group was consisted from 8 elongated stimuli, plus starting stimuli. Each stimulus within the group was repeated 10 times, which provided two audio files with 90 stimuli each, which were then presented to the listeners in two experimental sessions. Disposition of stimuli was random, and time interval in the presentation of adjacent stimuli was 5 seconds. Stimuli were presented to the listeners through TDK MP 100AX headphones.

Seven speech therapists-listeners participated in the experiment, and each of them had two sessions of listening (90 from the first and 90 from the second group of stimuli) for one word, and a total of 6300 stimuli for all 5 words. Before the experiment, speech therapists-listeners were introduced to the experiment content, examples of typical and atypical stimuli were demonstrated to them, and it was requested from them to recognize and mark two categories of stimuli in prepared form: typical and atypical, with the description of typical stimuli by features: elongated or shortened by duration („forced choice“ test).

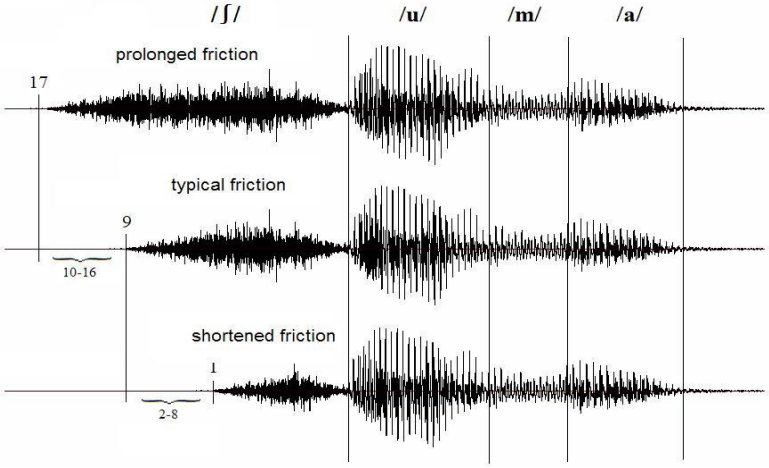


**Figure 1.** Method of stimuli synthesis in time domain

Procedures of stimuli modification, starting with stimuli of typical duration, are different for voiceless and voicing speech sounds. For example, we will present the procedure for modification of fricative /š/. Within the first experiment, averaged value of typical duration of fricative /š/ in the word /šuma/ was obtained, and it amounts 223 ms (Table 1). Word /šuma/ was modified so that the initial speech sound was elongated/ shortened in 17 steps, by nearly 11 ms, starting with stimuli of 223ms which was ninth in the row. More precisely, all interventions of shortening or elongating (multiplying short segments) were conducted within central segment of typical duration. /š/ modified in that way was added to the segment /uma/ on the initial position (Figure 1).

The procedure of shortening the duration of /š/ came down to careful „cropping“ of friction parts, while taking care of friction's envelope continuity. It was supposed to provide deviation of amplitude as little as possible, and also to provide phase rise in the point of joining of left and right signal after „cropping“ certain segment. „Cropping“ was conducted on signal passages through zero, and on increasing edges of wavy form. Noisy character of friction gives freedom to eject arbitrary segment on arbitrary place from the friction content.

Elongation was conducted starting with typical, ninth stimulus, whereby 10th and 17th stimuli were obtained. The procedure of stimulus elongating came down to repeating of short friction segment chosen from central part of fricative/affricate. It means that the chosen subsegment was copied and inserted into some other positions within the friction of initial speech sound. For less elongation of duration, copying and inserting one short segment was enough, but in the case of more significant elongation of duration, two or three short segments were needed. This manipulation was done very carefully, in order to avoid periodicity of short segments and to preserve continuity of whole amplitude envelope of initial speech sound. Three criteria needed to be satisfied: (i) general continuity of signal amplitude around point of joining of segments had to stay unimpaired, (ii) continuity of envelope of whole friction/affriction segment had to stay preserved (iii) this kind of manipulation had to stay undetected in spectral domain.

## 4 Results and discussion

Duration measurements were conducted after the segmentation of initial speech sounds in recorded words. Durations in typical and atypical production of all five speech sounds in initial position in isolated stimulus-words were measured respectively.

The procedure of determining the boundaries typicality/atypicality, based on distribution of duration characteristics for speech sounds was given on the example of speech sound /c/.

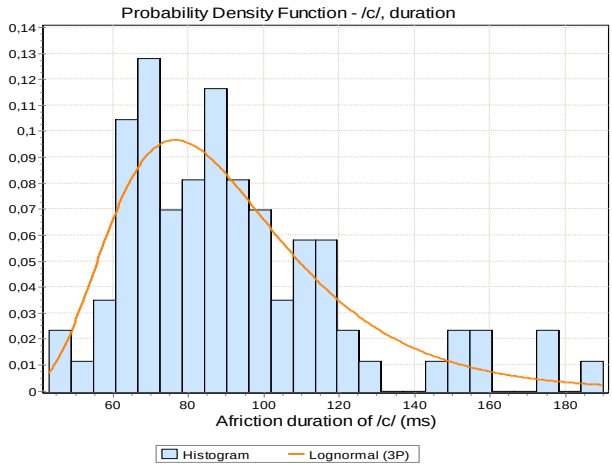


**Figure 2.** Distribution of speech sound /c/ duration

The distribution of duration of speech sound /c/ is shown in the form of histogram, on Figure 2. On the same diagram is drawn the curve of probability distribution (PDF – *Probability Density Function*), which is a very good approximation of basic form (envelope) of histogram. By the distribution analysis, two basic characteristics could be detected: first, PDF distribution is *Lognormal (3P)* type, which means that it is a three parametric distribution, where the logarithm has a normal distribution. The quality of histogram and PDF harmonization is very satisfying (*Kolmogorov-Smirnov Goodness of fit test*, P = 0,72985); second, the largest concentration of its values histogram has in the duration range of nearly 55 to 125 ms (approximation based on PDF distribution). Beyond this range are located values concerning shortened or elongated duration of speech sound /c/, namely, atypical production.

The same procedure was applied for characterization of other speech sounds, and obtained results are presented in Table 1.

**Table 1.** Variation field of duration and the duration typicality dynamics of examined speech sounds

| Speech sound | Duration of variation field (ms) | Typicality dynamics (ms) |
|---|---|---|
| /dž/ | {45, 190} | 145 |
| /ž/ | {90, 190} | 100 |
| /š/ | {155, 250} | 95 |
| /č/ | {45, 130} | 85 |
| /c/ | {55, 125} | 70 |

With the analysis of perceptive experiment results, identificational probability functions of the perceptual recognition of typical/atypical duration were obtained for following speech sounds: /c/, /č/, /dž/, /š/, /ž/, on initial positions in examined words, which helped to determine boundaries of typical/atypical duration in mentioned speech sounds. The procedure of obtaining the identificational probability function of the perceptual recognition of typical/atypical duration is given on the example of speech sound /š/.

Based on the listening of stimulus, marking into adequate patterns and results processing, individual identificational functions for fricative /š/ are formed, for both sessions. They are showed in Figure 3.

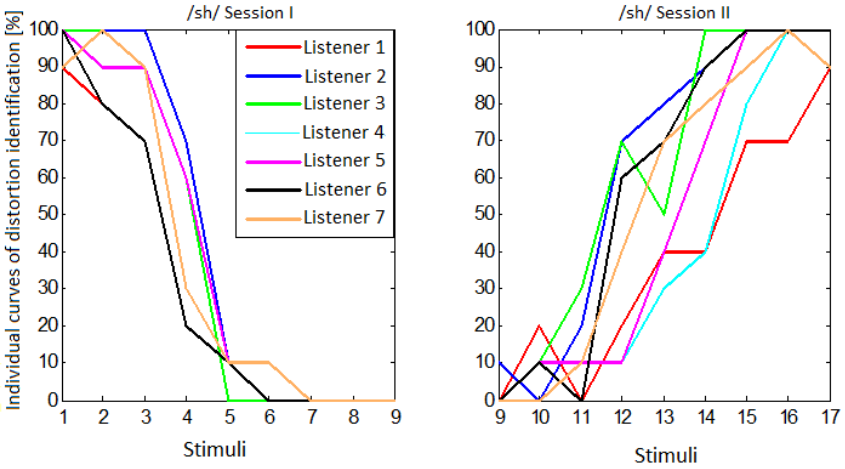


**Figure 3.** Individual identification functions for fricative /š/

On the figures, it can be clearly seen the individual differences between all 7 listeners while rating stimuli, in terms of shortening or elongating duration, based on perceptive identification. This shows that there are no universal boundaries which correspond to the shortened and elongated duration for given language, but they are dependent from the individual. Plausible factors which influence on individual differences of boundaries could be multiple, starting with experience, dialect, up until barely noticeable differences in hearing quality. More comprehensive research could give response to the question of which factors and how much they contribute to the individual difference in the evaluation of typical/atypical duration of speech sounds. On the same model, individual identificational functions for the rest 4 speech sounds were formed.

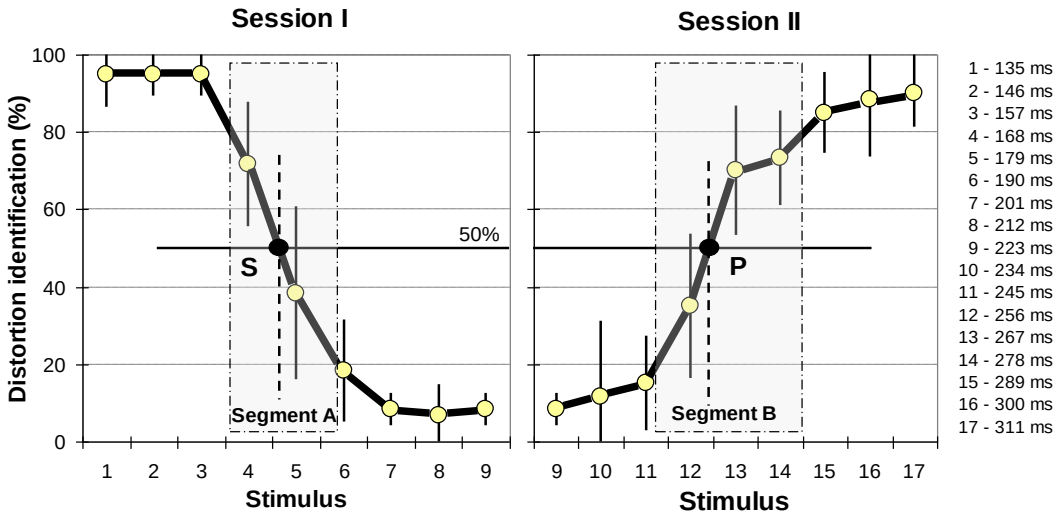


**Figure 4.** Identificational functions for recognition of typical/atypical duration of fricative /š/: session I for shortened frictions, and session II for elongated frictions

Figure 4 shows averaged identificational functions for recognition of typical/atypical duration of fricative /š/ for both sessions: session I for shortened frictions and session II for elongated frictions.

Stimuli from 6 to 11, with identification probability below 20% could be adopted as typical friction durations, namely, from 190 to 250 ms. Stimuli 1, 2 and 3 from first session and 15, 16 and 17 from second session, with probabilities above 80% are identified as atypical friction durations. More precisely, duration of speech sound /š/ below 165 ms, and over 285 ms could be adopted as atypical. Segments A and B represent those stimuli in which the listeners were uncertain in distinguishing typical/atypical friction duration. Segments of uncertainty in recognition of typicality/atypicality by speech therapists are durations of 15 ms for first session, and 34 ms for the second one. These transitional segments represent 6.75% and 15.25% of average typical friction duration, respectively. Fast changes of identificational functions show differentiated perception of speech therapists in recognition of typical and atypical duration of /š/. The drop of identificational function for shortened stimuli (stimulus 4) is steeper in comparison with the curve drop for elongated frictions (stimuli 12, 13 and 14). This was expected, just because of phonetic transformation of /š/ to /č/ in further shortenings, while in elongating, it does not come to speech sound substitution.

Segment A means a transition from typical to shortened stimulus, and segment B from typical to elongated stimulus. Part between segments A and B represents a segment of friction's typical duration perception. Points S and P, located at 50% of probability, represent points of contact between typical and atypical friction durations. Standard deviation in points S and P on level 50% is 4.89 ms and 12.81 ms. Standard deviation in shortened frictions is small, which indicates compatibility in speech therapists during perception of this duration, while in elongated frictions, individual differences in perception are expressed (first and fourth listener were a little more tolerant in their perception). These differences differ from typical friction duration (223 ms) in range from 2.2% to 5.7%. Results have shown high accordance in experts in determining the friction duration typicality (Jovičić et al., 2010).

During the testing, shortened stimuli were easier to recognize because of the subjective experience that the word /šuma/ transits to word /čuma/. With the shortening from the starting referent signal, yet from the value of about 146 ms comes to the substitution of /š/ into affricates /č/ or /ć/. As opposed to that, the elongation of fricative /š/ to the duration of 300 ms, besides the detection of elongated friction, did not lead to significant phonetic changes.

Comparing the obtained data of typical duration of speech sound /š/ {165 - 285 ms} with the data obtained in Table 1, we note that there is a difference in the duration boundaries. This is not unexpected result, if we have in mind that the sample of obtained speech sounds /š/ is not a representative sample, when we observe the duration's normality of distribution. However, that was not the purpose of experiment I, but to obtain the sample in which the typical and atypical (shortened and elongated) pronunciations will be represented.

The same procedure was applied for obtaining the identificational functions for recognition of other speech sounds: /c/, /č/, /dž/ and /ž/.

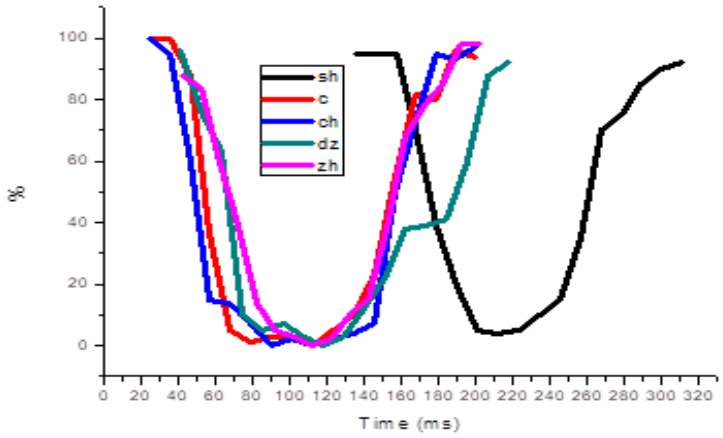


**Figure 5.** Comparative view of all identificational functions

Comparative view of identificational functions for all analyzed speech sounds is presented of figure 5. Based on identificational curves, parameters of typical duration of analyzed speech sounds, given in table 2, are obtained.

Even though identificational functions have similar shape, it can be noticed that there are significant deviations for speech sounds /dž/ and /š/. Identificational curve for speech sound /š/ is moved to the right (Figure 5), because of the length of duration, while the boundaries of duration in other speech sounds are close. In speech sound /dž/, different form of identificational function curve can be noticed, in area of transition from typical to elongated duration.

**Table 2.** Parameters of typical duration of analyzed speech sounds

| Speech sound | Typical duration dynamics [ms] | Range (S-P) [ms] |
|---|---|---|
| /dž/ | 122 | 62-184 |
| /č/ | 108 | 48-156 |
| /ž/ | 96 | 57-153 |
| /š/ | 96 | 164-260 |
| /c/ | 97 | 55-152 |

To get clearer insight into identificational curves characteristics, we normalized time axis in relation to duration of longest stimuli for each speech sound (Figure 6).

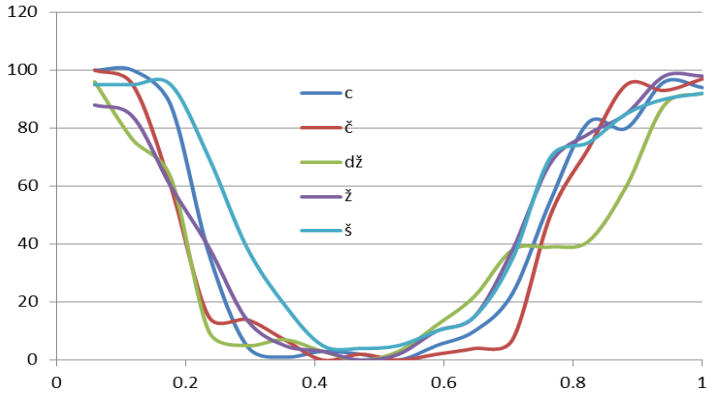


**Figure 6.** Comparative view of all identificational functions in which the duration is normalized

It can be noticed that there are certain differences in identificational function slopes. On segment A, which defines the vagueness zone, during shortening of speech sounds, it can be also noted that, the segment for speech sound /š/ was moved in relation to other speech sounds. On segment B, which defines the vagueness zone, during elongating speech sounds, it can be noted that, the segment for speech sound /dž/ was moved in relation to other speech sounds. To determine whether there is a difference in slopes of identificational curves, linear dependencies for all speech sounds, presented in Table 3, are obtained by linear approximation of descending and ascending segments in areas of Y axis between 20 and 80%.

It is noted that slopes of left side of identificational curves (coefficients along with variable ***dur***-duration) are steeper in relation to identificational curves slopes of right side, which are mild, for all 5 speech sounds. The change of perception identification function is faster (more steep slope) when it comes to shortening of duration, in comparison to duration elongation (milder slope). Steeper slope of identificational function for shortened stimuli in comparison to slope of curve for elongated stimuli was expected because of the substitution of speech sounds with some other speech sound or sound in case of further shortenings, while the elongation does not lead to changes on the phonemic plan. If the minimal typical duration of pronounced speech sound is shorter, we could expect that lesser variations

of duration around that point lead to bigger perceptive changes, namely, faster transition to another speech sound. However, from Table 3 it can be seen that the slope of identificational curve is biggest for speech sound /c/, even though its minimal duration is longer than duration for speech sound /č/ (Table 2). Listed example indicates that multiple factors have an influence on the identificational curves slope.

**Table 3.** Linear approximation of descending and ascending segments of speech sounds

| Speech sound | Area A approximation | Area B approximation |
|---|---|---|
| /š/ | y = ***-27.525 dur*** + 180.24 ($R^2$ = 0.9912) | y = ***20 dur*** – 204 ($R^2$ = 0.9059) |
| /ž/ | y = ***-23.586 dur*** + 132.3 ($R^2$ = 0.998) | y = ***20.289 dur*** - 204.93 ($R^2$ = 0.9595) |
| /c/ | y = ***-50.536 dur*** + 241.07 ($R^2$ = 0.997) | y = ***20.979 dur*** - 224.09 ($R^2$ = 0.9045) |
| /č/ | y = ***-46.512 dur*** + 197.52 ($R^2$ = 0.9967) | y = ***30.783 dur*** - 357.13 ($R^2$ = 0.9671) |
| /dž/ | y = ***-27.854 dur*** + 132.87 ($R^2$ = 0.8778) | y = ***10.41 dur*** - 92.999 ($R^2$ = 0.8841) |

The boundaries of variation field of pronounced speech sound duration represent the product of perceptive analysis of duration of given speech sound in a language. If we assume it is a statistical process, then, the number of listenings of one speech sound should have an influence on the preciseness in determining boundaries of variation field. In that case, frequency of appearing of pronounced speech sounds in mother tongue should be one of the factors which influence on defining acoustic boundaries of variation field. Frequency of appearing of observed speech sounds (Kostić, 1971) is given in Table 4.

**Table 4.** Frequency of appearing of observed pronounced speech sounds in Serbian language.

| Pronounced speech sound | Frequency of appearing in Serbian language |
|---|---|
| /č/ | 1.708% |
| /c/ | 1.528% |
| /š/ | 1.464% |
| /ž/ | 0.676% |
| /dž/ | 0.120% |

To determine the influence of individual parameters on slopes of identificational curves, the correlational analysis of descending and ascending slopes of identificational curves with following parameters of pronounced speech sounds was conducted: range of duration, minimal duration, maximal duration, average value of duration, frequency of appearing in Serbian language (Table 5).

**Table 5.** Correlation of slopes of identificational functions with parameters of duration and the frequency of appearing of pronounced speech sounds in Serbian language

Correlations

| | | Duration range | Min. duration | Max. duration | Average duration | Slope - | Slope + | Freq. of appear. |
|---|---|---|---|---|---|---|---|---|
| Slope - | Pearson Corr. | .071 | .411 | .452 | .434 | 1 | -.572 | -.682 |
| | Sig. (1-tailed) | .455 | .246 | .222 | .233 | | .157 | .102 |
| Slope + | Pearson Corr. | -.421 | -.140 | -.252 | -.196 | -.572 | 1 | .834* |
| | Sig. (1-tailed) | .240 | .411 | .341 | .376 | .157 | | .040 |

* Correlation is significant at the 0.05 level (1-tailed).

Correlation analysis showed presence of statistically significant positive correlation (alpha = 0.05) of area B slope and frequency of appearing of pronounced speech sounds (R = 0.840). Namely, with

rising frequency of appearing of speech sound in language, slope of identificational curve is bigger. When we observe area A slope, even though there is no statistically significant correlation, Pearson's correlation coefficient is also the biggest for the parameter of frequency of appearing of speech sounds in Serbian language (R = -.682). This coefficient is negative, so we could conclude that, in case of area A, slope of identificational curves is milder when the frequency of appearing of pronounced speech sounds is bigger. However, it is not the case, because the slopes of area A are negative numbers (Table 3). In both cases, the influence of frequency of appearing of pronounced speech sounds has the same tendency: with its arising, the slope of identificational curve rises too.

If we look at the influence of voicing on slope of identificational curves, from the data shown in Table 3 comes out finding that the slope of identificational curves in area A of voicing speech sounds is slightly milder then slope of its voiceless pair (/š/ - /ž/; /č/ - /dž/). However, this could be the indicator for further research, but not for the general conclusion about influence of voicing on the identificational curves' sharpness.

## 5 Conclusion

Perception of phonemes is that much automatized, that, in everyday speech, we are not aware of the processes occurring during the act of speech. Pronounced speech sound we perceive as a phoneme of given language, and we do not pay attention to the quality of its realization. Acoustic correlates which allow perception of pronounced speech sounds as phonemes, we notice only in certain situations. Bringing the meritorious decisions about speech sound quality, characterization of atypical features and the disorders diagnostics are based on complex perceptive process in which the expert „relies" on absolute and relative values of acoustic features relevant for the perception of phonemes. To the global impression on the degree of deviation (evaluation) of speech sound can contribute the presence of only one atypical feature, but also a summation on multiple features from perceptive domain, by which there is no correlation between the degree of deviation and number of features. Identificational functions of the perception of duration showed presence of categorical perception: perceptive mechanism is more sensitive to shortening than to elongation of speech sound duration. It has been showed that on the characteristics of identificational function of perception of duration influences the frequency of appearing of speech sounds in language. Even though the slopes of identificational functions in area of shortened duration are milder for voicing than voiceless pairs of pronounced speech sounds, these starting results could be interpreted as a trend and guideway for further research on larger number of speech sounds.

Obtained results do not indicate on the existence of consistent patterns of pronounced speech sounds duration influence on identificational curves of duration perception.

Further research is needed for more detailed examination of observed appearance, which would comprehend larger number of speech sounds. Based on analysis so far, we consider that, in the creation of following research, stimuli should be distributed non linearly, which would provide better time resolution in transitional areas.

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## Identifikacione funkcije verovatnoće perceptivnog prepoznavanja trajanja afrikata i frikativa

Akustičko obeležje trajanja je inherentna karakteristika fonetskog sistema. Trajanje svakog glasa ima svoje varijaciono polje unutar koga se njegove realizacije percipiraju kao tipične. Rezultati vezana za analizu trajanja u domenu patologije glasova, na relaciji tipično/atipično obeležje, nisu nađena u literaturi za srpski jezik.

Ciljevi ovog istraživanja bili su određivanje granica tipično/atipično trajanje na osnovu identifikacionih funkcija verovatnoće perceptivnog prepoznavanja trajanja i njihovo poređenje između zvučnih i bezvučnih glasova u grupi afrikata i frikativa.

Na osnovu analize izabranih glasova: /c/, /č/, /dž/, /š/, /ž/ definisane su granice tipičnog i atipičnog trajanja koje su poslužile za sintezu stimulusa korišćenih u perceptivnim eksperimentima. Po zadatoj

proceduri formirano je 6300 stimulusa koji su prezentovani slušaocima od kojih je zahtevano da identifikuju i markiraju stimulus tipičanog i atipičanog (produženog/skraćenog) trajanja.
Analizom rezultata dobijene su identifikacione funkcije verovatnoće perceptivnog prepoznavanja tipičnog/atipičnog trajanja za ispitivane glasove, na inicijalnim pozicijama u rečima, pomoću kojih su određene granice tipičnog/atipičnog trajanja navedenih glasova.
Rezultati su pokazali postojanje kategorijalne percepcije kroz pojavu veće osetljivosti perceptivnog mehanizma na smanjenje trajanja (veći nagib identifikacione funkcije verovatnoće perceptivnog prepoznavanja tipičnog/atipičnog trajanja) nego na produženje trajanja glasa čime je pokazano da obeležje trajanja može biti dobar indikator odstupanja u artikulaciji. Pored toga pokazalo se da postoje razlike u funkcijama verovatnoće perceptivnog prepoznavanja trajanja zvučnih i bezvučnih glasova, čije objašnjenje zahteva dodatna istraživanja. Osim značaja u logopedskoj teoriji i praksi ovi rezultati mogu biti korisni u govornim tehnologijama.
*Ključne reči:* percepcija, tipičan/atipičan izgovor, akustička obeležja, trajanje izgovornih glasova, varijaciono polje

# Modeling of the KSAFA speech therapy device transfer function using gamma-tone filter bank

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**Abstract.** A multi-channel frequency modifier is often used as a technical means in speech therapy. This device uses parallel structure of second order IIR filters defined by central frequencies, gains and Q-factors. The drawback of this solution is the influence of each filter on neighboring frequency bands which prevents easy design of the desired frequency transfer function. Inspired by the human auditory system, the solution proposed in this work uses parallel structure of equivalent rectangular bandwidth (ERB) gammatone filter bank with the same parameters tuning as in the previous solution. The quality of the proposed solution was experimentally verified.

## 1 Introduction

During speech therapy treatment, the patient with speech impediments needs to be auditory stimulated by speech stimuli with enhanced articulation features in order to improve development of his speech and language skills (Šarić & Subotić, 2016; Bilibajkić, Šarić, Jovičić, Punišić, & Subotić, 2016). The device, known as "Kostich selective auditory filtering amplifier" (KSAFA) is usually used for this purpose. At the time the KSAFA system was created, analog signal processing technology was used. The first digital version of the KSAFA device (Šarić et al., 2012), improves speech quality by using of the phase correctors which reduce the ripple in frequency response function. In the solution proposed in (Šarić et al., 2014), design of the transfer function has been improved by using the iterative procedure for correction of the channel filter gains in order to reduce the errors that occurred as a result of the interaction among adjacent channel filters. Further improvement of the system was howling suppression proposed in (Šarić et al., 2015).

The problems related with hands-free mode and automatic switching of the active speaker was considered in (Šarić & Subotić, 2016; Šarić et al., 2017) and (Bilibajkić, Šarić, & Punišić, 2017) by using a microphone array (Šarić & Jovičić, 2004; Šarić, Simić, & Jovičić, 2011).

KSAFA device uses Multi Band Filtering Amplifier (MBFA) which consists of seven band-pass filters that process input speech signal in parallel. Frequency characteristic of MBFA is determined by the central frequencies of channel filters, their Q-factors and gains. Although such a filter structure successfully simulates the formant structure of the vocal tract during speech production, there are some limitations in desirable frequency response design. Firstly, the slope of the used band-pass filters is not steep enough to prevent influence on neighboring frequency bands. Secondly, high Q-factors increase the ripple which degrades clearness of the speech. In order to solve these problems, a solution based on the gammatone filter bank is proposed in this paper. The use of the gammatone filter bank is inspired by Patterson's auditory model where the gammatone filter bank performs time-frequency analysis of the speech signal (Patterson & Holdsworth, 1996; Patterson, Allerhand, & Giguere, 1995; Slaney & Lyon, 1993). Design of the desired transfer function is realized by applying of an appropriate channel gains.

In order to ensure compatibility with the analog and digital band-pass filter KSAFA design, its parameters are transformed into gammatone filter bank gains by the method proposed in the paper.

## 2 Method

### 2.1 Speech therapy scenario

Speech therapy treatment is carried out individually with each of the patients according to the scenario shown in Fig. 1.

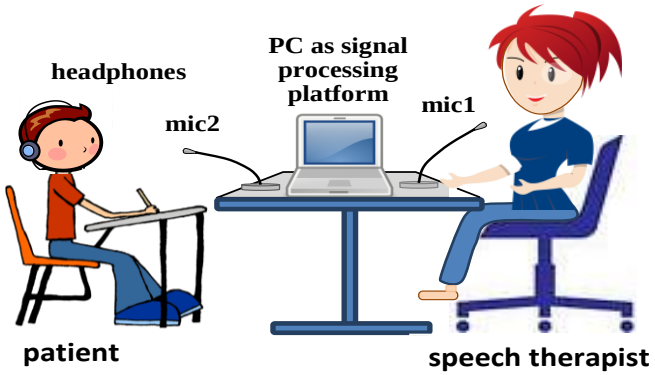


**Fig. 1** Scenario of the speech therapy treatment.

Speech stimuli are processed by KSAFA and played on patient's headphones. Fig. 2 shows block diagram of the speech processing. The main processing blocks are input amplifier (IA), multi-band filtering amplifiers MBFA for left and right ears, and output amplifiers also for left and right ear (OAL and OAR). Adjustment of KSAFA parameters in the analog version of the device is performed by a user interface that consists of a switches and a potentiometer. In the digital version of the device, the user interface is a set of graphic interactive controls that allows manual tuning of KSAFA parameters or selection of the predefined KSAFA parameters.

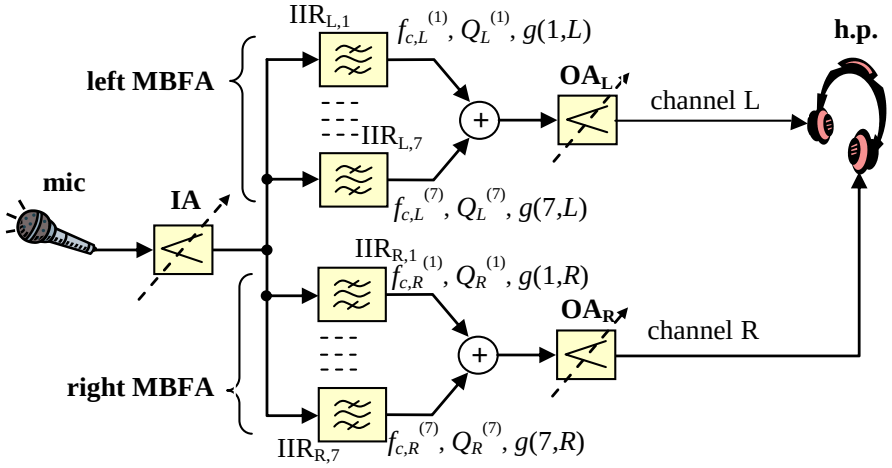


**Fig. 2.** Block diagram of the speech processing by band-pass filter KSAFA design.

### 2.2 KSAFA device based on band-pass filters

Each of the MBFA has seven IIR band pass filters, defined by three parameters: (*i*) central frequency $f_c(k,l)$, (*ii*) Q-factor $Q(k,l)$, and gain $g(k,l)$, where $k$, $k$=1,...,7 denotes index of the band pass filter, while $l$, $l \in \{L,R\}$ denotes left or right stereo channel, Fig. 2. Low slope of the channel filters cause the error between desired gain and MBFA gain at referent frequencies, $f_c(k,l)$, $k$=1,...,7. This can be partly reduced by method proposed in (Šarić et al., 2014).

In the case when the target gains of the adjacent channels are considerable different, Q-factors have to be increased. High Q-factors increase ripple in frequency characteristics which reduces clarity of speech. Hence, an acceptable compromise between high slope and small ripple cannot be obtained with the described filter structure. In order to solve this problem a new solution based on a gammatone filter bank is presented in the next section.

### 2.3 A solution based on gammatone filter bank

Gammatone filter bank is usually used in auditory modelling for time-frequency analysis of the sound signal. A lot of auditory models were developed in order to describe process of sound perception in human auditory system (Araújo, Magalhaes, Souza, Yehia, & Loureiro, 2005). The best known models are Flanagan's Model (Flanagan, 1962; Flanagan, 1972), Lyon's Model (Slaney & Lyon, 1993; Lyon & Mead, 1988), Meddis' Inner Hair Cell model (Meddis, 1988) and Auditory Image Model (AIM) (Patterson & Holdsworth, 1996; Patterson et al., 1995). The last AIM model was developed by Roy Patterson et al., 1995. It includes several modules comprising the stages of processing by the peripheral auditory system.

Inspired by the Patterson's AIM, the solution of the MBFA unit based on gammatone filter bank is proposed in this paper. The benefit of this approach is high degree of freedom in filter design provided by a lot of narrow-band-pass filters. Block diagram of the audio signal processing based on the gammatone filter bank is shown in Fig. 3. Gammatone banks of the left and right stereo channel filters are marked with GFB-left and GFB-right. Number of the filter bank channels is chosen to achieve the desired resolution in the frequency domain. In order to avoid the ripple and to provide "almost" ideal flat transmission for unit gains, a special technique of phase matching of impulse responses was used (Hohmann, 2002).

### 2.4 GFB gains design

In order to exploit the longtime experience with KSAFA device we have to transform parameters of KSAFA device based on band-pass filters described in 2.2 into gammatone filter bank gains.

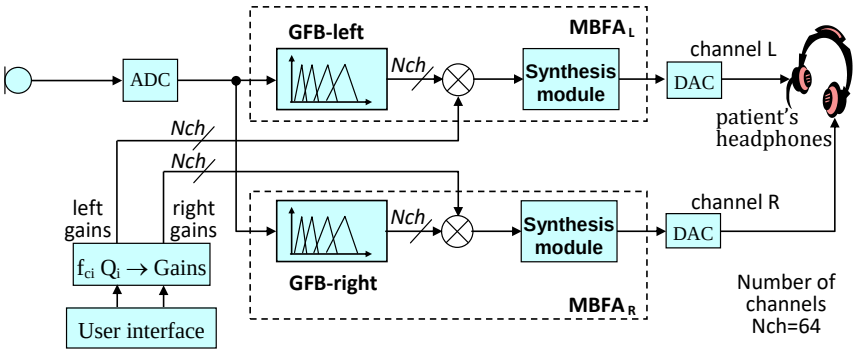


**Fig. 3.** Solution based on gammatone filter bank

First we have to calculate 3 dB bandwidths of the KSAFA device based on band-pass filters by

$$B_i = \frac{fc_i}{Q_i}, \quad i = 1,...,7, \tag{1}$$

where $fc_i$, $Q_i$ and $B_i$ are central frequency, Q-factor and bandwidth of *i*th channel filter *i*=1,...,7. Target transfer function $G(f)$ is calculated in 4 steps:

Step 1: Pick up all local minimums and maximums in sequence of the seven band-pass channel gains that can be identified by

$g_i$ is local maximum if $g_i > g_{i-1}$ *and* $g_i > g_{i+1}$

$g_i$ is local minimum if $g_i < g_{i-1}$ *and* $g_i < g_{i+1}$

Step 2: If $g_i$ is local minimum or local maximum, target gain pattern $G(f)$ is constant ($G(f) = g_i$), in $[(f_{Ci} - B_i),(f_{Ci} + B_i)]$

Step 3: From upper bound of the local maximum to the lower bound of the next local minimum, target gain pattern $G(f)$ consists of broken line segments that connects all gains of the central frequencies between the local maximum and the minimum.

Step 4: From upper bound of the local minimum to the lower bound of the next local maximum, target gain pattern $G(f)$ is designed in the same manner as the gain pattern between local maximum and minimum, as it is described in step 3.

Gammatone gains $gt(f_j)$ are obtained from target gain pattern $G(f)$ by

$$gt(f_j) = G(f_j), \qquad j = 1,\ldots,Nch \quad , \qquad (2)$$

where $f_j$ , $j=1,..Nch$, are discrete central frequencies of gammatone filter bank channels.

Finally, the frequency range from lowest audio frequency (i.e. 100 Hz) to the first central frequency $f_{C1}$ is fixed on the gain $g_1$, while the range form last central frequency to the highest audio frequency (i.e. 8000 Hz) is set on gain $g_7$. Fig. 4 shows an example of the target gain design using sequence of central frequency gains and corresponding bandwidths.

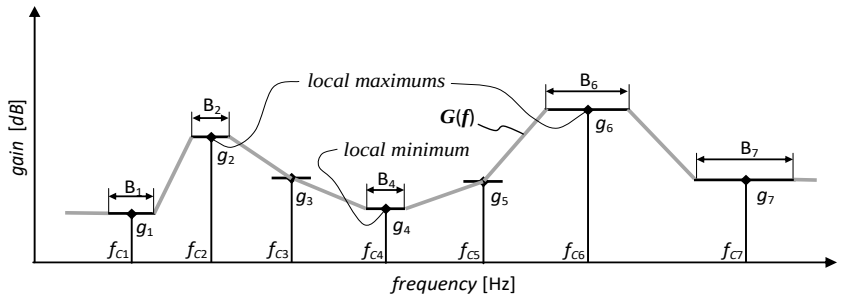


**Fig. 4.** An example of the target gain function design, $G(f)$, from sequence of central channel frequencies gains $g_i$ and channel bandwidths $B_i$, $i$=1,…,7, where $B_i = Q_i f_{Ci}$.

## 3 Results

Tests of the proposed method were carried out on gammatone filter bank with 64 channels. Sampling frequency was 48 kHz. The proposed method was compared with the band-pass filter KSAFA design. Central frequencies and Q-factors shown in table T1. Comparison of the algorithms was performed on the typical filters types with channel gains specified in table T2. The gains of gammatone filter bank were calculated by the procedure defined in section 2.4.

**Table 1**. Fixed KSAFA parameters during experimental testing

| channel | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| Central frequencies [Hz] | 145 | 235 | 450 | 780 | 1300 | 2400 | 4500 |
| Q-factors | 3 | 3 | 3 | 3 | 5 | 5 | 5 |

**Table 2**. Gains for the typical filters types

| channel | 1 | 2 | 3 | 4 | 5 | 6 | 7 |
|---|---|---|---|---|---|---|---|
| High-pass filter gain [dB] | 0 | 0 | 0 | 0 | 0 | 0 | 20 |
| Band pass filter gain [dB] | 0 | 0 | 0 | 20 | 20 | 0 | 0 |
| Low-pass filter gain [dB] | 20 | 20 | 20 | 20 | 0 | 0 | 0 |
| Sloping high end boost filter gain [dB] | 0 | 4 | 8 | 12 | 16 | 20 | 24 |

Fig. 5a, 6a, 7a, and 8a respectively show frequency responses of HP, LP, BP and Sloping high end boost filters optimized for the original KSAFA. Target gains are displayed by red diamonds.

Fig. 5b, 6b, 7b and 8b, respectively show frequency responses of the corresponding filter types obtained by the proposed method based on the gammatone filter bank. Target frequency responses obtained by steps 1-4, described in section 2.4 are displayed in red, while the final frequency responses obtained by gammatone filter bank are displayed in blue.

## 4. Discussions

Although the procedure described in section 2.2, (Šarić et al., 2014), significantly improves frequency response in comparison with analog KSAFA device, experimental tests shows a few drawbacks of this method. The first is the error between desired and obtained gains at the central channel frequencies shown in Fig. 5a, 6a and 8a. The reason for this is that the applied IIR filters do not have a sufficient steep slope to prevent their impact on neighboring frequency bands. The slope in the vicinity of the central frequency can be increased by increasing the Q factors, but it increases the ripple in the frequency characteristic. This adversely affects the clarity of the speech signal. In the example shown in Fig. 7a, where Q-factors are 3, the ripple is up to 8 dB which causes noticeable speech distortion. A further increase of the Q-factors affects the further increase of the ripple.

On the other side, the frequency response obtained by the proposed gammatone filter bank method ensures a high degree of accuracy of the realized transfer function in all of the tested cases. Fig. 5b, 6b, 7b and 8b show a high compliance of the desired response, shown in blue, and the obtained response shown in the red. Ripple of the response is rather low, under 0.5 dB in the worst case.

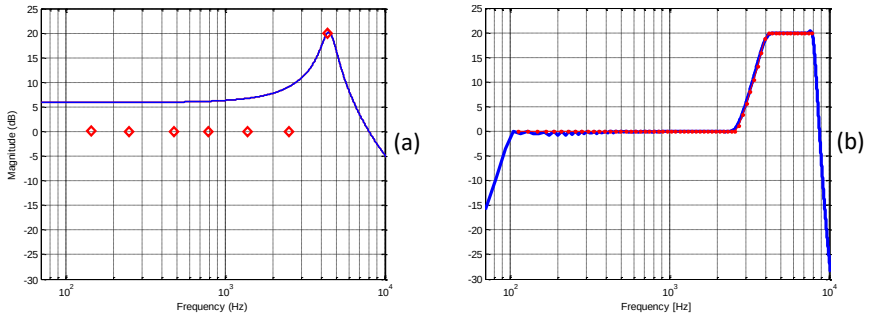


**Fig. 5**. Comparison of the HP filter design: (a) band-pass filter KSAFA design, (b) gammatone based KSAFA design (red-desired response, blue-obtained response).

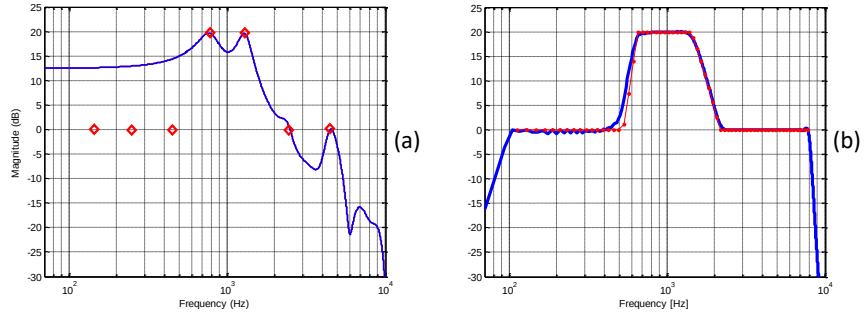


**Fig. 6**. Comparison of the BP filter design: (a) band-pass filter KSAFA design, (b) gammatone based KSAFA design (red-desired response, blue-obtained response).

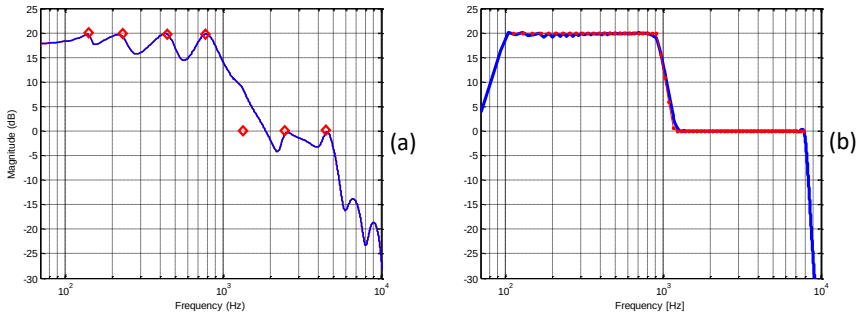


**Fig. 7**. Comparison of the LP filter design: (a) band-pass filter KSAFA (b) gammatone based KSAFA design (red-desired response, blue-obtained response).

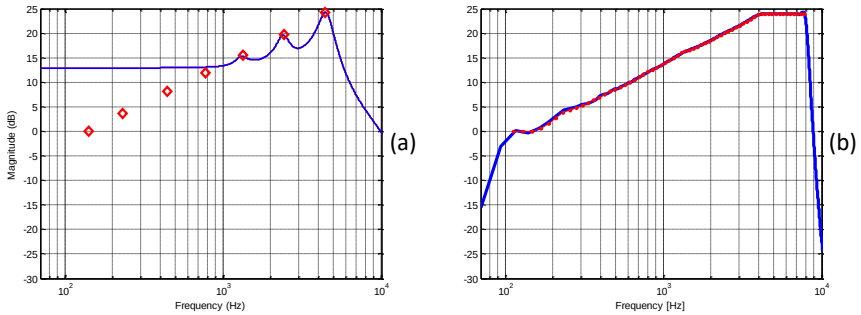


**Fig. 8**. Comparison of the sloping high end boost filter design: (a) band-pass filter KSAFA, (b) gammatone based KSAFA design (red-desired response, blue-obtained response).

The reason for *such a good* performance of the proposed method is a steep slope of single filters of the gammatone filter bank that prevents its influence on the adjacent frequency bands. In addition, the proposed solution provides higher degree of freedom in design of the transfer function with the accuracy that can be controlled by the number of channels used in gammatone filter bank.

## 5. Conclusions

The new method of speech processing aimed for speech therapy by KSAFA system is proposed in this paper. Its performances exceed the band-pass filter KSAFA design in following:

- The proposed method provides high precision in design of the frequency transfer function without any gain error on central frequencies.
- Large number of channel filters and their high slope provides high degree of freedom in transfer function design.
- Phase alignment method used in synthesis module provides small ripple of the frequency response, and hence high quality of the processed speech signal.

A procedure for recalculation of the KSAFA parameter into the channel gains of the gammatone filter bank proposed in the paper provides functional compatibility with analog and digital band-pass filter KSAFA design and makes the long-time therapy experience available for the usage with new gammatone filter bank method.

The usage of the gammatone filter bank, which is part of human auditory model, provides more natural speech processing and allows the usage some of the psychoacoustic effects in further upgrades of the system.

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## Modeliranje prenosne funkcije KSAFA logopedskog auditivnog stimulatora primenom gamaton banke filtara


Za potrebe stimulisanja razvoja govorno-jezičkih sposobnosti kod dece, u logopedskoj praksi se koristi višekanalni frekvencijski modifikator govora (KSAFA) baziran na paralelnoj strukturi sedam IIR filtara propusnika opsega. Podešavanjem pojačanja, centralnih učestanosti i Q-faktora kanalnih filtara ostvaruje se željena frekvencijska karakteristika uređaja. Nedostatak ovog rešenja je uticaj kanalnih filtara na susedne frekvencijske opsege što otežava podešavanje podešavanje uređaja. U ovom radu se predlaže rešenje na bazi paralelne strukture gamaton banke filtara. Predloženim postupkom transformacije polaznih parametara u pojačanja gamaton banke filtara ostvaruje se funkcionalna kompatibilnost sa izvornim KSAFA uređajem. Kvalitet predloženog rešenja je ocenjen eksperimentalno.

# Problems of creating stimulus sentences for hearing test with QuickSIN test

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**Abstract.** QuickSIN hearing test is based upon one's ability to perceive speech despite the presence of ambient noise. Regardless of the method's simplicity, the main drawback is it's lack of universality i.e., the need for new stimulus sentences for different languages. When test sentences are formed, special attention must be paid to the keyword selection, phonetical balance and the semantical contents. Noise is in the form of babbling which is created as a sum of four persons speaking: three women and one man. The main concern arises due to the different energy flow of the test sentence (a standard declarative sentence) and noise. These differences imply that particular keywords are masked with various levels of noise. In this paper, we consider the problems arising during the synthesis of the QuickSIN test sentences in Serbian language, intended for hearing check in adults. Special attention is directed towards correcting the noise energy flow in order to obtain the best statistical uniformity in the keyword perception.

## 1 Introduction

Speech is the most important form of communication between humans. During the speech communication there must be at least one speaker and one listener. On one side we have speech synthesis (speech apparatus) and on the other, speech perception (hearing). Both of these processes exist on several levels: linguistic, physiological and acoustical (Denes & Pinson, 1963.), Fig. 1. All together, levels of speech synthesis and perception are called speech chain. Primarily, speech is used to transmit information, but also it depicts the psycho-physiological state of the speaker. In order to achieve understandable speech communication, all parts of the speech chain must be undamaged. One of these elements is hearing. Hearing impairment is very common and great deal of attention is dedicated towards recognizing it.

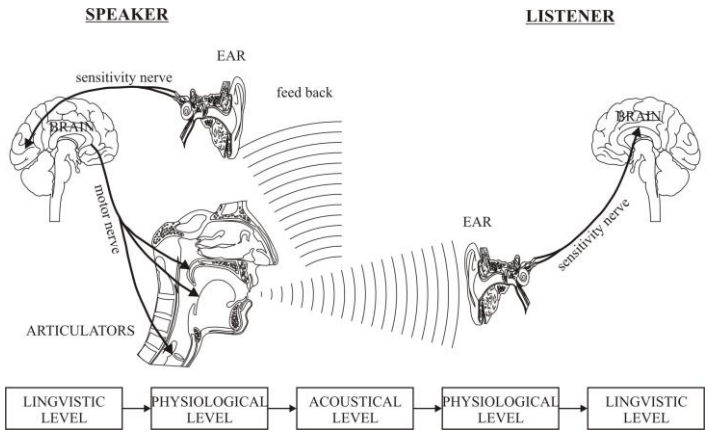


**Fig. 1**. Speech chain.

Hearing problems are especially pronounced in the presence of ambient noise. The levels of noise can vary. In some cases, speech communication isn't affected by ambient noise affects, but in some cases noise can completely disenable it. The presence of ambient noise has lead to the fact that hearing impairment checks are also presented in dependence of the noise level. This means that the speech perception is assessed in scenarios including various noise types and levels. The most interesting type of ambient noise is in fact the babble noise which implies simultaneous speaking of several people. The most efficient way to mask speech is by using other speech due to the similarity of the spectral characteristics.

## 2 Hearing check

Tonal audiometry is a standard clinical method for hearing checking. Pure sine tones in the frequency range from 125 to 8000 Hz are used as stimuli. Absolute hearing threshold is measured for different frequencies. The tonal audiometry procedure is as follows: level of stochastically chosen sine tone is gradually increased until the examinee hears the sound. This process is repeated for different frequencies. Due to the measurement of the absolute hearing threshold, the entire speech chain must be calibrated, and the hearing check must be conducted in acoustically treated cabins. The hearing threshold shift is compared against the standard human ear hearing curve (Kurtović, 1977), thus assessing the level of hearing impairment.

It was shown that tonal audiometry is not the best indicator of one's ability to perceive speech in noisy an environment (Etymotic Research, 2001). Besides, tonal audiometry is not even intended to address speech recognition. Instead it is used to measure the shift of the hearing threshold (depending on the frequency) with respect to the standard hearing curve. Methods designed to estimate speech understandability are somewhat different and differ regarding the chosen stimuli. One of the most well-known methods for checking the quality of communication channels is logatome intelligibility. Logatomes are two-syllable words with no meaning. Hence, the influence of semantics, language rules, and other factors bearing speech information redundancy, is avoided. Logatomes are formed in such a way so all the letters in a given language are included in the exact proportion deduced from everyday speaking. Sometimes, instead of logatomes, single words are used as stimuli (e.g. numbers).

Lately, a number of new methods emerged using normal speech as stimulus. These methods insist on estimating the hearing impairment through a standard speech communication in the presence of ambient noise (Nillson, Soli & Sullivan, 1994.). These are the so-called HINT methods (Hearing In Noise Test). Hearing loss is assessed by comparing the listening results obtained from the hearing-impaired examinee to those obtained from an examinee with no hearing impairment.

Compared to the tonal audiometry, the advantage of the HINT methods is in using normal speech communication adjusted to realistic life situations, which implies the presence of ambient noise. Standard multimedia equipment is used in these tests: microphones, headphones, speakers, PC or other device capable of reproducing audio files. Hearing check can be done at home, instead of using expensive calibrated audio equipment and acoustically treated rooms. HINT methods can be implemented as self- and online-tests. Regardless of these advantages, we must emphasize that tonal audiometry is universal and standardized hearing-impairment method which doesn't depend on the language, since pure sine tones are used as stimuli instead of speech. Tonal audiometry is used to estimate absolute hearing threshold, i.e. hearing threshold diagram depending on the frequency. The most distinct drawback of the HINT method is it's language dependence. Therefore, HINT methods don't have international universality and stimulus sentences must be created for each language separately. In addition, HINT methods are used only for preliminary assessment of the hearing impairment (screening).

There is a variety of HINT methods depending on the number of test sentences, type of noise, number of keywords, definition of degree of hearing impairment, etc. One of the simplest among HINT methods is the QuickSIN test. Stimulus sentences are reproduced with different ambient noise levels after which the correctly perceived keywords are counted (*TC*). Based on (1) and Table I, the degree of hearing impairment is defined.

**Table 1**. The degree of hearing impairment depending on the value of $SNR_{Loss}$.

| $SNR_{Loss}$ | Degree of hearing loss |
|---|---|
| 0÷3 dB | Normal/near normal. |
| 3÷7 dB | Mild hearing loss. |
| 7÷15 dB | Moderate hearing loss. |
| > 15 dB | Severe hearing loss. |

$$SNR_{Loss} = 25.5 - TC. \quad (1)$$

Once the stimulus sentences are created for the QuickSIN test, the testing procedure itself becomes very simple and quick. The main concern arises when creating the stimulus sentences.

## 3 QuickSIN Test

As stated earlier, QuickSIN test is one of the simplest methods for checking the hearing impairment. A couple of terms regarding this method should be defined: test sentence, noise, stimulus sentence and stimulus sentence list. Test sentence is a standard statement pronounced by a female speaker. Each test sentence comprises five to seven words, five of which are declared as keywords, i.e. the words relevant when the degree of hearing loss is calculated. In QuickSIN test perceiving the entire sentence is not important but the perception of single keywords.

The babble noise is obtained after mixing the speech from four speakers: three female and one male. All recordings are equalized regarding their sound level. Most often, professional radio or TV speakers are employed reading news, weather forecast, etc.

Stimulus sentence is obtained after mixing recordings of the noise and test sentence using an exactly defined speech-to-noise ratio (*SNR*). Test sentences without the noise are recorded first, after which they are masked, i.e. certain level of noise is added.

Stimulus sentence list is a fundamental unit for the QuickSIN hearing test, consisting of six sentences corrupted with various levels of noise. First sentence contains the lowest level of noise which increases with every next sentence (increase step is 5 dB). In other words, noise level is lowest in the first sentence and highest in the last sentence.

As with all the other HINT methods, in QuickSIN test hearing loss is estimated by means of comparison, i.e. after comparing keyword perception to that obtained from examinees with no hearing impairment. Noise level in stimulus sentences is adjusted in such a way so the examinees with no hearing loss perceive 50% of the keywords correctly. Next, examinees with hearing impairment listen to those stimulus sentences and perceive less keywords. Based on that percentage difference (eq. (1) and Table I) the degree of hearing loss is calculated. Therefore, the basic parameter in QuickSIN test to be determined is $SNR_{50\%}$ which represents the speech-to-noise ratio corresponding to the ability of the well-hearing examinees to perceive 50% of the keywords correctly. Another issue is related to the result repeatability and also the statistical validity of the measrement. Namely, test/stimulus sentences need to be created in such a way so the keyword perception depends solely upon the *SNR*.

Fig. 2. depicts the keyword perception percentage depending on *SNR*.

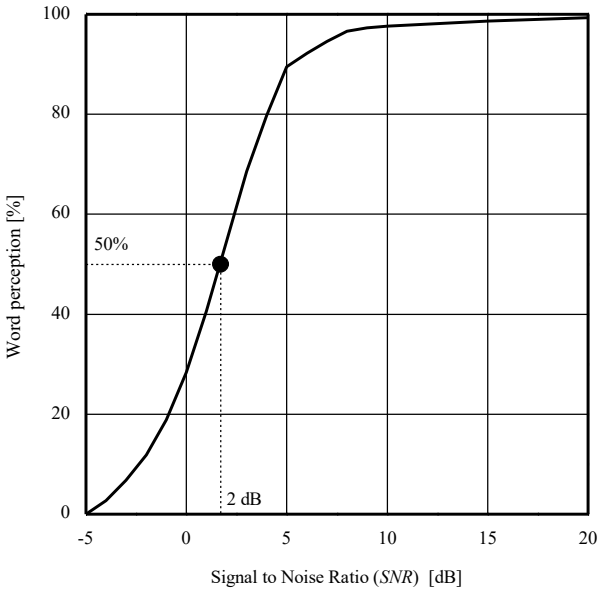


**Fig. 2**. Keyword percentage depending on speech-to-noise ratio.

Fig. 1. is related to English language and it can be seen that $SNR_{50\%}$ is equal to +2 dB, i.e. that well-hearing examinee will correctly perceive 50% of the keywords if *SNR* is set to +2 dB. For other languages the value of $SNR_{50\%}$ may differ and must be determined using a series of tests with well-hearing subjects. For example, in Serbian language, the $SNR_{50\%}$ value equals -2.85 dB (Vojnović & Subotić, 2012.), (Vojnović & Subotić, 2011.). Depending on the value of $SNR_{50\%}$ speech-to-noise level is defined for each stimulus sentence. With the value of $SNR_{50\%}$ equal to -2.85 dB, speech-to-noise levels are: 20.15, 15.15, 10.15, 5.15, 0.15, and -4.85 dB for first, second, third, forth, fifth and sixth stimulus sentence, respectively.

## 4 Creating Stumulus Sentences in QuickSIN Test

Main problems which arise during the synthesis of stimulus sentences in QuickSIN test are:

- choice of keywords,
- constructing of test sentences,
- generating noise,
- creating stimulus sentences based on recorded test sentences and noise,
- creating stimulus sentence list and
- defining the $SNR_{50\%}$ value for Serbian language.

When choosing keywords, special care must be taken in order to use frequent words, i.e. words often used in every-day speech. Long, one-syllable, foreign words and personal names should be avoided. It is desirable to phonetically balance the keywords, which implies that appearing frequency of certain groups of sounds (plosives, fricatives, affricatives and vowels) are similar as in normal speech.

Constructing test sentences can be somewhat problematic since some part of the sentence can be predictable bearing in mind the previously perceived part. This problem is very hard to overcome and it is often solved by starting with three to four times more test sentences, and in the end only the most suitable are chosen.

Noise is created after combining speech from four speakers: three female and one male. Speech from each speaker should be emotionally neutral and without any background noise. Level of each speaker is equalized assuring that neither of the speakers dominates n the mix. In addition, it is desirable to delete all pauses in their speech in order to achieve as much homogeneity in the obtained babbling noise.

Creating stimulus sentences seems like a trivial challenge since it consists of superimposing test sentence and noise. However, due to the difference in energy envelopes of a statement (test sentence) and noise, a scenario with varying keyword speech-to-noise ratio, is obtained.

The value of $SNR_{50\%}$ must be determined for every language separately. Therefore, a modified test is created, with all stimulus sentences having the same noise level adjusted in such a way so the word perception percentage is equal to 50%. The value of $SNR_{50\%}$ can be determined through a series of trial-and-error tests. It is implied that all the participating examinees have undamaged hearing. In the end, the estimated value of $SNR_{50\%}$ is verified on a group of 10-20 subjects.

## 5 Disscusion

The main problem while creating stimulus sentences in QuickSIN test, lies in the uneven energy envelops of a test sentence and noise. Problems arising while constructing test sentences, related to it's semantics and redundancy, are very difficult to overcome in advance. The only reasonable solution is to start with three to four times more test sentences and then, after a test defining the $SNR_{50\%}$ value, to choose those stimulus sentences most appropriate for the QuiskSIN test.

An attempt to solve the problem regarding uneven energy envelopes, involved the noise level continuously adjusting according to the level of the test sentence. This attempt turned out to be inadequate since the fluctuation of the noise proved to be too disturbing for the listener. Another attempt included changing the noise level in a discrete manner in order to obtain the same speech-to-

noise level for each keyword. This solution also failed to yield satisfying results.

Detailed analysis of the testing results showed that, besides the level of noise being relevant to the keyword perception, the whole problem must be addressed in the frequency domain.

## 6 Conclussion

Speech communication in noisy environments imply masking speech with noise. An important parameter in the masking process is in fact the noise level. When QuickSIN test is considered, this parameter is crucial when creating stimulus sentences, but it is only analyzed from a time-energy aspect. Namely, the criterion for the keyword perception is based on the speech-to-noise ratio without considering the spectral properties of speech and noise. Speech masking depends on the level of the masking signal, but also on it's spectral characteristics. It is well known that low-frequency noise masks high-frequency speech components very efficiently (Kalafata & Waye, 2017). Bearing this in mind, when creating stimulus sentences and defining the noise level, spectral contents of the two signals to be mixed, should also be taken into account.

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## Problemi kreiranja stimulus rečenica za proveru sluha QuickSIN testom

QuickSIN metoda provere sluha se bazira na sposobnosti percepcije govora u uslovima ambijentalne buke. Bez obzira što je QuickSIN metoda jednostavna za realizaciju, nepovoljno je to što ona nema univerzalnost već se za svaki konkretan jezik moraju kreitari stumulus rečenice. Kod kreiranja test rečenica mora se voditi računa o izboru ključnih reči, o fonetskoj izbalansiranosti i semantičkom sadržaju rečenica. Ometajuća buka je tipa žamora i kreira se kao aditivna smeša govora četiri osobe: tri ženske i jedne muške. Najveći problem kod kreiranja stimulus rečenica nastaje zbog raličitog energetskog toga test rečenice (klasična izjavna rečenica) i ometajuće buke. Ove razlike u energetskim tokovima dovode do toga da su pojedine ključne reči maskirane ometajućom bukom različitim nivoom. U radu su detaljno razmatrani problemi koje se javljaju u procesu kreiranja stimulus rečenica za QuickSIN metodu na srpskom jeziku koja je predviđena za proveru sluha odraslih osoba. Posebna pažnja je posvećena problemu korekciju energetskog toka ometajuće buke kako bi se dobila što bolja statistička ujednačenost u percepciji ključnih reči.

# Active imagination in the nature – verbal implications

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**Abstract.** The authors are discussing the use of active imagination in the nature, a very important method within Jungian psychology and psychotherapy. It was performed during the three day workshop held in La Gerona national park in Spain. The focus is put on the verbal implications that emerged as a result of doing active imagination with the material found in the forest. The authors compared verbal material that was collected as speech signal recordings, before and after the mentioned method was used. The significant differences that are noticed in the behaviour of participants are being looked at from two perspectives. On the one side, a phenomenological level of analysis was made from the point of view of analytical psychology and its notions. On the other side, the results are being shown in analysis of speech features as verbal expressions before and after active imagination in the nature. Preliminary results indicate statistically important differences between the quality of speech before and after working with active imagination. The authors also found a correlation between the speech quality analysis and the phenomenological analysis of the data that was done from the perspective of analytical psychology.

## 1 Introduction

### 1.1 Active imagination

Active imagination is a method of analytical psychology and psychotherapy. If we compare it with the usual, verbal mode of communication in analysis, it is a very useful and direct way of getting in touch with the unconscious material. In Jung`s work, (active) imagination is "the mother of all the possibilities, where like all psychological opposites, the inner and outer worlds are joined together in living union" (1).

It could be performed in a variety of ways. A person could establish a dialog with the internal figure, do creative writing, make music, draw, make collages and figures from clay and other material, move and dance, etc. James Hillman tells us that imagining is important for the process of moving from the abstract, objective psychology towards the one "that encourages the animistic involvement into the world (2).

It is possible to do it in the analytical room (what is the most common way), but in the nature too. The authors already have the experience of leading the active imagination workshop outdoors. The forest ambient represents a very inspiring setting for getting in contact with the material from the unconscious psyche. *Shinrin-yoku* movement, developed in Japan during the 1980-is, describes the benefits of spending the time in the forest (3). It is considered to be the important factor in preventive health care in Japan as well as in many other countries.

The authors are seeing a great potential in establishing a connection between Jungian psychology and forest therapy (based on *shinrin-yoku*). Active imagination could enrich the forest therapy in sense of giving it the additional dimension. That could enable a person to go deeper in exploring oneself and in furthering the process of individuation.

The starting point for active imagination could be the image from the dream, a feeling, a sensation in the body or any other unstructured experience that someone is having in that moment. Through this process, psychological images could emerge. The product of active imagination usually could then be seen (or heard). "By concentrating on a mood or a picture and by paying attention to them the images begin to have a life of their own. They develop according to their own logic this creates a new situation for the individual, feeling is raised and the conscious ego is stimulated to react more immediately" (4).

### 1.2 Speech as a verbal expression

In the informational sense, the voice communication takes place through two information channels: linguistic and nonlinguistic. The linguistic channel transmits linguistic message between people. Nonlinguistic channel transmits paralinguistic information (5), which characterizes the affective state of the speaker, and extra linguistic information (6), which contains biometric characteristics of a man. In the experiment, presented in this paper, we are focused primarily on paralinguistic manifestation in speech.

Scherer and Bänziger (7) have defined several general categories of affective states:

"• Emotions (e.g., angry, sad, joyful, fearful, ashamed, proud, elated, desperate),
• Moods (e.g., cheerful, gloomy, irritable, listless, depressed, buoyant),
• Interpersonal stances (e.g., distant, cold, warm, supportive, contemptuous),
• Preferences/Attitudes (e.g., liking, loving, hating, valuing, desiring),
• Affect dispositions (e.g., nervous, anxious, reckless, morose, hostile)."

The psychological source of these affective states could be found in the communication between people. In the experiment with active imagination we are interested in the psychological reactions of participants. More precisely - whether and how are certain changes in the features of their voice and speech manifested in relative comparison before and after the experiment. It is expected that there will be mostly positive reactions like satisfaction, physical and psychological relaxation, heightened sense of belonging to the group etc.

### 1.3 The goal of the experiment

After the experiment, the authors applied the analysis of psychological effects of active imagination and a computer analysis of voice recordings. This was done in order to detect certain acoustic features, to do the statistical analysis and to connect that with the psychological observations. The hypotheses are: *(i) positive psychological reactions in participants' verbal and non-verbal reactions could be seen after active imagination and they could be registered by the phenomenological-descriptive analysis; (ii) there are statistically significant differences in the verbal signal before and after working with active imagination*. For this purpose, audio recordings of the participants' voice and speech were made at the beginning and at the end of the experiment.

The continuation of this article includes the following components: in the second section there are the organization and the procedure of conducting the experiment; in the third section, experimental results of psychological analysis and analysis of speech recordings are presented. At the end, the conclusion is given after the discussion of the experimental results.

## 2 The experiment organization

### 2.1 General description

The workshop had been held in the forest of the La Gerona national park in Spain, in the organisation of M. Amos Clifford`s Association of nature and forest therapy (8). The suitable place was found where each participant could have enough place to make his product. On the way toward the chosen spot, they were given the instruction to collect the forest material that could be used during active imagination. That included: different colored leaves, flowers, branches, grass, partly disintegrated plants, dirt, water, etc.

When arriving to the place where the whole group could settle down, participants were given the instruction for the beginning of active imagination. The starting point for the persons could have been the feeling, the mood or the bodily sensation they were having at that moment, the image from the dream they were having that night or recently. The process lasted for two hours and was performed in silence, apart from the nature sounds that were the part of the forest ambient. After the work was done and the products could be seen, Jungian analyst was talking with each participant about the psychological images that emerged in a form of an object.

### 2.2 Subjects

There were 10 participants in the experiment - between 35 and 67 years old, 7 females and 3 males. They were people that did not have psychiatric problems (by their words and evaluated by the Jungian analyst who was leading the process) and were considered to be a part of, so called, normal population.

### 2.3 Speech signal recording and pre-processing

For speech signal recording we used professional recorder model: Handy Recorder H4n, ZOOM North America. Technical characteristics of speech recordings are the following: sampling frequency 44100Hz, 16-bit, stereo, file format PCM. In the recording phase, the experimenter held a recorder in his hand in front of the subject at a distance not more than 30cm long. The subjects successively pronounced their impressions about the active imagination they have done, before and after the experiment. The individual recordings were not longer than one minute. Significant attention was paid to the conditions of recording. The recordings were collected at the same place in the nature and in very similar ambient conditions, primarily in terms of ambient noise.

All recordings were stored in the local memory of the recorder as digital files, which were later transferred to the computer for speech signals analysis. Prior to analysis of speech recordings, the preprocessing was performed. It included the audible listening of the recordings in order to check their quality; it was possible to edit the audio signals in order to eject segments from the voice signal that contained an ambient noises such as wind blows, coughing, laughs or other speech disturbances.

## 3 Results of the experiment

### 3.1 Psychological analysis of the gathered data from the Jungian point of view

The psychological analysis was performed in the form of descriptive analysis. The behaviour, verbal and non-verbal expressions before and after active imagination were observed and analysed. While talking with each person, the analyst was paying attention to the features connected with the participants' expressions of feelings, moods, bodily sensations, connectedness with others and the nature.

It was shown that there were noticed significant differences before and after the experiment among mentioned features. After the experiment, the analyst observed that among the majority of participants: they were talking more and with more lively; their bodies looked more energized and in the motion; they looked more relaxing and satisfied and were expressing more connectedness with the group and the nature around them. These features were seen as indicating the positive psychological changes in participants' verbal and non-verbal aspects.

Connected with Jungian perspective, the analyst noticed that the majority of participants after active imagination: allowed psychological images to emerge and to shape; established communication with the images and the complexes and archetypal figures they represented.

It was also registered that one person (participant number 7) was not in accordance with others, concerning the rest of the group. She was quite indifferent toward the whole workshop. These results will be touched more during the discussion.

### 3.2 Speech signal analysis

For speech signal analysis we used Praat software (9). These three features were analyzed in the recordings, before and after active imagination:

- average value of the basic voice frequency (*pitch* - F0) during the entire recording, $F0_{ave}$ [Hz],
- a spectrum of changes F0 during the entire recording, $\Delta F0 = F0_{max} - F0_{min}$ [Hz],
- speech tempo manifested through the average number of syllables (S) in a second (s) estimated during the entire recording, TEMPO [S/s].

The results are shown in the Fig. 1, 2 and 3. Fig. 1 shows the average value of the basic voice frequency $F0_{ave}$ for each participant, before and after active imagination. This value is higher after active imagination for all participants, except participants 7 and 8, what is in agreement with psychological observation mentioned in the previous section. Both participants, especially participant number 7, do not show a change in the average value as a result of an indifferent state noted toward the whole workshop. Higher value of $F0_{ave}$ indicates a positive mood of participants (10). A statistical analysis with t-test was performed for all participants before and after experiment. The result indicates that there is a statistically significant difference [$t(9) = 4.527$, $p = 0.05$].

Fig. 2 shows the dynamic of the voice height change ΔF0. Dynamic of the voice height is significantly higher after experiment for the majority of participants. Again, participant number 7 does not show any change.

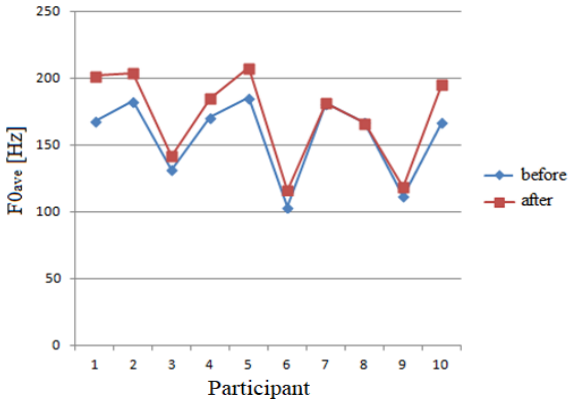


**Fig. 1**. Changes in the average value $F0_{ave}$ before and after active imagination.

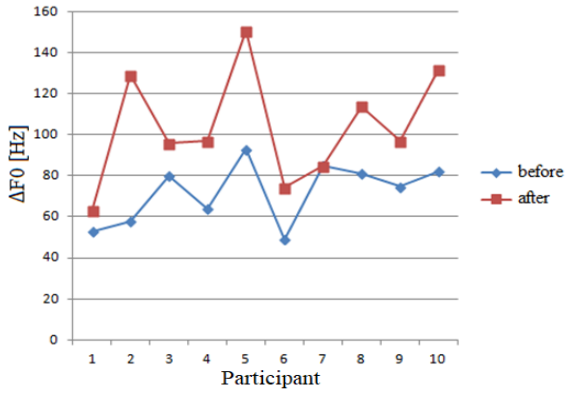


**Fig. 2.** The dynamic of the voice height change ΔF0 before and after active imagination.

A statistical analysis for all participants indicates a statistically significant difference before and after the experiment [$t(9) = 5.101$, $p = 0.05$]. Comparison of the results at Fig. 1 and 2 indicates that the feature ΔF0 shows larger changes than feature $F0_{ave}$ and because of that it is a better indicator for effectiveness of active imagination. The results for the participant number 7 for both features F0 and ΔF0 suggest that she was not ready for this experiment.

The analysis of the speech tempo indicates that it could be the indicator of the active imagination efficiency. Fig. 3 shows the results of this feature measurement. For three participants, the tempo is

minimally changed and for others it is higher. Statistical analysis for all participants shows a statistically significant difference before and after the experiment [t(9) = 3.605, p = 0.05].

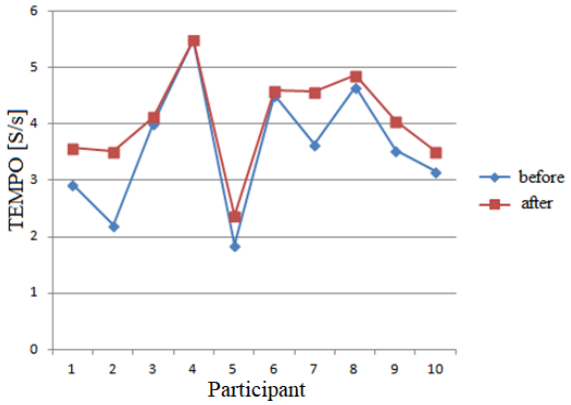


**Fig. 3.** Changes in the speech tempo (TEMPO) [S/s] before and after active imagination.

## 4 Discussion and conclusion

The results of this preliminary research showed that the positive psychological reactions could be seen after applying the method of active imagination. Those reactions were evaluated in the descriptive psychological analysis. Based on the variety of verbal and non-verbal features that were observed, the authors concluded that positive psychological reactions happened to the majority of the workshop`s participants. Besides that, the contact with valuable psychological images was established. Therefore, the experimental results confirm the first hypothesis.

Only one participant (number 7) did not have expected positive psychological reactions. Based on the information the authors were having about each of the participants before the beginning of the experiment, it was revealed that she had a traumatic experience while arriving to Spain (being robbed) that contributed to closing up for the new experiences.

The results concerning the features in the speech signal show that in the speech, as a verbal expression of the participants' impressions about the effects of active imagination, there are some features that are reliably indicating the psychological state of the participants. The analysis of the speech signal before and after active imagination was made on three acoustic features that represent the basic indicators of the participants' positive psychological state. This state is characterized by the increase in the value of the mentioned features. That is the exact speech manifestation that was expected after the application of active imagination. It was confirmed by the experimental results.

The dynamics of the voice ΔF0 turned out to be the best indicator of the participants' psychological state after the experiment. Inter-speakers variations in this features are also visible and expected, since each participant experiences in different ways the effects of active imagination. For example, in relation to others, a participant number 7 is indicative, since her results showed that the characteristics F0 and ΔF0 did not changes after active imagination. However, if these three features are observed together in the whole group, it could be seen that there is a positive shift towards higher values. That indicates a positive reaction of participants in the work with active imagination. Therefore, the experimental results confirm the second hypothesis.

Although the results are preliminary, they point to the multidimensionality of active imagination with effects on the psychological, paralinguistic and speech domains. As far as it is known to the authors, after the literature review, the experiment like this has not been done so far. The results are encouraging and they are indicating the way for further and deeper research toward a larger spectrum of speech features that could provide a more qualitative and reliable recognition of the effects connected with active imagination.

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## Aktivna imaginacija u prirodi - verbalne implikacije


Autori diskutuju upotrebu aktivne imaginacije u prirodi, veoma važne metode u jungovskoj psihologiji i psihoterapiji. Metoda je izvedena tokom trodnevne radionice održane u nacionalnom parku La Gerona u Španiji. Fokus je stavljen na verbalne implikacije kao jedan od rezultata aktivne imaginacije sa materijalom koji se nalazi u šumi. Autori su upoređivali verbalni materijal, koji je sakupljen u formi snimaka govornog signala, pre i posle pomenutog metoda. Značajne razlike koje su primećene u ponašanju participanata u eksperimentu razmatrane su iz dve perspektive. S jedne strane, analiziran je fenomenološki nivo sa stanovišta analitičke psihologije i njenih pojmova. Sa druge strane, prikazani su rezultati u analizi govornih obeležja pre i posle aktivne imaginacije. Preliminarni rezultati ukazuju na statistički značajne razlike između kvaliteta snimljenih glasova pre i posle rada sa aktivnom imaginacijom. Autori su takođe uočili korelaciju između analize kvaliteta glasa i fenomenološke analize podataka dobijenih iz perspektive analitičke psihologije.

# Developmental relationship between language and theory of mind in the children

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**Abstract**. Theory of the mind (Theory of mind-ToM, the theory of psychological states, social cognition) implies the ability to recognize different mental states: feelings, thoughts, desires, intentions, not only of their own, but also in others, which we experience different from ours. The theory of mind, like language, evolves from previous social experiences that need to be adequate and supportive early in life. In situations of inadequate language development or specific environmental conditions, this psychological developmental phenomenon does not develop in the period when it is expected to be, or not at all. The test used to investigate this phenomenon is a test of "false belief" that examines the existence of ToM, i.e. theory of psychological states in children of different ages, as well as the beginnings of its development. The aim of this pilot study is to better understand the relationship between ToM and the language ability of children with various speech communication disorders from 3 to 6 years of age. The conclusion of the research points to the specificity and reciprocity between the achieved level of speech and language and the development of the theory of the mind in children with language deficits.
*Key words*: theory of mind, speech and language development, linguistic deficit

## 1 Introduction

The theory of the mind as a term and as the appearance, immerge in literature for the first time in 1978 in the work of Premak and Woodruff (1978) entitled “Does the chimpanzee have a theory of mind?". This paper describes experiments that attempt is to examine whether the chimp predicts the behavior of a person by attaching to that person certain intentions and different mental states. They thought that a human being had the ability to understand the mental state of others, which inspire the researchers to implicitly interest in this phenomenon that has a specific developmental flow. The theory of the mind is the ability to understand the basic mental states of others, their feelings, thoughts, desires, and beliefs (Charman, Campbell, & dwards, 1998).

From a development point of view, the important question is, in which age children begin to understand these processes. The study of the theory of the mind has roots in Piaget’s research into child ego-centrism and the understanding of mental phenomena, such as thoughts and dreams, as well as in research on the development of metacognition (Flavell, 1999). Very young children in the first few months of life show interest and affinity towards the human faces, movements and emotional states of the people from the closest environment. Children aged about 12 months start to understand that other people have different inner states, emotions and desires. They understand certain regularities in people's movements and facial expressions, which is of great importance for the later understanding of thoughts, feelings, beliefs. Before they speak and develop linguistic abilities, small children imitate, which is one of the important forms of communication. Apart from being able to imitate others, they recognize that other people imitate them, i.e. their voting and facial expressions, and such mutual imitation of infants and parents is actually a practical exercise of social interactions and communication (Meltzoff & Gopnik, 1994). Common attention is directed and intentional action towards the same object in the interaction of both participants. It has been present for about 3 months (Scaife & Bruner, 1975), but it becomes more complex and more specific at the age of 9 to 18 months. Gestures, which sometimes replace verbal language as an effective means of communication between people, also play an important role in the development of common attention.

At the age of about the second year, the theory of the mind is manifested precisely through common attention and the pro-declaratory gesture, since the child is then able to understand not only what the other person sees but also that they both look at the same object. Three-year-olds often do

not differentiate the subjective beliefs of people from objective reality, while at the age between 4 and 5 years children distinguish the physical and mental world, and that other people have different feelings and experiences. Children then begin to understand the state of desire in the thought form, which precedes the understanding of belief (Stone, Baron-Cohen, & Knight, 1998). More and more of their reactions are not reflected only in the perception of the physical phenomenon of the thought process in connection with it. Understanding of the desires and some aspects of emotions develops earlier than understanding cognitive mental states.

The ToM development precursors include the earliest forms of non-verbal communication that begin after birth, and this relates to the physical and emotional contact between the mother and the child, which includes reciprocity, engagement, empathy, and imitation. Facial perception, differentiation of the mother's face from the unknown, and recognition of emotions and facial expressions are vital for the development of basic components of TOM. Perception, in fact, becomes a social perception and enables the development of ToM. Then also develope the empathy that relates to intuitive and emotional awareness of the feelings of others. ToM is a more complex cognitive ability than empathy because it understands the perspective of another person (Blair, 2008). A milestone in understanding the theory of the mind, which occurs at the age of four years, is the adoption of an understanding of the wrong beliefs, that is, the ability to predict the behavior of a person on the basis of her belief in reality, even when it does not correspond to the current reality known to the child (Wimmer & Perner, 1983). A research conducted by Nenadović (2002) also concludes that on tests of false belief there is a steady growth of success between the 3rd and 4th years and that around 5th this development is more pronounced. Therefore, pre-school children are expected to be successful in these tasks. Of course, this applies to children who have unhindered cognitive and socio-emotional development. In children with disabilities, the acquisition of the theory of the mind does not take place under the same conditions and does not follow the age-old norms.

### 1.1 Neuropsychological connection of language and theory of the mind

Different neurodevelopmental disorders, such as disorders from the autism spectrum, hyperactivity, developmental lingual disorders, congenital deafness, and traumatic brain injury, endanger the development of ToM as a complex function, which implies preserved memory, developed common attention, understanding complex perceptual patterns (e.g, facial expression or gaze), language development as well as executive functions emotional maturity and ability for empathy and imitation. According to the author, the development of TOM depends on the maturation of several brain systems, and later it is shaped by middle factors, family milieu, social relations and education (Korkmaz, 2011).

The development of TOM basically depends on the normal functioning of memory systems, including short-term and long-term memory, native memory, including emotional memory. It requires a certain minimum capacity for working memory for the development of TOM because children can not shape concepts about the minds of others until they are able to take into account the different perspectives of thought at the same time (Korkmaz, 2011). The ToM system, according to some researchers, begins to function about 13-15 months of age (Surian, Caldi, & Sperber, 2007) at a time when language is intensively developing. Between 18-24 months there are overlapping of several important developmental milestones, such as understanding common attention, deliberate imitation and the ability to observe the intent of the speaker during learning and decoding the word. The spontaneous development of ToM with the support of neuropsychological functions, as well as the social interaction of children with family environment and peers, takes place about 3-4 years. The difference between mental and physical occurs first so that a child realizes that mental phenomena are abstract, subjective and intangible, while physical objects and open behavior are concrete, visible, and manifest (Cohen, 1995). They understand why people feel in a certain way and notice other motives and learn to induce some mental states. They realize that the same people can in different ways experience different people and conclude from the viewpoint of what a person is thinking about or what a person wants. Without the development of language and the ability to communicate, from non-verbal to verbal, there is no adequate development of the theory of the mind. Early language development is a good predictor of later ToM abilities in typically developed children (Farrar & Maag, 2002). Although the simpler forms of ToM depend on visual images, high-order tasks with

higher demands depend on verbal thought (Astington & Jenkins, 1999). More precisely, the change from natural concepts to social concepts is a special stage in the development of TOM. The use of words such as "happy" and "sad" or "desires," and "needs" begins around the second year, and after the age of 3, children acquire semantic notions of mental states that include others, learning and using words like are "to know," "think," and "pretend" (Wellman, Harris, Banerjee, & Sinclair, 1995). The ability of ToM is especially important in the pragmatics, i. correct use of language in social contexts and narrative abilities, such as storytelling. Children with autism, who in varying degrees show deficiencies in ToM, have limited understanding and rare use of mental state concepts and have difficulty understanding the idioms and metaphors (Tager-Flusberg, 1999). Typical children, with no developmental disorders, about 4 or 5 years of age, differ in their passing through a direct experience from the story of that experience. And then they begin to recognize their previous false beliefs, as well as false beliefs of other people; Children aged 5 and 6 show a sophisticated understanding of emotions, revealing that emotions are based on people's beliefs rather than measures of objective reality (Rieffe, Terwogt, & Cowan, 2005). Adequate linguistic stimulation in the early period, especially by the mother and family environment, the frequent use of "I" and "you" alternatives, as well as the "know" or "thinking" verb forms, encourages children and later on to be more successful on the ToM tasks (Meins et al., 2002). Close contacts in the family, conversations about feelings, reading and talking stories, the rich lexical-semantic ability of the child and better understanding of social situations, and therefore ToM. The socioeconomic milieu in which the child grows greatly influences the speed of its development (Tager-Flusberg, 1999).

### 1.2 Deficiency of the theory of the mind in specific terms

The ability of the theory of the mind develops gradually, not only in typical, healthy children, but also in children with developmental disorders, whether it is autism, intellectual disability, or children with impaired hearing or sight, but this process is slower and has its own specifics. The first group of children that was studied was a group of children with autism (Baron-Cohen, Leslie, & Frith, 1985) and they failed to solve the problem of false belief. People with disabilities in speech-language development, which are the result of some deficiency, solve the tests of the theory of the mind in a much smaller percentage than the typical population.

According to a number of studies (for a detailed review see Đoković, 2008) involving children with hearing impairment and their understanding of ToM (e.g Sally and Anne), children of 10 years of age in a very small percentage are successful in this test, only 35% (Peterson &Siegal, 1995). In a review of these studies, according to Đoković (2008) hearing impaired children aged 7 to 10 were only partially successful and their results ranged in average values from 35% to 54%. Looking at these results and recalling that the ability of the theory of the mind is gradually evolving and that around the age of four should be adopted, we see how many children with hearing impairment later master this ability. It is important to say that these results are in high correlation with the way in which these children acquired language skills, because those children who had a good way of communicating with their family, in terms of exchanging opinions, attitudes, ideas, were the ones that were far more successful adequate training in a particular communication system from the earliest age. People with autism are among the first populations studied in this area. Children with autism express significant deficits in initiating and maintaining common attention, which later results in a weaker interaction with the social environment. The occurrence of symbolic thinking between 2 and 3 years is accompanied by the appearance of the "pretend play", which is a rare occurrence in children with autism, primarily due to the fact that the game of conversion is based on the ability of meta-representation (Glumbić, 2008). According to a study managed by Hape (Happe, 1994), Glumbic said that 20% of respondents solved false beliefs. People with high-performance autism in most cases successfully solve problems of false belief, which is somewhat expected due to the relatively preserved capacities of speech-language abilities, says Glumbić. Children with specific language disorders without other deficits also have a slower development of the ability of the theory of the mind. According to numerous studies (Spanoudis, 2016; Brooks & Meltzoff, 2015, Azabdaftari, 2012; Slade & Ruffman, 2005), children with linguistic disabilities are falling behind in the ability to solve ToM tests. Also, tests that assess semantic and pragmatic linguistic ability contribute to predicting results on ToM tests, which leads to the conclusion that the influence of semantic language

development on the ability to develop the theory of the mind (Spanoudis, 2016) is influenced. In this study, we examined children with Dg of developmental dyspasia of the expressive type. Developmental dysphasia of the expressive type is a specific developmental disorder in which the child's expressive speech is significantly below the expected age, but who understands the speech within the limits of normal or below the average (Golubović, 2012). Also, the second group which was examine is a group of children with Dg Dyslalia( F80.0), which is a specific developmental disorder in which the child's use of spoken voices is below the expected level of his / her age with a normal level of speech abilities (ICD-10,1992). In a study on the influence of language on the development of ToM (Hale & Flusbeg, 2003), a group of 60 pre-school children who were stimulated in language development, particularly in the syntax, were more successful in the theory of the mind when compared to the period before stimulation, which leads to to the conclusion that improving language development leads to better scores on tasks ToM. On the contrary, the study concludes, stimulation, that is, only the understanding of the tasks of false beliefs leads to further improvement in linguistic abilities, but only to better results on ToM tests. It can be concluded that the relation between language and the theory of the mind is more one-way, which is somewhat natural, since the development of language precedes the development of the theory of the mind, which depends on the ability of the individual to understand the specific social interactions that are realized in the process of verbal communication.

## 2 The aim

The aim of the research is to evaluate the development of the theory of the mind of the children's with disturbances in the speech-language development of ages from 4 to 7 years, as well as a comparison with the population of children who have a proper development of speech and language.

## 3 Methodology of research

*Research instrument*

The test used to evaluate the development of the theory of the mind is the "Sanja and Ana" test (eng. "*Sally - Anne test*", Baron-Cohen, Alan, Leslie, & Frith, 1985). The child is shown a picture and, according to a clearly defined procedure, the story from the image that the child watches and then the question arises. The picture shows the girl Sanja who puts the ball in the basket and then leaves the room. The second girl Ana, after Sanja's exit, takes the ball out of the basket and shifts her into her box. When Sanja returns, we ask the child where she will look for the ball. The test procedure begins like this: "Let's take a look at these pictures." We show the child: "This is Sanja". Then we show the basket and say:" Sanja has a basket". We show the other girl: "This is Ana". We'll show you on the box and say: "Ana has a box". We show the picture and say:" Sanja also has a ball. She puts her in her basket". We show the picture on which Sanja leaves and say "Sanja goes for a walk". We show how Ana moves the ball out of the basket in the box and say, "Ana takes the ball out of the Sanja's basket and puts it in her box." We show the picture of the Sanja that comes back and say: "Now Sanja is coming back" and we ask the child: "Sanja wants to is playing with his ball. Where will Sanja search for her ball? ". The child gives the answer and we thank him.

*Sample*

The test sample consisted of children aged 4 to 7 years. In total, there were 49 respondents. Children with the diagnosis of dislalia (F80.0, specific articulation disorder) were N = 10; with the diagnosis of developmental expressive dysphasia N = 19 (F80.1, specific speech and language disorder) and children with no disturbance in the development of speech and language was 20 - N = 20. The children were of average intellectual abilities and did not have any further damage. Children with diagnoses of deviation in speech-language development come to audiolinguistic treatments in IEFPG. Children with no disabilities in the development of speech and language are attendants of kindergartens in Belgrade. The test was carried out under appropriate conditions.

### 3.3 Data processing

For the presentation of basic statistical indicators, the measures of descriptive statistics, percentage indicators, and Pearson test ($X^2$ test) were used to determine the significance of the relationship between groups.

## 4 Research results with discussion

Based on the analyzed data, the differences between groups were obtained

**Table 1.** Sample characteristics

| | **age of children** | | | |
|---|---|---|---|---|
| ***Dg*** | **4-5** | **5-6** | **6-7** | **total** |
| *Dyslalia* | 6 | 3 | 1 | 10 |
| *Dysphasio* | 10 | 6 | 3 | 19 |
| *b.o* | 12 | 7 | 1 | 20 |
| *total* | 28 | 14 | 7 | 49 |

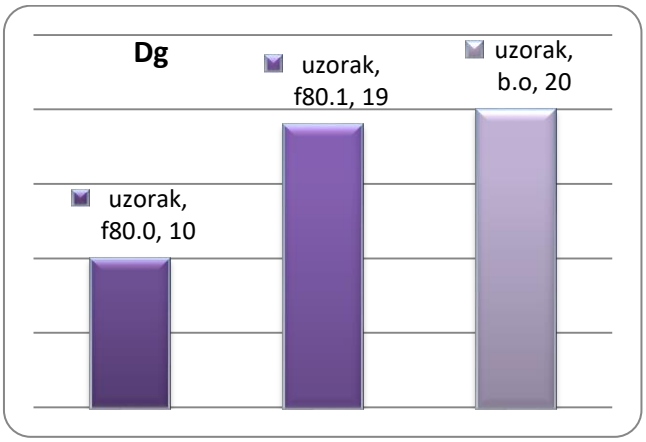


**Chart 1** numerical distribution of the sample by group

Table 1 shows a sample of the study rated into three groups: group F80.0 (children with Dg. Dyslalia) N = 10, 20%; group F80.1 (children with Dysphasia Expressive) N = 19, 39%; and the group b.o (children who no disturbances in the development of speech and language) N = 20, 40%. From Table 1 we see that the sample is rated according to age: group 4 to 5 years, N = 28; group from 5 to 6 years N = 14, I group from 6 to 7 years, N = 7. The largest number of subjects was aged between 4 and 5 years. The total sample consisted of 49 respondents.

Chart 1 shows the numerical distribution of the sample by group. The highest number of subjects is from the healthy control group (b.o.)-N = 20, which is 40%, then from the group F80.1-N = 19 or 39% I group F80.0-N = 10, which makes 20%.

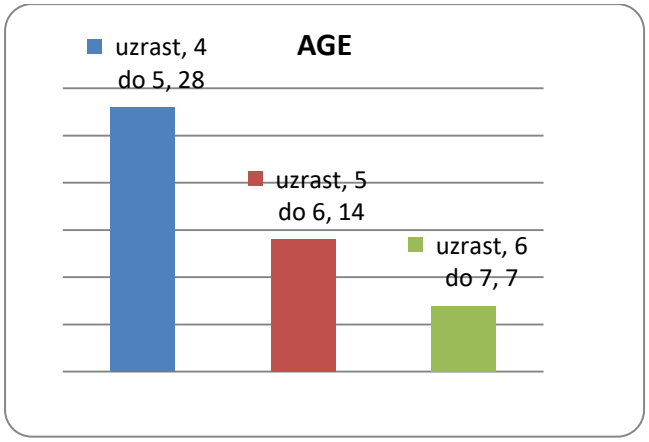


**Chart 2.** Sample distribution by age

Chart 2 shows the distribution of the sample by age. The highest number of respondents was aged 4 to 5 years N = 28 (57%), then respondents from 5 to 6 years. N = 14 (28%) The lowest number of respondents belonged to the group from 6 to 7 N = 7 (14%).

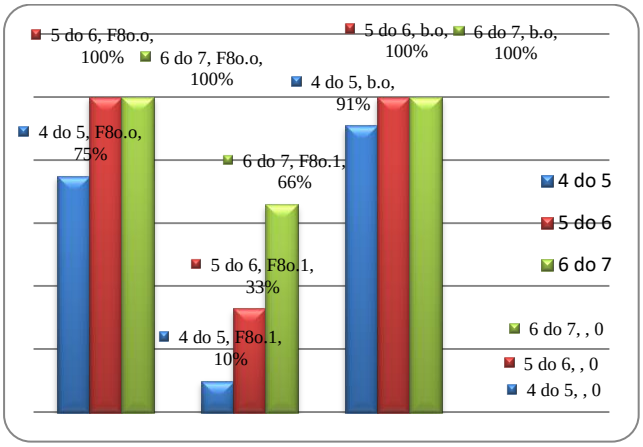


**Chart 3.** Efficiency on the Sally-Anne task

Chart 3 shows the success of Sally and Anne's task in relation to age and relative to group affiliation. We see that the most successful were the older respondents: from 5 to 6 and from 6 to 7 years, 100% success was in the group of children F80.0 (Dyslalia) and b.o group (children without speech-language disturbances). The least successful were the respondents aged 4 to 5, especially from the group F80.1 (dysphasia expressive), only 10% of the performance.

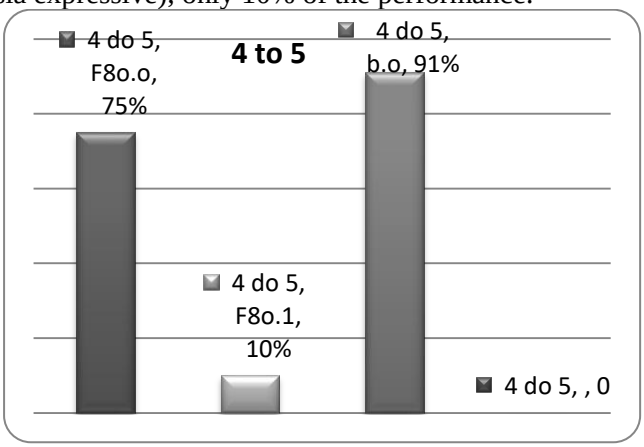


**Chart 4**. Distribution of the performance of the sample of ages 4 to 5 years per Dg

Chart 4 shows % performance on the Sally-Anne task at the age of 4 to 5 years. Group of children b.o. without disturbance in speech-language development, had the best achievements of 91% of performance. Children with disability F80.0 - 75%, while children with dysphasia had significantly lower % of performance, only 10%.

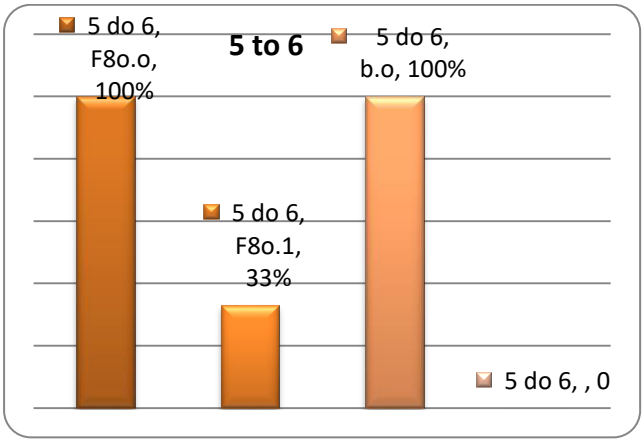


**Chart 5**. Distribution of the performance of the sample of ages 5 to 6 years per Dg

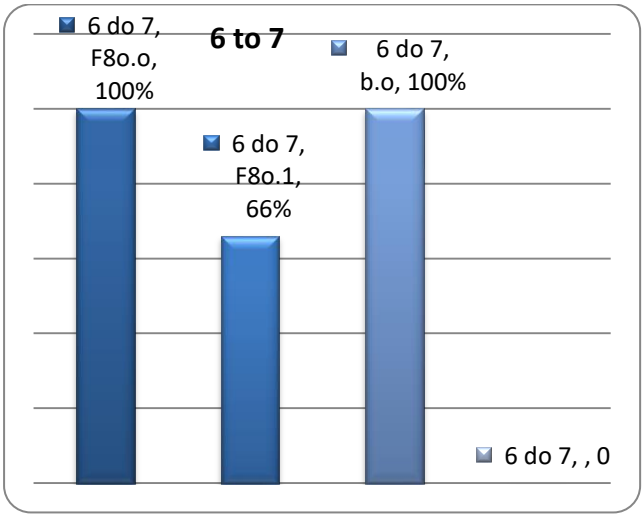


**Chart 6.** Performance distribution of the sample of ages 5 to 6 years per

Chart 5 shows% performance on the Sally-Anne task at the age of 5 to 6 years. Group of children b.o. without disturbance in speech-language development had the best achievements of 100% success. Children with dyslalia F80.0 were also maximally successful at 100%, while children with expressive dysphasia had significantly lower performance%, only 33%.

Chart 6 shows% success on the Sally-Anne task at the age of 6 to 7 years. Group of children b.o. without disturbance in speech-language development had the best achievements of 100% success. Children with dyslalia F80.0 were also maximally successful at 100%, while children with expressive dysphasia had lower % of performance, 66%.

**Table 2**. Results on the Sally-Anne task in relation to group affiliation

| **Chi-Square Tests** | | | |
|---|---|---|---|
| | Value | df | Asymp. Sig. (2-sided) |
| Pearson Chi-Square | 23,834 | 2 | ,000 |
| Likelihood Ratio | 25,563 | 2 | ,000 |
| Linear-by-Linear Association | ***20,296*** | ***1*** | ***,000*** |
| N of Valid Cases | 49 | | |

Table 2 shows statistically significant differences between groups. Using $\chi 2$ (Hi square test), a statistically significant difference in the achievement on the Theory of the Mind between children with developmental dysphasia, dyslalia and control group of typical speech-language development was determined, $\chi 2 = 20.296$, $p < 0.001$. Children from the control group and children with dyslalia achieved significantly better results on the Theory of the Mind test when compared to children with developmental dysphasia.

## 5 Conclusion

The theory of mind (ToM) is a complex cognitive ability that evolves gradually in constant interaction with different factors that shape it. From this and earlier studies using the Sally and Anne task, it can be concluded that the ToM ability can be expected at the age between 4 and 5 when it comes to children with no disturbance in the development of speech and language (91% of children of this age in the group bo). The older age of this group reached maximum achievements. More precisely, all respondents from age groups 5 to 6 and 6 to 7 answered correctly the question from the task. Children with disabilities in the phonetic-phonological status (according to ICD-10 the diagnosis is Dyslalia - F80.0) had weaker achievements-75% of the youngest group answered correctly, while the elderly answered all. Particularly poor achievements were children with Dg F80.1 (dysphasia expressive), especially the youngest age, only 10% gave the correct answer to the task Sally and Anne. As the age increases, the percentage of correct answers increases, but even then the oldest respondents from 6 to 7 years have 66% of the correct answers, which compared to the group b.o. significantly less achievement. If we look at the research (Spanoudis, 2016; Brooks & Meltzoff, 2015) children with slow linguistic development, and in our case children with expressive developmental dysphasia, we can conclude that they achieve poorer results because the levels of their development of speech and language are not in accordance with age and late for their peer group. In their anamnesis, we often find information about the delay in the development of vocalization, then babbling, weaker non-verbal communication with the closest environment, and later due to modest linguistic abilities, there are problems in communicating with peers, which leads to the avoidance of social interactions and weaker experience in social situations. Based on the results obtained in this study, we can conclude that children with developmental dysphasia of the expressive type significantly lag behind in the acceptance of the ability of the theory of the mind because of the complexity of their speech-language problem that has been present since early childhood. Early diagnosis and prevention of such disorders could affect the improvement of their linguistic abilities and the prevention of difficulties in communicating with the environment, which can lead to emotional and other problems. In this process should involve a family that will be led by an expert team, but also the main support in the process of rehabilitation of children with speech and language disorders.

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## Razvojni odnos između jezika i teorije uma kod dece

Teorija uma (eng. "*Theory of mind-ToM*", teorija psiholoških stanja, socijalna kognicija) podrazumeva sposobnost da se prepoznaju različita mentalna stanja:osećanja, misli, želja, namera, ne samo sopstvenih, već i kod drugih a koje doživljavamo različite od naših. Teorija uma se kao i jezik razvija iz prethodnih socijalnih iskustava koja treba da budu adekvatna i podržavajuća i to u ranoj životnoj dobi. U situacijama neadekvatnog jezičkog razvoja ili specifičnih sredinskih uslova, ova psihička razvojna promena se ne razvija u periodu kada se očekuje već kasni ili se uopšte ne desi. Test koji se koristi za istraživanje ove pojave je test "pogrešnog uverenja" (eng. "*false belief*") kojim se

ispituje postojanje ToM, tj. teorije psiholoških stanja kod dece različitih uzrasta, kao i začeci njenog razvoja. Cilj ovog pilot istraživanja je bolje razumevanje odnosa između ToM i jezičke sposobnosti dece sa različitim smetnjama govorne komunikacije uzrasta od 4 do 7 god. Zaključak istraživanja ukazuje na specifičnost i uzajamnost između dostignutog nivoa govora i jezika i razvoja teorije uma kod dece sa jezičkim deficitima
*Ključne reči:* teorija uma, razvoj govora i jezika, jezički deficit

# Onomatopoeias as precursors of grammar in the ontogenesis

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**Abstract:** The paper focuses on the earliest phases of grammatical ontogenesis. The object of observation and research is child-produced onomatopoeias from the periods of pre-morphology and the transition to proto-morphology, excerpted from the spoken language corpora of two Bulgarian girls (Alexandra and Stefani, marked in the respective longitudes in CHAT-format in the CLAN programme as ALE and TEF respectively).
*Keywords***:** onomatopoeia, pre-morphology, grammar acquisition, Bulgarian language

## 1 Introduction

Onomatopoeias are among the first words in the vocabulary of small children. They represent words based on the imitation of typical sounds produced by animals, machines, people, and objects, and they can be included in the group of iconic signs.

In the present work, an attempt has been made to outline the role of onomatopoeia in establishing the verb as a part of speech in the earliest phases of language acquisition. To this end, the chronological model of natural morphology has been used, according to which the beginning of the ontogenesis is associated with two phases that precede the development of grammar (the morphological phase), and namely – the pre- and proto-morphological phase, when any real system (or even module) of morphological grammar till does not exist, since this still is not necessary for extra-grammatical operations and the few rudimentary precursors to later morphological rules. In the group of pre-morphological means are included the different units, including onomatopoeias, which play the role of ancillary mechanisms in the process of language acquisition (cf. Bittner, Dressler, 2000; Popova, 2006).

The observations and analysis in this research encompass onomatopoeias in child language from the period of pre-morphology and the transition to proto-morphology, excerpted from the speech corpora of two Bulgarian girls, Alexandra and Stefani.

## 2 The data

The longitudinal and observational data in the present study are taken from mother-child interactions of two Bulgarian girls, Alexandra (ALE) and Stephani (TEF) (Popova Corpus[13]). The data consist of 30 hours of recordings of the children's spontaneous speech in interactions with their caregivers. ALE has been observed between the ages of 1;1–2;4, and TEF, between 1;3–2;5. The data have been transcribed using CHILDES (MacWhinney 2000). For the purposes of the study, each child's files have been grouped to correspond to the pre-morphological, transitional, and proto-morphological phases of their language development (Table 1).

[13] The research described here is based on empirical material from the Bulgarian corpus of children's speech (and in particular on **Corpus A**), created by the team at the Laboratory of Applied Linguistics at Shumen University "Konstantin Preslavski."

**Table 1**. Data

| **Subject** | **age** | | |
|---|---|---|---|
| **Alexandra (ALE)** | **0;11–1;4** | **1;05–1;7** | **1;08–2;4** |
| *Total of word tokens: 13058 Total of utterances:* 3871 | | | |
| **Stefani (TEF)** | **1;1–1;8** | **1;9–2;1** | **2;1–2;5...** |
| *Total of word tokens: 11514 Total of utterances: 3603* | | | |
| | **pre-morphology** | **transitional phase** | **proto-morphology** |

## 3 Onomatopeias in the early speech of two bulgarian children

Onomatopoeias are found even in the first recordings of both of the two girls studied, ALE and TEF. They belong in the category of the so-called pre-morphological means, highlighting their specific role as ancillary mechanisms that they play in the acquisition of certain language phenomena.

Before proceeding with a detailed analysis of how onomatopoeia works in the framework of the early stages in the language development of the two children, it is worth outlining in general terms its place among the other pre-morphological means. It will immediately be clear that the two corpora are saturated with examples of extra-grammatical morphological operations, namely:

a) Reduplications: *bau-bau* ('dog'), *mjau-mjau* ('cat'), *pa-pa* ('duckling'), *am-am/am-ma* ('eating'/'eat'), *vova* ('water'), *nani-nani* ('sleep'), *lju-lju* ('swing'), *puf-paf* / *pu-paf* ('train'), *Ni-ni* (Niki), *Ti-ta* (Čita), etc.;

b) Shortenings: *boni* ('bonbons'), *lad/olad* ('chocolate'), *kal* ('orange'), *min* ('chimney');

c) Truncations / abbreviations of various kinds (Pačesová 1968: 204), e.g. in unpredictable hypocoristics of the type: *Stefani →Teti, Teče* ; *Ivelin→Ici, Vin*.

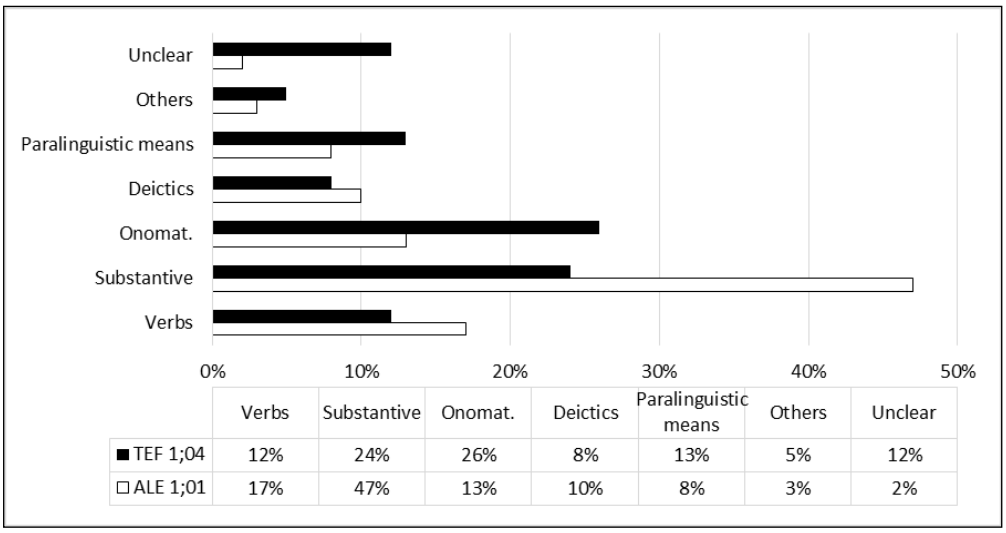
d) Surface analogies such as *Pipika* (instead of *Pipi*) by analogy with *Anika*.

e) Blends: *akapish* (*akam* + *pišam* 'poop + pee'), *pljunki* (*pljušeni pantalonki* 'fleece pants [dim.]'), *kakajeja* (*kaka* + *lelja* 'older sister + aunt') And interesting example in this regard is introduced by Jean-Paul Sartre in his autobiographical book "Les Mots," namely the blend *Karlémami*, a combination of *Karl + Mamie (Karl et Mamie)*: "... I adored her: since she was my grandmother. It had been suggested that I call her Mamie and call the head of the household by his Alsatian name, Karl. **Karl and Mamie**, that sounded better than Romeo and Juliet, than Philemon and Baucis. My mother would repeat to me a hundred times a day, not without a purpose: '**Karlemami** are waiting for us; **Karlemami** will be pleased; **Karlemami**…', conjuring up, by the intimate union of those four syllables, the perfect harmony of the persons. I was only half taken in, but I managed to seem to be entirely: first of all, to myself. The word cast its shadow on the thing; through Karlemami I could maintain the flawless unity of the family and transfer a good part of Charles' merits to Louise. Suspect and sinful, always on the verge of erring, my grandmother was held back by the arms of angels, by the power of a word" (Sartre, 1963: 29–30).

The extra-grammatical morphological operations shown above, used by the observed children during their pre-morphological phase, are accompanied by many onomatopoeias (*bau-bau, myau-myau, lyu-lyu, am-am, bum,* etc.), non-prototypical diminutives (*pisi* – a diminutive of *kitten, čiči* – a diminutive of *uncle, Teti* – a diminutive of *Stefani, babi* – a diminutive of *granny, mami* – a diminutive of *mummy*), "frozen" forms (rote-learned forms) of the type *mina* 'pass', *daj* 'give', *njama* 'don't, won't', *la tuka* (*ela tuk*) 'come here'. The extra-grammatical morphological operations, as well as the non-prototypical rules, however, do not follow the functional evolution of

the Bulgarian morphological system and therefore tend to preserve their characteristics of the pregrammatical phase (especially in the early diminutives with their non-prototypical pragmatic meaning). In such a case the only data from the pre-morphological phase, during which one would expect switching on of phases of grammaticalization, are the rote-learned inflected forms (which are a necessary basis for the metamorphosis of early universal morphological preferences, which lead to the language-specific system adequacy that can only be supported by a grammatical module). In this line of thinking the role of onomatopoeia could more likely be expected in the morphosemantics than in the morphotactics.

The data from the two corpora recording the relative portion of pre-morphological means in the speech of ALE and TEF (presented in Graph 1) are indicative of the significant place of onomatopoeia among the other precursors of grammar.




| | Verbs | Substantive | Onomat. | Deictics | Paralinguistic means | Others | Unclear |
|---|---|---|---|---|---|---|---|
| ■ TEF 1;04 | 12% | 24% | 26% | 8% | 13% | 5% | 12% |
| □ ALE 1;01 | 17% | 47% | 13% | 10% | 8% | 3% | 2% |

**Graph 1:** Percentage of Pre-morphological Means (ALE and TEF)

From the very beginning of the recording, both children use onomatopoeias, marking by them the situations completely and not – partially. For example, when TEF (1;06) looks at the table as well as at the cake, plates, and the utensils sitting on it, she says: *"Am-am."* This *am-am* may refer to practically anything involved in the situation: the cake, the utensils, the participants, the process of eating. The mixed use of the onomatopoeias without any clear referential relation is typical. So, for example, *lyu-lyu* in the speech of TEF (1;06) can be observed regularly both in the sense of 'cradle' and 'to swing':

| **Context 1:** | **Context 2:** | **Context 3:** |
|---|---|---|
| BAB: *Na lyulkata kak pravish, babo?*<br>'*How do you do in the cradle, Granny?*'<br>BAB: *Kak se lyuleesh?*<br>'How do you swing?'<br>*TEF: Lyu-lyu*@onomat. | BAB: *Kăde shte hodim?*<br>'Where will we go to?'<br>TEF: *Lyu-lyu*@onomat. | BAB: *Kakvo e tova?*<br>'What is this?'<br>TEF:*Lyu-lyu*@onomat. |
| BAB: *И какво ще правим там?*<br>'And what will we do there?'<br>TEF: *Ulka [:lyulka]*.<br>'Cradle.' | BAB: *Kăde shte hodite s vuycho?*<br>'Where will you go with uncle?'<br>TEF: *Ulka [:cradle]*.<br>'Cradle.' | BAB: *Kakvo e tova?*<br>'What is this?'<br>TEF: *Ulka [:lyulka]*.<br>'Cradle.' |

From the examples indicated it immediately becomes clear that the parts of speech have not been differentiated yet, though in the child's production there are already formal possibilities for this (cf. the later realizations of the sort ***Teti lyu-lyu***, in which the predicative function of the onomatopoeia is clearly differentiated, versus uses from the sort of ***Mau-mau*** *papa*).

Later, onomatopoeia is used more often particularly for marking the perceived subject or event (action). At this stage of the language development (before the verb appears), the question of the adult determines to a certain degree the predicative function of the onomatopoeia and thus aids the forming of the verbs category. For example, compare:

BAB: *To kakvo pravi?*
'What is it doing?'
TEF: Am-am@onomat.
BAB: *A-a, to* ***am-am***, ***yade***.
'A-a, it's am-am, eating'

In the example above, the adult (BAB) first repeats the onomatopoeia *am-am*, used by the child to indicate the action, and immediately after this adds the corresponding word-equivalent *yade* 'eat' (3SG PRES) from the standard language. This communicative practice is used frequently in early language acquisition. The question of the adult (most often the mother) "What is he/she doing?" and its reply with the correct verb following the child's answer create clear conditions to highlight the "place" of the onomatopoeia and the verbs among the remaining classes of words, and it makes it easier for the child to acquire the word itself. The child, following this sort of "training" strategy of the mother, often repeats the corresponding form.

At the same time, there are instances of the first attempts of the girls studied to make the connection between the onomatopoeia and the normative lexeme, when they selectively repeat after the adult only the normative equivalent of the onomatopoeia. For example:

*DIM: *A kăde e, tati, kokoshkata?*
'And where is, daddy['s child], the hen?'
*ALE: *Ko-ko*@onomat.
*VEL: *Ko-ko*@onomat, *kokoshka*.
*ALE: Koka. [:kokoshka]
'hen'

The use of the onomatopoeia is an important stage in the acquisition of verb morphology, because it helps the child: a) to learn how to make difference between events (actions) and subjects; b) to recognize different kinds of situations (with the help of the interlocutor's explanations) and to mark them initially with onomatopoeias, and then also with the relevant verbs. The adults' strategy to repeat selectively the onomatopoeia with the relevant verbs and nouns can additionally catalyze the process of forming word categories. In this way, a moment is reached in the child's speech production when there has been clearly outlined the tendency towards dissociation of the global system into two fields, namely – that of the noun and that of the verb. Thus, for example, in the longitudinal data of TEF at the age 1;08.0, when there had already been made the first steps in this process, there are observed specific uses of onomatopoeias, in which there has been clearly demonstrated the striving for formal representation of a fragment of the reality once as a complete (limited) essence, i.e. – as a noun, and in another context – as an unlimited essence, i.e. – as a verb. Compare, for example:

*BAB: *Kakvo e tova, babo?*
'What is this, [grandchild]?'
*BAB: *Pile?*
'Chicken?'
%sit: *she shows her a toy chicken*
*TEF: *Pi-pi*@onomat.
'Pi-pi'
*BAB: *Kakvo pravi pileto?*
'What is the chicken doing'
*TEF: *Pi-pi-pi*@onomat.
'Pi-pi-pi'
*VEL: kakvo ima tam?
'What is this there?'
*TEF: *Pipi* [:pile].
'Pipi' [:*pile*: 'chicken']

**Table 1**: Verbs and onomatopoeias (TEF – 1;08.0)

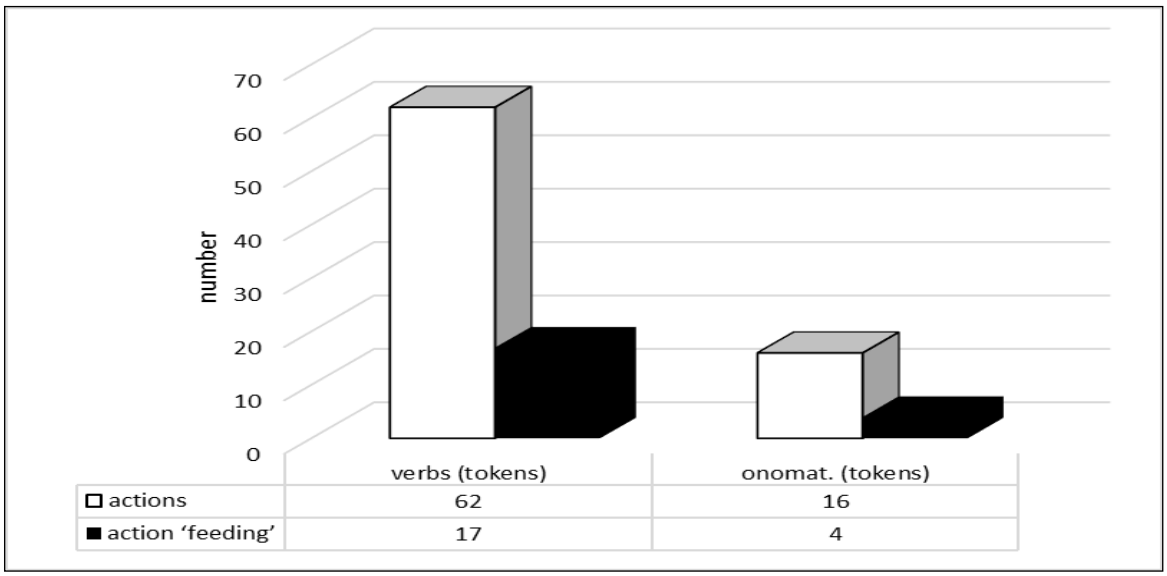
| **VERBS** (14 lemmas / 62 tokens / 17 types) | **ONOMATOPOEIAS** (11 lemmas / 16 types) |
|---|---|
| **amam** 'eat'<br>1 ama [:amam] – *3/1P SG PRES[14]<br>**dam** 'give'<br>3 daj – 2P SG IMP<br>**dojda** 'come'<br>1 ela – 2P SG IMP<br>4 elja [:ela] – 2P SG IMP<br>**mina** 'pass'<br>3 mina – 3P SG AOR<br>**molja** 'please'<br>1 motja [:molja te] – 1P SG PRES<br>**nanjam/njanjam** 'sleep'<br>9 nani [:nanjam] – *3/1P SG PRES<br>1 nani-nani [:nanjam] – *3/1SG PRES<br>1 nanja [:nanjam] – *3/1P SG PRES<br>**nedej** 'don't'<br>1 dej [:nedej] – 2S IMP<br>**njama** 'won't, there isn't'<br>13 njama – 3SG PRES<br>**placha** 'cry'<br>1 pachi [:plache] – 3SG PRES<br><br>**opravja** 'fix'<br>2 pai [:opravim] – *3SG/1PL PRES<br>**papam** 'eat'<br>12 papa – 3SG PRES<br>2 papa [:papam] – *3/1P SG PRES<br>1 papaj [:papam] – *2SG IMP/1SG PRES<br>1 papau [:papal] – *SG PART/PL<br>**pija** 'drink'<br>1 pij [:pie] – 3SG PRES<br>1 pija – 1SG PRES<br>**otivam** 'go'<br>2 piva [:otivam] – *3/1P SG PRES<br>***titam [:slusham]** 'listen'**– quasiverb**<br>1 titam [:slusham] – 1P SG PRES | 1 a-am / 2 am-am / 1 am-am-am-am<br><br>1 a-kha<br><br>2 bum<br><br>1 kh-kh-kh / 1 khu-khu<br><br>1 lju-uu<br><br>1 mush<br><br>1 na<br><br>1 opa<br><br>1 pish<br><br>1 skok<br><br>1 pi-pi-pi |

Similar onomatopoeic realizations in the speech of TEF are not the only proof for the availability of primary lexical paradigms during the age discussed. Together with them, the aspiration of the child to mark certain lexemes as verbs is shown also in the use of inflected verb forms for naming actions, though very often this is accomplished incorrectly. Thus, in the child's utterances there are inflections for 1P SG, 1P PL; 3P SG (Present); 3P SG (Aorist); 2P SG (imperative); as well as a form for 3P SG (perfective). As an illustration, there will be quoted the verb lemmas (together with the formal types) and the onomatopoeias that marked 'action' in the speech passage analyzed: 14 verb lemmas / 62 tokens / 17 types versus 11 onomatopoeias / 16 tokens (TEF – 1;08.0). See **Table 1.**

In the given speech fragment, regarding the act of 'feeding', it can be observed how the child "rewrites" the corresponding action from one format to another, namely, how she reformats the onomatopoeia *a-am / am-am / am-am-am-am* into the verb *ama*. Alongside this, in the same type of contexts during this recording, multiple uses of the verb *papam* 'eat' are recorded. The statistical analysis shows that at the age 1;08.0, in the presence of synonymous means for formal marking of a

[14] The asterisks (*) in Table 1 mark the non-normative forms used instead of the corresponding normative forms, which are shown after the dash.

certain verbal concept, TEF demonstrates an apparent preference for the verb forms at the expense of the onomatopoeic ones, which is illustrated in **Graph 2**.

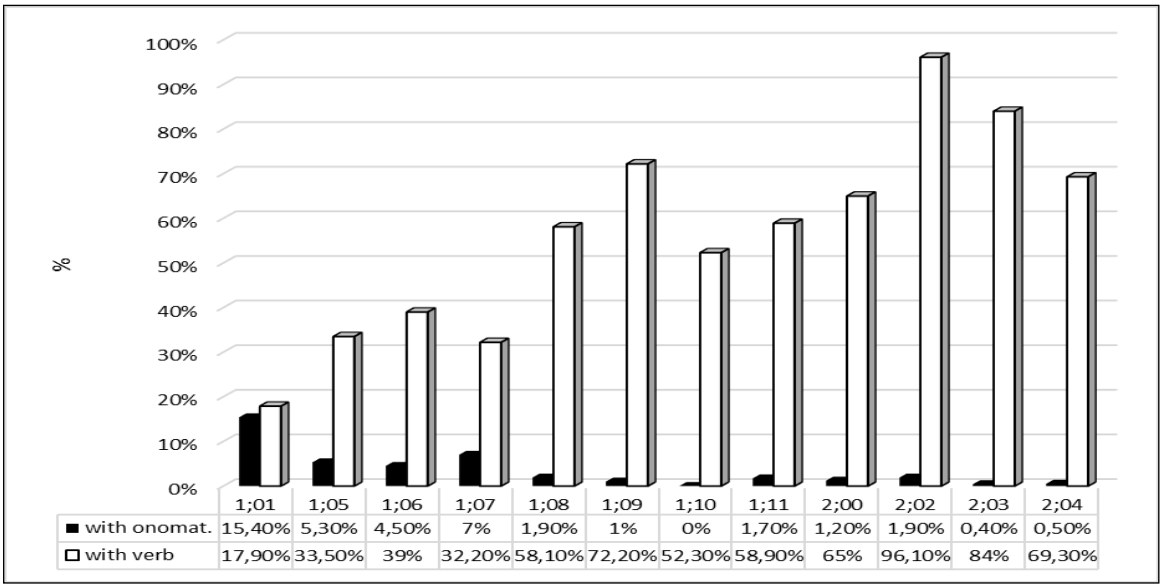



**Graph 2:** Quantitative indicators for the designation of actions (TEF, 1;08)

In further language development, the tendency towards functional limiting of the onomatopoeias has been observed, and in a certain moment it has even resulted in encountering them only in predicative use (cf. for example *TEF – 1;11.04: *Granny, **pish*** ('I will pee'); *Bebito. Kok-kok* ('jumps'); *Dus-dus* ('I joggle'); *Rm-rm-rmy-rmy* ('growls'); *Botzi* ('I stick/prick'); *Am* ('Eat!')). Some of them change also their phonetic appearance and start looking like verbs (for example – the *botzi* form instead of the usual so far *botz / botz-botz* onomatopoeia used), and some of them have already totally lost their onomatopoeic character and are perceived mostly as elements of the relevant verbal paradigm (for example the *chipi* form, used in parallel with *chipa* 'bathe', has been associated with 3P SG PRESENT form and could be explained by the peculiar competition of the language forms at the entry during the process of constituting the miniparadigms).

When both of the children studied were still in the one-word phase, for describing actions consisting of one act, or which appear to be complete and limited in scope, the use of single onomatopoeias (e.g. *mush, shtrak, pus / push, bum,* etc.) is observed, whereas for indicating continuous actions or actions consisting of separate motions of the same type, reduplicated onomatopoeias are observed (e.g. *lju-lju, am-am, kok-kok / kok-ko-kop, mjau-mjau-mjau-mjau, tik-tak-tik-tak,* etc.). For indicating duration of action, in some cases lengthened pronunciation of the relevant onomatopoeia (of the type: *muush, aam, naa*, etc.) is observed, which accompanies the carrying out of the action itself.

The role of onomatopoeia as "laying the foundation" for the verb appearing is undoubted. In the case of both children, there has been observed a period of accelerated use of onomatopoeias in predicative function. With the appearance of the verb (as well as its contrastive forms), the reverse tendency has been detected – in both children's recordins there has been registered decreased use of onomatopoeias (cf. for example Graph 3, which illustratively represents how even from their origination, the first verb forms become apparently preferred by ALE). Thus, for example, in the case of ALE, the first significant decrease is from 15,4% (during the age of 1;01.29) to 5,3% (during the age of 1;05.06). After an unimportant increase at 1;07 to 7%, later this percent does not exceed 2%. The first decrease in the use of onomatopoeia is observed during the transition from pre- to proto-morphology, when the first proto-morphological signs appear; the second considerable decrease, observed at the age of 1;08, is accompanied by increase of a relative share of the utterances with verbs (more than 50%), which coincides with the beginning of the proto- morphological stage and the appearance of real mini-paradigms. This is illustrated in Graph 3.

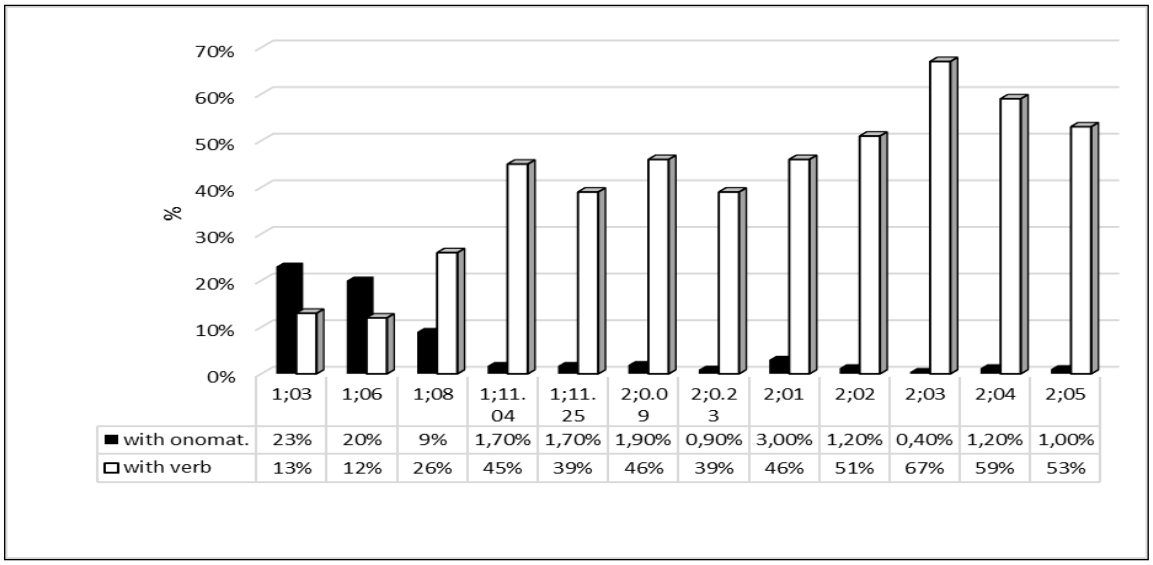



| | 1;01 | 1;05 | 1;06 | 1;07 | 1;08 | 1;09 | 1;10 | 1;11 | 2;00 | 2;02 | 2;03 | 2;04 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ■ with onomat. | 15,40% | 5,30% | 4,50% | 7% | 1,90% | 1% | 0% | 1,70% | 1,20% | 1,90% | 0,40% | 0,50% |
| □ with verb | 17,90% | 33,50% | 39% | 32,20% | 58,10% | 72,20% | 52,30% | 58,90% | 65% | 96,10% | 84% | 69,30% |

**Graph 3:** Percentage of utterances with onomatopoeia (ALE)

In the case of Stefani, the first significant decrease in the use of onomatopoeias in the predicative function is observed at the age of 1;08, which (as with Alexandra as well) corresponds with the beginning of the transition from pre- to proto-morphology. During this phase, in the following months, onomatopoeias gradually decrease to 0,9%. The stabilized presence of verbs after the age of 2;01 (over 50%) signals the establishment of the proto-morphological phase (see Graph 4).

From Alexandra's and Stefani's data analyzed, it becomes clear that during the earliest stages, the predicative functions can be expressed by onomatopoeias (including onomatopoeic reduplications), i.e. by extra-grammatical means (for more details cf. Popova 2002). Little children have a rich repertoire of means for expressing predication, even before they have mastered the correct verb forms. But even though they have forms of specific verbs expressing a pragmatic or morpho-semantic sense, they may use in the same meaning non-verbs as well (called also predecessors of verbs), together with onomatopoeias (cf. also: *dolu* (= down) in the meaning of 'put me down!'; *opa* in the meaning of 'pick me up!'; *na* in the meaning of 'take!'/'give' (ALE, 1;01.29)); and peculiar fillers, which constitute the phonetic structure of the relevant verb being mastered from the sort of *tititeni*, *tititani* respectively, in the meaning of 'sit down' and 'stand up' (TEF). During the transitional stage from pre- to proto-morphology, these verb predecessors are gradually replaced by the real verb lemmas, whose increase, however, is insignificant. This is evidence of the instability of the verb system, in which pre-morphological and proto-morphological elements cohabit. The appearance of verbs is followed by dramatic changes in the whole grammar system: contrastive forms – conjugated forms for perfect and imperfect type (in the case of verbs) – appear; there are observed changes in the structure of sentence (sentences with subjects and predicates); and children start an intensive movement towards generalization of grammatical rules.




| | 1;03 | 1;06 | 1;08 | 1;11.04 | 1;11.25 | 2;0.09 | 2;0.23 | 2;01 | 2;02 | 2;03 | 2;04 | 2;05 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| with onomat. | 23% | 20% | 9% | 1,70% | 1,70% | 1,90% | 0,90% | 3,00% | 1,20% | 0,40% | 1,20% | 1,00% |
| with verb | 13% | 12% | 26% | 45% | 39% | 46% | 39% | 46% | 51% | 67% | 59% | 53% |

**Graph 4:** Percentage of utterances with onomatopoeia (TEF)

## 4 Conclusion

In conclusion, the use of onomatopoeias is an important step in the earliest phases of morphology acquisition, because it helps the child: a) to learn to differentiate events (actions) and subjects; b) to recognize different types of situations and to designate them first with onomatopoeias and subsequently with the corresponding verbs. In this way, in their capacity as precursors of grammar in the phase of pre-morphology, onomatopoeias have a special contribution primarily in a child's morphosyntactic acquisition. At the same time, however, from the observations and analysis it become clear that these language units play a role also as a type of base for the primary testing of different inflectional forms. Thus to a large extent their use is a necessary preliminary step in the awareness of the relationship of form and function, which is realized in the ontogenetic process first in the initial global differentiation of child speech in two areas: the verb and the noun. This initial differentiation of classes of words, which is actually the first proto-grammatical opposition (see Bittner, 2003; Popova, 2006), gives grounds to assert that onomatopoeias are not simply a component of the early childhood lexicon, but are a type of ancillary mechanism in the mastery of language, which is contained in the language itself. To corroborate this statement, other data with the characteristics of onomatopoeia can be identified (atypical displays of echolalia, late babbling, vocal harmony, and others), some of which are observed not only in the dawn of language ontogenesis, but also through the entire period of childhood. Research on these phenomena, however, is not within the parameters of this work, but is an open possibility for the future. The work presented here has a more modest goal. With the review of the data presented here from the two Bulgarian girls studied, Alexandra and Stefani, an attempt was made to demonstrate the place and role of onomatopoeia in the earliest phases of language acquisition. It was demonstrated how with the help of onomatopoeia, the child gradually manages to free herself from the constraints of so-called expressive morphology, based only on general cognitive principles and not subject to inclusion in any specific grammatical module.

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# Assessment of linguistic closeness and comparison of acoustic characteristics of croatian and serbian languages

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**Abstract.** The aim of this study was to examine how the educated speakers of General Croatian assess the linguistic closeness of Croatian (N=37) and Serbian speakers (N=37) based on the verified tokens of spontaneous speech. In order to determine whether there are acoustic differences between the languages the acoustic analysis included: F0 in Hz and semitones (Pt) and vowel formants (F1-F4). Also, Df was calculated from formant values. The results show the difference in linguistic closeness ($p<0.00001$) and as well as differences in F0 values, F1 for vowels /a/, /i/, /u/ and F2 for /i/ and /e/, while the differences for F3 were smaller. No significant differences were found for Df, so it can be concluded that vocal tract length does not influence the results of vowel formants.
*Key words***:** vowels, formant frequencies, linguistic closeness, Croatian, Serbian

## 1 Introduction

Contemporary authors differ in their arguments about linguistic closeness or distance of Croatian and Serbian languages. The farthest claim on one side is that they are completely different languages, while the other is that it is one language. Undoubtedly, there is mutual understanding between the speakers of the two languages without translation. Some contemporary dictionaries have focused on the differences between the two languages like recently published one authored by Samardžija (2015). The question is, of course, the corpus used for the preparation of the corpus which has shown such vast differences. Another question is about the differences and weather they are really present so frequently in the contemporary languages. Therefore, we wanted to examine not only auditory assessment of the tokens, but also comprehensibility between the two languages and the influence of the acoustic differences on the assessment of linguistic closeness, i.e. is the influence of the segmental units (vowels and consonants) stronger than the influence of the supragementals. On the other hand, acoustic analysis provided objective results about $F_0$, formant values and formant dispersion. Fundamental frequency values were previously studied in both languages. For Serbian relevant data comes from Jovičić (1999) and for Croatian from Varošanec-Škarić (1998). Average formant values were measured for vowels in both languages, most often for F1 and F2, but the studies included smaller samples (number of speakers) as in Škarić (1991) or only nonsense words Bakran and Stamenković (1990). This study includes larger number of participants and the same methodology used for both languages.

## 2 Methodology

The aim of this paper was to test the attitudes of educated Croatian speakers (N=40) about the linguistic closeness, comprehensibility, word stress and pronunciation of vowels and consonants. The speech samples were randomized, they included spontaneous speech (60 s duration) spoken by male speakers of Croatian and Serbian (N=37 for each language, 74 in total). The seven-degree continuum scale was used for the assessment. Perceptual differences were compared to the results of acoustic analysis in both languages (cca 3 min x 74 speakers). The acoustic measures used for the analysis were F0 in Hz and st (st – semitones; Pt), vowel formant analysis, Df – formant dispersion based on F1, F2, F3 and F4 in Hz. Statistical analysis included ANOVA.

## 3 Results and Discussion

### 3.1 Results of the assessment of the linguistic closeness

Perceptually, the greatest difference was found for language closeness (H 5.91 :S 4.43; p<0,00001; **Table 1**, **Figure 1**), and for vowel pronunciation respectively (5.23:4.20), followed by the difference in word stress closeness, consonant pronunciation and comprehensibility showing the smallest differences.

**Table 1**. Mean values and differences in the assessment of closeness for Croatian and Serbian speakers

| | | M | S.D. | T | p |
|---|---|---|---|---|---|
| JEZ./LANG. | CRO | 5,91 | 1,25 | 47,44 | 0,000 |
| | SRB | 4,43 | 1,47 | | |
| RAZ./COMPR. | CRO | 5,48 | 1,21 | 7,25 | 0,000 |
| | SRB | 5,08 | 1,22 | | |
| NAG./STRESS | CRO | 5,26 | 1,28 | 15,98 | 0,000 |
| | SRB | 4,30 | 1,35 | | |
| VOK./VOWEL. | CRO | 5,23 | 1,27 | 16,93 | 0,000 |
| | SRB | 4,20 | 1,39 | | |
| KONS./CONS. | CRO | 5,36 | 1,28 | 12,04 | 0,000 |
| | SRB | 4,65 | 1,31 | | |

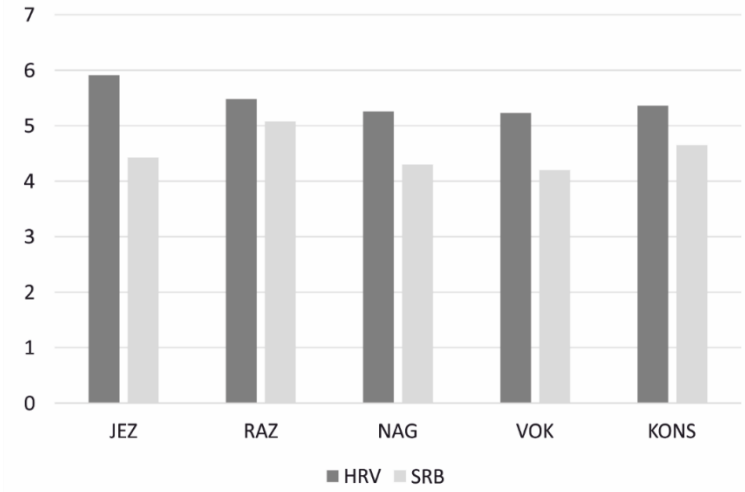


**Fig. 1**. Comparison of auditory assessment of linguistic closeness (JEZ), comprehensibility (RAZ), stress system similarity (NAG), vowels and consonants in the general pronunciation of the Croatian and Serbian speakers

The hypothesis that Croatian speakers understand Serbian well was confirmed regardless of the perceptual differences indicated by other factors. Considering the overall results, it can be concluded that the differences in linguistic closeness are influenced the most by the vowel pronunciation. It is in accordance with the findings from the sociophonetic studies since the vowels strongly influence speakers' recognition. Voice characteristics, such as F0, also depend on stressed vowels and intonation patterns more on which can be seen from the results of the acoustic analysis.

## 3.2 The results of the acoustic analysis

### *3.2.1 F0 measures*

Special programs in Praat were used for the calculation of acoustic measures (Boersma and Weenink, 2015; Ver. 6.0.05). Since vowels are extrauditive and also the word stress carriers, it is interesting that the results have shown that the greatest difference between two groups of speakers was in median F0 in semitones (p=0.0005; **Figure 2**) and in Hz (Croatian 117.25 Hz, Serbian 124.09 Hz; p=0.0007) respectively. The results also show that younger Croatian speakers have significantly lower mean F0 in both measurements in comparison to the values measured in Serbian speakers (Croatian 117.11 Hz, Serbian 126.64 Hz; p=0.001; **Table 2**), significantly lower Fb (Croatian 90.86 Hz, Serbian 97.30 Hz; in Hz: p=0.001; in semitones: 0.002) and lower Alt_Fb. The overall results for both groups of speakers show less significant differences between reading passage and spontaneously spoken utterance for measures in semitones and in Hz for Fb (p=0.017; 0.015), respectively, median F0 (p=0.014; 0.018), for F0 minimums (in Hz, p=0.016; 0.022), for F0 mean (p=0.02; 0.024), for F0 maximums (Croatian 198 Hz, Serbian 201 Hz; p=0.04) and in semitones for Alt_Fb (p=0.04).

**Table 2**. The differences between spontaneous speech and reading in two groups (ANOVA)

| | Hz | M $F_0$ | Med. $F_0$ | S.D.$F_0$ | Min.$F_0$ | Maks. $F_0$ | Alt Fb | Fb |
|---|---|---|---|---|---|---|---|---|
| Spont. speech | SRB | 119.61 | 117.25 | 15.6 | 76.57 | 201.2 | 101.4 | 97.3 |
| | CRO | 111.75 | 108.37 | 14.61 | 72.06 | 198.3 | 97.01 | 90.86 |
| Reading | SRB | 126.64 | 124.09 | 16.78 | 77.46 | 193.77 | 107.45 | 102.64 |
| | CRO | 117.11 | 114.37 | 15.03 | 81.05 | 179.83 | 99.7 | 95.62 |
| ANOVA | Sample | 0.0017 | 0.0007 | 0.0919 | 0.8298 | 0.1811 | 0.0072 | 0.0013 |
| | Columns | 0.0244 | 0.0180 | 0.3265 | 0.0221 | 0.0406 | 0.0516 | 0.0153 |
| | Interaction | 0.7590 | 0.8775 | 0.6390 | 0.0599 | 0.3804 | 0.4524 | 0.8866 |

| | Pt | M $F_0$ | Med. $F_0$ | S.D. $F_0$ | Min. $F_0$ | Maks. $F_0$ | Alt Fb | Fb |
|---|---|---|---|---|---|---|---|---|
| Spont. speech | SRB | 34.45 | 34.10 | 2.19 | 26.73 | 43.45 | 31.59 | 30.88 |
| | CRO | 33.27 | 32.74 | 2.09 | 25.68 | 43.20 | 30.82 | 29.69 |
| Reading | SRB | 35.44 | 35.09 | 2.27 | 26.93 | 42.80 | 32.59 | 31.80 |
| | CRO | 34.08 | 33.67 | 2.09 | 27.71 | 41.51 | 31.30 | 30.57 |
| ANOVA | Sample | 0.0011 | 0.0005 | 0.1197 | 0.8890 | 0.0985 | 0.0074 | 0.0024 |
| | Columns | 0.0207 | 0.0148 | 0.6651 | 0.0162 | 0.0401 | 0.0437 | 0.0173 |
| | Interaction | 0.7579 | 0.8821 | 0.6651 | 0.0628 | 0.3047 | 0.4469 | 0.8547 |

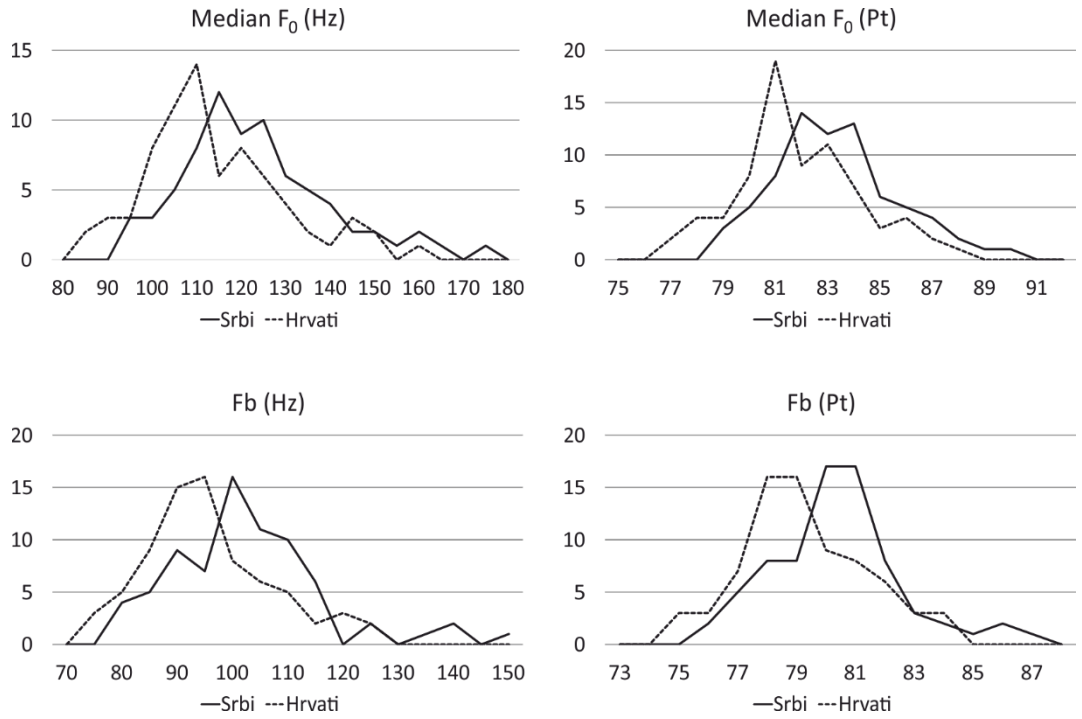


**Fig. 2**. Distribution of results for median F0 and basal F0 (Fb) in HZ and semitones (Pt) for younger male speakers of Croatian and Serbian

The values of mean F0 from this paper agree with the values reported in Varošanec-Škarić (1998) for Croatian speakers, while for Serbian speakers the values are somewhat higher than the F0 value reported in Jovičić (1999). It can be concluded from the collected data that intonation patterns are more different between the groups of Croatian and Serbian speakers, which is important for further research in two similar languages. Overall, it can be concluded that clearer differences were found in the semitone measures, but both type of measurements, Hz and semitones, are useful for comparing speakers with different mother tongues. In wider context these results are similar and can be compared with the results in European languages (Traunmüller and Eriksson, 1995) and the results of the study aiming to compare Slavic and German languages (Andreevna et al, 2014). The results are also similar with the research in Swedish (Lindh, 2006) and Czech language (Skarnitzl and Vaňková, 2016).

#### *3.2.2 Comparison of the results for vowel formants and formant dispersion (Df)*

Acoustic analysis of vowels usually includes F1 and F2 and recently, especially for the comparison of speakers of similar and different languages, F3 values have been included in order to provide precise description of vowel pronunciation. On the other hand, when similar groups according to age and/or education are being compared, it is valuable to examine the vowel formant i.e. F4 in order to determine the possible differences in the length of the vocal tract. This provides results about the influence of the vocal tract length on the vowel formant frequencies.

Vowel formants. Formant values are based on Praat program (Boersma and Weenink, 2015; Ver. 6.0.14). The reference for Croatian formant values come from the 14 speakers which were considered best in the previous study (Varošanec-Škarić&Bašić, 2015). Pronunciation was assessed by two experts in each language. The results have shown that F1 values are significantly higher for vowel [a] for Croatian speakers (704.86: 632.72 Hz; $p<0.0001$) which means that this vowel is more open in Croatian. Further on, F1 was lower for [i] (295.12: 322.06 Hz) and [u] (344.1: 391.02 Hz; $p<0.0001$) which means that [i] and [u] they are closer in Croatian than in Serbian. F1 differences for vowel [e] were not statistically significant, although the value was somewhat lower in Serbian language. F2 values are significantly higher in Croatian for the following vowels: [i] (2177.19: 2063.41 Hz) and [e] (1811.21: 1725.51 Hz) ($p<0.0001$) which means they are more fronted in Croatian language. Significant difference was found for the values of F1 and F2 for vowel [u] ($p<0.0001$) and F3 ($p=0.$

01) revealing more back pronunciation in Croatian language. It is interesting to notice that average values of F3 for all vowels are lower in Croatian language and significantly lower for [e] and [u] (p=0.01) showing that the vocal tract is somewhat longer in the pronunciation of Croatian vowels. Comparison of formant distances for F1, F2 and F3 for the five cardinal vowels in General Croatian and Serbian was shown in **Figure 3**.

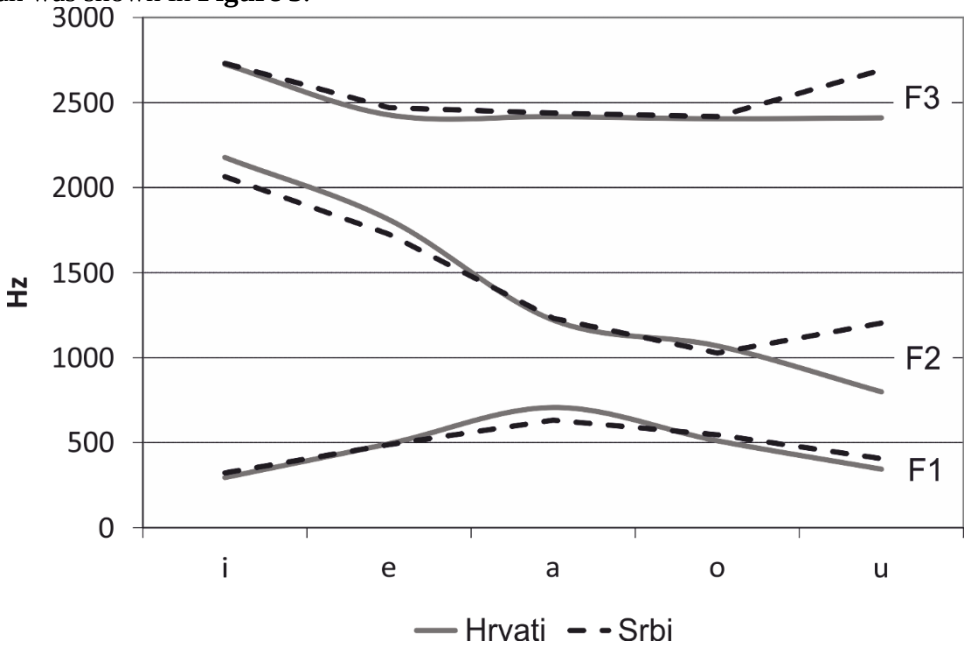


**Fig. 3**. Comparison of formant distances for F1, F2 and F3 for the five cardinal vowels in General Croatian and Serbian

The results partly confirm the hypothesis that some Croatian vowels are more closed in Croatian: significantly for [i] and [u] and insignificantly for [e]. However, it is surprising that the vowel [a] is significantly more open in Croatian then in Serbian language. And it is confirmed that vowels [i] and [e] are significantly more front in Croatian language.
Formant dispersion measure (Df) is used in the group of participants of the same sex in order to examine whether the vocal tract length influences the overall results of formant analysis.
It is calculated as follows:

$$Df = [(F4-F3) + (F3-F2) + (F2-F1)]/3 \quad (1)$$

lower Df values indicate longer vocal tract and higher shorter.

The results have shown that the average DF (in Hz) for Croatian and Serbian is very similar, i.e. that there are no significant differences (1005.76 : 1013.76; p = 0.09), standard deviations of Df are equal (S.D. Df = 83.47 : 81.20), as well as Df minimum and maximum values, so it can be concluded that the vowel formant differences were not influenced by vocal tract length in the experimental groups, but the significant differences in vowel pronunciation are results of the articulatory placement. The results are interesting because both general Croatian and Serbian have five cardinal vowels. Comparison of Df values is more difficult for languages with different vowel systems, it is possible to select vowel pairs for formant values comparison (F1 to F4) (Varošanec-Škarić et al., 2017). That study showed that speakers of Slovene have significantly different Df (p) i.e. that the vocal tract is significantly shorter. Since Df is based on acoustic values and not on direct vocal tract measures, it is not seen as a biological information, but it can be seen as an indicator of the virtual vocal tract length.

## 4 Conclusion

Based on the overall results we can conclude that Croatian and Serbian speakers are more different than expected, based on F0 measures, vowel formants of /i, a, u/, but do not differ in Df values. These

results have valuable methodological contribution, because they indicated how important it is to have larger number of homogeneous groups (higher that 30) which can provide more sensitive intergroup comparisons of acoustic speech measures.

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# The effect of F0 and formant manipulations on the perception of voice attractiveness and likeability in the Czech context

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**Abstract.** The aim of the present paper is to examine the perception of voice attractiveness and likeability in Czech male and female speakers in relation to the fundamental frequency (F0) and formant frequencies. Voice pitch modifications can be observed in a variety of social contexts; people can modulate the pitch of their voice both voluntarily and unconsciously reflecting their communication goals. In our perception test, we used original and manipulated recordings of 4 male and 4 female voices; computational manipulations included fundamental frequency shifts and overall formant frequencies shifts. 36 listeners (18 men and 18 women) participated in our forced-choice perception tasks to evaluate the effect of the manipulations on both vocal attractiveness and likeability ratings. Our results suggest that sex-typical voice pitch manipulations (i.e. lowering F0 independently or in combination with overall formant frequencies in men and raising F0 independently or in combination with overall formant frequencies in women) do not necessarily increase vocal attractiveness or likeability. Interestingly, voice likeability ratings showed less variability among raters compared to vocal attractiveness ratings. Overall, it can be stated that listeners preferred the unmanipulated stimuli to the manipulated ones, and a slightly greater tendency of women to prefer the original voices to the manipulated ones can be observed suggesting that women might be somewhat more sensitive to unnatural sounding stimuli than men.

## 1 Introduction

The importance of an individual's voice as one of non-verbal behaviours within social interaction can hardly be overlooked. Although, as listeners, we do not usually separate voice from speech, i.e. we do not tend to consciously listen to the voice alone, an interlocutor's voice represents a rich source of information about him/her. Some studies have shown that especially when no visual cues are available, we tend to unconsciously use vocal cues as indicators to judge the speaker's personality traits, his/her emotional states, social attractiveness, credibility and competence (Bartsch, 2012:16). However, the impressions we make of the speaker based on his/her voice quality may not be necessarily accurate (Kreiman & Sidtis, 2011:1). Despite such occasional mismatches, human voice – an individual's 'auditory face', represents one of the primary means enabling speakers to project their identity – physical, psychological and social characteristics (Laver, 1980:2; Belin, Fecteau & Bédard, 2004; Babel, McGuire & King, 2014).

Several empirical findings have shown that more attractive voices are (stereotypically) associated with more favourable personality impressions. Interlocutors with an attractive voice tend to be credited with more socially desirable personality traits; they are perceived as more successful, intelligent, competent, dominant and powerful (Zuckerman, 1989, 1990; Berry, 1990, 1992). Vocal attractiveness is thus an important social evaluation and is of great importance in interpersonal relations.

Voice attractiveness plays a significant role in various spheres, for instance in business, marketing and politics. Bartsch (2012: chapter 2) argues that it does affect customers' evaluations of voice-to-voice encounters within customer service call centres, and confirms the vocal attractiveness stereotype. An interaction with an employee with high vocal attractiveness leads to a higher customer attribution of expected effort, abilities and satisfaction. A well-chosen voice is essential in advertising as it should help attract consumers' attention to the advertisement; an attractive voice may enhance favourable responses and create positive attitudes towards the advertised product (Kreiman & Sidtis, 2011: 376). DeGroot, Aime, Johnson and Kluemper (2011) tested the relationship between vocal

attractiveness and leadership effectiveness using both field and laboratory samples. Their results revealed positive correlations in both conditions.

According to some researchers, voice quality seems to play an important role when it comes to mate selection context. Their findings are often interpreted from an evolutionary perspective. Sarah Collins (2000) argues that men with deeper voices, i.e. lower F0 (correlating with a higher testosterone level) and less dispersed formants (correlating with a longer vocal tract), are perceived as more attractive and more masculine, which is in line with other research (Feinberg et al., 2004, 2008; Vukovic et al., 2008; Saxton et al., 2009; Pisanski & Rendall, 2011, Xu et al., 2013). However, several factors have been reported moderating preferences for deeper voices, e.g. use of hormonal contraceptives (Feinberg et al., 2008).

As for female voices, several studies suggest that higher-pitched voices and breathier voices are perceived as more attractive/sexy. Breathy voice quality is associated with intimacy, confidentiality and arousal (Henton & Bladon, 1985; Collins & Missing, 2003; Liu & Xu, 2011). Higher F0 and formant frequencies are positively correlated with a smaller body size and youthfulness (Collins & Missing, 2003; Liu & Xu, 2011). Nevertheless, Borkowska and Pawlowski (2011) have shown that the relationship between female voice pitch and perceived attractiveness is not linear; female voices above approx. 280 Hz were rated as less attractive suggesting that women whose pitch is too high sound babyish and such voices are associated with sexual immaturity.

Evidence suggests that speakers can manipulate their voice both voluntarily and unconsciously in a variety of social contexts to convey desirable identity and situational images (Hughes, Mogilski & Harrison, 2014). Some studies show that American women who speak with creaky voice are often very successful, work in the sectors that are traditionally male-dominated, e.g. finance and print media (Anderson, Klofstad, Mayew & Venkatachalam, 2014) and are perceived as educated, urban-oriented and upwardly mobile (Yuasa, 2010). Creaky voice thus seems to be exploited when communicating intelligence, seriousness and determination. Given that this type of voice quality typically occurs when speakers lower their pitch, this interpretation is in line with research showing that speakers with lower-pitched voices tend to be perceived as stronger and more dominant (Puts, 2005; Borkowska & Pawlowski, 2011) and also more attractive if male but less attractive if female (Collins, 2000; Feinberg et al., 2004; Pisanski & Rendall, 2011).

Experimenters examining voice pitch modifications may apply two different approaches: speakers are asked to vary their delivery in a particular manner and researchers examine the impact of these variations (Fraccaro et al., 2012; Hughes et al., 2014), or speech synthesis/computational manipulations are applied to observe the effects of specific acoustic parameters – F0 and formants on the examined category/categories (Borkowska & Pawlowski, 2011; Pisanski & Rendall, 2011).

Fundamental frequency (F0) is an acoustic measure of the rate of vocal folds vibration and it is the primary acoustic correlate of perceived vocal pitch and an important correlate of perceived speaker's sex/gender. A man's larynx is about 20% larger than woman's and the length of the membranous part of vocal folds differs by 60% resulting in a lower rate of the vibration of vocal folds in men (and correspondingly in lower-pitched voices) (Titze, 1989). Mean F0 for men and women differs by about an octave; commonly stated average F0 in men is about 130 Hz and 220 Hz in women. These reported mean values may, however, vary across different cultures (Kreiman & Sidtis, 2011:125).

Formant frequencies (vocal tract resonances) are about 20% higher in females than in males corresponding to the difference in length of the vocal tract in men and women. Resonances cluster closer together in male voices than in female voices (Arnold, 2012). Formants are associated with percepts of timbre (Pisanski & Rendall, 2011), and similarly to F0, they contribute to the perception of pitch and speaker's sex/gender, however with a slightly less accuracy than F0 for the latter (Kreiman & Sidtis, 2011:129).

The aim of this study is to examine the effect of F0 and formant manipulations on perceived voice attractiveness and likeability in the Czech speaking context. In our experimental design, we decided to approach voice assessment using two categories: likeability relating to a more general context of social interaction and attractiveness implying a rather narrower context of mating. As for the latter, we wanted to test whether sex-typical pitch manipulations (lowering pitch in men and raising pitch in women) have a positive impact on our speakers' voices assessment as suggested by previous studies from different linguistic contexts mentioned in this section, and whether the same findings would be applicable to the perception of voice likeability.

## 2 Method

### 2.1 Stimuli

We recorded nine native Czech female and nine Czech male speakers (median age = 30) reading thirteen complex sentences of neutral content consisting of an equal number of syllables and containing solely voiced segments. The recordings were made at 48 kHz sampling frequency and 16-bit resolution using an AKG C4500 B-BC condenser microphone in the recording studio of the Institute of Phonetics, Charles University in Prague. For our perception test, we only used the first clauses of the complex sentences because we wanted to avoid the effect of declination e.g. the tendency of the intonation to drift downwards in pitch over the course of an utterance (Pierrehumbert, 1979), which could have a negative impact on average F0 value, and we also wanted to eliminate potential non-modal phonation types commonly occurring towards the end of the utterance making automated F0 detection difficult.

**Table 1**. Extracted F0 median values, F1 and F2 mean values for each speaker used in perception test.

| Speakers ID | F0 median (Hz) | F1 mean (Hz) | F2 mean (Hz) |
|---|---|---|---|
| **F1** | 215 | 450 | 1559 |
| **F2** | 204 | 506 | 1753 |
| **F3** | 179 | 539 | 1616 |
| **F4** | 205 | 427 | 1578 |
| **M1** | 128 | 498 | 1534 |
| **M2** | 138 | 457 | 1571 |
| **M3** | 109 | 462 | 1465 |
| **M4** | 106 | 400 | 1491 |

In our next step, we extracted the median F0 value for each stimulus using Praat software (median F0 is more suitable than mean F0 with regard to manipulations) (Boersma & Weening, 2015) and performed F0 and overall formant frequencies manipulations in four different ways using PSOLA (Moulines & Charpentier, 1990), as indicated in Table 2: 1) raising F0 by 3 semitones while holding formant frequencies constant, 2) lowering F0 by 3 semitones while holding formant frequencies constant, 3) raising F0 by 3 semitones while raising overall formant frequencies by 8%, 4) lowering F0 by 3 semitones while lowering overall formant frequencies by 8%.

**Table 2.** Performed manipulations.

| ID | Manipulation |
|---|---|
| 1 | F0 shifted by + 3 ST |
| 2 | F0 shifted by - 3 ST |
| 3 | F0 shifted by + 3 ST & formants by +8% |
| 4 | F0 shifted by - 3 ST & formants by -8% |

All the stimuli (18 speakers x 13 stimuli x 5 different stimuli versions: original version + 4 manipulated ones) were subject to an aural inspection and led to the selection of three stimuli x 5 stimuli versions by four male and four female speakers (see Table 1 for extracted frequency values ). All the selected stimuli were free from any speech errors, non-speech noise, as well as artefacts due to the manipulations. We obtained 120 stimuli for our perception test (8 speakers x 3 stimuli x 5 versions; the original stimuli were also subject to resynthesis).

The following 3 phrases consisting of 7 syllables and three stress groups were used in the perception tests: *Dáme vládě důvěru [We will put our trust in the government], Známe hodně důvodů [We know a lot of reasons]* and *Máme novou naději [We pin our hopes again].*

### 2.2 Test procedure and participants

Our objective was to examine the effect of both independent F0 manipulations and joint F0 and overall formant manipulations on two categories: perceived voice attractiveness and voice likeability. Therefore we created two different perception tests using ExperimentMFC (multiple forced choice) environment in Praat. Each test consisted of 96 pairs of stimuli grouped in five blocks with a short pause between them. The onset of the sequence of two stimuli, which consisted of an original stimulus and a manipulated one by the same speaker, was signalled by a short tone with a one-second pause between the stimuli. The order of all the items in the test session was randomized for each listener.

36 listeners (18 men and 18 women) took part in the perception tests (median age = 29). All the listeners were native speakers of the Czech language and none of them reported any hearing or speech disorders. They were divided into two groups; the first group (18 listeners; 9 men and 9 women) was asked to choose which voice they perceive as more attractive, the second group (18 listeners; 9 men and 9 women) was asked to decide which voice they perceive as more likeable. They could hear each pair of stimuli only once. Before the listeners proceeded to the actual voice evaluation within the perception tests, they were asked to rate four trial pairs of voice stimuli to make themselves familiar with the task. Each participant performed the test individually in a quiet room using high quality headphones; the duration of the test was approximately 15 minutes.

### 2.3 Analysis

To test our hypotheses, we used bootstrap method conducted in R (R Core Team, 2016). The final score for each listener was obtained in the following way: if the manipulated item was rated as the more attractive / more likeable, the value is +1, whereas if the original item was rated as the more attractive / likeable, the value is 0. The mean value for each target stimulus and the confidence interval were computed from 36 listeners (18 listeners x 2 rated categories) with the significance level $\alpha = 0.05$ and with Bonferroni correction applied.

## 3 Results

As shown in Figure 1, overall, it can be stated that our computational manipulations did not yield a significant effect on perceived vocal attractiveness or voice likeability.

Sex-typical manipulations in women, i.e. Manipulation 1 (F0 shift by +3 ST) and Manipulation 3 (F0 shift by +3 ST + formant shift by +8%) were not rated as more attractive or likeable by listeners. All the mean values and their confidence intervals are to be found below the value of 0.5, suggesting a distinct preference for the original stimuli.

As for sex-typical manipulations in men, Manipulation 2 (F0 shift by -3 ST) yielded a greater effect on rated voice likeability than Manipulation 4 (F0
shift by -3 ST + formant shift by -8%), however, the overall positive effect of Manipulation 2 on perceived voice likeability cannot be stated as significant due to confidence interval range containing values below 0.5. In case of perceived voice attractiveness, the mean values and confidence intervals for Manipulation 2 oscillate around 0.5, indicating an indistinct effect of the manipulation. The results for Manipulation 4 for both rated categories do not show a positive effect.

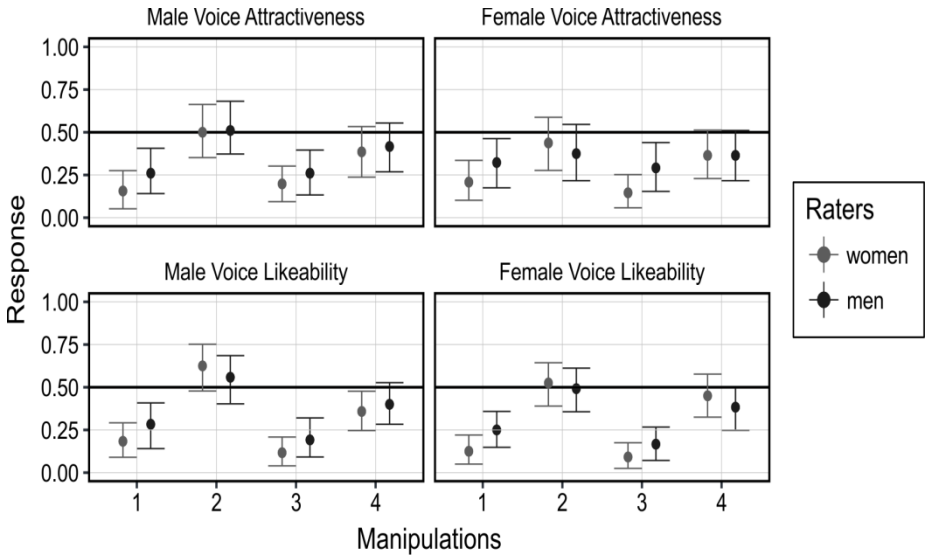


**Figure 1**. Voice attractiveness and likeability ratings. X-axis shows all four manipulations (see Table 1), y-axis shows mean values and confidence intervals for all 4 manipulations; +1 indicates the preference for the manipulated item, 0 indicates the preference for the original item.

Both Manipulations 2 and 4 representing sex-atypical manipulations in women seem to yield a greater effect on both attractiveness and likeability, with a slightly better result for the latter, than sex-typical manipulations (Manipulation 1 and 3).

Sex-atypical manipulations in male speakers, i.e. Manipulation 1 and 3, did show a worse effect of the manipulations on both rated categories.

Considering the mean values and their confidence intervals with regard to the male speakers obtained from female listeners, women seem to prefer the unmanipulated stimuli to the manipulated ones in all the cases except for Manipulation 2 (sex-typical) within perceived voice likeability. When rating female voices, women showed a greater preference for the manipulated items only in the case of Manipulation 2 in relation to both rated categories, and Manipulation 4 with regard to the rated likeability.

## 4 Discussion

The aim of the experiment was to investigate the effect of F0 and formant manipulations on the perception of vocal attractiveness and voice likeability in both male and female speakers of the Czech language. We wanted to test the hypothesis stating that sex-typical manipulations can increase perceived voice attractiveness based on the published literature (see studies mentioned in section 1). We also wanted to examine whether these findings would be applicable to the perception of voice likeability.

According to the results of our experiment, sex-typical manipulations (raising pitch in women and lowering pitch in men) do not necessarily lead to higher ratings of perceived vocal attractiveness as opposed to several voice attractiveness studies (e.g., Collins, 2000; Feinberg et al., 2004). Our findings revealed no significant preferences for the sex-typical manipulated stimuli neither in male nor in female Czech speakers. As for male voices, the independent F0 shift by -3 ST had a slightly better effect than when combined with the overall formant shift by -8% , however, female speakers showed no distinct preferences for the manipulated stimuli. Such findings are not in line with previous research examining the role of the fundamental frequency (associated with the level of testosterone and perceived masculinity) and formant frequencies (correlating with the overall vocal tract size) in attractiveness ratings suggesting that speakers with relatively low F0 and/or low formants are assessed as more attractive if male (Feinberg et al., 2004, 2008; Vukovic et al., 2008; Saxton et al., 2009; Pisanski & Rendall, 2011, Xu et al., 2013). Additionally, some studies suggest that women's

preferences for lower-pitched male voices may vary depending on the nature of mating contexts (short-term liaisons, long-term committed relationships), the phase of menstrual cycle (Puts, 2005; Feinberg et al., 2006) and oral contraceptives use (Feinberg et al., 2008).

Similarly, sex-typical F0 and formant frequencies manipulations in female speakers in terms of perceived attractiveness did not increase the listeners' ratings; the unmanipulated stimuli were preferred to the manipulated ones in both Manipulation 1 and 3. Several studies suggest that higher-pitched female voices are rated as more attractive (Collins a Missing, 2003; Saxton et al., 2009; Pisanski & Rendall, 2011; Xu et al., 2013) as higher F0 is associated with a higher degree of perceived femininity and younger age, and higher formant frequencies with a smaller body size. Our experiment, nevertheless, did not confirm such findings. Moreover, both Manipulation 1 and 3 were rated in a similar way by male listeners, suggesting that the role of the overall vocal tract size (associated with the apparent body size) does not seem to be significant in attractiveness ratings. Some empirical findings also suggest that the relationship between female voice pitch and perceived attractiveness is not linear; female higher-pitched voices are rated as more attractive up to an optimal pitch. If the pitch of the female voice is perceived as too high, it may sound babyish and may be associated with sexual immaturity (Berry, 1992; Borkowska & Pawlowski, 2011).

The effect of F0 and formant frequencies manipulations on perceived voice likability yielded similar results to these for perceived vocal attractiveness. Nonetheless, considering the width of confidence intervals of the obtained mean values in our experiment (see Figure 1), a certain difference between voice attractiveness ratings and voice likeability ratings can be observed. Confidence intervals for perceived vocal attractiveness are wider than for voice likeability suggesting more variability in ratings compared to perceived voice likeability. These findings are quite surprising – if perceived vocal attractiveness is thought to be of cross-cultural relevance and universal character, as suggested by the studies cited in section 1 approaching the topic of voice attractiveness from an evolutionary perspective, a relatively high inter-judge agreement should thus be expected.

The effect of listeners' sex/gender on the rated categories is also worth mentioning – both women and men seemed to evaluate perceived voice attractiveness in a similar way. Considering the fact that rating vocal attractiveness of same-sex speakers might be a rather difficult or unnatural task as suggested by Pisanski & Rendall (2011), this is an interesting finding. No significantly different ratings by the two genders can be observed. However, we can notice a stronger preference of women for the original stimuli in almost all manipulation conditions suggesting women's greater sensitivity to unnatural sounding stimuli as shown by Hughes and her colleagues (2014).

## 5 Conclusions

In this study, we focused on perceived voice attractiveness and likeability with regard to their social relevance as shown by previous research; people tend to attribute favourable personal traits to speakers whose voice is perceived as attractive or likeable. One of the aspects contributing to the perceived vocal attractiveness/likeability is voice pitch. Therefore we performed F0 and formant manipulations to investigate their effect on the examined categories.

As opposed to numerous empirical findings, our experiment conducted in the Czech context did not show a significant effect of F0 and formant manipulations on perceived vocal attractiveness and voice likeability. Listeners preferred the original stimuli to the manipulated ones although the manipulations did not introduce any audible artefacts into the sentences. Future research could therefore further explore the effect of voice pitch manipulations on the two rated categories in the Czech context - perceived vocal attractiveness and likeability.

Additionally, voice attractiveness and voice likeability ratings yielded similar results, although these two categories might not be interchangeable. It could therefore be of interest to investigate possible correlations between the two categories.

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# Single gene disorders and language phenotype

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**Abstract.** During the past few years, advances in genetic tools have lead to the recognition of several chromosomal copy number variants and single gene changes associated with onset of developmental milestones and deficits of speech and language.
Disorders of speech and language may be disregarded as they often present without clearly defined clinical appearance or phenotype, except of speech or language delays and sometimes only mild developmental delay.
Speech or language disorders are not often genetically evaluated, despite evidence sustaining a role for genetic factors in the etiology of these disorders. Because of that, individuals without a precise genetic diagnosis are less likely to receive optimal treatment including beneficial speech and language interventions.
Bearing in mind that are speech and language pathology also a symptom of several well recognized genetic conditions, such as 22q11.2DS, we try to look for potential gene candidates from the deleted region responsible for an isolated speech or language disorders. Regarding the involvement of genes from the 22q11.2 region in speech and language development, literature present some single gene disorders, such as homozygous deletion of *Sept5* and *GP1BB* gene deficits, associating in motor development, social-emotional function and speech/language development.
Early detection, diagnosis and treatment of speech and language disorders significantly influence psychosocial, cognitive and education outcomes, so it may improve children's quality of life and prevent serious consequences.
*Key words:* genes, developmental milestones, speech and language development

## 1 Introduction

Many disorders, as well as various functions, although inherited, are not present immediately after birth, but are revealed later in life. The last ten to fifteen years of age have seen significant advances in human genetics, and so the mechanisms of certain genetic disorders that lead to disorders of speech, language, hearing, cognition, behaviour and learning are finally described.

Spontaneous speech pathology occurs within certain global conditions in children, such as autistic spectrum of disorders, states of cognitive impairment, certain syndromes or hearing impairment, but can also occur in children with a regular developmental path, when there is no obvious cause of its occurrence (Bishop, 1995). Children with an isolated speech or language disorder are not often genetically evaluated, despite recent evidence supporting a role for genetic factors in the etiology of these disorders (Graham, 2013).

Speech and language pathology include speech disorders and language disorders. Speech disorders include voice problems and/or the inability to produce speech sounds correctly or fluently. Language disorders include expressive and receptive language disorders. Children with an expressive language disorder are more able to understand language than they are to express themselves with language. Such children also frequently have receptive language delay; difficulties to understand meaning of words of some language. Expressive and receptive language delay can occur separately or can occur together in children or person and either can be isolated or occur as part of a larger developmental delays. Through the past few years, advances in genetic technology have led to the identification of several chromosomal copy number variants (CNVs) and single gene changes associated with abnormalities of speech and language.

In the past years, researchers have been searching for loci and genetic causes that could explain the biological and neurological mechanisms of speech-language disorders. Studies suggest that linguistic language pathology is significantly dependent on genetic factors (Barry et al., 2007; Clark et al., 2007; Conti-Ramsden et al., 2007). Numerous twin studies have shown greater concordance among

monogamous twins compared to concordance among the twin twins, which again speaks in favor of the genetic impact on the development of speech and language (Bishop, 2002; Felsenfeld et al., 2000; Hayiou-Thomas, 2008).

A major negative aspect of the biological and neurological mechanisms of speech-language disorders reports is the lack of a consistent description of the type of speech/language disorder reported. As a consequence, the potential relevance of these reported genetic alterations to the causation of speech/language disorders is often not highlighted in the literature. Furthermore, in contrast to genetic syndromes, disorders of speech/language may be overlooked as they often present without clearly defined clinical features. This is particularly true when speech or language problems are the main presenting symptom in a child who has only mild developmental delay or otherwise normal development. Individuals without a precise genetic diagnosis are less likely to receive optimal management including beneficial treatment interventions. This paper summarizes the clinical features and etiology of known chromosomal and single gene disorders that are associated with some clinical features of speech and language pathology (Table 1).

## 2 Metodology

The aim of this paper was to report on monogenic and chromosomal disorders involving speech and language pathology. Information on chromosome and single gene disorders associated with developmental speech and language problems was extracted from Pub Med using search terms 'speech', 'language', 'chromosome' and 'mutation'. In addition, this report aimed to focus on primary speech and language pathology, which we define as speech and language pathology occurring in the setting of normal or only mildly impaired cognitive function.

## 3 Genetics (chromosomal) disorders

Copy number variants (CNVs) include deletions and duplications on chromosomes and are a common type of genomic variation. CNVs changes may range in size from a kilobase (kb) to several megabases (Mb) or even a whole chromosome (trisomies and monosomies) and may comprise one or more genes. CNVs can be detected using genomic microarrays, which are often used as a first-tier test in the evaluation of individuals with developmental delay, autism, epilepsy and/or congenital anomalies. Clinical interpretation of rare CNVs still remains challenging as many CNVs are rare and non-recurrent and large cohort studies of healthy control individuals have shown that each person carries multiple, most often benign, CNVs (Mefford H.C, et al., 2012).

In general, interpretation of the causality of a CNV in an affected individual is based on its frequency in healthy control individuals, the inheritance pattern in the respective family, the presence of overlapping aberrations in patients with similar phenotypes and the CNV characteristics such as size, copy number state (gain or loss) and gene content (Carter MT., 2011).

A CNV may result in disruption of gene structure or change in gene dosage. Where known, information on candidate genes underlying the phenotypical features is discussed.

In literature data speech and language pathology is often associated with several chromosomal disorders such as deletion of some part of chromosome.

Carter 2011.and colleagues reported less than 10 individuals with a deletion of chromosome 1p21.3 including genes DPYD and MIR137. They showed severe speech delay, features of ASD, normal gross motor development and absence of major medical problems. Cognitive function varied between IQ in the normal range and borderline-mild ID. Several individuals showed a discrepancy between verbal and performance IQ with a relatively low score on verbal capacities. Speech deficits included poor intelligibility and pronunciation difficulties. There is at least one report of an intragenic deletion in DPYD in a patient with speech delay and autism, suggesting that DPYD is a candidate gene for speech delay (Willemsen MH. 2011). Point mutations and intragenic deletions in DPYD confer carrier status for dihydropyrimidine dehydrogenase deficiency. Recently, a rare variant in MIR137 has been reported as a possible risk factor in schizophrenia and bipolar disorder.

The another autors reported that in most carriers of a 12p13.3 deletion the first symptom was speech delay, with first words at around 36–40 months (Thevenon J. et al., 2013). In some, walking development was also delayed. Variable expression within families has been reported. The majority showed borderline-mild ID. Some individuals had a normal IQ. However, retrospective interviews revealed all had speech delay and learning difficulties during childhood and none of them graduated secondary school. ADHD and behaviour problems have been frequently reported. The ELKS/ERC1 gene has been proposed as the best candidate gene as it is the only gene located in the smallest region of overlap in all individuals with 12p13.33 deletions and speech delay (Thevenon J. et al., 2013).

Literature data suggest that the patients with the proximal deletion of 15q region had speech and language and motor developmental delay in the Prader-Willi syndrome and Asperger Syndrom (AS) critical region (Burnside RD, et al., 2011). The possible involvement of this region in speech impairment reporting an increased absence of vocalisation in AS individuals that carry the larger deletion including this proximal region (Varela MC, et al., 2004). The 500 kb region includes four non-imprinted genes, NIPA1, NIPA2, CYFIP1 and TUBGCP5. Three of these genes are implicated in central nervous system development and/or function (Cox DM, 2015). Most individuals show normal development or only mild cognitive impairment (Burnside RD, et al., 2011). Speech delay has been reported in the majority of individuals, also as behaviour issues including ADHD or ASD, epilepsy and congenital heart disease (Vanlerberghe C., 2015).

Recreantly, we published paper about speech and language abilities at patients, monolingual speakers of Serbian language, with an autosomal dominant *heterozygous* microdeletion of the q11.2 band of chromosome 22 (Rakonjac et al., 2016a). This 22q11.2 DS is the most common microdeletion syndrome in humans (Kobrynski & Sullivan, 2007). Moreover, it is the second most common genetic syndrome associated with congenital heart malformations after Down syndrome (Bassett & Chow, 1999; Wiehahn et al., 2004) with an estimated incidence of approximately 1/4000 per live births (Fernandez et al., 2005). Most patients (90%) have a deletion of 3 Mb (encompassing ~60 genes); less frequent (8%) is a 1.5 Mb deletion (~28 genes); while a few patients have atypical deletions shorter in size and in variable locations (Beaujard et al., 2009). Speech impairment and delay in language development are common in patients with 22q11.2 microdeletion (Persson, Friman, Oskarsdottir, & Jonsson, 2012; Solot et al., 2001). Children with 22q11.2DS often exhibit persistent hypernasality and articulation skills that are significantly below those of their age peers (Kummer, Lee, Stutz, Maroney, & Brandt, 2007; Persson, Lohmander, Jonsson, Oskarsdottir, & Soderpalm, 2003; Scherer, D'Antonio, & Kalbfleisch, 1999). Additionally, a higher rate of apraxia characteristics was detected in this children compared to those with cleft lip and/or palate (Kummer, et al., 2007). Moreover, delay in language milestones is characteristic for children with the 22q11.2DS (Antshel, Kates, Roizen, Fremont, & Shprintzen, 2005). Decreased volume of babbling and less variety in vocal play are found in infants with VCFS during the prelinguistic, babbling stage of language development (Solot, et al., 2001). Furthermore, some literature data indicate that the majority of children (90%) with 22q11.2DS are nonverbal prior to age 2 or using just one single word for communication (Solot, Gerdes, & Wang, 1998, Rakonjac, et al., 2016a).

Beside these chromosomal deletions, literature data suggest single gene that are associated with some speech and language clinical features. Some of these are presented in Table 1.

**Table 1.** The table summarize chromosomal locus/gene of mutation/deletion which influence speech, language, learning and behaviour from literature data that we collect for this study. SLI- represents specific language impairment

| Locus | Gene | Speech and language, behaviour pathology | References |
|---|---|---|---|
| 2p23 | DNMT3A | *De novo*, autism specter disorder | Ryan KC Yuen et al. 2016 |
| 3p14 | FOXP1 | SLI | Pariani et al. 2009 |
| 4q28.3 | PCDH10 | autism specter disorder | Morrow et al., 2008 |
| 4q23 | EIF4E | autism specter disorder, intellectual disability | Christos G. 2013 |
| 6p22.1 | DCDC2 | dyslexia | Cope et al., 2005 |
| 6p21 | KIAA0319 | dyslexia | Cope et al., 2005 |
| 7q31 | FOXP2 | verbal dyspraxia | Fisher et al., 1998 |
| 11q13.2 | SHANK2 | autism specter disorder, intellectual disability | Christos G. Gkogkas et al., 2013 |
| 12q23.3 | GNPTAB | Stuttering | Kang C, Drayna D., 2012 |
| 13q | ROBO1 | Dyslexia, dyslalia; Absent of active speech until 2 years; Deficits in social interactions | Hannula-Jouppi et al., 2005. Beate St Pourcain et al. 2014. |
| 15q21.3 | DYX1C1 | dyslalia | Grigorenko et al., 1997; Wigg et al., 2004 |
| 16p13.3 | GNPTG, NAG PA | Stuttering | Kang C, Drayna D., 2012 |
| 16q24 | ATP2C2; CMIP | SLI | Newbury et al., 2009; SLIC., 2002 |
| 18p | DYX1C1 (DYX6) | dyslexia | Fisher et al., 1999, 2002, Wigg et al., 2004 |
| 19q13 | - | SLI | SLIC, 2002 |
| 20q13.13 | ADNP | *De novo*, autism specter disorder | Ryan KC Yuen, et al., 2016 |
| Xp22.3 | CLCN4 | Intellectual deficits from border to severe. Behavioral disorders and psychiatric disorders (autism spectrum disorders, mood disorders, obsessive compulsive disorders, auto and heteroagresion). | Palmer et al., 2016. |

## 4 Conclusion

Knowledge of genetics might assist speech-language pathologies in their understanding of how medical issues might influence treatments quality and duration, in setting up realistic goals and treatment targets for their patients, in improving communicating with parents and enhancing chances for cooperation with teachers about behavioural, emotional or learning difficulties associated with a genetic syndrome or disorder.

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## Genetički poremećaji i jezik

Tokom poslednjih nekoliko godina, napredak na planu genetičkog inženjeringa je doveo do detekcije nekoliko kopija varijanti gena i genetičkih varijanti koje se mogu povezati sa pojavom razvojnih faza i deficita govora i jezika. Poremećaji govora i jezika se obično zanemaruju u genetici jer su često prisutni bez jasno definisanog kliničke pojave ili fenotipa, osim kašnjenja govora i jezika, a ponekad i samo blagog kašnjenja u razvoju. Govorno- jezički poremećaji obično nisu genetički detektovani, uprkos dokazima uloge genetičkih faktora u etiologiji ovih poremećaja. Zbog toga se pojedinci bez precizne genetičke dijagnoze redje primaju u optimalni tretman. Imajući u vidu da je govorno-jezička patologija simptom nekoliko dobro priznatih genetičkih sindroma, kao što su 22q11.2DS, neophodno je tražiti potencijalne kandidate gena iz deletiranih regiona koji bi mogli biti odgovorni za izolovani poremećaj govor i jezika. Što se tiče učešće gena iz 22q11.2 regiona u govorno-jezičkom razvoju, literatura navodi homozigotnu deleciju gena Sept5 i GP1BB, kod dece sa udruzenim poremećajima u motornom, društveno-emocionalnom i razvoju govora / jezika.

Rano otkrivanje, dijagnostika i lečenje govorno jezickih poremećaja značajno utiče na psihološke, kognitivne i obrazovne aspekte pojedinca, tako da se ovim saznanjima može značajno poboljšati kvatetet života ove dece, a posebno sprečiti nastanak daljih ozbiljnih konsekvenca u razvoju ove dece, kao i u društvu u kom oni žive.

*Ključne reči:* geni, genetički faktori, razvoja govora i jezika

# Overview of the language neurobiology

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**Abstract.** With the advancement of cognitive neuroscience and neuropsychological research, the associated terminology of the language neurobiology community, is no longer adequate for contemporary investigations into the neurobiology of language. We review literature data and found that the classic model of the neurobiology of language is based on an outdated brain anatomy. Also, this model does not adequately represent the distributed connectivity relevant for language. On this way, its offers a cortical structures, for the most part leaving out subcortical regions and relevant connections. In this paper, we discuss novel literature data about the issue of anatomical specificity of the language neurobiology community. We found that literature data confirms that there is no consistent anatomical definition of speech-language areas, and propose to replace these terms with more precise anatomical definitions.
Bearing the literature data for this finding in mind, it is very important for speech and language pathologist to improve and update their knowledge about brain anatomy and conditions related to speech and language. Also, it is very important to recognize neurobiology and also genetic causes of communication disorders. This knowledge from neurobiology studies may provide new approaching into early identification of children at-risk for specific speech, language, literacy, and hearing disorders, which would encourage earlier interventions and stimulations of verbal communication, targeted at specific verbal or nonverbal deficits.
*Keywords*: speech, language, anatomical, brain anatomy

## 1 Introduction

There is no consistent definition of Broca's and Wernicke's areas, and propose that the terms' usage in contemporary models should be replaced by more precise anatomical definitions. Namely, we review literature data and found that the classic model of the neurobiology of language is based on an outdated brain anatomy. Here, we argue that the notion that a single fiber pathway, the arcuate fasciculus, supports language functions in the human brain is out of date. Without the two major pillars of the theory—i.e., the regions and their connections—we consider the model to be outdated, and suggest a path forward in defining a replacement. Also, the classic model of Broca's and Wernicke's areas does not adequately represent the distributed connectivity relevant for language. Following this, we overview data base on internet and undertake a brief review of the major advances in understanding the fiber pathway connectivity of the language network. The foundation of the Classic Model can be found in the pioneering clinical work of the French surgeon Paul Broca who, in 1861, based on observations of brain lesions and associated behavioral consequences, first described the posterior two thirds of the inferior frontal gyrus (IFG) as the seat of the ability to articulate language. Instead it was the German neurologist Carl Wernicke who, in 1874, described two patients who had difficulty understanding spoken language, even though their articulation was fluent (1). However, applied to contemporary research questions, with current knowledge of brain structure and function, the earliest Classic Model instantiations offer a spatial accuracy that is too limited to test modern hypothesis about brain/behavior relationships. For example, it is unclear if is one area located within the primary (core) auditory area (i.e., the transverse temporal gyrus, which is the main output of the ascending auditory projections from the medial geniculate body of the thalamus), or in the surrounding secondary (belt) auditory areas (2). Moreover, second area is not precisely localized within the inferior frontal area, and is assumed to be directly connected to the motor nerves (which we now know to be false).

Speech and language functions engage a very large number of brain regions that extend far beyond ''Broca's and ''Wernicke's areas", in the frontal, parietal, and temporal lobes, in the medial

hemispheres of the brain, as well as in the basal ganglia, thalamus and cerebellum (3).

In this review, we have attempted to provide novel insights into the biological mechanisms that contribute to human language ability. It is very important for speech and language pathologist to improve and update their knowledge about brain anatomy and conditions related to speech and language.

## 2 Metodology

Literature data overview passes on throughout the paper to a short survey that was conducted online. Literature data demontrated posted a short survey online and distributed through the Neurobiology of Language Society newsletter, and through targeted emails to language neurobiology researchers. Literature data suggest that a total of 159 responses were collected, most of them from PhD-level academics. The majority of the respondents (87%) reported working in an academic setting, and 11% reported working in a clinical or hospital setting (3% reported ‘‘Other”). Most (73%) reported holding a PhD; 13% a master’s degree; 9% a medical degree, and 4% a baccalaureate. Respondents worked in a variety of disciplines (speech and language pathology, psychology, biomedical engineering, neurology, linguistics/neurolinguistics), with an average of 9 years of experience (SD = 8.63 years; Max = 40 years).

Additionally, literature suggests that respondents reported familiarity with the classic model (94%), and good expertise in neuroanatomy (47% reported ‘‘A lot [extensive training and frequent use of neuroanatomy knowledge]”; 29% ‘‘Some [a single course in neuroanatomy]”; 20% ‘‘A little [some exposure in coursework]”; 4% ‘‘None”). Importantly, only 2% of the respondents endorsed the idea that the classic Model (in a generic sense, not referring to any particular iteration of the model) is the best available theory of language neurobiology. But it is notable that while 90% of respondents endorsed the notion that the Classic Model is outdated, they were split on whether there is a good replacement for the model. Only 24% endorsed the idea that the model should be replaced by another available model from the literature, but 19% suggested that there is not a good replacement. A large number of the respondents (47%) suggested that, while they thought the lassic model was outdated, they considered that it still served a heuristic function. Thus, the survey reflects a significant range of opinions about the Classic Model. Some support its use. In contrast, another respondent wrote ‘‘The ‘classic’ model is not a model of language neurobiology. It simply associates poorly defined functions to poorly defined anatomical regions. It doesn’t try to explain how any language-related processes actually happen in the brain.”

## 3 Update findings and discussion

In the past years, researchers have been searching for the biological and neurological mechanisms of speech-language disorders. Speech and sound disorder is a relatively common childhood disorder that affects the ability to produce and properly use speech sounds and include deficits in articulation, a range of phonological tasks, and/or cognitive representation of language (4). The disorder is heterogeneous depending on the severity, cause, speech errors, and involvement of other aspects of the linguistic system. Various subtypes have been proposed based on error types or underlying etiology, but a universal classification system is lacking (5). A subgroup of SSD has motor impairment (6), while the majority of cases have primarily affected phonological development. The conversational speech normalizes at later ages, but residual differences remain and can be identified in adults with a history of SSD. In adolescents with childhood history of SSD, involvement of speech production-related processes was supported by fMRI analysis that detected right lateralized hypoactivation in the inferior frontal gyrus, suggesting a deficit in the phonological processing loop that supports phonological memory, and also hypoactivation in the middle temporal gyrus that may indicate a deficit in speech perception (7).

To illustrate the issue with respect to Broca’s area, Hagoort (8, 9) begins this examination with a brief review of the Classic Model, states that it is a historical model, and then initially continues to

work within that framework, using the terminology of Broca's and Wernicke's areas. It is difficult, though, for Hagoort to work within this framework for long, because if he does so, he does not go very far toward advancing a new theory that is different in major respects from the Classic Model. His pivot is to take seriously the notion that - language is subserved by dynamic networks of brain regions. With this perspective in hand, Hagoort is careful to break up Broca's and Wernicke's regions into smaller anatomical parts. For example, his model parses the sub-regions of the IFG into pars opercularis, pars triangularis, and pars orbitalis, which he notes have different associated connectivity and functions (9). He does the same with the temporal and parietal lobes—in this way his model evolves to having nine nodes supporting language function, anchored by a network of fiber pathways. Thus, in order to present his new model, he makes a significant break with the Classic Model. Hagoort shows that the Classic Model terminology is too constraining, for him, to develop a serious model of language neurobiology in the face of new thinking about network architectures supporting cognition, which requires the specification of multiple interacting nodes within the network, and serious reflection on their connectivity. The new model specification is also more agreeable to empirical assessment using more modern analytic techniques, such as network analysis (10). The Classic Model cannot be tested with such techniques because, as a two-node, one connection model, it is too simple.

This consensus paper brings together a range of different viewpoints and opinions regarding the contribution of the cerebellum to language function.

Two centuries of research on cerebellar function have been dominated by the role of the cerebellum in motor control. The cerebellum seems to be directly engaged in the processing of—at least some—phonetic features. It must be noted, however, that other—aspects of speech timing such as the categorical perception of voice onset time and vowel duration appear more or less preserved in cerebellar patients, especially, when the respective portions of the acoustic speech signals encompass spectral energy and do not represent silent intervals (11, 12, 13). Similarly, cerebellar disorders were found to compromise motor tasks only in case of discontinuous movements characterized by an explicitly specified temporal goal, rhythmic continuous activities being spared (14). In addition to phonetic and phonological aspects of verbal communication, the cerebellum appears also to contribute to speech perception at the preceding stage of acoustic processing (15, 16) although textbook displays of the central-auditory pathways do not encompass the cerebellum (16).

Multitude of human genome sequence variants have emerged recently that are either functionally linked to or associated with phenotypes characterized principally as language ability. Such sequence variants are either present as allelic variants within the coding sequence of known genes and/or sequence variants in non-coding genetic elements. A similar range of sequence variants have also been shown to be associated with more complex phenotypes in which language impairment is only a part of the phenotypic spectrum of these clinical conditions. Additionally, numerous twin studies have shown greater concordance among monogamous twins compared to concordance among the twin twins, which again speaks to support the genetic impact on the development of speech and language (17, 18). In literature data usually is mentioned gen *FOXP2* which is crucial for the development of brain circuits involved in procedural learning and is found mutated in people with speech and language problems (19).

The gen and expression in brain tissue has also been related to disorders involving phonological deficits, such as dyslexia or speech-sound disorder (20, 21, 22,) but also to autism (23, 24). Recently, we published paper about children with heterozygous deletion on chromosome 22, locus q11.2, monolingual speakers of Serbian language and demonstrate that this children have a delay of language milestones and disorders in speech and language (25). On this way, we tried, once again, to discover gene candidate and their function- how gene expression in brain tissue during embryonic period which can cause speech and language pathology. Our future research might be good introduction in some novel findings in area of genetics and neuroanatomic networks.

## 4 Conclusion

Bearing the literature data for this finding in mind, it is very important for speech and language pathologist to improve and update their knowledge about brain anatomy and conditions related to speech and language. Also, it is very important to recognize neurobiology and also genetic causes of communication disorders. This knowledge from neurobiology studies may provide new approaching into early identification of children at-risk for specific speech, language, literacy, and hearing disorders, which would encourage earlier interventions and stimulations of verbal communication, targeted at specific verbal or nonverbal deficits.

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## Pregled neurobioloških istraživanja jezika

Sa napretkom neuronauke i neuropsihološkog istraživanja na planu kognitivnog razvoja, terminologija koja se odnosi na zajednicu jezika i neurobiologije nije više dovoljna da opise savremena saznanja iz oblasti neurobiologije. Pregledom podataka iz dosadašnje literature utvrdili smo da je dosadašnji, klasični model pristupanja neurobiološkim osnovama jezika zasnovan na zastarelim anatomskim saznanjima. Ovaj klasični, prevaziđeni model neadekvatno predstavlja povezane moždane oblasti koje su relevantne za jezik. Na ovaj način, ovaj dosadašnji model ukazuje na značaj moždanih struktura - Vernikeove i Brokine zone, dok su u najvećem delu izostavljene subkortikalne regije i druge relevantne veze.

U ovom radu, razmatramo nove podatke iz literature o problemu anatomske specifičnosti i neurobiologije jezika. Otkrili smo da literaturni podaci potvrđuju da ne postoji konzistentna definicija anatomskih govorno-jezičkih područja, te se sugeriše da se ovi dosadašnji pristupi zamene preciznijim anatomskim definicijama. Imajući literaturne podatke za ovaj nalaz u vidu, veoma je važno za audiolingviste-logopede da poboljšaju i ažuriraju svoje znanje o anatomskim i funkcionalnim oblastima odgovornim za nastanak govora i jezika. Takođe, veoma je važno prepoznati neurobiološke i takođe genetskičke uzroke poremećaja komunikacije. Ovo znanje iz neurobiologije može da omogući i približi ranu identifikaciju dece sa rizikom za specifične poremećaje govora, jezika, pismenosti i slušnih poremećaja, što bi takođe dovelo do ranih intervencija i stimulacije verbalne komunikacije, usmerene na specifične verbalne ili neverbalne deficite.

*Ključne reči:* govor, jezik, moždane strukture

# The importance of live blood analysis dark field microscopy in treatment of neurodevelopmental disorders

T. Antin Pavlović

**Abstract***:* Live blood analysis Dark Field Microscopy is a non-standard microscopic analysis based on the principles of the basic medical science (physiology, microbiology, biochemistry and immunology). It has been used since 1901 for the detection of Treponema pallidum, and 35 years ago it found practical application in the assessment of the body homeostasis and observation of the effects of various agents acting on the blood, and thus, the human body. Neurodevelopmental disorders intertwine functions such as verbal communication, behavior, attention, lack of social motivation and ability to establish social contacts and they occur as a consequence of the bio-psycho-social factors. The research of etiology of neurodevelopmental disorders has shown that the vulnerable genetic basis can affect the so-called "triggers" and "take" children's body in a pathological condition. "Triggers" include metabolic disorders, gut dysbiosis, nutritional imbalances, heavy metals, etc. Live blood analysis Dark Field Microscopy is a part of biomedical interventions and it became a methodological postulate in order to identify existing disorders and implementation of appropriate biomedical treatment. As part of biomedical interventions DFM is integrated in the Protocol for prevention and treatment of disorders of verbal communication, behavior and learning in children up to the age of 3", as the Innovation Project of the Ministry of Science and Technological Development of Republic of Serbia, 2012. Stressing the need for an integrative approach, Dark Field Microscopy analysis has made significant contributions to the concept of prevention, diagnosis and early treatment of neurodevelopmental disorders.
*Keywords*: Live blood analysis Dark Field Microscopy, Neurodevelopmental disorders, Biomedical interventions

## Introduction

Neurodevelopmental disorders include Autism Spectrum Disorders (ASD), attention-deficit hyperactivity disorder (ADHD), Specific Learning disorders, Intellectual disability (also known as mental retardation), Communications disorders and Motor disorders. ADHD and ASD are among most common of the neurodevelopmental disorders. Children with neurodevelopmental disorders can experience difficulties with language and speech, social interactions and communications, behavior, attention, memory, learning or other neurological and cognitive functions. Genetics can play an important role in many neurodevelopmental disorders, and some cases of certain conditions such as intellectual disability are associated with specific genes. However, most neurodevelopmental disorders have complex and multiple contributors rather than any one clear cause. These disorders likely result from a combination of genetic, biological, psychosocial and environmental risk factors. There is credible evidence that many neurodevelopmental disorders are the result of complex gene–environment interactions. A broad range of environmental risk factors may affect neurodevelopment, including, but not limited to, maternal use of alcohol, tobacco, or illicit drugs during pregnancy, lower socioeconomic status, preterm birth, low birth weight, the physical environment, and prenatal or childhood exposure to certain environmental contaminants like lead, methyl mercury, organophosphate pesticides, polybrominated diphenyl ether flame retardants (PBDEs), bisphenol A(BPA), arsenic and perchlorate.

Neurodevelopmental disorders often coexist with other types of co-comorbidities. Many children and adults with a diagnosis of autism spectrum disorder (ASD) have comorbid health problems. Comorbidity is the presence of one or more additional diseases or disorders co-occurring with a primary disease or disorder. A detailed assessment conducted by the US Centers for Disease Control and Prevention demonstrated that children with autism had much higher than expected rates of all of the medical conditions studied, including: eczema, allergies, asthma, ear and respiratory infections, severe headaches, migraines, nutritional deficiencies or imbalances, oxidative stress, acquired mitochondrial dysfunction, gastrointestinal problems such as non-celiac food sensitivity, abnormal bacterial flora, gut dysbiosis. Current neurological, immunological, metabolic, endocrinological, and

epidemiological research is at the leading edge of a paradigm shift in our understanding of ASD. Studies published in the recent years confirm many earlier findings of widespread biomedical abnormalities in autism. While autism has been commonly assumed to be a neurodevelopmental and behavioral disorder and kept within the boundaries of psychiatry and neurology, it is now increasingly recognized **as a whole-body disorder**, with the core deficits in communication, social interaction, restrictive/stereotypic behaviours, and other commonly seen behaviours that have been attributed to ASD, being surface manifestations of a systemic and complex disease process.

Biomedical interventions are a group of interventions that are designed to diagnose and identify and then stop or reduce the negative effect of biomedical problems – medical comorbidities in ASD and other neurodevelopmental disorders. Biomedical abnormalities can cause anxiety, aggression, agitation, irritability, impulsivity, lack of focus, disturbed sleep, self-harming, self-stimulatory behaviours, lack of coordination, and visual, tactile and auditory oversensitivity in children and adults with neurodevelopmental disorders.

## Dark Field Microscopy - A Microscopic Viewing Of Living Cells

A valuable part of biomedical procedures is Live Blood Analysis Dark Field Microscopy. It is non-standard microscopic analysis, based on the principles of basic medical science (physiology, microbiology, biochemistry and immunology). It has been used since 1901 for the detection of Treponema pallidum, and 35 years ago it found practical application in the assessment of body homeostasis and observation of the effects of various agents acting on the blood, and thus, the human body. Live Blood Analysis uses a drop of peripheral blood taken from the patient's finger and then viewed under a compound microscope using a Dark field condenser. Conventional methods of blood analysis use chemical stains to help colour certain morphologies in the blood and make them visible, but at the same time it kills most of what is alive in the blood. Under a Dark Field microscope, the blood sample is neither dried nor fixed - it remains alive and active, allowing the viewer to see and discover the secrets of invisible, unknown “microcosms”. With dark field microscopy the light does not travel directly through the specimen, but comes in from the sides and only light which is reflected by the specimen is viewed against a dark background, hence “dark field microscopy” as the background field is black or very dark. In this way a highly contrasted image is obtained and there is no need to use a stain. Therefore, the living material is seen. Dark field condenser enables to identifying different appearances in blood plasma like heavy metals, fungal forms, cholesterol crystals, etc., which the standard light microscopy techniques cannot show.

There are much health information that the astute scientist can determine from viewing live blood - observations are made on variations in size, shape, ratios and fine structure of red blood cells, white cells, platelets and blood plasma. Observations can infer:

• Nutritional deficiencies – determined by the shape and size of the erythrocyte and other morphologies.

• Organ-system dysfunctions – some morphologies can reflect dysfunctions with the liver, the pancreas, the gut and so forth.

• Gut Permeability and Digestive health.

• Antioxidant levels and Free-Radical impact.

• Certain biochemical imbalances, particularly in relation to the pH of the body tissues.

• Immune surveillance and activity – according to the viability of the white blood cells.

## Reading Live Blood in Children with Neurodevelopmental Disorders

In a healthy, well-balanced individual with adequate nutrition, with no enzyme deficiencies, without physical, chemical and mental stress caused by acting free radicals, the red blood cells should be free flowing within the black-colored liquid called plasma. Normal healthy erythrocytes are round in appearance with no irregularities in the cell wall. They are neither clumped nor stacked and they have the correct number, size and types of forms, and do not show advanced pleomorphic development. White blood granulocytic (Neutrophiles) appear as motile white masses when viewed under the dark field microscope with moving granules within the cell wall. Normal ratio between red

and white blood cells is 1000:1-3. **Normal healthy blood** is most rarely obtained in neurodevelopmental disorders. *(Fig.1)*

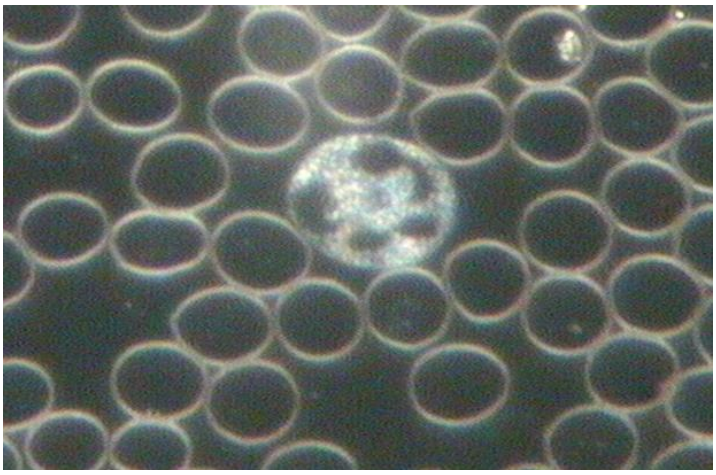

**Fig.1.** Normal healthy blood

**Protein Linkage, Rouleaux formations, Erythrocyte Aggregation:** protein linkage (*Fig.2*) is characterized by the tendency of the red blood cells to stick together with a minimal amount of surface area touching. This gives the appearance of the cells stretching out and touching point-to point**.** With rouleaux, the red blood cells appear in stacked columns, forming a shape of a necklace and it is worse stage of protein linkage (*Fig.3*). Erythrocyte aggregation is an unmistakable, mass clumping of the red blood cells. It is a strong indication of the inability to digest and assimilate protein from milk and whey (gluten and casein). It is one of the more seriously detrimental blood pictures *(Fig.4)*

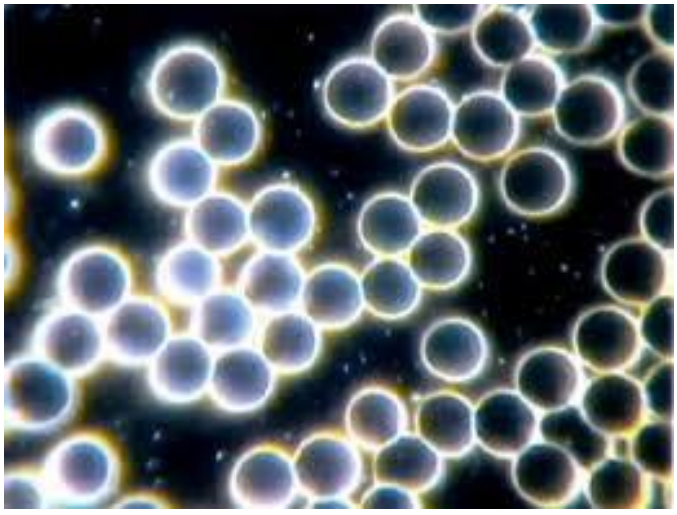

**Fig.2**. Protein linkage

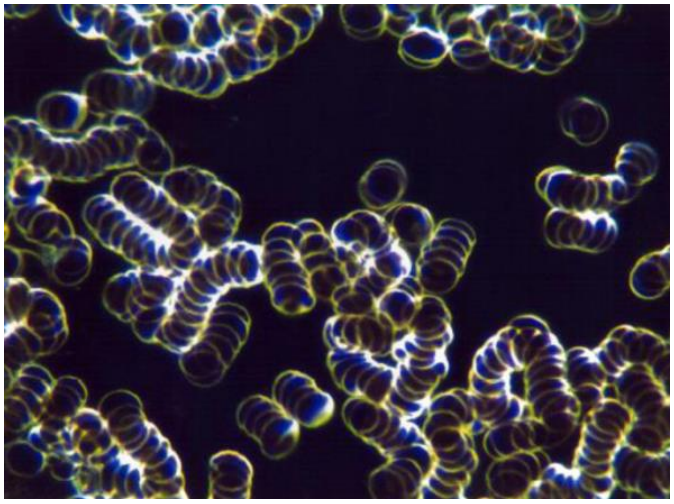

**Fig.3.** Rouleaux formations

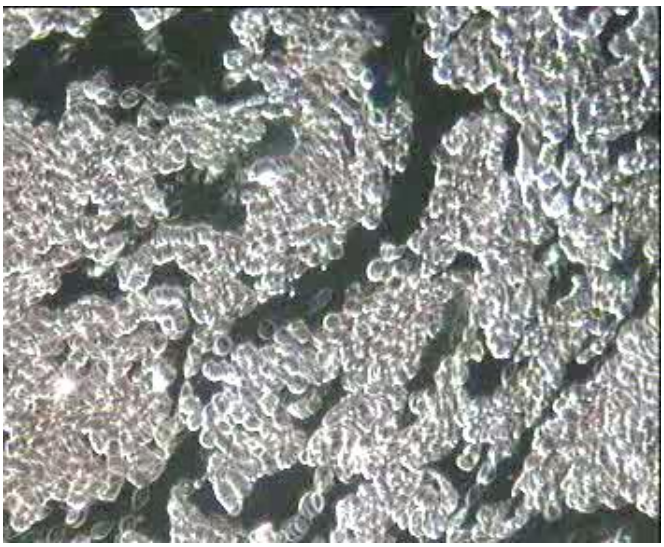

**Fig.4.** Erythrocyte Aggregation

This findings are related to water deficiency, deficiency of trace minerals, digestive insufficiency, non-celiac gluten sensitivity, excessive meat, milk and diary products consumption, passive smoking, Ph blood imbalance, inflammatory processes, poor physical activity, hormonal imbalances, etc. Erythrocyte aggregation is a strong indication of the inability to digest and assimilate protein from milk and whey (gluten and casein).

The presence of massive rouleaux and erythrocyte aggregation causes the impairment of blood flow in the small vessels that can compromise the red blood cells ability to exchange carbon dioxide and oxygen gases. This results in localized hypoxia and acidosis as well as generalized fatigue and less than optimum performance. Other signs and health consequences are sleepiness, fatigue, weakness, muscle and joint aches, headaches, feeling of being "hung over", cognitive dysfunction like poor memory, attention problems, lack of concentration.

**Spicules- fibrinous threads:** Fibrin is produced from fibrinogen, a protein which is dissolved in the blood and plays an important role in the clotting process. The fibrin precipitates as needle-like projections which look and appear as long white strands under dark field microscopy. *(Fig.5)*

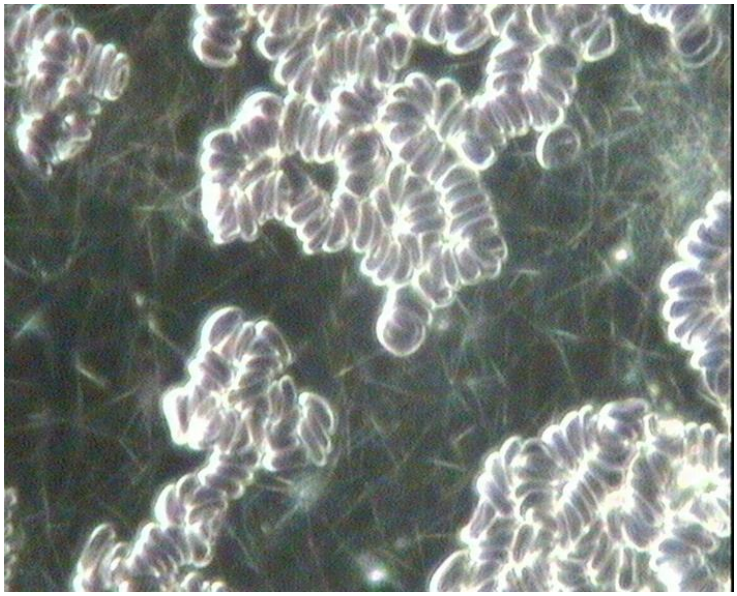

**Fig.5.** Spicules- fibrinous threads

The appearance of these white strands in a properly taken blood sample is considered to be an indication of incomplete protein (gluten, casein) digestion and poor assimilation, problems in gut permeability, digestive enzymes deficiencies, inflammatory process (acute or chronic), intestinal disorders, liver intoxications, etc.

**Echinocytes and Acanthocytes:** they are related to the impact of free radicals and they are the sings of oxidative stress. Echinocytes *(fig. 6)* are red blood cells that no longer have a smooth cell wall surface and have lost their characteristic shape. They still appear round, but they have become rough and thorny projections of consistent length in appearance (looks like chestnut or thorn-apple). Acanthocytes *(fig.7*) are red blood cells with an irregular pattern of coarse projections along the outer surface of the cell membrane. They differ from the echinocytes in that that the spicules vary in length. The spicules on an acanthocyte will tend to appear as bumpy protrusions as opposed to the fine thorny appearance of the echinocyte spicules. Unlike echinocytes, which acquire their appearance due to free radical damage in the blood, acanthocytes are poorly formed in the bone marrow under conditions of excessive free radical activity. The discovery of a large percentage of irregularly shaped erythrocytes is a valid reason to further investigate the potential sources of toxic exposure of the patient. Evaluation of nutrient status should also occur in these patients since vitamin E, beta-carotene, Co Q10 and vitamin C nutritional status may affect the body's ability to metabolize various toxins and successfully adapt to toxin exposure. The presence of echinocytes and acanthocytes in native blood sample could be a red flag for possible oxidative stress in brain tissue. The lipid peroxidation of cellular neurons membranes provoked by high level of oxidative stress is considered one of the main biochemical mechanisms involved in the pathogenesis of mental illnesses. Nerve tissue is susceptible to oxidative damage, due to the high extent of metabolic process, high content of polysaturated fatty acid and relatively low level of anti-oxidative defense system.

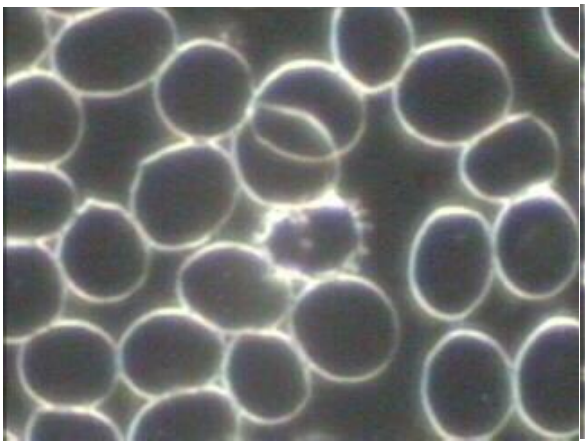

**Fig. 6.** Echinocytes

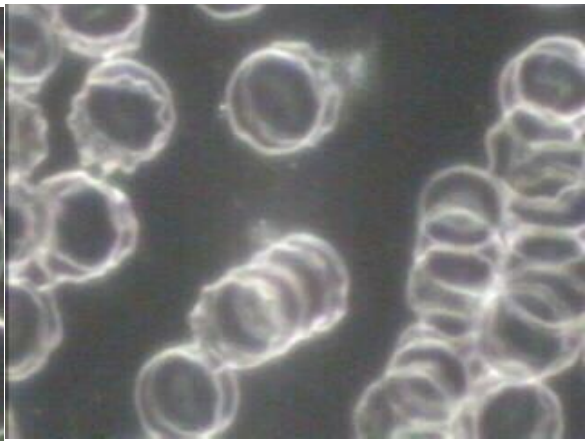

**Fig.7.** Acanthocytes

**Fungal forms:** Yeast and other fungal forms in the blood indicate that the normal balance of the immune system is upset and has allowed these forms to proliferate beyond the normal boundaries of the intestinal tract. The principle yeast found in the blood is Candida Albicans ( Fig.8).The presence of fungal forms is related to high intestinal permeabilty, fungal dysbiosis, poor assimilation of nutrients and an acidic condition in the body fluids. It is also likely that incomplete digestion and malabsorption of carbohydrates allows the generation of these fungi which under the phase contrast microscope appear as white disc-like objects in the blood. The number of these white disks observed shortly after the sample is placed under the microscope is indicative of the level of fungal activity. Leaving the sample up for an extended period of time (twenty minutes or more) will accentuate fungal growth.

**Fig.8.** Fungal forms

**Heavy metals (Mercury, Lead, Cadmuim):** are natural components of the Earth's crust and they cannot be degraded or destroyed. To a small extent they enter our bodies via food, drinking water and air. As trace elements, some heavy metals (e.g. copper, selenium, zinc) are essential to maintaining the metabolism of the human body. However, at higher concentrations they can lead to poisoning; heavy metal poisoning could result, for instance, from drinking-water contamination (e.g. lead pipes), high ambient air concentrations near emission sources, or intake via the food chain. Heavy metals appear in blood plasma as a small shining dot with concentric circles surrounding it. (Fig. 9)

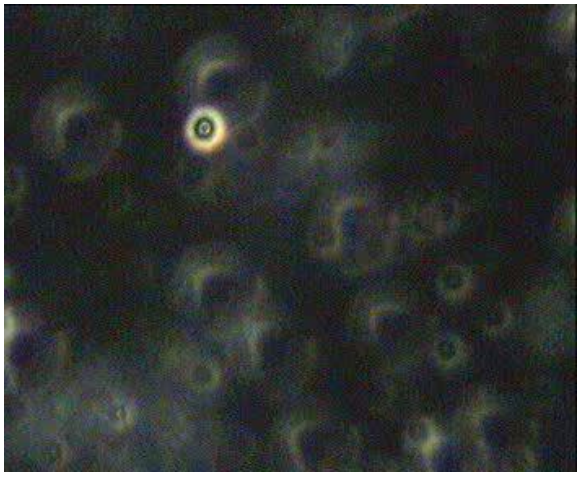

**Fig.9.** Heavy metals

**Target cells, Anisocytosis:** Target cells *(Fig.10)* are seen in hypochromic anemia, liver disease and on occasion following splenectomy. Erythrocytes with this configuration are cells lacking iron; therefore any disease process that affects red cell iron absorption may produce target cells. Anisocytosis *(Fig.11)* refers to abnormal size variations in the red blood cells. Some cells appear larger than the norm of 7-7.2 microns, and some smaller than the norm. It is observed along with anemia (Iron, vitamin B12, B6, Folic Acid deficiencies) and liver dysfunction and is characterized by RBC's that exhibit more than normal variation in size. It may be related to a number of different imbalances, which may be caused by poor diet, loss of blood, industrial poisons, or any of several other conditions affecting the metabolic balance of the body.

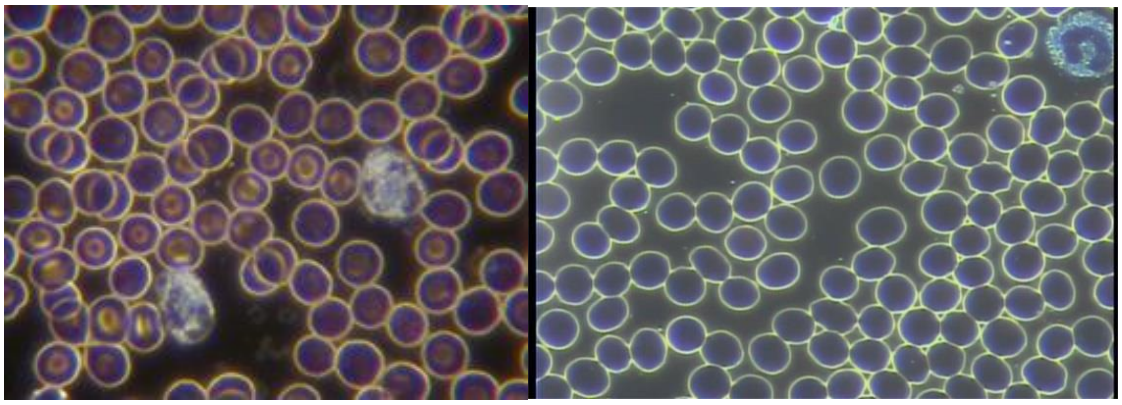

**Fig.10.** Target cells

**Fig. 11.** Anisocytosis

## Conclusion

Live Blood Analysis Dark Field Microscopy is an important part of biomedical interventions because it enables identifying specific environmental factors that increase risk of neurodevelopmental disorders and detect different medical comorbidities conditions such as gastrointestinal abnormalities, immune dysfunctions, detoxification abnormalities, nutritional deficiencies or imbalances, presence of heavy metals, etc. However, it can often give directions towards the further diagnostic testing. Dark field analysis is also a guide for prescribing dietary interventions and special food supplements. It is integrated in the Protocol for Prevention and Treatment of Disorders of Verbal Communication, Behaviour and Learning in Children up to the Age of 3, as the Innovation Project of the Ministry of Science and Technological Development of Republic of Serbia published by The Institute for Experimental Phonetics and Speech Pathology "Dr Đorđe Kostić" in Belgrade, 2012. Stressing the

need for an integrative approach, Dark Field microscopy analysis has made significant contributions to the concept of prevention, diagnosis and treatment of neurodevelopmental disorders.

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## Značaj Darkfield mikroskopskeanalize nativne kapi krvi u tretmanu neurorazvojnih poremećaja


Darkfield mikroskopska analiza nativne kapi krvi je vanstandardna mikroskopska analiza, zasnovana na principima bazične mediciske nauke ( fiziologije, mikrobiologije, biohemije i imunologije) i primenjuje se od 1901. godine za detekciju *Treponeme pallidum,* a od pre 35 godina je našla praktičnu primenu u proceni homeostaze organizma i posmatranju efekta delovanja najrazličitijih agenasa na krv, a samim tim i na ljudski organizam.

Neurorazvojni poremećaji prožimaju funkcije kao što su verbalna komunikacija, ponašanje, pažnja, motorna aktivnost, socijalna motivisanost i sposobost za uspostavljanje socijalnog kontakata i posledica su delovanja bioloških, psiholoških i društveno- kulturnih činilaca; smatra se da na vulnerabilnu genetsku osnovu deluju »okidači » koji narušavajući homestazu mogu »odvesti« dečiji organizam u patološko stanje. Kao okidači se navode metabolički poremećaj nekomletne digestije glutena i kazeina, deficit nutritivnih elemenata, teški metali, intestinalna disbioza, intolerancija na hranu... Darkfield mikroskopska analiza nativne kapi krvi je deo biološkog seta pretraga koji je uveden kao metodološki postulat u cilju otkrivanja faktora koji remete homeostazu organizma i u cilju sprovođenja odgovarajućeg biomedicinskog tretmana. Kroz biološki set pretraga DFM je integrisana u »Protokol prevencije i lečenja poremećaja verbalne komunikacije, ponašanja i učenja dece od 0-3 godine« , kao Inovacioni projekat Ministarstva za nauku i tehnološki razvoj Republike Srbije 2012. godine.

Ističući neophodnost integrativnog pristupa, Darkfield mikroskopska analiza je dala značajan doprinos u koncepciji prevencije, dijagnostike i tretmana neurorazvojnih poremećaja, jer se samo na taj način organizam deteta dovodi u fiziološki optimum.



*Ključne reči*: Darkfield mikroskopska analiza nativne kapi krvi, neurorazvojni poremećaji, biomedicinski tretman

# Hyperbilirubinemia as a potential predictor of speech and language deficits expression

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**Abstract.** There are certain brain regions particularly vulnerable to elevated bilirubin. Based on this sensitive areas it is possible to anticipate cognitive or behavioral deficit. Even moderate elevations of bilirubin are associated with various developmental delays and learning problems. We compared oral praxis and articulation skills of children with speech and language deficits who had elevated bilirubin and children with normal levels of bilirubin. The results showed that children with speech and language deficits with elevated bilirubin had more difficulties in developing speech and language abilities, particularly articulation skills, compared to children with speech and language deficits and normal bilirubin levels. It is important to consider elevated bilirubin as a potential risk factor and to include these children in early stimulation and treatment in order to prevent future potential deficits.

## 1 Introduction

As well as risk factors during the pregnancy, various risk factors during labor and after the birth may have a negative influence on early child development, including the process of speech and language acquisition. Intrauterine development might be affected by the biological and environmental factors. Prenatal or intrauterine development is referred to fetal development from conception till birth and lasts 40 weeks. All conditions under which the fetus is developing, as well as the conditions during the delivery and after the birth, have a role in creating the basic capacity of the child given at birth. This is the main factor that determines the development of child`s abilities for accepting and using environmental influences (Barlov, Jelicic, Sovilj & Vujovic, 2007). The brain development in the perinatal period is characterized by differentiation and maturation of oligodendrogliocytes which are responsible for myelination, a neurodevelopmental process that peaks during this period (Thompson & Nelson, 2001). Therefore, premature infants are vulnerable to abnormal brain myelination from developmental disruption or injury during the critical period of perinatal brain development.

One of the postnatal risks may be an extremely neonatal hyperbilirubinaemia that may translate into a chronic bilirubin encephalopathy. Neonatal jaundice is arguably the most common syndrome encountered by pediatricians and occasionally presents as a pathologic phenotype reflected in an abnormal elevation or pattern of circulating bilirubin (hyperbilirubinemia) in the transitional period after birth (Bhutani, Johnson & Sivieri, 1999; Avery, Fletcher & MacDonald, 1999).

Extreme neonatal hyperbilirubinemia has been known for a long time to cause the clinical syndrome of kernicterus or chronic bilirubin encephalopathy. Bilirubin – a breakdown product of hemoglobin catabolism – is a pigment which is extremely toxic to biological systems, and especially to the nervous system (Hansen, 2000; Shapiro, 2005). The chronic condition of kernicterus may be, but is not always, proceeded in the acute stage by acute bilirubin encephalopathy. Hearing loss is a common feature of kernicterus and carries with it the expected challenges in language and speech development.

Clinically, may manifest after the neonatal period as developmental delay, cognitive impairment, speech and language deficits and disordered executive function. In many cases, affected children have multiple risk factors for neurodevelopmental impairment including specific effects on developmental delay, cognition, speech and language development, executive function, and the neurobehavioral disorders, such as attention-deficit/hyperactivity disorder.

The concept of risk is crucial for prevention programs. In terms of language impairment, to be at-risk means that “individuals with certain characteristic are more likely to have undiagnosed language

impairment or will develop this condition in the future than individuals without these characteristics" (Finkelstein & Ramey, 1980). Also, early neonatal risks in newborns can later lead to development problems in the field receptive and expressive communication skills in the areas of attention, playing, gesture, vocal development, social communication, vocabulary, concepts, language structure, integrative language skills, and phonological awareness. That is important so effective intervention can be initiated at an earlier age to reduce neuromorbidity and maximize functional potential.

## 2 Method

The examined group consisted of 80 children at the age between 3 and 7 years (mean 4.8; median 4.8) who were diagnosed with speech and language impairment according to estimation by IEPSP Test Battery. All children were on continuous audio-linguistic treatment in Institute for experimental phonetics and speech pathology (IEPSP) in Belgrade where the research was conducted. The children were divided into the two groups matched by age and gender. In one group were the children with elevated levels of bilirubin at birth (24 boys and 16 girls) and on the other, children with normal levels of bilirubin at birth (24 boys and 16 girls). The data of bilirubin levels were collected from children's medical files. Speech and language evaluation was done by speech therapist from IEPSPS with following tests from IEPSP Test Battery: Test of oral praxis and Global articulation test. The data were statistically analyzed. The correlations analysis were used in order to determine whether elevated levels of bilirubin at birth was related to oral praxis and articulation skills of children with speech and language impairment.

## 3 Results and Discussion

The sample consisted of 80 children with speech and language impairment. Adequate data for analysis was available for all participants. The mean level of bilirubin in the group of children with elevated levels at birth was 239μmol (SD = 18.9, median 235) with a range from 210μmol to 296μmol.

Test of oral praxis includes 31 oral movements that child should repeat after the examiner had demonstrated it to him. Children with elevated levels of bilirubin at birth had correctly performed an average of approximately 18 of maximum 31 movements while in the other group children performed approximately 21 movements.

Furthermore, we compare articulation skills in these two groups of children. Taking in consideration that children at the 5.5 years of age should not have articulation errors (Kasic, 2003) we excluded all developmental errors in younger children. A higher number of articulation errors (deviations and/or replacements of sounds) were detected in the group of children with elevated levels of bilirubin at birth. Namely, from 30 sounds in Serbian language, children from this group made an average of approximately 12 articulation errors (minimum 5 and maximum 21). In the Table 1 are presented types of articulation errors from both groups of children.

**Table 1.** Articulation errors

| | Distortion | | Substitution | | Omission | | Sum | |
|---|---|---|---|---|---|---|---|---|
| | max | mean | max | mean | max | mean | max | mean |
| With elevated bilirubin | 19 | 8 | 11 | 3 | 7 | 1 | 21 | 12 |
| Without elevated bilirubin | 12 | 5 | 10 | 4 | 5 | 1 | 16 | 9 |

The correlations analysis (Table 2) were run in order to determine whether elevated levels of bilirubin at birth was related to oral praxis and articulation skills of children with speech and language impairment. The elevated levels of bilirubin at birth were positively correlated with articulation skills ($r=0.324$; $p<0.003$) and there was negative correlation between articulation and oral praxis skills

(r=0.383; p<0.000). Association between the elevated level of bilirubin at birth and oral praxis skills was not found.

**Table 2**. Correlation analysis

| | Bilirubin | Oral praxis | Articulation |
|---|---|---|---|
| Bilirubin | 1 | | |
| Oral praxis | - .199<br>.077 | 1 | |
| Articulation | .324**<br>.003 | -.383**<br>.000 | 1 |

The results revealed that children with elevated levels of bilirubin at birth had more difficulties during adequate articulation acquisition with more errors comparing with their peers who had normal levels of bilirubin at birth. Additionally, we found the negative correlation between oral praxis skills and articulation skills, which imply that deficit in motor planning, may influence articulation skills.

Limitations of this study are a smaller sample size compared with literature and for more detailed evaluation of speech and language further studies should consider to include more tests.

It should be pointed out that elevated levels of bilirubin at birth may have a significant role in the further child's development, especially on speech and language development. According to that, it is important to implement activities and procedures which would recognize elevated levels of bilirubin as a potential risk factor and prevent all consequences and adverse outcomes.

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## Hiperbilirubinemija kao potencijalni prediktor ekspresivnih deficita govora i jezika

Povišene vrednosti bilirubina imaju značajan uticaj na određene delove mozga. Moguće je predvideti kognitivne ili deficite ponašanja na osnovu ovih osetljivih zona. Čak i umerena povećanja nivoa bilirubina su povezana sa različitim razvojnim problemima i problemima učenja. Grupu dece sa govorno-jezičkim poremećajima smo podelili u zavisnosti da li su imali povišene vrednosti bilirubina na rođenju ili ne. Poredili smo veštine oralne praksije i artikulacije, kao i ukupan rezultat na skali za

procenu psihofizioloških sposobnosti deteta. Rezultati su ukazali da je grupa dece sa povišenim vrednostima bilirubina imala više teškoća u razvoju jezika u poređenju sa decom čije vrednosti bilirubina nisu bile povišene. Od velikog je značaja razmotriti bilirubin kao potencijalni riziko faktor i decu sa povišenim vrednostima nakon rođenja uključiti u rani stimulativni tretman kako bi se prevenirali budući poremećaji.

# Risk factors in children with speech, language, learning and behavioral disorders and type of delivery

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**Abstract**. The conditions under which intrauterine development is happening and the factors during and after childbirth, are fundamental for creating the basic capacity of the child's organism that it brings by birth. Development of its primary capacities is dependent on that basic capacity, but also the ability to receive and use the influence of the external environment. Each child comes to the world in the best possible way and the experience he/she acquires during the conception, pregnancy and birth period prepares him to adapt to the environment in which he will live. In the last half century, childbirth at the hospital has become a standard and at the same time the percentage of Caesarean sections has increased .
*The aims of the study were to establish:*
The aims of this research were to determine:
1. risk factors during pregnancy and birth that are present in children with speech, language and behavioural disorders (maternal and birth-related risks for babies) and
2. types of childbirth by which these children were born.
*Methodology*: The sample consisted of 205 children aged 2 to 7 years who were admitted to the Institute of Experimental Phonetics and Speech Pathology "Đorđe Kostić" and diagnosed with speech, language, learning or behavioral disorders and started the audiolinguistic treatment in 2015.
*Results*: The reasults of our study showed that 33% of mothers had some risk during pregnancy and that 47% of children with speech, language, learning or behavioral disorders had one or more (up to six) birth risks factors. The first four most frequent risks in the ranking are: prolonged jaundice, asphyxia, nuchal cord and torticollis. The risks associated with the mother were: infection/bacterial or viral (upper respiratory tract, vaginal, digestive, urinary) (32%), stress (31%), elevated pressure (26%), diabetes (0.7%), intervention during pregnancy (amniocentesis) (0.5%), others (anemia, myoma, gestational diabetes, preeclampsia, eclampsia, Rh incompatibility, hydronephrosis, thyroid disorder) 9.8%. Sixtythree precent of children with speech, language, learning and behavioral disorders were born by delivery during which the anesthesia was used. Of that, 29% were planned Caesarean section, 14% were emergent Cesarean section and 20% vaginal delivery with epidural anesthesia.
*Conclusions:* The highest percentage of children with a risk were born by delivery with anesthesia, a total of 28%, while 18% of risk children were born with vaginal induced delivery, which indicates further comparative studies on the effect of additional oxytocin used in the process of induction of labor and anesthesia and medicines used during the Cesarean section and their relationship with certain types of speech, language, learnig and behavioral disorders and the severity of the clinical picture.

## 1 Introduction

Speech and language acquisition is a very complex developmental process, and the understanding of this process is particularly important for the therapy of speech-language disorders. The development of speech and language is influenced by a large number of factors that can be related to the integrity of the nervous system, cognitive and intellectual capacities, information processing pathways, and emotional influences. The concept of risk factor is used to emphasize any trait or characteristic of an individual that increases the possibility for developing disorders, illnesses or injuries (Bogavac, Rakonjac and Fatic, 2016).

### 1.1 Risk factors (maternal and fetal)

Chronic maternal illnesses can have a great effect on the course of pregnancy and can affect the baby, both before and after the birth. Certain diseases of the cardiovascular and pulmonary system

(pulmonary hypertension, heart failure, cardiac defects, enlargement or narrowing of the aorta associated with Marfan's syndrome), insulin dependent diabetes, substance abuse (alcohol, drugs), and chronic intrauterine infections (CMV, HSV, HIV or toxoplasmosis) are indicative markers for high risk pregnancies (Kersten et al., 2014). One study investigated the effects of chronic maternal illness on the course of pregnancy and childbirth. The most important data is that the incidence of prematurally born fetuses in diseased mothers and the increased frequency of Caesarean sections have been increased. The children of these mothers are more often hospitalized (Kersten et al., 2014).

A large number of neonatal complications are associated with maternal diabetes in pregnancy, which may affect further cognitive development of progeny (Rizzo et al., 1995; Nelson et al., 2000). It is possible that fetal neurocognitive development is endangered, as well as long-term cognitive ability through altered brain structure due to high or variable glucose levels, and potentially due to ketoneemia (Gin et al., 2006). Studies that have investigated the relationship between diabetes and subsequent educational potential of the child showed that there is a direct impact on speech and language potentials.

Hypertension during pregnancy is a very common risk factor that can potentially affect fetal brain development. It may be hypertension that has already been present or hypertension induced by pregnancy, usually after 20 weeks of gestation. During pregnancy hypertension is often associated with preeclampsia, a systemic disease that is characteristic for pregnancy (Kronenberg et al., 2006). It should be noted that about 15% of women have hypertension during pregnancy and that most of them have to take anti-hypertensive drugs. Numerous studies have shown that there is possibility for various outcomes of these pregnancies including preeclampsia, abortion, intrauterine growth retardation, prematurity and stillbirths (Koren, 2013).

On the other hand, a small number of studies have dealt with long-term neurocognitive consequences in these children, and there are almost no studies that investigate the links between hypertension and medications that are used during pregnancy. Whittehouse et al., (2012) examined whether gestational hypertension and preeclampsia are associated with neurocognitive functions, including verbal and non-verbal abilities. Children from their sample had a lower median score on a Pibody picture vocabulary test if their mothers had hypertensive complications during pregnancy. The second study showed that maternal hypertension during pregnancy can be a predictive factor for lower cognitive performance in male offsprings (Tuovinen et al., 2012).

Viral infections during pregnancy can be very dangerous for the fetus due to potential intrauterine transmission. The consequences are determined by the type of virus. Certain viruses have a teratogenic effect, while others may cause fetal or neonatal diseases of varying degrees. The ability of the virus to infect the fetus through the placenta and damage it, depends, inter alia, on the mother's immune status towards the specific virus. In general, primary infection during pregnancy results in more consequences than secondary infections or reactivation of the virus (Mendelson et al., 2006).

Taking into account the trends in the world and in our country, with several decades of monitoring there is a trend of increasing the percentage of children with developmental problems (in Serbia, 25% of children are born with one or more birth risks) (Selaković et al, 2012)

Ontogenesis of language system is legitimate process with its stronghold in the period from conception to acquire skills in verbal communication (Radičević et al., 2008). This is also a period of high vulnerability of individual to the effects of different risk factors. In accordance to the period of influence they are divided into: 1) prenatal: genetic predisposition (Rakonjac and Bogavac, 2011), rubella during pregnancy, viral infection, hypoxia of the fetus, vaginal infections of the mother, the use of ototoxic drugs in pregnancy, chronic and infectious mother’s disease, Rh incompatibility, toxoplasmosis, toxic poisonings of the mother, stressful experiences, nephropathy, cardio-myopathy, hypertension, diabetes, addictions and others. 2) perinatal: preterm birth, asphyxia of the newborn baby, hypoxia, hyperbilirubinemia, hypoglycemia, Apgar score (APGAR) under 9, respiratory distress syndrome, low birth weight, cerebral bleeding (hematoma), completion of delivery with forceps, vacuum, caesarean section, etc. 3) postnatal: inflammation of the middle ear, respiratory and other infections accompanied by high body temperature, encephalitis, meningitis, febrile convulsions, ototoxic drugs, various intoxications, bacterial and mycotic infections (Candida, Escherichia coli, Clostridia), vaccines, head injuries, allergies, food intolerance, sensory-motor disorders, not enough stimulating family environment, poor communication models,excessive exposure to TV contents (especially cartoons, commercials) and computer games, premature exposure to foreign languages (in monolingual

environments) and others. It has been shown that influence of certain factors in the prenatal and perinatal period is crucial for the formation of certain abnormalities in the development of verbal communication, declaring as risk factors for language disorders (Barlov et al., 2007; Nelson, 1983; Manning, 1995; Beversdorf, 2010; Punišić et al., 2015).

### 1.2 Type of delivery – complexity

Thousands of years of human evolution (phylogenesis) human babies are born through a narrow channel, which has been developed as a compromise between the narrow pelvis of the mother and the baby's big head (Janus, 1991). The human baby is the only orphan on this planet that requires internal rotation in the birth canal to be born. It makes the birth painful and difficult. Both mother and baby's body have biochemical capabilities to relieve pain. This birth process is biologically programmed in every baby. The baby knows when to activate her birth process, knows how to go through the delivery channel, knows how to work with her mother and expects to finish in her hands. Any interference with this process can be painful, stressful, and even traumatic for the baby. Caesarean section is a one kind of interruption and sudden disturbance of the natural birth process. It is not just a different way of birth, but it is a violation of the natural biological birth program that the baby has and that is activated during birth. Trauma occurs when any experience that threatens the baby, overwhelms it and leaves it unconnected with the body. All defense mechanisms are falling apart and the baby is in a state of helplessness and hopelessness. Modern trauma studies have shown that the trauma is not in the event for itself, but the trauma "finds its place" in the nervous system (Levine and Kline, 2007). It's also the case with babies. When the trauma finds its place in the nervous system, the body will not forget the trauma experience. Caesarean section can be seen as a traumatic experience for a baby that has not only very limited defense mechanisms to combat the situation, but this trauma is stored in the body of the baby, leading to physical symptoms.

Since the birth at the hospital is imposed as a standard, the rate of Cesarean sections has increased from 25 to 65% (Maksimović, 2015, according to Gouna 2012). High prevalence is a consequence of clinical, social and economic implications. Urgent Caesarean section is a consequence of complications, while the planned Caesarean section is organized in advance, most often due to medical implications, but there are cases when it comes to the mother's request. Curran et al. (2015) found a link between Caesarean delivery and increased chances of developing autistic spectrum di7sorders. It is known that the Caesarean section carries a greater risk of injuries at birth and that it is a traumatic experience for the baby, probably because the natural flow of delivery is suddenly interrupted. A large sample study showed a link between the Caesarean section and a lower scores in on the math test at the age of 16 (Ahlberg et al., 2014).

By introducing the Caesarean section as a procedure, medicine had the goal to make the delivery less painful for the mother, but he became more painful for babies.

The pain experienced by the baby during the Caesar section is still denied (Chamberlain, 1988). To this day, many scientists and practitioners still believe that babies are born without consciousness and sensitivity, that they have no memory of their prenatal life, that they are unable to experience what is happening during childbirth, and that no consequences can be caused on their emotional functioning. From this point of view, the Caesarean section is considered as an easy and painless way to be born, and that it has many benefits for both mother and the child. In medical circles, the Caesarean section is considered a safe, rapid and routine surgical intervention (Verdult, 2009, 2009b).

According to the literature (Špoljarić, et al., 2003), in the United States from year 1964 the percentage has been increased from 5% to over 23% in year 1991 (Asakura and Myers, 1995; Banović et al., 1994; Taffel, 1990, Eskew et al., 1994) and until 1994th, it grew to 29% (Gregory et al., 1994) and 30%. But in the observed period, in some hospitals, it remained at about 15% (Legrew and Morgan, 1996). In Europe, the incidence of Caesarean section in year 2000 was between 13-15% (Klein M et al., 2000). Although the lowest but still tough reliability of the Caesarean section is not known, it is becoming more and more commonly reported that in general hospitals it ranges between 10-12% in the case of an eutrophic newborn infant from one-fetus pregnancies (Joffe et al., 1994; Rooney et al., 1996) . It should not be forgotten that maternal mortality, although significantly lower in recent years, is still about 10 times higher than in vaginal delivery (Dražancic, 2002) and that 1-2 deaths can be expected per 1,000 Cesarean sections (Miller, 1988; Danforth, 1985 ).

In the Varazdin Maternity Hospital, the incidence of Caesarean section in the general population increased from 2.94% in the period from 1962 year to 1976 year (Špoljarić and Matas, 1977) to 10.34% in the period from 1998 to 1999. to 14.09% in the period from 2000 to 2001 (Špoljarić, et al., 2003).

Epidural analgesia is a common procedure during childbirth. It causes changes in the mother's body and consequently can affect the baby. There are certain adverse effects, such as hypertension, prolonged delivery, increased necessity for oxyctinine, and in some cases delivery is instrumental assisted. But it also has good effects, such as reduced maternal stress and vasodilation of the uterus. The outcome of the newborn depends on two opposite effects. Haegawa et al., (2013) showed that women with epidural analgesia have prolonged delivery and that a high percentage of vacuum was used during delivery or Cesarean section due to fetal stress.

The World Health Organization (2011) in theirs recommendations for the induction of delivery uses oxytocin. Hypothetically, this additional oxytocin may impair the receptor system of physiological oxytocin in the fetus and thus impair the function of the fetal brain. This can be the cause of various neurodevelopmental disorders in children later in life. Kurth and Haussmann (2011) state that exposure to oxytocin is a predictor for attention deficit hyperactive disorder.

In recent years, the trend of cesarean section application in the second childbearing period has been expressed, without considering operational vaginal delivery. However, when vaginal delivery is unsuccessful, or when it is noticed that it will be unsafe, or unacceptable for a woman, Caesarean section is the only appropriate choice although it carries the risk for serious complications.

Caesarean section involves a large abdominal surgery and increases the risk for maternal death approximately four times (Enkin et al., 2000). Mother and baby are separated several hours after delivery, so breastfeeding is usually postponed, and the first contact is being missed and the maternal and child bond is significantly and indispensable in the first hours. Both of them are exposed to certain medications during the procedure (epidural, spinal or general anesthesia) and preparations for postoperative analgesia.

Babies born by Cesarian section are more likely to have respiratory problems with the necessary artificial ventilation (Hook et al., 1997). Caesarean section increases the risk of next pregnancy for uterine rupture (Martel and MacKinnon, 2004), which can lead to fetal death or serious fetal hypoxia injury (Obstetrical Care Review Committee, 2001; Martel and MacKinnon, 2004). Caesarean section also increases the risk of placental overload, placental abruption and invasive placental disease (Jackson and Paterson-Brown, 2001). Maternal risk due to Cesarean section involves increased maternal mortality. Maternal mortality is four times higher in women who had Caesarean section delivery than in the maternal population who had vaginal delivery. The woman is under an increased anesthetic risk, especially because of the possibility of aspiration (Martel and MacKinnon, 2004) and the risk of increased blood loss, infection, venous thromboembolism and surgical uterine and intestinal injuries (Jackson and Paterson-Brown, 2001). Use of vacuum or forceps also may be necessary at the time of the Caesarean section.

Caesarean section can result in injuries of different types but also significant psychological consequences for the child.

A study by Alexander and colleagues (2006) found that in a total of 37,110 children born with Caesarean section, 1.1% had a lesion: skin cuts (0.7%), kephalhematics, fracture of the clavicle, breach of brachial plexus, skull fracture, and paralysis of the facial nerve. The incidence of fetal injuries during the Cesarean section varies and depends on the length of time from incision to delivery and type of uterine incision (Alexander et al., 2006).

The percentages given by the Agency for Health Research and the Patient Safety Indicator show that children born by Caesarean section are at the highest risk for various types of trauma (bone fracture, injuries to brachial plexus, scalp injuries) (Moczygemba et al., 2010).

The birth by Cesarean section carries the disadvantages and risks for the physical body of the child, but the psychological traumatic aspects of Cesarean-born babies are negated and ignored. Most parents seek help from psychotherapists because they have problems with their babies. Intensive crying,sleep problems and nutritional problems are among the most common symptoms. Most parents do not find reasons for these problems, nor do they recognize emotional pain in their babies, and are surprised when they learn about the traumatic aspects of their baby's birth. Unfortunately, emotional trauma in children and especially in the babies is still not recognized. Prenatal and perinatal

psychology shows that it is differently. Babies are aware, cautious, interactive, and social human beings. Fetuses and babies can respond to signals from their surroundings and can be traumatized through superior impulse (outer signal) to their system. Thanks to Verny's work (1981, 1992, 2002), Chamberlain (1988) and Emerson (1998), we now know that babies can experience emotional pain, anxiety, rage, loneliness or sadness during and after birth, and that the Caesarean section is a traumatic experience for the baby with immediate and long-term consequences.

According to William Emerson (1998), an pioneer in the field of supporting children with birth trauma, the following eight factors can be traumatic in the process of childbirth by the Caesarean section and can result with somatic and psychological consequences:

*1. Obstetric interventions*: which are necessary because of the complications of childbirth leading to the Caesarean section; this kind of intervention traumatizes the child in addition.

*2. Cephalopelvic proportions*: the baby's head is large compared to the narrow mother's pelvis, if it get stuck in the delivery channel, the feeling of helplessness and hopelessness occurs (this can later manifest itself as claustrophobia).

3. *Obstruction of the path*: the passage through the birth canal is obstructed, alternatives are crushed.

*4. Border Limit*: The mother's stomach is cut off and open and the arms of the obstetrician are taking off the baby. This process, in the name of saving a baby (which is true in cases of urgency) is violent and causes psycholo*gical shock.*

*5. Movement (dislocation*): the baby is pulled out of the pelvis. This act causes a lot of confusion. The baby is helpless because of the mechanical force that was used.

*6. Lifting*: The baby is often rashly raised from the uterus, which can later be associated with difficulties in transition.

*7. Separation and Abonding*: The baby is taken from a mother/parent and this can be linked to separation and abandonment patterns of behavior later in life.

*8. Parental stress*: Birth is not going as planned. In many cases, the parent feels frustrated and because of the symbiosis between mother and child this parental stress/frustration increases the traumatization of the baby.

## 2 Aims

The aims of this research were to determine:

1. risk factors during pregnancy and birth that are present in children with speech, language and behavioural disorders (maternal and birth-related risks for babies) and

2. types of childbirth by which these children were born.

## 3 Methodology

The sample consisted of 205 children aged 2 to 7 years who were admitted to the Institute of Experimental Phonetics and Speech Pathology "Đorđe Kostić" and diagnosed with speech, language, learning or behavioral disorders and started the audiolinguistic treatment in 2015.

## 4 Results

The results showed that 33% of mothers had some risk during pregnancy, and that 47% of children with speech, language, learning and behavioural disorders had one or more (up to six) birth risks (Fig. 1).

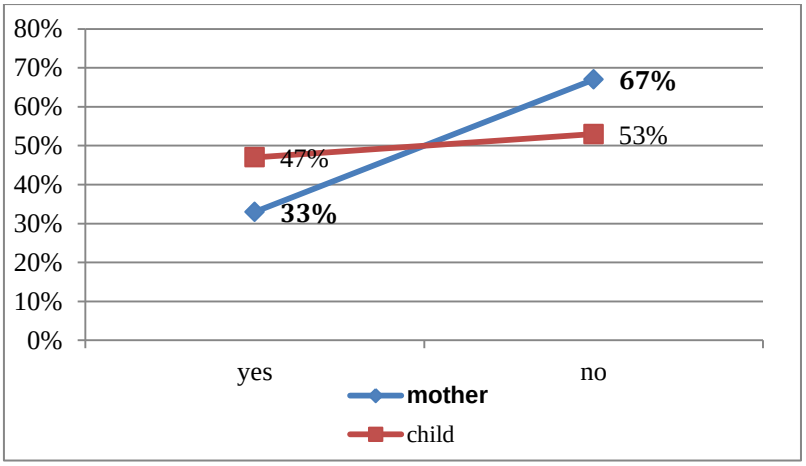


**Fig. 1.** Risk factors during pregnancy, for mother and child

The risks associated with the mother are: infection / bacterial or viral (upper respiratory tract, vaginal, digestive, urinary) (32%), stress (31%), high blood pressure (26%), diabetes (0.7%), interventions in pregnancy (amniocentesis) (0.5%), the rest (anemia, myoma, gestational diabetes, preeclampsia, eclampsia, Rh incompatibility, hydronephrosis, thyroid disorder) 9.8% (Fig.). According to the data, a gestation week of infection development is also very significant for brain development due to the specific vulnerability of neurons (Lanari et al., 2012). Prenatal prevention includes for now TORCH infections (toxoplasmosis, rubella, cytomegalovirus, and herpes simplex) and as diagnostic is enabled, there is no treatment or preventive strategy to prevent unwanted outcomes (Silasi et al., 2015).

Our results showed that only one risk had 62% of mothers, two risks had 32%. Most common combined risks were: high pressure/stress; elevated pressure/diabetes. Three or four risks had 6% of mothers.

The first four most frequent risks for children in the ranking were: prolonged jaundice (28%), asphyxia (8%), torticollis (8%) and nuchal cord (7.8%). Other present risks were: hypotonia (6.3%), cerebral hematoma (3%), respiratory syndrome and cephalopathy (3%), hypertonia (2.4%), and anemia, sepsis, hyperglycaemia, hypoglycaemia, other body anomalies (Figure 3). One study (Koziol et al., 2013; Voeller, 2004) showed that neonatal jaundice still occurs in 60% of cases. Some of these children have irreversible brain damage, although prevention is possible with a better understanding of the condition itself. Even moderate increases in bilirubin can increase the risk of motor, cognitive, perceptive and auditory disorders. They are associated with ADHD, autistic spectrum disorders, auditory and learning disorders.

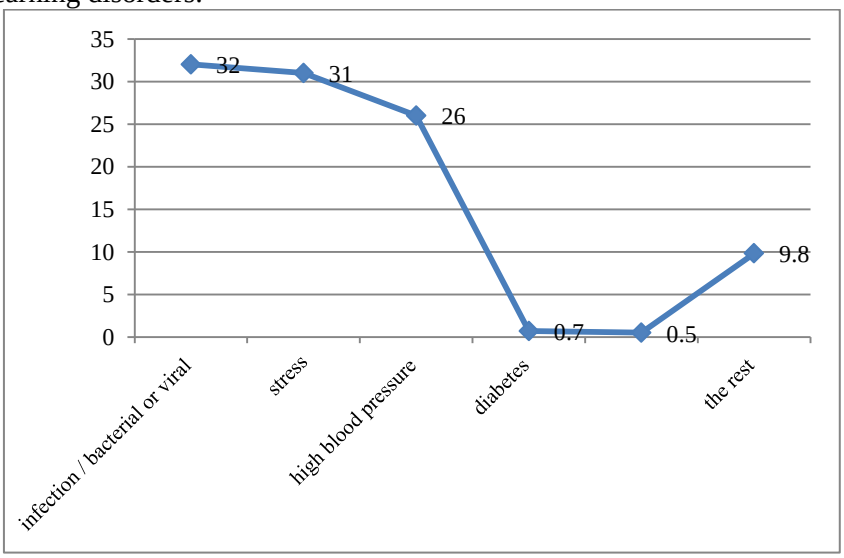


**Fig. 2.** Maternal risks during pregnancy

Region of the brain particularly sensitive to hyperbilirubinaemia are well known. It is possible to predict cognitive or behavioral disorders according to these regions. Lidong et al. (2013) states that bilirubin is particularly harmful for the auditory system. There are some allegations that the lesions are limited to the central auditory system, without touching the cochlea and the auditive nerve path, while recent studies link the hyperbilirubinemia with auditory neuropathy.

Neonatal jaundice is associated with the development of autistic spectrum disorders, developmental disorders in general, as well as speech-language disorders (Chen et al., 2014).

The percentage of nuchal cord in the Punišić and associate study (2015) is 6.17%.

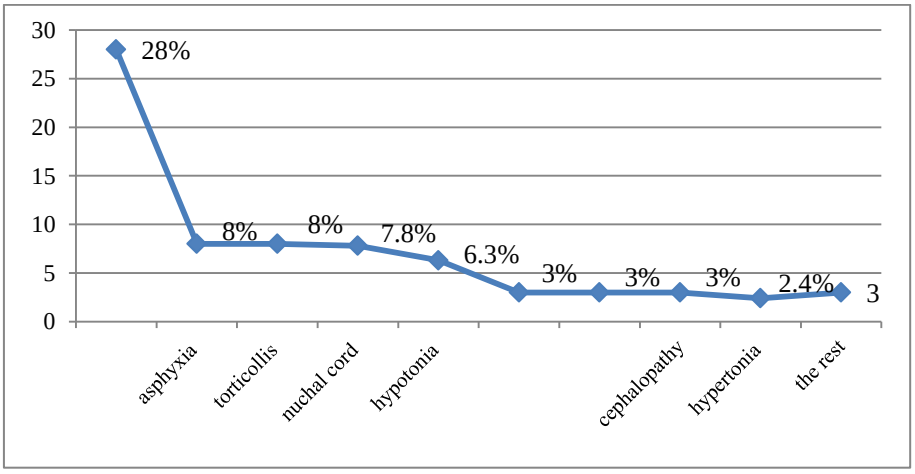


**Fig.3.** Risk factors related to children

In our sample 63% of children with speech, language, learning, and behavioral disorders were born by delivery during which anesthesia was used (Figure 4). Of these, 29% were planned Caesarean sections, 14% emergent Saesarean section and 20% vaginal delivery with the use of epidural anesthesia. Vaginal induced delivery was present in 35% of cases while instrumental delivery was 2% (Figure 5).

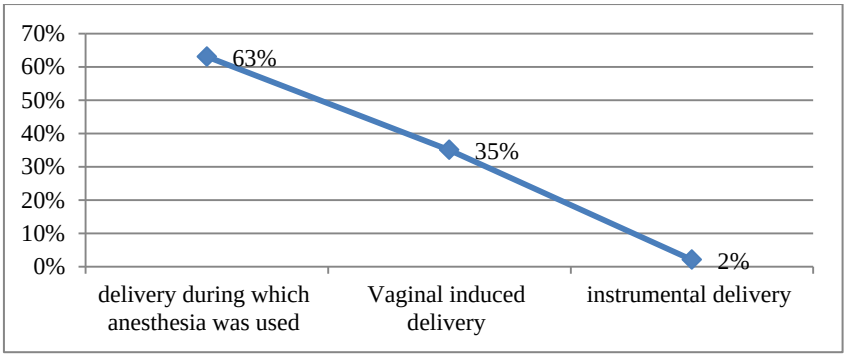


**Fig.4.** Type of delivery in children with speech, language, learning and behavioural disorders in relation to anesthesia and application of instrumentation

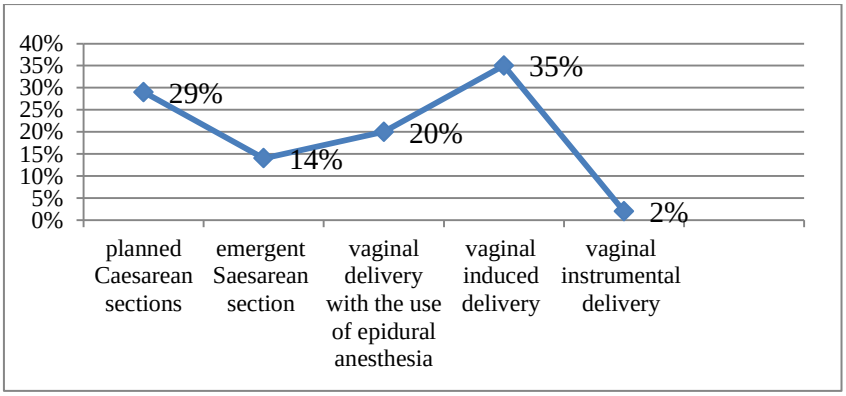


**Fig.5.** Type of delivery in children with speech, language, learning and behavioural disorders

The type of delivery and the presence of risk are shown in Fig. 6, where it can be seen that the highest percentage of children who had a risk after birth had been born with vaginal induced delivery (18%), vaginal delivery with epidural anesthesia 11%, planned Caesarean section 10%, an emergent Caesarean section of 4% and a vaginal instrumental delivery of 1%. In contrast to such redistribution in children without risk 20% were born by planned Caesarean section, 20% by vaginal delivery with epidural anesthesia, 8% vaginal induced delivery, 4% by emergent Cesarean section and vaginal instrumental delivery 1%.

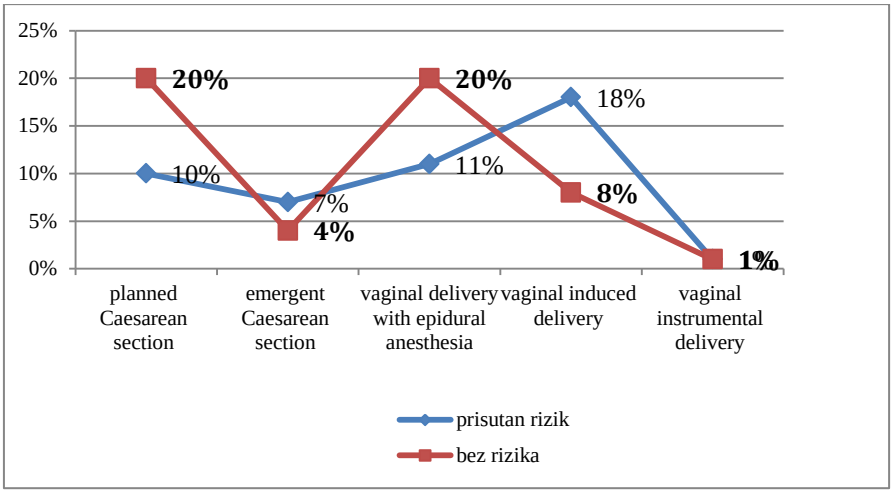


**Fig.6.**Type of delivery and risk factors at birth

## 5 Conclusions

A study of the prenatal and perinatal risk factors related to mother and children on the sample of 205 children with speech, language, learning and behavioural disorders, which were on audiolinguistic treatment at the Institute for Experimental Phonetics and Speech Pathology "Đorđe Kostić" showed that:

1. 33% of mothers of children with speech, language, learning and behavioural disorders have some risk during pregnancy;
2. 47% of children with with speech, language, learning and behavioural disorders have one or more (up to six) birth risk factors;
3. Risks related to mother are: infection/bacterial or viral (upper respiratory tract, vaginal, digestive, urinary) (32%), stress (31%), high blood pressure (26%), diabetes (0.7%) , interventions in pregnancy (amniocentesis) (0.5%), others (anemia, myoma, gestational diabetes, preeclampsia, eclampsia, Rh incompatibility, hydronephrosis, thyroid disorder);

4. The first four most frequent risks related to children in the ranking are: prolonged jaundice (28%), asphyxia (8%), torticollis (8%) and nuchal cord (7.8). Other present risks are: hypotonia (6.3%), cerebral hematoma (3%), respiratory syndrome and cephalopathy (3%), hypertension (2.4%), and anemia, sepsis, hyperglycaemia, hypoglycaemia, anomalies (other);

5. 63% of children with speech, language, learning and behavioral disorders were born by delivery during which anesthesia was used. Of these, 29% were planned Caesarean sections, 14% emergent Caesarean section and 20% vaginal delivery with the use of epidural anesthesia. Vaginal induced delivery was 35% while instrumental delivery was 2%.

6. The delivery by Cesarean section has no advantages over the vaginal, it does not represent any lesser trauma for the baby or for the mother,

- babies born with use of anesthesia, due to the drugs used during surgery, are not fully active immediately after delivery,

-the breastfeedingof such born babies requires more effort from those born by natural path,

- the first breath is often difficult for babies born by Caesarean section,

- After Caesarean section, milk is enabled from 24 to 36 hours after labor, so artificial milk must be used.

- it is necessary for the child to leave the womb for three to nine minutes from the beginning of the procedure to avoid anesthetic to come in contact with the baby during surgery,

The fact that the highest percentage of children born with some of risk factors are born by delivery with anesthesia, a total of 28% (planned Cesarean section 10%, emergent Caesarean section 7%, vaginal delivery with anesthesia 11%), while 18% children with risk were born by vaginal induced delivery, indicates further comparative studies on the effect of additional oxytocin used in the process of induction of labor and anesthesia and medicines used during the Cesarean section and their relationship with certain types of speech, language, learnig and behavioral disorders and the severity of the clinical picture.

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## Riziko faktori kod dece sa poremećajima govora, jezika, učenja i ponašanja i vrsta porođaja

Uslovi pod kojima se odvija intrauterini razvoj, uticaji tokom porođaja i u periodu posle porođaja, osnova su za stvareanje bazičnog kapaciteta organizma deteta koji ono donosi rođenjem. Od toga zavisi razvoj njegovih primarnih kapaciteta ali i sposobnosti primanja i korišćenja uticaja spoljašnje sredine. Svako dete na svet dolazi na najbolji mogući način a iskustvo koje stiče u periodu koncepcije, trudnoće i rođenja ga priprema da se prilagodi sredini u kojoj će živeti. U poslednjih pola veka, porođaj u bolnicama je postao standard i u isto vreme procenat carskih rezova se povećao.
*Ciljevi* rada su bili da se utvrde:
1. riziko faktori u toku trudnoće i rođenja, prisutni kod dece sa poremećajima govora, jezika i ponašanja (maternalni i rizici na rođenju vezani za bebu)
2. vrste porođaja kojima su ova deca rođena.
*Metodologija istraživanja*: uzorak je činilo 205 dece uzrasta 2 do 7 godina koji su u Institut za eksperimentalnu fonetiku i patologiju govora "Đorđe Kostić" zbog dijagnostikovanih poremećaja govora, jezika, učenja i ponašanja primljeni i započeli audiolingvistčki tretman 2015 godine.
*Rezultati istraživanja***:** Istraživanje je pokazalo da je 33% majki imalo neki rizik u toku trudnoće. 47% dece sa poremećajima govora, jezika, ponašanja i učenja je imalo jedan ili više (do šest) rizika na rođenju. Prva četiri rizika po rangu su: produžena žutica, asfiksija, pupčanik oko vrata i tortikolis. Rizici koji su se javili kod majke su: infekcija / bakterijska ili virusna (gornji disajni putevi, vaginalna, digestivna, urinarna) (32%), stres (31%), povišen pritisak (26%), dijabetes (0.7%), intervencija u trudnoći (amniocenteza) (0.5%), ostalo (anemija, miom, gestacijski dijabetes, preeeklampsija, eklampsija, Rh inkopatibilija, hidronefroza, poremećaj štitaste žlezde) 9.8%
63% dece sa poremećajima govora, jezika, učenja i ponašanja je rođeno porođajima u toku kojih je korišćena anestezija. Od toga 29% su bili planirani carski rezovi, 14% hitni carski rezovi i 20% vaginalni porođaji uz primenu epiduralne anestezije.
*Zaključci***:** Najveći procenat dece sa rizikom rođen je iz porođaja uz primenu anestezije, ukupno 28%, dok je vaginalnim indukovanim porođajem rođeno 18% dece sa rizikom, što ostavlja mesto za dalja komparativna istraživanja o uticaju dodatnog oksitocina koji se koristi u procesu indukcije porođaja i anestezije i medikamenata koji se koriste u toku carskog reza i njihovu vezu sa pojedinim vrstama poremećaja govora, jezika, ponašanja i učenja i težinom kliničke slike.

# Irregular patterns in EEG activity as a potential predictor of speech – language deficits

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**Abstract:** Theta dysfunction is defined as a special form of abnormal theta wave components that relate to a slow rise of the ascending limb, and a rapid fall of the descending limb with a slight sharpening of the top and with a spectral power of 1 - 2 μV higher than the usual for children up to 3 years.
Research aim was the examination of speech-language signal processing by analysing alpha 1 and alpha 2 spectral powers during defined periods of stimulation in children with specific language impairment (SLI) who have irregular patterns in EEG activity. Methods: The sample consisted of 12 children, 4 to 5 years old, who have specific language impairment (SLI) and were on continuous speech-language treatment in the Institute for experimental phonetics and speech pathology (IEPSP) in Belgrade. The sample was divided into two groups: E1 group consisted of 6 children with SLI and irregular patterns of EEG activity defined as theta dysfunction (E1=6), while E2 group consisted of 6 children with SLI and without irregular patterns in EEG activity. The method included the use of cartographic EEG. Cartographic EEG patterns was performed on Nihon Kohden Corporation, EEG – 1200K Neurofax apparatus in longitudinal bipolar electrode assembly schedule by utilizing 10/20 International electrode positioning. Impedance was maintained below 5 kΩ, with not more than 1 kΩ differences between the electrodes. Lower filter was set at 0.53 Hz and higher filter at 35 Hz. Recording was performed in a quiet period and during stimulation procedures that include speech and language basis. Spectral powers of alpha 1 and alpha 2 rhythms were analyzed. Obtained results showed that children with SLI and theta dysfunction had significantly less represented left-hemisphere speech-language processing and lower decrease of theta rhythm spectral powers during auditory stimulation. Conclusion:: theta dysfunction disturbs speech-language information processing in children with SLI.
*Key words:* specific language impairment, irregular EEG patterns, theta dysfunction

## 1 Introduction

Some previous research regarding information processing in children with speech-language impairment (SLI) indicated that children with SLI and irregular patterns in EEG activity may have disturbed speech-language language information processing (Radicevic, Jelicic Dobrijevic**,** Stokic, Sovilj, Subotic, 2013). On the other hand, recent electrophysiological investigations of various forms of sensory information indicate a grouping of processing responses primarily in the General Interpretative Area – Gnostic Area which is located in the forefront parts of the occipital lobe, posterior parts of the upper temporal lobe as well as in posterior and central parts of the parietal lobe. This area is by long neural pathways projected into specific associative regions among which are those responsible for complete speech-language processing located in the central and medial structures of the prefrontal and motor areas (Guyton & Hall, 2008). Generally speaking, general interpretative area receives info from all sensory areas and integrates sensory info and coordinates access to visual and auditory memories.

Our practical work pointed that children with speech-language impairment have significant reduction of general interpretative area space, it is often dissociated and predominantly right-hemisphere presented in period of auditory stimulation by defined story. Also, very poor projection of these structures into the speech linguistic regions of the forebrain is noticed.

In that manner, we decided to analyze this phenomenon through the relation between the size of the general interpretative area in alpha 1 rhythm (8-10Hz) and alpha 2 rhythm (10-12 Hz) processing, which according to the current opinions represent the ratio of closed and open consciousness (Thompson & Thompson, 2003). In relation to clinical and electrophysiological correlates interpretation, when alpha 2 rhythm is dominant it is interpreted as focused attention to auditory

information, which is brain primary element for registering and subsequent processing of speech-language information. This should be present in children regardless of whether they are children with SLI which include receptive and expressive speech disorder or they have prevalent expressive form. It was noticeable in in our research where the subject were children with SLI aged 4-5 years, and there was no difference in relation to gender (Radicevic & Dobrijevic, 2009; Radicevic, Jelicic, Sovilj, Barlov, 2009).

Routine work and several years of experience in examination of functional speech and language signal processing in EEG recordings (cartographic EEG, EEG mapping, quantitative EEG - QEEG) during resting state and speech - language stimulation (auditory stimulation: listening to a story) has pointed out that some children with SLI have irregular theta activity when their eyes are opened during these mentioned periods (Radicevic et al., 2013).

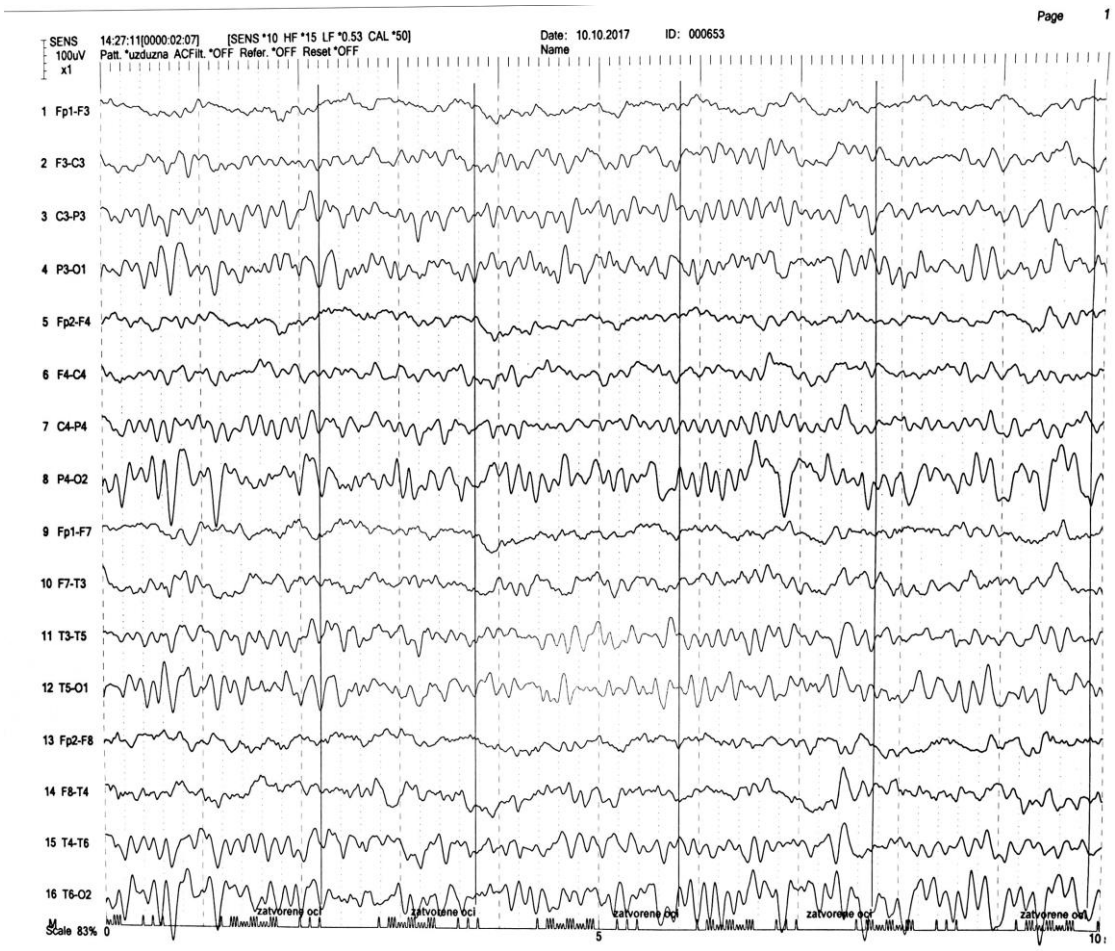


**Figure 1.** Irregular EEG patterns of theta waves with open eyes

Theta frequency range includes waves of 4 to 8 Hz. Theta brainwaves are most likely to be dominant during sleep but are also dominant during deep meditation. In theta state the senses are withdrawn from the outside world and focusing on the signals coming from within. This is a condition that we feel when we are waking up from sleep or falling to sleep. When theta waves are the dominant we feel intuition and remember information that are beyond our consciousness. These waves are usually symmetrical between the right and left hemisphere. High range is associated with creativity and spontaneity. Asymmetry in theta waves can be an indication of depression or anxiety. Theta activities are also associated with negligence and poor impulsiveness. Slow-wave disorders usually refer to excessive theta; however, delta (1-4 Hz) and slow alpha (8-10 Hz) are also included in the slow-wave category. EEG slowing is associated with foggy thinking, slow reaction time, poor

calculation, poor judgment, and impulse control. Children have higher theta amplitudes than older adults (Blume & Kaibara, 1995)

Irregular theta activity noticeably deviates from regular theta activities expressed out until the end of the third year, the theta activities present during some short-term memory tasks, when remembering and theta which occurs in light sleep. In our routine work we called this irregular theta activity as theta mix compounded of individual or in shorter groups theta waves which are steep or with a plateau on the wave`s top and are clearly distinct from the usual normal theta activity (Figure 1). These forms were mainly found during EEG recording of resting state and defined stimulation periods with open eyes, while only some children showed this phenomenon and with closed eyes.

## 2 Aim

Research aim was the examination of speech-language signal processing by analysing alpha 1 and alpha 2 spectral powers during defined periods of stimulation in children with specific language impairment (SLI) who have irregular patterns in EEG activity. We try to determine whether theta dysfunction confirmed in certain children with SLI significantly disturbed the processing of auditory information observed through a number of related regions in general interpretative area in high alpha rhythm versus the low alpha rhythm, rather than in the case of children with SLI and regular EEG patterns.

## 3 Research Methodology

The sample consisted of 12 children, 4 to 5 years old, who have specific language impairment (SLI) and were on continuous speech-language treatment in the Institute for experimental phonetics and speech pathology (IEPSP) in Belgrade. The sample was divided into two groups: E1 group consisted of 6 children with SLI and irregular patterns of EEG activity defined as theta dysfunction (E1=6), while E2 group consisted of 6 children with SLI and without irregular patterns in EEG activity. The children were gender balanced and did not have localized or non-localized lesions of the central nervous system listed in either a medical history or in a neurological and magnetic resonance imaging findings. These children began to walk with 1-2 months of delay, most of them had transient axle hypotonia and during medical examination of the motor system showed regular muscle reflex on stretching, the absence of pathological reflexes, and only discrete changes in a fine walk patterns that could be verified only by careful analysis of a walking at different speeds. Before the testing procedure, all children were examined by detail electroencephalographically for the exclusion of specific activities.

The method included the use of cartographic EEG. Cartographic EEG patterns was performed on Nihon Kohden Corporation, EEG – 1200K Neurofax apparatus in longitudinal bipolar electrode assembly schedule by utilizing 10/20 International electrode positioning. Impedance was maintained below 5 kΩ, with not more than 1 kΩ differences between the electrodes. Lower filter was set at 0.53 Hz and higher filter at 35 Hz. Recording was performed in resting state and during stimulation procedure that include speech and language basis (listening the story "Three pigs" in period of three minutes). Spectral powers of alpha 1 and alpha 2 rhythms were analyzed. We chose EEG trace parts lasting from 10 seconds and without artefacts which were taken immediately before or behind the middle of resting state or the stimulation period (listening to story). The obtained material was analyzed in terms of activating processing in higher spectral powers (higher than 50% on the scale) by electrode points. That means that electrode point which had spectral power higher than 50% on the scale in alpha 1 and alpha 2 rhythms was determined as point that is involved in information processing and is marked as positive processing value, while those electrode points which spectral powers were below the average value on the scale were not considered as belonging to information processing and were marked as negative processing values.

Theta dysfunction is defined as a special form of abnormal theta wave components that relate to a slow rise of the ascending limb, and a rapid fall of the descending limb with a slight sharpening of the

top and with a spectral power of 1 - 2 μV higher than the usual for children up to 3 years (5-6 μV). The frequency of mentioned irregular theta waves is such that they do not occur in form of a series waves but rather in the form of individual waves, doublets or triplets: These waves are non-rhythmic and with relatively slower frequencies (4-5 Hz or 5-7 Hz). They most often occur in posterior regions, rarely combined in posterior and anterior regions, never bilaterally synchronous and often with prevalence in left, right or left and right hemispheres.

## 4. Results

Resting state in children with SLI and theta dysfunction in terms of activated regions with positive processing values is shown in Table 1. There was no stimulation during this resting state except the natural ones that make a quiet ambient. Children with SLI and theta dysfunction has activated information processing in significantly more EEG electrode points in low than in high alpha activities. These activated regions with positive processing values in alpha 1 rhythm were equally arranged in both hemispheres. In both alpha (alpha 1 and alpha 2) visual and auditory regions were more engaged than central and frontal regions while frontal regions were more engaged in low than in high alpha activity.

**Table 1**. Resting state in children with SLI and theta dysfunction: activated regions with positive processing values

| E1 | RESTING STATE in children with SLI and theta dysfunction | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alpha 1 | | | | | | | | | | | | | | | | | | | | | | Alpha 2 | | | | | | | | | | | | | | | | | | | |
| | **Fp1** | **F3** | **F7** | **C3** | **P3** | **T3** | **T5** | **O1** | **Fz** | **Cz** | **Pz** | **Fp2** | **F4** | **F8** | **C4** | **P4** | **T4** | **T6** | **O2** | | **Fp1** | **F3** | **F7** | **C3** | **P3** | **T3** | **T5** | **O1** | **Fz** | **Cz** | **Pz** | **Fp2** | **F4** | **F8** | **C4** | **P4** | **T4** | **T6** | **O2** |
| VĐ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| ĐV | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| LA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| GM | - | + | + | + | + | + | + | + | - | - | - | - | + | - | + | - | - | - | + | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - |
| MN | + | - | - | - | - | - | - | + | - | - | - | + | - | + | - | - | - | - | + | | + | - | - | - | - | - | + | + | - | - | + | - | - | - | - | - | - | - | - | - | - |
| PP | - | - | - | - | - | - | - | + | - | + | - | - | - | - | - | - | - | + | + | | - | - | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + |
| Σ | 1 | 1 | 1 | 1 | 1 | 1 | 1 | 3 | 0 | 1 | 0 | 1 | 1 | 1 | 1 | 0 | 0 | 1 | 3 | | 1 | 0 | 0 | 0 | 0 | 1 | 1 | 1 | 0 | 0 | 2 | 1 | 0 | 1 | 0 | 0 | 0 | 0 | 1 | | |

Results of auditory stimulation processing (listening to story) in children with SLI and theta dysfunction in terms of activated regions with positive processing values are shown in Table 2. Obtained results showed that the number of electrode points with positive processing values (regions included in the information processing) has dropped significantly during period of auditory stimulation (listening to story) in children with SLI and theta dysfunction. This reducing the number of activated regions is more pronounced in alpha 2 than in alpha 1 activity. It is particularly noticeable that there is reduced number of auditory and visual regions in high alpha activity (alpha 2) as opposed to low alpha acitivity (alpha 1), where this decrease is less pronounced in relation to resting state, especially within the left hemisphere.

**Table 2**. Auditory stimulation (listening to story) in children with SLI and theta dysfunction: activated regions with positive processing values

| 1 | Auditory stimulation in children with SLI and theta dysfunction | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alpha 1 | | | | | | | | | | | | | | | | | | | | | Alpha 2 | | | | | | | | | | | | | | | | | | | | | |
| | Fp1 | F3 | F7 | C3 | P3 | T3 | T5 | O1 | Fz | Cz | Pz | Fp2 | F4 | F8 | C4 | P4 | T4 | T6 | O2 | | Fp1 | F3 | F7 | C3 | P3 | T3 | T5 | O1 | Fz | Cz | Pz | Fp2 | F4 | F8 | C4 | P4 | T4 | T6 | O2 | | | | |
| VĐ | - | - | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | |
| ĐV | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | |
| LA | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | |
| GM | - | - | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | + | + | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | |
| MN | - | - | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | - | + | | | | |
| PP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | |
| Σ | 0 | 0 | 0 | 0 | 0 | 0 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | | | | |

Table 3 shows data regarding the engagement of activated regions (regions with positive processing values) during resting state in alpha 1 and alpha 2 in children with SLI and regular EEG patterns. There is a noticeable advantage regarding the number of activated regions in low alpha versus high alpha rhythm, especially in auditory, visual and parietal regions.

**Table 3.** Resting state in children with SLI and regular EEG patterns: activated regions with positive processing values

| E2 | RESTING STATE in children with SLI and regular EEG patterns | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alpha 1 | | | | | | | | | | | | | | | | | | | | | Alpha 2 | | | | | | | | | | | | | | | | | | | | | |
| | Fp1 | F3 | F7 | C3 | P3 | T3 | T5 | O1 | Fz | Cz | Pz | Fp2 | F4 | F8 | C4 | P4 | T4 | T6 | O2 | | Fp1 | F3 | F7 | C3 | P3 | T3 | T5 | O1 | Fz | Cz | Pz | Fp2 | F4 | F8 | C4 | P4 | T4 | T6 | O2 | | | | |
| PĐ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | - | + | | | | |
| VS | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | |
| KP | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | |
| JL | - | - | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | + | + | - | - | - | - | - | - | - | - | - | - | | | | |
| SL | + | - | + | - | - | - | + | + | + | - | + | - | - | - | - | + | + | + | + | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | - | + | | | | |
| KF | - | - | - | - | - | - | - | - | - | - | + | - | - | - | - | + | - | + | - | | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | | | |
| Σ | 1 | 0 | 1 | 0 | 0 | 0 | 2 | 2 | 1 | 0 | 2 | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 1 | | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 2 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 1 | 0 | 1 | 2 | | | | |

**Table 4.** Auditory stimulation (listening to story) in children with SLI and regular EEG patterns: activated regions with positive processing values

| E2 | Auditory stimulation in children with SLI and regular EEG patterns | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Alpha 1 | | | | | | | | | | | | | | | | | | | | | Alpha 2 | | | | | | | | | | | | | | | | | | | | | |
| | Fp1 | F3 | F7 | C3 | P3 | T3 | T5 | O1 | Fz | Cz | Pz | Fp2 | F4 | F8 | C4 | P4 | T4 | T6 | O2 | | Fp1 | F3 | F7 | C3 | P3 | T3 | T5 | O1 | Fz | Cz | Pz | Fp2 | F4 | F8 | C4 | P4 | T4 | T6 | O2 | | | | |
| PĐ | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | + | | - | - | - | - | + | - | + | + | - | - | - | - | - | - | - | - | - | + | | | | |
| VS | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | - | | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | - | + | + | | | | |
| KP | + | + | + | - | - | - | - | - | - | - | - | - | + | + | - | - | + | + | - | | - | - | - | - | - | - | - | - | - | - | + | + | - | - | - | - | + | + | | | | |
| JL | - | - | - | - | + | - | + | + | - | - | + | - | - | - | - | + | - | - | + | | - | - | - | - | - | - | - | + | - | - | + | - | - | - | - | + | - | + | | | | |
| SL | - | - | - | - | - | - | - | + | - | - | - | + | + | - | - | - | - | - | + | | - | - | - | - | - | - | - | + | - | - | + | - | - | - | - | + | - | + | | | | |
| KF | - | - | - | - | - | - | - | + | - | - | - | - | - | - | - | + | + | + | - | | - | - | - | - | + | + | + | - | - | - | + | - | - | - | - | - | - | + | | | | |
| Σ | 1 | 1 | 1 | 0 | 1 | 0 | 1 | 3 | 0 | 0 | 1 | 1 | 2 | 1 | 0 | 2 | 2 | 2 | 3 | | 0 | 0 | 0 | 0 | 2 | 1 | 2 | 4 | 0 | 0 | 4 | 1 | 0 | 0 | 0 | 2 | 0 | 5 | 6 | | | | |

Results of auditory stimulation processing (listening to story) in children with SLI and regular EEG patterns in terms of activated regions with positive processing values is shown in Table 4. It is shown that the total number of activated regions with positive processing values is increased in both low and high alpha but this increase is higher in alpha 2 than in alpha 1 rhythm. It is also remarkable

that the advantage of alpha 2 activity in relation to alpha 1 acitivity is particularly expressed in auditory, visual and parietal (Pz) regions. Right-hemispheric engagement of auditory and visual regions is more frequent in both alpha than left-hemispheric engagement.

## 5. Discussion

The term of theta dysfunction is present more in practical than theoretical work as an approximately defined state rather than relatively reliable phenomenon (Martinovic, 2009). As we mentioned above, theta dysfunction is defined as a special form of abnormal theta wave components that relate to a slow rise of the ascending limb, and a rapid fall of the descending limb with a slight sharpening of the top and with a spectral power of 1 - 2 μV higher than the usual for children up to 3 years (5-6 μV). The frequency of mentioned irregular theta waves is such that they do not occur in form of a series waves but rather in the form of individual waves, doublets or triplets: These waves are non-rhythmic and with relatively slower frequencies (4-5 Hz or 5-7 Hz).

Our routine work in the field of cartographic EEG has pointed that this theta dysfunction is often seen in children with SLI. During determining theta dysfunction in child`s EEG trace patterns we have respected the basic rule that the new abnormal wave forms must show the systematic nature of the phenomenon (repetition of individual or group waves during approximately the entire EEG recording with variable intermediate periods in which theta with normal components occur). The awake condition was strengthened by the fact that the EEG recording was performed when the alpha activity is the largest ie. between 10 am and 12 pm. In this way we exclude theta in light sleep. A camera for shooting child`s face was turned on during the whole EEG recording.

Obtained findings indicate that, in the so-called resting state, children with SLI and theta dysfunction had lower processing in which auditory and visual regions are engaged in the right hemisphere, especially in lower alpha activity (so-called closed consciousness). This may correspond to redirection attention or some kind of excitability condition which causes this disorder in the field of information registration.

It seems that the ambient information that comes from the static environments affects even children with SLI and regular EEG patterns what is expressed in alpha1 activity engaged in auditory and visual regions of the right hemisphere. This may be considered as some kind of expectation, but this processing is considerably less represented in this group of children compared to children with SLI and theta dysfunction.

## 6 Conclusion

The results obtained in this research led to the following conclusion:

1. Children with SLI and theta dysfunction had significantly less represented left-hemisphere speech-language processing and lower decrease of theta rhythm spectral powers during auditory stimulation in relation to children with SLI and regular EEG patterns.
2. Children with SLI and theta dysfunction had significantly less global decrease of theta spectral power than children with SLI and regular EEG patterns during auditory stimulation by listening to story.
3. P3-Pz regions and T5-O1-P3 regions are significantly less involved in processing within the general interpretative area in children with SLI and theta dysfunction in relation to children with SLI and regular EEG patterns.
4. Theta dysfunction disturbs speech-language information processing in children with SLI.

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## Iregularne promene EEG aktivnosti kao potencijalni prediktor izraženosti govorno-jezičkih deficita


Theta disfunkcija smo definisali kao poseban oblik abnormalnih komponenti talasa koje se odnose na spori porast uzlaznog kraka, a brzi pad silaznog kraka sa blagim zaoštravanjem vrha, snage oko 1 – 2 mikrovolta veće od uobičajene theta za decu do 3 godine (5-6 mikrovolti). Cilj istraživanja je ispitivanje procesiranja govorno-jezičkog signala analizom spektralne snage alpha 1 i alpha 2 ritma tokom definisanog perioda stimulacije kod dece sa razvojnom disfazijom i iregularnim promenan EEG aktivnosti. Uzorak ispitivanja je sačinjen od 12 dece uzrasta 4-5 godina sa dijagnozom razvojne disfazije i podeljen je u dve grupe: E1 grupu su činila deca sa razvojom disfazijom i iregularnim promenama u EEG aktivnosti koje su definisane kao theta disfunkcija (E1 =6), dok su E2 grupu činila deca sa razvojnom disfazijom i bez specifičnih ili subspecifičnih promena u EEG aktivnosti (E2=6). Sva deca su na kontinuiranom audiolingvističkom tretmanu u Institutu za eksperimentalnu fonetiku i patologiju govora (IEFPG) u Beogradu. Snimanje je vršeno na Nihon Kohden Corporation, EEG – 1200K Neurofax aparatu, u longitudinalnoj bipolarnoj montaži u kojoj su elektrode pozicionirane prema 10/20 Internacionalnom sistemu za pozicioniranje lektroda. Impedanca je održavana ispod 5 kΩ, sa ne više od 1 kΩ razlike između elektroda. Niži filter je postavljen na 0.53 Hz i viši filter na 35 Hz. Snimanje je izvršeno tokom mirnog perioda i tokom stimulacije koja ima govorno-jezičku osnovu. Analizirana je spektralna snaga alpha 1 i alpha 2 ritma. Dobijeni rezultati su pokazali da deca sa razvojnom disfazijom i theta disfunkcijom imaju značajno ređe aktivirano levo hemisferno opšte interpretacijsko područje u odnosu na decu sa razvojnom disfazijom i urednim nalazom standardnog EEG-a. Zaključak: Theta disfunkcija ometa procesiranje govorno jezičke informacije u dece sa razvojnom disfazijom mešovitig tipa



*Ključne reči:* govorno-jezički poremećaj, iregularne promene EEG aktivnosti, theta disfunkcija

# Increased right dorsolateral prefrontal cortex activity reflects anxiety-related memory decline in adults who stutter

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**Abstract.** The aim of this study was to quantify the effect of anticipation of oral response in The Digit Span Task (DST) on recall accuracy and on EEG power spectra changes in beta (13-30 Hz) frequency bands in adults who stutter (AWS). The EEG was recorded during a forward DST in 20 AWS and 20 peers who do not stutter (AWNS). The DST had three levels: three, five and seven digits to be remembered. The trials were randomized in memory load level and response modality. After stimulus presentation, the participants were instructed to recall digits in either oral or written response modality. The 5-second retention period taken from EEG trace after stimulus presentation and recall modality requirement, and recall was analysed using spectral analysis (Fast Fourier Transform). AWS had lower accuracy during oral response in DST compared to AWNS. Written response modality yielded no difference between AWS and AWNS. Increase in EEG beta (13-30 Hz) spectral power in right dorsolateral prefrontal (rDLPFC) region (F4 region in 10/20 International system for electrode placement) was found during anticipation of oral response in AWS. A negative correlation was found between EEG beta (13-30 Hz) spectral power increase in rDLPFC and verbal recall accuracy in AWS. AWS show a drop in performance on orally tested short-term memory, which could be connected to anxiety due to anticipation of verbal response. Increased EEG beta (13-30 Hz) spectral power could be response modality- and not load-related in DST.

## 1 Introduction

There are studies that explored the link between stuttering and anxiety (Iverach, Menzies, O'Brian, Packman, & Onslow, 2011). Some studies showed that persons who stutter (PWS) have higher trait anxiety (Alm & Risberg, 2007; Craig, 2003; Ezrati-Vinacour & Levin, 2004) and also state anxiety (Craig, 1990; Peters & Hulstijn, 1984) levels when compared to persons who do not stutter (PWNS). Stuttering in adults is associated with negative emotional reactions to difficulties in producing fluent speech in social contexts (Craig & Tran, 2006; 2014). Reactions might include anxiety and frustration which are associated with anticipation of embarrassment when speaking. This could possibly lead to lowered motivation and avoidance of those situations where they anticipate disfluent speech (Tran, Blumgart, & Craig, 2011). This "anticipation effect" (for detailed review see Garcia-Barrera & Davidow, 2015) has been examined in numerous studies. It is central to several theories of stuttering. Bloodstein and Ratner (2008) placed the anticipation effect under the term "Anticipatory struggle hypothesis" and stated that the anticipation of disfluent speech is a direct causal factor for stuttering. Neuropsychological research based on somatic marker hypothesis has pointed out an important role of the ventromedial prefrontal cortex (vPFC) in the storage of those links and the importance of this cortical region in facilitating the retrieval of those links during complex processes (prediction of action outcome, decision-making etc.) (Bechara, 2004). In addition, there are some reviews of the somatic marker hypothesis that have demonstrated the role of dorsolateral PRF and insular cortex (Damasio, 1996; Dunn, Dalgleish, & Lawrence, 2006). It has been shown that those regions are active during tasks designed to activate somatic markers leading to poor performance on cognitive tasks. Finally, it could be expected that activation of the somatic markers within the PFC might lead to anticipation and stress-related low achievement in cognitive tasks. However, there are no studies that explored activation of PFC during task induced anticipation of stuttering in PWS. Studies of brain activity patterns under stressful conditions have focused on determining patterns of brain activity generated by different external potential stressors such as words, pictures, video clips and mental tasks (Matsunami, Homma, Han, & Jiang, 2001; Lewis, Weekes, & Wang, 2007). One of the most frequent goals of neurophysiological studies of emotions concerns hemispheric specialization. Coan & Allen (2004) showed that the left hemisphere appears to be more involved in the processing of

positive emotions as well as approach-related behaviors. The right hemisphere is more active during processing of negative emotions and withdrawal behaviors. The frontal and prefrontal cortex appears to play a significant role in emotional processing. Lewis, Weekes, and Wang (2007) reported a shift from greater left frontal activity during low stress to greater right frontal activity during high stress condition. These differences are represented by a model of emotional processing in which the frontal cortex has a central role. Positive moods or reactions have been shown to be associated with relatively greater left prefrontal activity (LpFA) and negative moods or reactions with relatively greater right prefrontal activity (RpFA) (Davidson, Jackson & Kalin, 2000). Davidson (1992) suggests that processing of negative emotions activate the right prefrontal cortex, amygdala, and insula. The right prefrontal cortex may be involved in the response to stress because it is a structural and functional component of both the emotional and vigilance networks. Papousek and Schulter (2002) stated that the extent of this asymmetry varies under conditions of chronic stress. In addition, activation of the right prefrontal region is associated with electrodermal activity in anxious participants. Chronic stress increases the variability of central-autonomic responses and decreases physiological adaptability as well as immunity (Fuchs, Uno & Fluegge, 1995).

### 1.1. Research aim

Based on the theoretical framework described earlier, on anticipation of disfluent speech, we hypothesized that PWS would be less accurate in a verbal recall modality in a digit span task when compared to PWNS. Further, we hypothesized that PWS would have different EEG beta spectral power during anticipation of verbal recall when compared to written. We hypothesized that verbal recall in a digit span task would lead to an increase in EEG beta in the frontal lobe in PWS.

## 2 Method

### 2.1 Participants

Twenty male persons who stutter (PWS), aged 20-23 years (mean 21.6, SD 1.17) and twenty peers who do not stutter (PWNS), aged 20-24 years (mean 22.2, SD 1.69) participated in the experiment. Participants from the control group were undergraduate students who received credits for their exam. Participants from the experimental group were referred to the Institute for Experimental Phonetics and Speech Pathology for assessment and speech therapy. None of the participants reported use of medication that could have influenced the EEG signal. They were all right-handed, according to the Edinburgh Inventory (Oldfield, 1971) and passed standard hearing screening.

### 2.2 Stimuli

The stimuli were digits ranging from 1 to 9. They were recorded by a male speaker and were read one by one without variation in melody, rhythm and emotional expression. The stimuli were grouped into trials with three levels of memory load: L1 – 3 digits, L2 – 5 digits, and L3 – 7 digits and afterwards randomized in sets consisting of 30 trials.

### 2.3 Procedure

During the experimental procedure, the participants were seated in a comfortable position in a sound and electrically shielded room. The participants were placed in a square-shaped cube made of white non-transparent curtains in order to eliminate visual stimuli that may have influenced the experimental tasks. The first part of the experiment consisted of the 2 minutes resting state EEG recording. The participants' task was to keep their eyes open for the one minute and they were instructed to minimize their movements. During the second part of the experiment, The Digit Span task was used to test short-term memory. The stimuli were presented binaurally at 50 dB sound pressure level using earphones, with ear-plugs. First, a 500 ms 1 kHz tone indicated the start of the

trial, followed by a 2-second pause. After the pause, the participants listened to auditory presented digits with an inter-stimulus interval of 1.5 seconds. After listening to the last stimulus, participants were given the instruction whether to expect a verbal or written response. The participants' task was to recall digits in the exact order (Forward Digit Span task). This was followed with a 5-second retention period. After the retention period, a 1 kHz tone indicated the start of the recall. Each trial was followed with 10-second resting state. Each participant performed a total of 300 trials. One hundred and fifty trials had to be recalled in verbal and written response modality, respectively. The trials were divided into three levels of memory load (L1, L2 and L3) in the following way: L1-100 trials, L2 – 100 trials, and L3 – 100 trials. The trials were grouped into 5 sets each containing 60 trials in the following way: L1-20 trials (10 verbal, 10 written), L2 – 20 trials (10 verbal, 10 written), and L3 – 20 trials (10 verbal, 10 written). After each study set, the participants had a 5 minutes brake. The total number of correctly recalled digits for each trial was calculated and further averaged across memory load levels (L1, L2, L3), recall modality (verbal, written), and group (PWS, PWNS). Presentation of trials was randomized in each study set in recall modality and memory load level.

### 2.4 EEG recording and analysis

EEG was recorded using the Nihon Kohden Corporation, EEG 1200K Neurofax apparatus with Electrocap providing 19 EEG channels. Electrodes were positioned according to the International 10/20 system for electrode placement. The reference was set offline to A1 and A2 (ear lobes). The sampling rate was 200 Hz. These data were transposed into EEGLAB Software. We selected 5-second artifact-free continuous data from each 10-second resting state before each trial from each study set. It was then coded according to corresponding trial (5-second retention period between recall modality requirement and the tone indicating beginning of the recall). After EEG data selection, first we normalized each trial according to corresponding retention period. Second, EEG epochs were averaged according to corresponding normalized trial. Total of 300 EEG epochs per participant and 6000 per experimental group (PWS, PWNS) were analyzed. We used fast Fourier transform (FFT) in order to separate brain rhythms. In this way, beta brain rhythm: 13-30 Hz was obtained, and their spectral power was analyzed. For beta rhythm, the mean spectral power during each 5-second retention period (after response modality requirement is present and before recall) was first normalized with corresponding resting state prior the stimulus presentation. Further, each normalized trial was averaged for each memory load/response modality for each participant, in Fp1, Fp2, F3, F4, F7, F8 regions and in Fz region and used in statistical analysis. Spectral power was calculated in MATLAB (MathWorks, version 7) and EEGLAB software packages.

## 3 Results

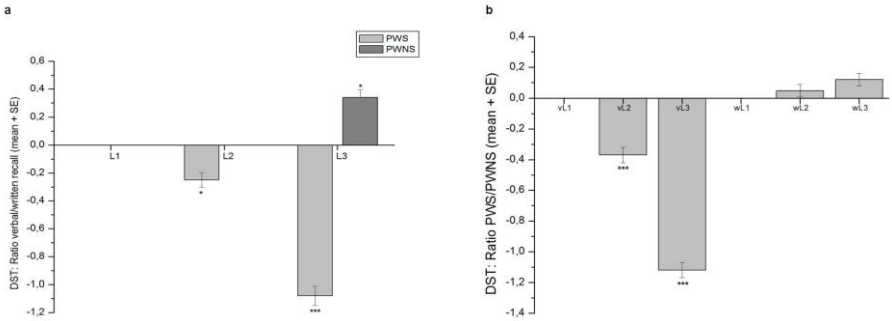


**Fig. 1 Results of The Digit Span task. a) Differences between verbal and written response in PWS and PWNS.** Level ratio between verbal and written response ((mean verbal – mean written)/mean verbal) was calculated for each memory load; L1 – memory load level 1 (3 digits); L2 – memory load level 2 (5 digits); L3 – memory load level 3 (7 digits); PWS – persons who stutter; PWNS – persons who do not stutter. Note – no data on the chart for L1 denotes "0" difference between verbal and written modality in both PSW and PWNS and for L2 no differences between verbal and written modality in PWNS only; negative value of the ratio denotes higher recall during written response modality while positive value denotes higher verbal response. **b) Differences between PWS and PWNS on each memory load level and recall modality.** A ratio between PWS and PWNS ((PWS – PWNS)/PWS) was calculated for each memory load level and response modality; vL1 – verbal response-memory load level 1 (3 digits); vL2 – verbal response-memory load level 2 (5 digits); vL3 – verbal response-memory load level 3 (7 digits); wL1 – written response-memory load level 1 (3 digits); wL2 – written response-memory load level 2 (5 digits); wL3 – written response-memory load level 3 (7 digits); Note – no data on the chart for vL1 and wL1 denotes "0" difference between PSW and PWNS. DST – Digit Span Task, SE – Standard Error, *** $p < .01$, * $p < .05$

The MANOVA revealed significant effect of group $F(1,228) = 14.594$, $p < .001$, response modality $F(1, 228) = 9.289$, $p < .001$, and load $F(2, 228) = 11.619$, $p < .001$. Significant interactions were found between group and response modality: $F(1, 228) = 8.972$, $p < .01$, group and load: $F(1, 228) = 6.172$, $p < .05$, as well as group, response modality, and load intercept: $F(2, 228) = 9.479$, $p < .001$. Figure 1 – a presents the ratio between verbal and written recall in The Digit Span task in PWS and PWNS. Post hoc analysis ($t$ test) obtained a difference between verbal and written response modality in PWNS for memory load level 3: $t(19) = 2.200$, $p < .03$. PWNS had more recalled digits during verbal when compared to written response modality in memory load level 3. No differences between verbal and written response modality were obtained for memory load levels 1 and 2 in PWNS. In contrast to PWNS, post hoc analysis on the PWS sample showed lower results during verbal, when compared to written response modality for memory load levels 2: $t(19) = -2.671$, $p < .001$, and 3: $t(19) = -6.429$, $p < .001$.When groups were compared (Fig. 1 – b), results showed that PWS had less recalled digits for the verbal response modality, in memory load levels 2: $t(39) = -4.671$, $p < .01$, and 3: $t(39) = -6.178$, $p < .001$. No significant differences were obtained between PWS and PWNS during verbal response modality in memory load level 1. No differences were obtained between PWS and PWNS for the written response modality.

The beta spectral power (Fig. 2) values in Fp1, Fp2, F3, F4, F7, and F8 regions were first examined with a 2 (group: PWS, PWNS) x 3 (load: L1, L2, L3) x 2 (response modality: verbal, written) multivariate analysis of variance (MANOVA). The MANOVA revealed significant effect of group $F(1, 228) = 18.307$, $p < .001$, and response modality $F(1, 228) = 24.922$, $p < .001$ on beta spectra power in F4 region. Significant interaction was found between group and response modality, $F(2, 228) = 8.416$, $p < .001$. No effect of load on beta spectral power in F4 region was obtained. One–way ANOVAs obtained a significant effect of response modality on beta spectral power in F4 region in PWS, $F(1, 119) = 14.677$, $p < .001$. No effect of load was obtained in PWS in beta spectral power in F4. Post hoc t test showed that these differences were due to significantly higher beta spectral power in F4 region during verbal response modality compared to written, for each memory load level: L1: $t(38) = 5.289$, $p < .001$; L2: $t(38) = 5.728$, $p < .001$; L3: $t(38) = 5.805$, $p < .001$. Although there is a trend of beta increase with increase in memory load during verbal response modality in PWS, no

statistically significant differences were obtained. In PWNS, one-way ANOVA obtained no significant effect of response modality or load on beta spectral power in F4 region. When groups were compared in beta spectral power in F4 region for verbal response modality and each memory load level, a t test obtained significant differences between PWS and PWNS – L1: $t(38) = 4.116$, $p < .001$; L2: $t(38) = 5.438$, $p < .001$, and L3: $t(38) = 5.977$, $p < .001$. PWS had higher beta spectral power during verbal response for each memory load level compared to PWNS. No differences in beta spectral power in F4 region between PWS and PWNS were obtained for written response modality for each memory load level.

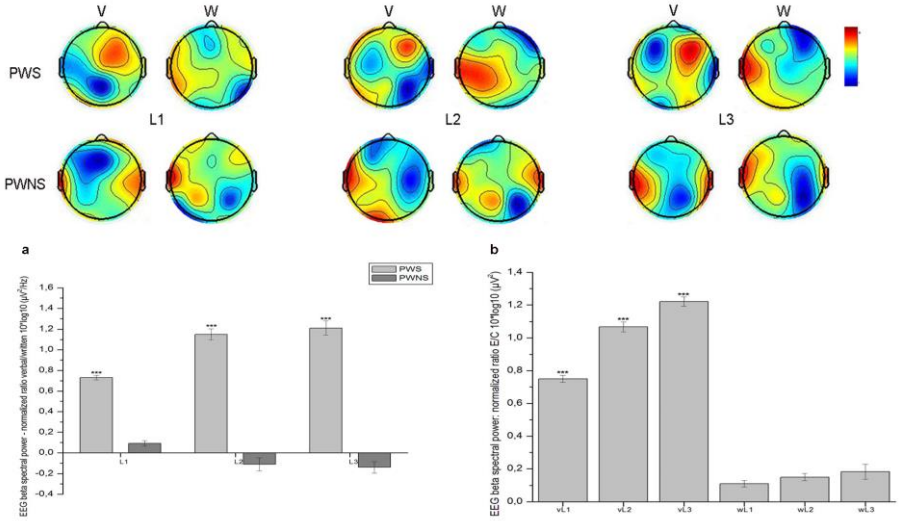


**Fig. 2 Spectral power changes in right frontal (F4) beta (13-30 Hz) band during retention period in The Digit Span task. Upper panel** – spectral power maps of EEG beta band distribution across scalp during anticipation of response modality. V – verbal response, W- written response, PWS – persons who stutter, PWNS – persons who do not stutter, L1 – load 1 (3 digits), L2 – load 2 (5 digits), L3 – load 3 (7 digits). **Lower panel – a) Differences in normalized EEG beta spectral power between verbal and written response in PWS and PWNS**. The level ratio between beta spectral power during verbal and written response ((mean verbal-mean written)/mean verbal) was calculated for each memory load and further normalized using natural $\log_{10}$; each trial was normalized according to preceding resting state **b) Differences in normalized EEG beta spectral power between PWS and PWNS for each memory load level and response modality.** For each memory load level and response modality, a ratio between beta spectral power for PWS and PWNS ((PWS – PWNS)/PWS) was calculated and further normalized using natural $\log_{10}$; vL1 – verbal response-memory load level 1 (3 digits); vL2 – verbal response-memory load level 2 (5 digits); vL3 – verbal response-memory load level 3 (7 digits); wL1 – written response-memory load level 1 (3 digits); wL2 – written response-memory load level 2 (5 digits); wL3 – written response-memory load level 3 (7 digits); *** $p < .01$.

## 3 Discussion

In this study, we examined the influence of anticipation of verbal response on achievement on a digit span task with increasing memory load in PWS. We have used a digit span task to probe memory capacity in PWS and introduced a modification in response modality, using both verbal and written. The main finding of this study was the drop in performance in The Digit Span task in PWS for verbal response, compared to PWNS. In addition, results showed a drop in performance for verbal when compared to written response modality in PWS. No similar differences between recall accuracy due to response modality were obtained for PWNS. When spectral power of EEG theta and beta rhythms were analyzed, it has been shown that beta spectral power in the right frontal region (F4) correlated with a drop in performance for verbal response modality in PWS, compared to PWNS. The effect of stress and anxiety on achievement in cognitive tasks is well documented (Eysenck, Derakshan, Santos, & Calvo, 2007). The present study contributed to unravelling possible factors of anticipation

anxiety and verbal performance expectancy and their effect on recall accuracy in a short term-memory task in PWS. A drop in verbal recall accuracy in PWS might be explained by the effect of anticipation anxiety. During a digit span task (or any task that requires speech production) PWS will experience not only higher arousal due to the task itself, but also due to possible anticipation of disfluent speech.

The aim of this study was to probe the effect of anticipation of verbal response on verbal recall accuracy in a digit span task in PWS. The advantage of using a digit span task is its simplicity of use and replicability, based on the assumption that the verbal demand might cause anticipatory anxiety in PWS. It has to be noted that this is also a limitation, as results obtained in experimental conditions cannot be generalized because of the complexity of speech situations in everyday life. An important question is what does increased right frontal beta spectral power reflect? Is it a measure of increased anxiety, a possible over-activation as a compensatory mechanism or an inherent characteristic in PWS? Preibisch et al. (2003) reported right-sided increases both during speech production and other tasks, suggesting that greater right hemisphere activation in adults who stutter may not be task-specific. Similar question was raised by Ludlow (2000) who stated that there was a possibility that increased right hemisphere activation may be inherent in PWS. It can be hypothesized that overactivation in the right hemisphere in PWS might reflect a compensatory mechanism (Lu et al., 2010). This is a potential explanation of why right hemisphere speech motor region's activity is increased in adult PWS and not in CWS. We found no increase in beta spectral power during anticipation of written response in PWS when compared to PWNS. Thus, it can be speculated that the non-verbal task did not induce anticipation anxiety and increased activity of the right DLPFC beta spectral power. Research based on Damasio's somatic marker hypothesis revealed an important role of the VMPFC in the storage of links between experiential knowledge and bioregulatory states. This region is also shown to be involved in facilitating retrieval of emotional experience during complex processes such as decision-making, estimation, and prediction of outcomes (Bechara, 2004). In addition, an association between activation of DLPFC and lower performance in tasks designed to elicit the activation of the somatic markers has been shown (Dunn, Dalgleish, & Lawrence, 2006). It could be expected that activation of somatic markers within the PFC might lead to anticipation. This hypothesis is supported also with the finding that DLPFC is related to monitoring generally (Stuss, 2007), as well as performance monitoring (Stuss et al., 2002).

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## Pojačana aktivnost desnog dorzolateralnog prefrontalnog korteksa reflektuje anksioznošću uslovljen deficit memorije kod odraslih osoba sa mucanjem

Cilj istraživanja bila je kvantifikacija efekta anticipacije usmenog odgovora na postignuće na testu ponavljanja brojeva (eng. *The Digit Span Task*) kao i na promenu spektralne snage EEG beta frekventnog opsega (13-30 Hz) kod odraslih osoba koje mucaju (OKM). Ispitano je 20 OKM i 20 osoba koje ne mucaju (OKNM). Svaki zadatak je bio sastavljen od kontrabalansiranog broja pokušaja različitog stepena složenosti (3, 5 i 7 brojeva u nizu) i različitog modaliteta ponavljanja (usmeno, pismeno). Nakon prezentacije stimulusa, ispitanici su dobijali instrukciju da dati niz ponove usmeno ili pismeno. Segment EEG trase u trajanju od 5 sekundi u periodu između instrukcije za modalitet ponavljanja i zvučnog signala da ispitanik ponovi niz je uziman za analizu spektralne snage beta ritma primenom brze Furijeove transformacije. OKM su pokazale slabije postignuće pri usmenom ponavljanju brojeva u odnosu na OKNM. Utvrđen je porast spektralne snage EEG beta ritma u desnom dorzolateralnom prefrontalnom korteksu (F4 region) tokom anticipacije usmenog ponavljanja brojeva kod OKM.

# Electrophysiological correlates of verbal memory in children with specific language impairment

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**Abstract** Brain rhythms represent electrophysiological correlates of certain physiological and pathological cognitive characteristics. There is a connection between brain rhythms and verbal memory abilities. It is known that short-term, as well as long-term verbal memory, is often impaired in children with SLI, thus it is of special interest to investigate brain rhythms in this population. The aim of this study was to investigate electrophysiological correlates of short-term and long-term verbal memory in children with SLI. Sample of this study consisted of 10 children with SLI that are diagnosed at Institute for Experimental Phonetics and Speech Pathology in Belgrade. EEG recordings were conducted using Nihon Kohden Corporation, EEG 1200K Neurofax apparatus with 10/20 system of electrode placement. We used Digit Span Task for assessment the ability of short-term verbal memory. For assessment of long-term verbal memory we used Peabody Picture Vocabulary Test and Three Pictures from IEPSP Battery of Tests. Results of our study showed certain specifics of electrophysiological correlates of verbal memory in children with SLI.
*Key words:* brain rhythms, verbal memory, SLI

## 1 Introduction

Specific language impairment (SLI) is a disorder defined by delayed language development in the absence of any apparent handicapping limitations such as hearing disorders, behavioral or emotional disorders, neurological impairments, or intellectual disability (Plante, 1998; Stark & Tallal, 1981; Tomblin, Smith, & Zhang, 1997). Children with SLI typically exhibit limited vocabulary knowledge, underdeveloped or unusual syntax, and impaired grammatical morphology (Bishop, 1992). Given that intact memory system represents one of the essential component for language development many authors has dealt with memory characteristics in SLI children (Daneman & Merikle, 1996; Gathercole, Hitch, Service, & Martin, 1997; Hick, Botting, & Conti-Ramsden, 2005; Menyuk & Looney, 1972; Nickisch & von Kries, 2009; Riccio, Cash, & Cohen, 2007; Tallal, 1975). Memory can be divided into long-term memory and short-term memory, which differ, not only in duration, but also in capacity and the way in which memories are stored. Long-term memory is a more or less permanent memory store that has a large capacity and its encoding requires neurobiological changes at the cellular level while a short-term memory represents a temporary storage of informations and its capacity is limited system for which encoding involves neurobiological modifications rather than cellular changes (Baddeley, 2012). Children with SLI show poor verbal short-term memory when compared with language-matched, typically developing children (Bishop, North, & Donlan, 1996; Conti-Ramsden, Botting, & Faragher, 2001; Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990; Hick et al., 2005; Montgomery, 1995). Receptive deficits in SLI children have been linked with verbal short-term memory deficits (Clegg, Hollis, Mawhood, & Rutter, 2005). Rice, Oetting, Marquis, Bode, and Pae (1994) and Gray (2003) found that children with SLI require as many as two to three times the number of exposures to novel words in order to make gains comparable to their age-matched peers and that compared with typically developing peers, children with SLI are less likely to retain the newly learned words after a few days have passed (Rice et al., 1994).

Correlation between specific cognitive functions, including memory, and EEG findings has been subject of many research (Giannitrapani, 1985; Marosi et al., 1999; Martin-Loeches, Munoz-Ruata, Martinez-Lebrusant, & Gomez-Jarabo, 2001; Schmid, Tirsch, & Scherb, 2002; Thatcher, North, & Biver, 2005). The EEG amplitude or power studies generally report a positive correlation between absolute power and IQ and thus demonstrated predictive validity between EEG and neuropsychological performance (Marosi et al., 1999; Schmid et al., 2002; Thatcher et al., 2005). It

has been showed that power of theta rhythm is in negative correlation with cognitive performance (Jelic et al., 2000; Jelic et al., 1996; Prichep et al., 2006; Schmid et al., 2002). Klimesch (1996) emphasized the role of alpha wave in memory performance. It has been shown that good memory performers, show a significantly higher alpha frequency and that even in a resting period alpha frequency differs between good and bad memory performers (Klimesch, Schimke, & Pfurtscheller, 1990, 1993).

Given that SLI children have deficits in verbal memory it is of special interest to investigate electrophysiological correlations in this population. The present study did not include EEG recordings during memory performance but EEG recordings during resting state. The special question was the positive correlation of memory abilities and the spectral power of alpha rhythm and a negative correlation with the spectral power of theta rhythm.

## 2 Method

### 2.1 Participants

Sample consisted of 10 male subjects age from 4,6 to 6,5. All subjects were referred to the Institute for Experimental Phonetics and Speech Pathology (IEPSP) and received the diagnosis of Specific Language Impairment by the experienced speech-language pathologist. Inclusion criteria was no history of neurological disorders.

### 2.2 Instruments

For the assessment of short-term verbal memory we used Digit span task (DST). Participants repeated lists of digits, beginning with two digits. There are ten items in blocks from two to four digits in length. The test is aborted when five items of one block are continuously failed. One item scored one point. Maximum possible score was 30.

For assessment of long-term memory we used two tests. Peabody picture vocabulary test- PPVT (Dunn et al., 2010). This test measures children's receptive vocabulary. This test measures children's receptive vocabulary. The child is shown four pictures and is required to point to the picture named by the investigator. The test begins with set deemed appropriate for the child's age. The test finishes when the child makes eight or more errors in a set. For the purpose of this study we summarized number of correct answers. Maximum possible score was 204. The other test was Three Pictures Test from IEPSP Battery of Tests (Kostić & Vladisavljević, 1983). The test consists of three subtests representing different pictures (Room, Street and Faces) in which child need to point to the item that is named by the investigator. Each picture is represented to the child separately and there is a special set of items for each picture. For the purpose of this study we used subtest Room (TPR). Maximum possible score was 50.

### 2.3 EEG recordings

During the EEG recording, the participants were placed in a comfortable sitting position in a sound and electrically shielded room. The participants were isolated from visual and auditory.

EEG was recorded using the Nihon Kohden Corporation, EEG 1200K Neurofax apparatus with Electrocap (model number 16 755) International, Inc., silver/silver chloride (Ag/AgCl) ring electrodes filled with electroconductive gel, providing 16 EEG channels. Electrodes were positioned according to the 10/20 placement system in longitudinal, monopolar montage. The reference electrode was set offline to A1 and A2 (ear lobes). The horizontal and vertical electrooculograms (EOGs) were recorded in order to detect eyeblinks and eye movements. The heart rate and hand movement sensors and electrodes for jaw muscle activity were used for offline artifact removal. The AC filter was on. The sampling rate was 200 Hz.

Impedance was kept below 5 kΩ, lower filter was set on 0.53 Hz and upper filter on 35 Hz in order to select frequency bands of interest and to cut off higher frequencies that might be muscle artifacts.

The following cortical regions were analyzes: Left Frontal (Fp1, F3, F7), Right Frontal (Fp2, F4, F8), Left Temporal (T3, T5), Right Temporal (T4, T6), Left Centro-Parietal (C3, P3), Right Centro-Parietal (C4, P4) and Central (Fz, Cz, Pz). The spontaneous (resting) EEG was recorded for 10 minutes. The participants' task was to keep their eyes open. Participants were asked to minimize their movements (eye blink, head and limbs movement) as much as possible in order to eliminate artifacts from the raw EEG trace. Resting state was used to determine mean spectral power values for theta (4–8 Hz), low alpha (8–10 Hz), high alpha (10–13 Hz), low beta (13–20 Hz), and high beta (20–30 Hz) in frontal, temporal and parietal cortical regions. These five brain rhythms were obtained, and their spectral power was analyzed. For each rhythm, the mean spectral power (averaged for epochs for each participant) in left frontal (LFR), right frontal (RFR), left temporal (LTR), right temporal (RTR), left centro-parietal (LCPR), right centro-parietal (RCPR) and central (CR) regions was further used in statistical analysis.

### 2.4 Statistical analasys

The data were analyzed using IBM SPSS 20 software. Mean absolute spectral power was computed by using the descriptive statistics. In order to estimate correlations between brain regions and brain rhythms we used bivariate analysis to compute Pearson's correlation coefficient.

## 3 Results

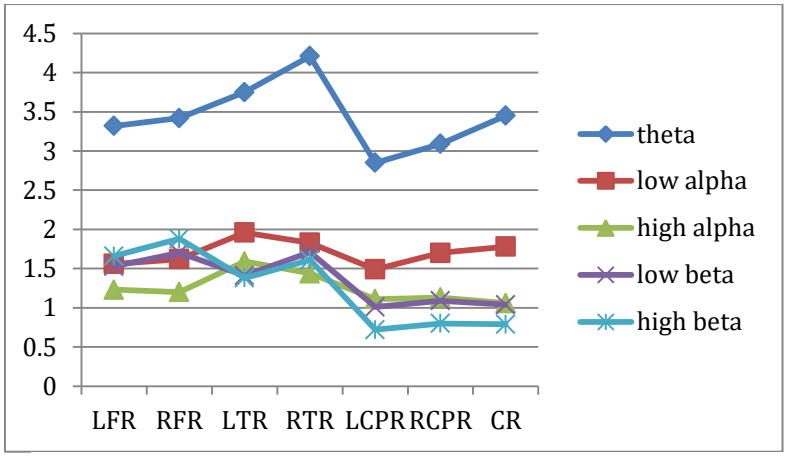
Our results showed that mean spectral power for theta rhythm was: 3,32$\mu V^2$ (SD=1,17) for LFR; 3,42$\mu V^2$ (SD=1,12) for RFR; 3,75$\mu V^2$ (SD=1,13) for LTR; 4,21$\mu V^2$ (SD= 1,59) for RTR; 2,85$\mu V^2$ (SD=0,86) for LCPR; 3,09$\mu V^2$ (SD=1,77) for RCPR; 3,45$\mu V^2$ (SD=1,26) for CR (Graph 1).

Mean spectral power for low alpha rhythm was: 1,56$\mu V^2$ (SD=0,51) for LFR; 1,62$\mu V^2$ (SD=0,42) for RFR; 1,96$\mu V^2$ (SD=0,61) for LTR; 1,83$\mu V^2$ (SD= 0,48) for RTR; 1,49$\mu V^2$ (SD=0,62) for LCPR; 1,70$\mu V^2$ (SD=0,89) for RCPR; 1,78$\mu V^2$ (SD=0,88) for CR. High alpha rhythm showed mean spectral power of: 1,23$\mu V^2$ (SD=0,24) for LFR; 1,20$\mu V^2$ (SD=0,19) for RFR; 1,59$\mu V^2$ (SD=0,47) for LTR; 1,44$\mu V^2$ (SD=0,33) for RTR; 1,11$\mu V^2$ (SD=0,41) for LCPR; 1,13$\mu V^2$ (SD=0,33) for RCPR; 1,06$\mu V^2$ (SD=0,21) for CR (Graph 1).

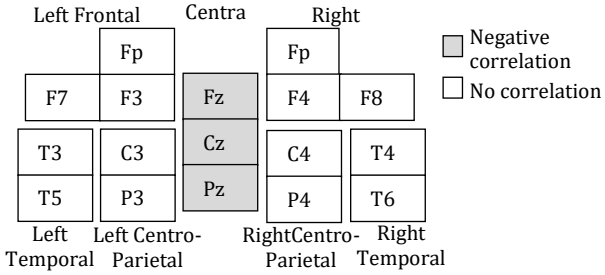
Mean spectral power for low beta rhyrthm was: 1,53$\mu V^2$ (SD=0,42) for LFR; 1,70$\mu V^2$ (SD=0,61) for RFR; 1,41$\mu V^2$ (SD=0,28) for LTR; 1,71$\mu V^2$ (SD= 0,42) for RTR; 1,01$\mu V^2$ (SD=0,23) for LCPR; 1,09$\mu V^2$ (SD=0,27) for RCPR; 1,04$\mu V^2$ (SD=0,23) for CR.High beta rhythm showed mean spectral power of: 1,66$\mu V^2$ (SD=0,44) for LFR; 1,88$\mu V^2$ (SD=0,72) for RFR; 1,38$\mu V^2$ (SD=0,58) for LTR; 1,61$\mu V^2$ (SD=0,57) for RTR; 0,72$\mu V^2$ (SD=0,19) for LCPR; 0,80$\mu V^2$ (SD=0,24) for RCPR; 0,79$\mu V^2$ (SD=0,17) for CR (Graph 1).

Pearson's correlation coefficient showed that there is a statistically significant strong negative correlation between DST and theta rhythm in CR with r =-0,617, $p<0,05$. There was no correlation between these two variables in other brain regions. DST also showed statistically significant strong negative correlation with high beta rhythm in RTR with r=-0,614, $p<0,05$. There was no correlation between other rhythms and DST in other brain regions.

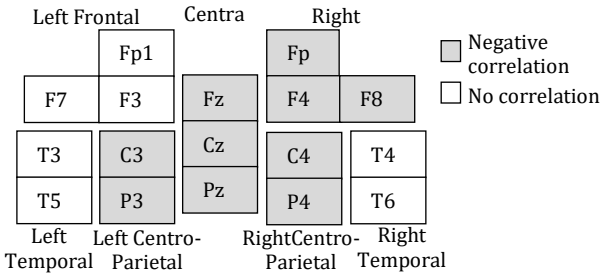
PPVT showed statistically significant strong negative correlation with theta rhythm in RFR (r=-0,646, $p<0,05$), LCPR (r =-0,721, $p<0,05$), RCPR (r=-6,14, $p<0,05$) and CR (r=- 0,760, $p>0,05$). There was no statistically significant correlation between PPVT and other brain rhythms in other brain regions. TPT did not show any correlation regarding to brain rhythms and brain regions.




**Graph 1** Mean spectral power of brain rhythms in brain regions




**Graph 2** Correlation between spectral power of theta rhythm and short-term verbal memory performance




**Graph 3** Correlation between spectral power of theta rhythm and long-term verbal memory performance

## 4 Discussion

The aim of the study was to investigate correlations between brain rhythms spectral power and memory abilities in SLI children. Given that many studies have dealt with electrophysiological correlates of cognitive abilities (Giannitrapani, 1985; Marosi et al., 1999; Martin-Loeches et al., 2001; Schmid et al., 2002; Thatcher et al., 2005), especially memory (Klimesch et al., 1990, 1993), and that it is known that memory performance is often impaired in SLI children (Bishop et al., 1996; Conti-Ramsden et al., 2001; Dollaghan & Campbell, 1998; Gathercole & Baddeley, 1990; Hick et al., 2005; Montgomery, 1995) our goal was to find connection between resting state EEG findings regarding spectral power of brain rhythms and short-term as well as long-term memory abilities in SLI children.

It is important to explain connection between short-term and long-term memory given that short-term memory is thought to be essential to the process of forming stable phonological representations in long-term memory and thus, in combination with lexical representations, is thought to play a crucial role in vocabulary development, especially in early language acquisition (Gathercole & Baddeley, 1989; Gathercole, Willis, Emslie, & Baddeley, 1992).

Our results showed negative correlation between short-term memory abilities and spectral power of theta rhythm in central region. Regarding long-term memory our results also showed negative correlation with theta rhythm in right frontal, left centro-parietal, right centro-parietal and central regions. Authors who conducted studies on adults found that higher baseline theta power can be indicative of subsequent cognitive decline (Jelic et al., 2000; Prichep et al., 2006). Schmid et al. (2002) also found higher spectral power of theta in children with lower scores on verbal performance of IQ scale in school-age children.

One of the questions of this study was the appearance of negative correlation between theta rhythm spectral power and memory performance, which is confirmed, and the positive correlation with spectral power of alpha rhythm, which was not supported by our results. The specific relationship between alpha frequency and memory performance is demonstrated by the fact that alpha frequency is significantly and positively correlated with memory performance. Klimesch, Doppelmayr, Schimke, and Pachinger (1996) stated that increasing memory performance is related to increasing processing speed and that alpha frequency reflects the speed of cognitive processes in semantic long-term memory. The results of Matousek and Petersen (1973) research indicated that theta activity is dominant until the age of 4 years, with decreasing with age. Alpha and beta activity increased throughout childhood and the total amplitude decreased with age during childhood. Matthis, Scheffner, Benninger, Lipinski, and Stolzis (1980) found, with increasing age, that slow wave activity appeared to be replaced by faster frequencies. Given that our sample consisted of children from 4 to 6 years our results regarding to alpha rhythm may be explained by maturation process by itself or by the characteristic of SLI. For further research inclusion of control group with normal speech-language abilities children as well as bigger sample is needed.

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## Elektrofiziološki korelati verbalne memorije dece sa specifičnim jezičkim poremećajem

Moždani ritmovi predstavljaju elektrofiziološke korelate određenih fizioloških i patoloških kognitivnih karakteristika. Pokazana je veza između moždanih ritmova i sposobnosti verbalne memorije. Poznato je da su kratkoročna kao i dugoročna verbalna memorija oštećene kod dece sa specifičnim jezičkim poremećajem tako da je ispitivanje moždanih ritmova u ovoj populaciji od posebnog interesa. Cilj ovog istraživanja bio je da se istraže elektrofiziološki korelati kratkoročne i dugoročne verbalne memorije kod dece sa specifičnim jezičkim poremećajem. Uzorak je činilo 10 dece sa specifičnim jezičkim poremećajem koja su dijagnostikovana u Institutu za eksperimentalnu fonetiku i patologiju govora u Beogradu. EEG snimanje izvršeno je korišćenjem Nihon Kohden Corporation, EEG 1200K Neurofax aparata 10/20 sistemom postavljanja elektroda. Za procenu kratkoročne verbalne memorije koristili smo *Digit span* zadatak. Za procenu dugoročne verbalne memorije koristili smo Pibodi test receptivnog rečnika i Test tri slike iz IEFPG baterije testova. Rezultati su pokazali da postoje određene specifičnosti elektrofizioloških korelata verbalne memorije kod dece sa specifičnim jezičkim poremećajem.

# The relationship between the ability to understand speech and EEG findings in children with disabilities in language development

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**Abstract.** Language is a complex code system that denotes objects, symbols, actions or relationships that carry the function of coding, the transmission of information and its introduction into different systems, while the word is the basic means of encoding and transferring experience. Language is, therefore, an abstract system, and speech is its concrete realization. Language disorders in children are characterized by slow or disturbed language development due to the lack or lack of capacity to develop the same language skills. In children with developmental language disorders, there are interferences in the understanding, use and expression of language. Interferences can occur in one or all areas of the language structure: phonology, semantics, morphology, syntax, and pragmatics. Specific language impairment is a developmental language disorder, or disorder of the development of expressive (language production) and receptive speech (language understanding), with specific pathological patterns of expression, damage to language development. At the same time, children with a specific disorder of language development have preserved hearing, typical intellectual abilities. Neurological and psychiatric findings in these children are, as a rule, neat. The main goal of this research is to determine the level of speech understanding in children with altered EEG finding.
The sample consisted of 17 children with altered EEG findings and 17 children with a regular EEG finding. All data is graphically processed and displayed.
The results indicated that children with a proper EEG finding had better achievements in most of the applied tests than children with altered EEG findings.
*Key words:* language development, specific language impairment, EEG finding

## 1 Language

Language is a complex system of codes which denote objects, symbols, actions or relationships that carry out the function if coding, the transmission of information and its introduction to different systems, while the word represents the basic means of coding and trasfering experience (Luria, 2000).

Using language as a system of codes which charactarise objest and their relationships, and by which objects are introduced to certain systems or categories, this code system leads to the information of abstract thinking and the formation of the ”categorical’’ consciousness.

Language is a system of signs, a unique code related especially to the universal ability of symbolic voice communication, which reflects the formal structure and rules of functioning of sign systems, that is, the creation and transmission of messages through organized characters. At the same time, language is a social phenomenon, linked in particular to the existence of language units, human groups defined in a language interconnected by their members. Finally, language is also a psychological phenomenon, linked in particular to the mental and mental life of a man who is greatly permeable. (Bugarski , 1991). Language structures speech, and for people to communicate with it the linguistic system strives for the immutability and permanence of its structures.

So that communication is effective, there is a constant tendency in the speech to make changes to the language system. Although language and speech are two aspects of one phenomenon - linguistic activity from their interaction comes from linguistic creativity, i.e. the ability of speech and language to adapt to the constantly new needs of language practice.

### 1.2 Adoption of a language

Adoption of the mother tongue in normal children of a particular language environment is most often unfolding for adults from the child's immediate surroundings. The fact is that the general development of each individual area of functioning, including the development of language, takes place in the framework of the entire sensomotor and psychomotor organization of the child, but nevertheless, to some extent, follows its own principles. So, it is about subsystems that are connected in a unique functional network, characteristic for each individual. Sovilj (M. Sovilj, 2002) emphasizes the importance of the first cry and the very prevalent phase for the development and adoption of languages. By analyzing the first cry, the presence of general language universals has been determined, which, depending on the language of the environment, will develop in one of the languages. Later, there is a difference in the type of salary that is immanent to the type of physiological needs. Already during the second half of the first month, a period of vocalization begins, the occurrence of a blow when the child is in the homeostasis, when their needs are met. In the next phase (at the beginning of the second month), the dragging is characterized by an abundance of varying phonation (scribbling and subtraction) with a high degree of oscillation of tone and intensity. Here we can look at the dragging as an expression of children's feelings, emotions and communication needs and can be accepted as a means of communicating with other people. At the beginning of the third month, the phenomenon of diftong (which does not usually exist in our own language) is observed, the shortening of the duration of the vocals in a series and their interconnection.

Babbling phase can be seen as a child's need to communicate their feelings, the desire to imitate human speech. In this way child builds a sentence melody and verifies the dynamics of tone and accent.

The final phase is the speaking, which is associated with the first socialized word, by which the child consciously names an object or being and which occurs between the 9th and 12th month when the child forms the word that connects with the object or being, thus forming its meaning (M. Sovilj, 2002)

### 1.3 Level of language development

Language is a complex character system, composed of several hierarchically organized levels. It is a double-broken system because it always distinguishes the plan of terms (words) and the content plan (voices).

The first level of the linguistic system is the phonological level. Level indicating the function of phonemes in the language as a communication system.

The second level of the language system is a lexical level. Level indicating words. The word is a complete and independent linguistic unit, formed in the conventional conjunction of sound and meaning, by the fact that certain phonemes or combinations of phonemes are associated with a certain and proportionally constant conceptual content (Bugarski, 1991)

The third level of the language system is a grammatical level. A level that includes morphology and syntax. Morphology, which studies the shape change of the word. It is supplemented with syntax, which deals with the combination of words into a larger language unit.

The next level is a semantic level. Level relevant to the meaning of words and sentences. This level of language organization consists of lexical semantics, which deals with understanding the meaning of the word and sentence semantics, which deals with the understanding of sentences (Vuković, 2010).

The highest level of the language system is a pragmatic level. Level relating to the use of language in the communication process, i.e. the way in which social needs and intentions are realized. The pragmatic level is realized through discourse (oral speech) and text (written speech) (Vukovic, 2010).

In addition to lingual characters, the person uses non-verbal characters during communication, which can be symbols and signals.

### 1.4. Specific language impairment

Language disorders in children are characterized by slow or disturbed language development due to lack or lack of capacity to develop the same abilities or loss of already acquired language abilities.

Depending on the time of development, language disorders in children are divided into developmental and acquired. Developmental language disorders are those that arose before speech and language began to develop (from birth to the first year), while acquired language disorders occurred between the ages of 3 and 12, or after the tongues skills have already begun to develop. In children with developmental language disorders, there are interferences in the understanding, use and expression of language in a different degree in one or all of the fields of phonology, semantics, syntax and pragmatics (Bashir Kban, Kleinman, Scavuzzo, 1983; Leonard, 1797; Ludlow, 1980 , Golubovic 2007).

From the population of etiological factors that are considered responsible for the emergence of language disorders in children, they can be divided into primary and secondary (Ludlow, 1980).

Under primary disorder of language development, they are those that are not the result of peripheral or motor deficits, cognitive deficits, or adverse central conditions. As the primary etiological factor of developmental linguistic disorders, cns are often cited as dysfunctional, although they are often also idiopathic. Secondary language disorders are those that occur as a result of hearing loss or mental retardation.

Specific speech and language disorders are specific developmental disorders in which there are damage to normal patterns of speech acquisition from early stages of development. These conditions can not be directly attributed to abnormalities of neurological or speech mechanisms, sensory impairments or environmental factors.

According to the ICD-10 classification, developmental language disorders are classified in:

- Expression speech disorder
- Disorder of receptive speech

Expression speech disorder (Dysphasia evolutionis expressiva - F 80.1) is a specific developmental disorder in which the child's ability to use expressive speech is significantly below the expected level for his mental age. Understanding the speech is within the limits of the normal. Damage to the spoken language must be noticeable from the earliest childhood without clear longer phases of normal language use.

A receptive speech disorder (Dysphasia evolutionis receptiva - F 80.2) is a specific developmental disorder in which speech understanding is below the expected level for the child's mental age. In most cases, there is a pronounced impairment of expressive speech, with frequent abnormalities in the production of voices.

## 2 Electroencephalography

Electroencephalography (EEG) is the recording of electrical activity and the bark of large-scale surface electrodes on the skin of the head using an electrocorticogram (recording the electrical activity of a large brain of surface electrodes at the bark of the big brain) and electrosubkortigograms (microelectrode capture in the brain itself).

Clinical electroencephalography is a standard diagnostic method that determines the existence of waves of a certain frequency in longer and shorter periods under precisely determined conditions.

EEG is a result of the potential of the potential that originates from extracellular currents generated by a large number of neurons. The EEG shows the constant rhythmic activity of the brain cells. The rhythmic activity may come from the so-called. neuron pacemaker and neurons that can not generate rhythm, but can synchronize through excitatory and inhibitory connections by forming a network with pacemaker characteristics. (H.H. Jasper, 1958).

### 2.1 Quantitative EEG

Quantitative EEG is the term used when the software analyzes the EEG signal and quantifies various aspects of EEG. In this process, something gets and something loses. This process does not reflect data on the specific waveform morphology (form), and on a multitude of specific waves, but it enables us to visualize easier. The computer shows us a picture and a form of histogram or a three-dimensional topographic map. At the same time, the software calculates in real time and a number of statistical parameters that can help us quickly and easily obtain important data for diagnostics.

The EEG signal is a composite signal composed of multiple frequency ranges. These frequency bands are also called brain rhythms or brainwaves, and are divided into: Delta (0.1-3.5 Hz), Ate (4-7.5 Hz), Alpha (8-13 Hz), Beta (14- 35 Hz) and Gamma (35-70 Hz) (H.H. Jasper, 1958).

## 3. Method

### 3.1 Participants

The sample in our research was obtained by random selection and is made up of 34 children with a diagnosis of a specific linguistic disorder, which are at the Institute for Experimental Phonetics and Pathology of Speech on Speech Treatment, age 5 to 7 years. For the experimental group, only children with altered EEG findings and diagnosis of specific lymphatic disorders were selected, and the control group was made up of children with a regular EEG finding and diagnosis of a specific linguistic disorder. The full sturcture of the sample of our research is as follows: In the experimental group, 30 percent are girls, and 70 percent are boys. The same full structure is present in the control group. We did not want to artificially equate the sample, but we felt it was right for sub-partners to realistically map the situation that exists in the population of children with speech-related language disorders. In the previous research carried out in the last decade in our country, we have obtained results that show that among the children of pre-school age with a diagnosis of a specific language disorder there is a significantly higher percentage of boys compared to girls. Adequate test conditions are provided. Regarding the EEG findings in children from the experimental group, we can state that they were essentially the same or similar EEG findings that consisted mainly of harsh and highly volatile aortic waves, alpha wave spores, while beta activity was lowered or average values. We can also indicate the presence of delta wave.

### 3.2 Measuring instruments

In our research, the following measuring instruments were used Token test (Spreen & Staruss, 1991 - shortened version), Test for the assessment of the adoption of the proposal (IEFPG Test Battery, 2003) and Digit Span Task.

## 4 Results

### 4.1. Results of a Token test

Using the ANOVA test, a statistically significant effect of the group (experimental, control) on the TOKEN test was determined: $F(1.32) = 14.954$, $p < 0.01$. Respondents from the experimental group achieved statistically significantly lower values on the TOKEN test compared to the subjects from the control group

### 4.2 Test results for assessing the adoption of the proposal

Significant effect of the group (experimental, control) on the achievement of the Test for the assessment of the adoption of the proposal (active) was determined: F (1.32) = 16.681, p <0.001. Respondents from the experimental group achieved statistically significantly lower values on the Test for the assessment of the adoption of the proposal (active) compared to subjects in the control group. Also, a significant effect of the group (experimental, controlling) on the Test for the assessment of the adoption of the proposal (passive) was determined: F (1.32) = 9.011, p <0.01. Respondents from the experimental group achieved statistically significantly lower values on the Test for the assessment of the adoption of the proposal (passive) compared to the subjects in the control group.

### 4.3 Test for the assessment of verbal memory (Digit Span Task)

By using the ANOVA test, the statistically significant effect of the group (experimental, control) on the DST was not determined: F (1.32) = 1.948, p = 0.172.

**Table 1.** Test results

| | TOKEN TEST | DST | PROPOSAL_ACTIVE | PROPOSAL_PASSIVE |
|---|---|---|---|---|
| E | 46,18 (40,30) | 19,53 (6,26) | 2,24 (1,60) | 4,65 (1,77) |
| C | 100,94 (42,25) | 22,59 (6,52) | 5,06 (2,36) | 6,41 (1,66) |

E –experimental group, K – control group, DST – Digit Span Task, mean values are shown (standard deviation)

The next level of analysis was the application of Pirson's correlation coefficient to determine the relationship between achievements on the TOKEN test and the achievements in the DST, the test for examining the acceptance of the proposal (active) and the test for the examination of the adoption of the proposal (passive).

**Table 2** The results of the Pirson coefficient of correlation (r) – control group

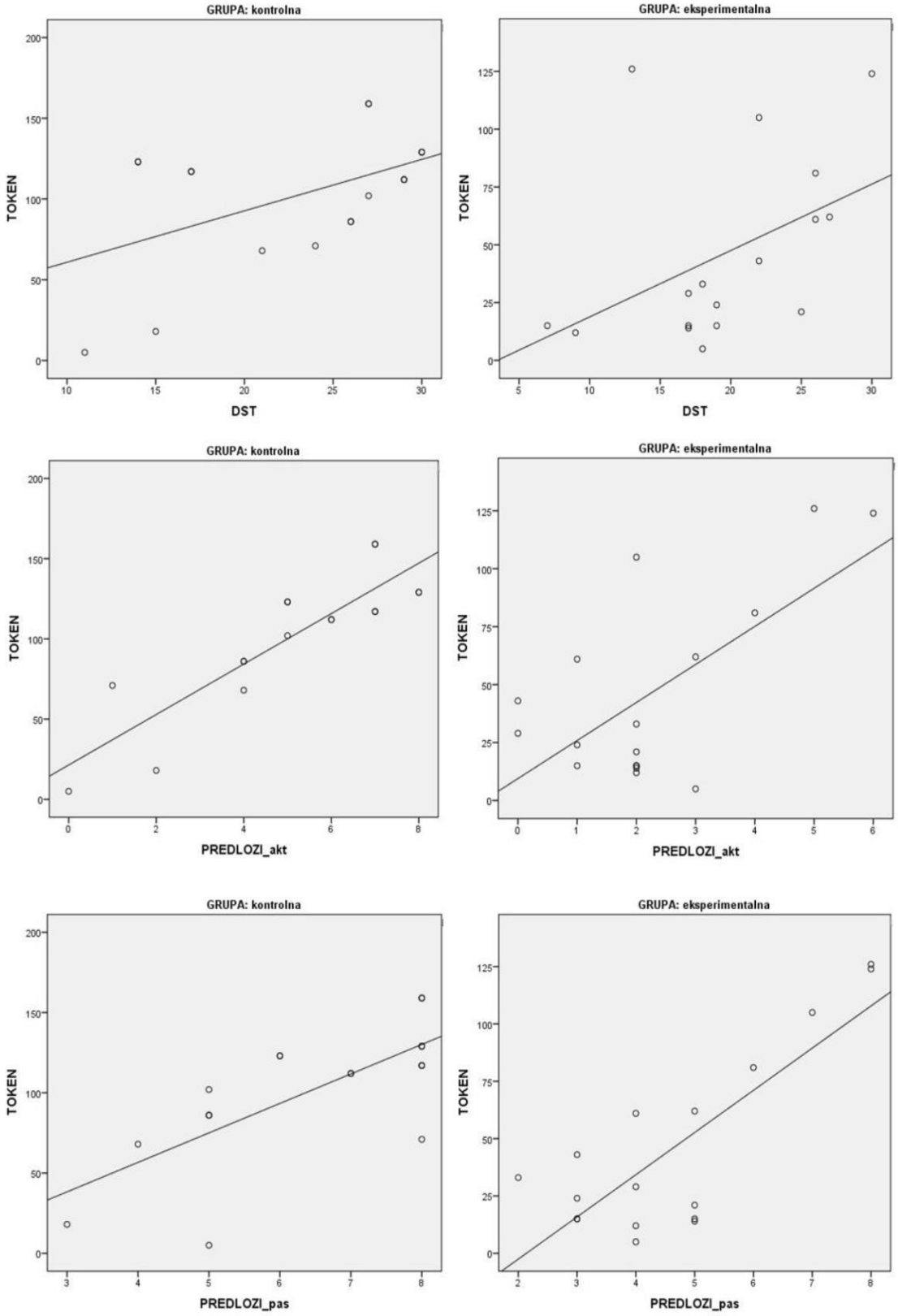
| | TOKEH | DST | PROPOSAL_active | PROPOSAL_passive |
|---|---|---|---|---|
| TOKEH | / | / | / | / |
| DST | 0,491* | / | / | / |
| PROPOSAL_active | 0,877** | 0,498* | / | / |
| PROPOSAL_passive | 0,722** | 0.386 | 0,632** | / |

DST- Digit Span Task, * p<0,05, ** p<0,01

**Table 3.** The results of the Pirson coefficient of correlation (r)- experimental group

| | TOKEH | DST | PROPOSAL_active | PROPOSAL_passive |
|---|---|---|---|---|
| TOKEH | / | / | / | / |
| DST | 0.446 | / | / | / |
| PROPOSAL_active | 0,653** | 0.299 | / | / |
| PROPOSAL_passive | 0,806** | 0.352 | 0,760** | / |

Following is a graphical representation of the obtained results. The graph illustrates the achievements of the Test for the assessment of verbal memory t in the experimental and control group. From the given presentation it is noticed that the control group of children has the correlation of the results of the Token test and DST, as well as the resolution of the adoption of the proposal at the active and passive level. Also, there is a positive correlation in the experimental group between the Token test and the result of the adoption of the proposal at the active and passive level.




## 5. Discussion

Understanding speech is a mental process that allows the listener to interpret what the speaker has produced, based on the language symbols that the speaker has produced. Language disorders in

children are characterized by slow or disturbed language development due to the lack or lack of capacity to develop the same language skills.

The aim of this paper was to examine the relationship between EEG findings and speech understanding in children with specific language disorders. The ability to understand the verbal tasks given in the Token test, the ability of short-term verbal memory and the degree of adoption of the proposal.

The results of our research have shown the significant impact of changes in the EEG findings on the Token test results and tests for assessing the adoption of proposal. By applying Pirson's correlation coefficient, it was found that there is a positive correlation of the Token test and DST, as well as on tests for assessing the adoption of proposals at the active and passive level, within the control group.

Also, a positive correlation exists in the experimental group between the Token test and the results on the test of the adoption of the proposal at the active and passive level. This finding suggests that children with a specific language awareness and an altered EEG finding have a significantly lower level of understanding of the language compared to children with developmental disorders with a proper EEG finding.

Our cuts coincide with the results of other authors who have determined the significance of the changed EEG findings on the ability to understand languages in children with specific linguistic disorders (Škara and Vuković, 2017). The obtained data indirectly point to the worse linguistic abilities of children with altered EEG findings compared to children of regular EEG findings, which was also shown by the results of previous research (Milošević i Vuković, 2011, Milošević i Vuković, 2011b). The finding is in line with research that confirmed that theta dysfunction as a specific modality of altered, non-specific EEG activities can have a negative impact on speech language processing in the segment of understanding and speech production, and that it causes a time-delayed duration of a specific language disorder under conditions of speech therapy (Radičević et al., 2013). The results of the study suggest that children with a specific language disorder who have changes in electroencephalographic activity require more intensive treatment in terms of language understanding.

## 6.Conclusion

Based on the analysis of the obtained results of the research, the following conclusions were drawn.

Children with a specific language impairment and altered EEG findings exhibit worse achievements on the Token test than children with a regular EEg finding. This finding points to the possible impact of changes in the EEG finding on the understanding of verbal assays in children with a specific language disorder.

Children with a specific linguistic disorder and altered EEG findings exhibit poorer achievements on the test of the inclusion of children's proposals with a regular EEG finding. This finding points to the impact of changes in the EEG finding on the degree of adoption of the proposal in children with a specific language disorder.

Changes in the EEG findings in our cause of the respondents are not related to the achievement of the Verbal Memory Test. This finding suggests that an altered EEG finding does not worsen the ability of short-term verbal memory in children with a specific language disorder. However, the verbal memory estimate requires the application of more extensive techniques and the control of other variables in order to make a valid conclusion.

The results of our research and research by other authors show that the use of EEG in children with language disorders has scientific and professional implications.

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## Odnos sposobnosti razumevanja govora i EEG nalaza kod dece sa poremećajem u jezičkom razvoju

Jezik predstavlja složeni sistem koda , koji označava objekte, simbole, akcije ili veze, koje nose funkciju kodiranja, kao i prenos informacija i njegovo uvođenje u različite sisteme, dok je reč osnovni način kodiranja i prenosa iskustva. Jezik je, pre svega, apstraktan sistem, a govor je njegova konkretna realizacija. Poremećaji jezika kod dece se karakterišu usporenim razvojem jezika, zbog nedostatka ili nepostojanja kapaciteta za razvijanje jezičkih veština. Kod dece sa poremećajem u razvoju jezika, ispoljavaju se teškoće u razumevanju i produkciji. Smetnje se mogu ispoljiti u jednoj ili svim oblastima jezičke strukture: fonologija, semantika, morfologija, sintaksa i pragmatika. Specifični jezički poremećaj je poremećaj razvoja ekspresivnog (jezička produkcija) i receptivnog govora (jezičko razumevanje), sa specifičnim obrascima ispoljavanja. Istovremeno, deca sa a specifičnim jezičkim poremećajem imaju očuvan sluh i normalne intelektualne sposobnosti. Neurološki i psihijatrijski nalazi kod ove dece su, po pravilu, uredni. Glavni cilj ovog istraživanja jeste da odredi nivo razumevanja govora kod dece sa izmenjenim EEG nalazom. Uzorak se sastojao od 17 dece sa izmenjenim nalazima EEG-a i 17 deca sa urednim nalazima EEG-a. Svi podaci su grafički prikazani.
Rezultati pokazuju da su deca sa urednim EEG nalazima postizala bolje rezultate na većini primenjenih testova nego deca sa izmenjenim EEG nalazom.
*Ključne reči* : jezički razvoj, specifični jezički poremećaj, EEG nalaz

# Correlation of balance ability and speech-language development in 5 year-old children

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**Abstract:** The evaluation of balance in children has long been recognized as an important link for the evaluation of child development. Pre-school age is a very important period for future motor behavior, because in that period basic motor skills are developed. During preschool age, the ability to maintain balance reaches the appropriate level, while its development completes in the course of later childhood. Children with disabilities, ranging from milder to more serious ones, have poor performance on tests of the ability to maintain balance. The goal of this paper was to examine whether there is a correlation between the ability to maintain balance and a certain degree of speech-language development in 5-year olds. The basic test group comprised N=54 children of both sexes, 5.0 to 5.4 years of age who were evaluated for their ability to maintain balance (AMB), speech-language development (SLD), sensorimotor development (SMD) and social-emotional behaviour (SEB) based on the standardized battery of tests. The obtained data were documented by means of a digital camera, then scored and statistically and descriptively processed. In addition, for each child within the examined sample, the data were taken about the time when it started to sit, stand, walk and talk (SSWS). The research results indicated very high positive correlation between the results from the scale for the evaluation of AMB (both in individual tasks as well as on the scale in total) on the one hand and the results from the scales for the evaluation of SLD, SMD and SEB on the other hand, i.e. children with better AMB at the age of 5, also have a higher degree of SLD, SMD and SEB, and vice versa. With 99% confidence, we can conclude that the psychophysiological abilities of children at the age of 5 are better if their function of the vestibular sense is more mature and therefore the overall ability to maintain balance is better.
*Key words*: balance ability, child, speech, language, sensorimotor development

## 1 Introduction

The physiology of maintaining balance is a complex adjustment process that is based on a system of interactions of several organs which influence the spatial orientation of the body. Bioelectric signals that are generated by the body movements in semicircular channels and otolithic apparatus of the ear are transferred by the vestibular nerve to the vestibular nuclei, and then integrate and modulate the activities of other neurological structures (Guyton and Hall, 1999). Given the complexity of this interaction, it is not surprising that a minimal pathological variety can cause balance disorders. The vestibular apparatus is the most important part of the physiological system in creating a motor response that is of importance for daily functioning and survival in the conditions of daily movement through space (Lemajić-Komazec, 2011).

Rajović (2012) suggests that certain balance exercises stimulate physical and mental development of children. In this sense, this author highlights the significance of one of the most complicated movements in space - rotation around one's axis, listing the structures involved in it. The vestibular apparatus of the inner ear transmits impulses to the structure of the brainstem, and from there to the core of the cerebrum and cerebellum that are connected with III, IV and V cranial nerves, while simultaneously influencing eye movements. Given the complexity of this physiological process, it is important to develop it in the early years of life in order to take advantage of the period of the highest brain maturation and to help the child develop the natural potentials as much as possible.

Balance is a motor skill, it participates in solving motor tasks and can be measured. The coefficient of innate balance is very high. Balance reaches its maximum at about 25 years of age, while its greatest impact on the organism of a person is in childhood, from 4 to 8 years of age. Balance is a key prerequisite for moving (Malina et al, 2004).

The connection between the function of the vestibular sense and the speech-language development is increasingly becoming the subject of a great deal of research (Magrun et al, 1981; Ray et al, 1988; Tomatis 1997; Ayres, 2005; Kranowitz, 2006; Niklasson et al, 2010; Emami et al, 2012).

Movement activates speaking ability. Therapists have found that when they treat a child with a disturbed vestibular function, speech and linguistic abilities are improved along with improved balance, movement and motor planning (Kranowitz, 2006). A child who cannot stand on one foot, probably cannot read and write, as standing on one foot demonstrates the ability to maintain balance. The ability to maintain good balance is the result of a strong, well-developed vestibular system. The vestibular system is closely related to linguistic abilities (Hannaford, 1997).

Performing a normal movement involves biomechanical assumptions of muscles and joints, normal posture tone, reciprocal innervation, sensorimotor control and balance reaction. Each movement can lead to a change in balance because it changes the muscle tone, the center of gravity, and the posture. If the weight transfer is small, the balance is maintained only by changing the muscle tone without a visible movement. Only large and rapid changes in the body's position require compensation for movement in order to maintain balance. Two types of automatic reactions, righting reaction, and balance maintenance reaction are normal postural reflex mechanisms that provide the basis for carrying out the movement. The balance maintenance reactions are invisible, fine, gradual tone changes in relation to posture in response to the action of the gravitational force. They are always present and happen automatically. Balance is the basis for moving against the force of gravity, adjusting to changes of the surface of the support, selective movement and automatic functional activity (Kosinac, 2009).

## 2 Aim

The goal of this paper was to examine whether there is a correlation between the ability to maintain balance and a certain degree of speech-language development in children 5 years of age.

## 3 Research methodology

The research of the ability to maintain balance (AMB), and the evaluation of speech-language, sensorimotor and social-emotional development, were conducted on the sample of N=54 children, 5.0 to 5.4 years of age, out of which N=29 examinees were males and N=25 examinees were females. The conditions for each child to be included in the research sample were as follows: the child was not older than 5.6 years of age at the time of testing; an examination of a neurologist was performed with no pathological findings and from the neurological point of view the child is completely healthy; it was born as a healthy baby, in term, from a regular pregnancy. The research was conducted at the Institute for Experimental Phonetics and Speech Pathology (IEPSP) and the Life Activities Advancement Centre (LAAC) in Belgrade.

For the evaluation of the ability to maintain balance in five-year olds, the research instrument consisted of 15 standardized tests (Čupić and Miklošić, 1981). Due to the large number of tests used to evaluate AMB of five-year olds in our research, we labeled the tests as Test 1 (T1), Test 2 (T2), ending with Test 15. The tests were as follows: Romberg's test (T1), evaluation of standing balance (T2), evaluation of walking in a straight line (T3), standing on one foot (T4), finger to finger test (T5), evaluation of vestibulo-ocular reflex (T6), evaluation of body and head posture in the sitting position (T7), balance reaction in the sitting position (T8), trunk rotation in the sitting position (T9), evaluation of body and head posture in a standing position (T10), position with the arms extended forward (T11), evaluation of forward and backward walk (T12), evaluation of toe walking (T13), evaluation of heal walking (T14) and jumping in place (T15).

Children conducted each test i.e. task in three attempts which were scored with 0 points - unsuccessful, 1 point – partially successful and 2 points – successful. Then the average score was calculated for all three attempts together thus creating the scale of 0 –2 points for the achievement in each of 15 tasks. In certain tests, depending on their complexity and in accordance

with the methodologically clearly defined standard procedure, the tasks were conducted in three attempts to the left and to the right, three times forwards and backwards, i.e. three times upwards and downwards. While processing the obtained data, average marks for the left and the right side were calculated first, then for the attempts upwards and downwards i.e. backwards and forwards, based on which the mark for the execution of the complete test was calculated.

The obtained data were documented by means of a digital camera, then scored and statistically and descriptively processed.

For the evaluation of speech-language development (SLD), sensorimotor development (SMD) and social-emotional behaviour (SEB) of five-year olds included in this study, three tests with the same name or subscales were used (test for the evaluation of SLD, test for the evaluation of SMD and test for the evaluation of SEB) within the standardized Scale for the evaluation of psychophysiological abilities of a child aged 0 to 7, by the author Neda Subota. This scale is an integral part of the IEPSP battery of tests and enables relatively quick and accurate evaluation of overall abilities of a child compared to its calendar age. The results on each of the three subscales are expressed as a percentage of success.

## 4. Results and discussion

Results presented in Table 1 indicate that the five-year olds from our testing sample achieved the lowest average results in the test of the ability of standing on one foot (T4), where the arithmetic mean equaled 1.50 points on average (with the standard deviation of 0.53 points).

Only 1.9% of examinees, i.e. only one child, had the minimum score of 0 points. Maximum score of 2 points had 37.0% of the sample i.e. 20 out of 54 examinees. That was the only task in which the five-year-olds realized an average achievement which was not higher than 1.50 points, i.e. all other examined parameters of AMB were more developed than the ability of maintaining balance while standing on one foot. On the other hand, the highest average achievement of 1.90 points was recorded in Task 10 which evaluated the body and head posture when standing (T10). None of 54 examinees scored below 1 point. Only in one case (1.9% of children) the score of 1 point designated a task completed with a partial success. The total of 14.9% of children scored 1.33 and 1.67 points, whereas 83.3% of examinees scored the maximum of 2 points.

On the scale for evaluation of speech-language development, as shown in Table 2, the minimum result equaled 35.29 points, which was present in only one child (i.e. in 1.9% of cases). None of the five-year olds from our research had a score below 35.29 points, i.e. there were no children with such a low degree of speech-language development.

Maximum possible achievement (100 points) was registered in the total of 22.2% of children (i.e. in 12 out of 54 examinees in total). Average achievement is 83.22 points on the scale of 0 to 100 points, with the standard deviation of 16.22 points.

**Table 1 –** Basic results of the evauation of AMB in five-year olds

| | Min. | max. | AM | SD | N |
|---|---|---|---|---|---|
| T 1 | 1,00 (14,8 %) | 2,00 (59,3 %) | 1,73 | 0,38 | 54 |
| T 2 | 1,00 ( 1,9 %) | 2,00 (57,4 %) | 1,78 | 0,31 | 54 |
| T 3 | 0,67 ( 1,9 %) | 2,00 (77,8 %) | 1,88 | 0,28 | 54 |
| T 4 | 0,00 ( 1,9 %) | 2,00 (37,0 %) | 1,50 | 0,53 | 54 |
| T 5 | 0,00 ( 1,9 %) | 2,00 (68,5 %) | 1,84 | 0,34 | 54 |
| T 6 | 0,67 ( 3,7 %) | 2,00 (61,1 %) | 1,83 | 0,33 | 54 |
| T 7 | 0,67 ( 3,7 %) | 2,00 (53,7 %) | 1,68 | 0,41 | 54 |
| T 8 | 0,50 ( 1,9 %) | 2,00 (51,9 %) | 1,70 | 0,41 | 54 |
| T 9 | 1,00 ( 7,4 %) | 2,00 (40,7 %) | 1,75 | 0,30 | 54 |
| T 10 | 1,00 ( 1,9 %) | 2,00 (83,3 %) | 1,90 | 0,24 | 54 |
| T 11 | 0,00 ( 1,9 %) | 2,00 (61,1 %) | 1,70 | 0,46 | 54 |
| T 12 | 1,00 ( 1,9 %) | 2,00 (57,4 %) | 1,83 | 0,24 | 54 |
| T 13 | 0,00 ( 1,9 %) | 2,00 (61,1 %) | 1,68 | 0,46 | 54 |
| T 14 | 0,00 ( 1,9 %) | 2,00 (61,1 %) | 1,68 | 0,46 | 54 |
| T 15 | 0,00 ( 1,9 %) | 2,00 (50,0 %) | 1,67 | 0,49 | 54 |

**Table 2 –** Basic results of SLD, SMD and SEB in five-year old children

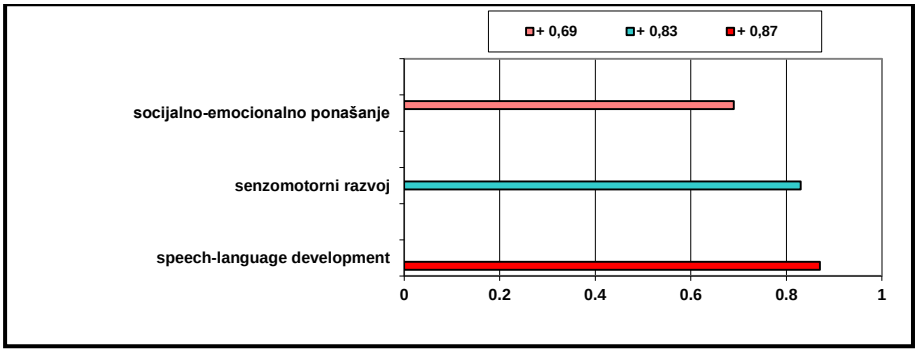
| | min. | max. | AM | SD | N |
|---|---|---|---|---|---|
| speech-language devel. | 35,29 (1,9 %) | 100,0 (22,2 %) | 83,22 | 16,22 | 54 |
| sensorimotor devel. | 27,27 (1,9 %) | 100,0 (18,5 %) | 77,60 | 17,81 | 54 |
| social-emotional beh. | 25,00 (5,6 %) | 100,0 (50,0 %) | 81,02 | 22,74 | 54 |

The lowest result on the scale for the assessment of sensorimotor development, which was 27.27 points, was present in one child or 1.9% of the examined sample. The degree of sensorimotor development ranging from 0 to 27 points was not recorded in any of the five-year olds from our study.

Maximum achievement (100 points) was determined in 18.5% of children (10 out of 54 examinees in total). Average achievement was 77.60 points, on a scale of 0 to 100 points, with the standard deviation of 17.81 points. The total of 22.2% five-year olds achieved results lower than the average value (ranging from 27.27 points to 63.63 points). At the same time, in 76.8% of the examinees of the same age, the degree of sensorimotor development was above average. On the scale for evaluation of

social-emotional behaviour 5.6% of the sample (3 examinees out of 54 in total) aged 5 achieved the lowest score of 25.00 points. All other children from the examined sample had a higher degree of social-emotional development. The total of 50% children realized the score which was lower than an average achievement (AS=81.02 points) for the total sample of five-year olds, with the standard deviation of 22.74 points.

The three correlation values, presented in Graph 1, from +0.87 (for the connection of speech-language development and the ability to maintain balance in five-year olds), +0.83 (for the connection of sensorimotor development and the development of AMB) and +0.69 (for the connection of social-emotional behaviour and the ability to maintain balance), fall into categories of very high and high *positive* correlation and are significant on the level of 0.01.




**Graph 1 –** Correlations between AMB on the one hand, and speech-language, sensorimotor and social-emotional development on the other hand

## 5. Conclusion

The results obtained in this research led to the following conclusion:

The correlation between the results from the scale for the evaluation of AMB both in individual tasks as well as on the scale in total) on the one hand, and the results from the scales for the evaluation of SLD, SMD and SEB on the other hand, is of high statistical significance, i.e. children with better AMB at the age of 5, also have a higher degree of SLD, SMD and SEB, and vice versa. With 99% confidence, we conclude that the psychophysiological abilities of children at the age of 5 are better if their function of the vestibular sense is more mature and therefore the overall ability to maintain balance is better.

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## Korelacija sposobnosti održavanja ravnoteže i govorno-jezičkog razvoja kod dece na uzrastu od 5 godina

Procena ravnoteže kod dece, već dugo se prepoznaje kao važna karika evaluacije dečijeg razvoja. Predškolski uzrast je veoma važan period za buduće motorno ponašanje čoveka, iz razloga što se u tom periodu razvijaju osnovne motoričke veštine. Tokom predškolskog uzrasta, veština održavanja ravnoteže dostiže odgovarajući nivo, dok se njen razvoj u potpunosti završava tokom kasnijeg detinjstva. Deca sa smetnjama u razvoju, koja se kreću od blažih pa do onih ozbiljnijih, imaju lošu izvedbu na testovima za ispitivanje sposobnosti ravnoteže. Cilj ovog rada je bio da se ispita da li postoji povezanost između sposobnosti održavanja ravnoteže i određenog stepena govorno-jezičkog razvoja kod petogodišnjaka. Osnovna ispitivana grupa je obuhvatila N=54 dece oba pola, uzrasta od 5.0 do 5.4 godina kod kojih je, na osnovu standardizovane baterije testova, obavljena procena sposobnosti održavanja ravnoteže (SOR), govorno-jezičkog razvoja (GJR), senzomotornog razvoja (SMR) i socio-emocionalnog ponašanja (SEP). Dobijeni podaci su dokumentovani uz pomoć digitalne kamere, potom bodovani, statistički i deskriptivno obrađeni. Pored toga, za svako dete unutar ispitivanog uzorka, uzeti su podaci o vremenu kada je počelo da sedi, stoji, kada je prohodalo i kada progovorilo (SSPP). Rezultati istraživanja su ukazali na postojanje veoma visoke pozitivne povezanosti između rezultata sa skale za procenu SOR (kako na pojedinačnim zadacima tako i na skali ukupno), s jedne strane, i rezultata sa skala za procenu GJR, SMR i SEP, s druge strane, odnosno deca koja imaju bolju sposobnost održavanja ravnoteže na uzrastu od 5 godina, ujedno imaju i viši stepen GJR, SMR i SEP, i obratno. Sa 99% pouzdanosti možemo zaključiti da su psihofiziološke sposobnosti dece na uzrastu od 5 godina bolje, ukoliko je njihova funkcija vestibularnog čula zrelija pa samim tim i sveukupna veština održavanja ravnoteže – bolja.
*Ključne reči:* sposobnost ravnoteže, dete, govor, jezik, senzomotorni razvoj

# Assessment of vestibular function at birth as an early intervention in the prediction of speech and language development of the child

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**Abstract:** The influence of vestibular function on the development of speech and language is still considered to be insufficiently investigated. The goal of this paper was to examine the correlation of the function of the vestibular sense at birth on the one hand, and a certain degree of speech-language development of the same sample of children, but at the age of 5 on the other hand. The research of speech-language development was carried out on the sample of N=54 children, 5.0 to 5.4 years of calendar age, out of which N=29 examinees were males and N=25 examinees were females. In all children from the sample, the testing of a group of reflexes related to the function of the vestibular sense was previously performed on the third day after birth. The following were clinically examined: Moro reflex (MOR), vestibulo-ocular reflex (VOR), head righting reflex (HRR) and asymmetrical tonic neck reflex (ATNR). The testing of these reflexes in all newborn babies from our sample was performed exclusively by trained medical personnel, while the examiner performed instructing, observing and recording of data. For the evaluation of speech-language development (SLD) of five-year olds included in this study, the test with the same name or subscales was used (test for the evaluation of SLD) within the standardized Scale for the evaluation of psychophysiological abilities of a child aged 0 to 7, by the author Neda Subota. Research results indicated that between the presence of four reflexes in total (MOR+HRR+ATNR+VOR) at birth on the one hand, and SLD of children at the age of 5 on the other hand, there is statistically significant correlation. Thus, children who had a higher number of reflexes immediately after birth, have a significantly more advanced degree of SLD at the age of 5, and vice versa - children with lower SLD at the age of 5, had a lower number of reflexes at birth.
*Key words:* vestibular sense, newborn, speech, language, child

## 1 Introduction

The development of speech-language communication is of key importance for the development of personality and the complete psychophysiological structure of a child. It is based on the development of cognitive, emotional and intellectual potentials of the personality and is expressed in interaction with the environment. An integrated multidisciplinary approach in early prelingual diagnostics and early habilitation of speech and language represents a contemporary approach in the prevention of speech-language disorders (Subota, 2003).

An increasing number of authors point to the importance of vestibular stimulation, stating its multiple positive effects (Arendt et al, 1991; Uyanik et al, 2003; Meli, 2006; Murray, 2001). Among other things, as the same authors point out, vestibular stimulation contributes to the development of gross motor skills and the integration of reflexes, the establishment of functional balance, the increase in perceptual-motor skills, the development of hearing, speech and cognition, the promotion of socio-emotional development, the reduction of self-injuries and stereotypical behaviour; it helps to start a rehabilitation treatment, enabling a person to more easily accept different types of stimulating therapy.

Movement activates the ability to speak. Therapists have found that when they treat a child for vestibular dysfunction, speech and language abilities can improve along with balance, movement and motor planning skills (Kranowitz, 2006). A child who cannot stand on one foot, probably cannot read and write, as standing on one foot demonstrates the ability to maintain balance. The ability to maintain good balance is the result of a strong, well-developed vestibular system. The vestibular system is closely related to language abilities (Hannaford, 1997).

Although the incidence of vestibular system and balance disorders in children is rising, vestibular function is still insufficiently controlled in children due to the existing techniques that are most often used to examine the vestibular apparatus of children. These techniques have been designed to test balance disorders in adults and are only modified to be used with children. In any case, many authors are of the opinion that the application of these techniques with children of the younger age is not safe. Namely, the calorie test can cause dizziness and vomiting (Fife et al 2000), the rotation chair test cannot examine chronic unilateral vestibular hypo function, it can also cause dizziness and sickness and, above all, this device is too expensive and only very few clinics have it (Valente, 2007; Valente, 2011). Finally, VEMP is a diagnostic procedure applied in differential diagnosis of adult vertigo. It helps to determine if only the sacculus or the lower vestibular nerve is affected by the damage. This method is relatively easy to perform, but it cannot be used as the only method, but rather an additional one, for assessing the status of the vestibular apparatus and central vestibular pathways (Welgampola and Colebatch, 2005, Akin et al, 2003). Because of this, parents are reluctant to subject children to this type of examination, except in cases when it is strictly indicated.

The need to find easily applicable, non-invasive and economically acceptable tests to examine vestibular function in children is more than justified. There are several reflexes which can be examined and which indicate whether vestibular sense is realizing its function already at birth (Adamović, 2012). They are: vestibulo-ocular reflex, Moro reflex, asymmetrical tonic neck reflex and head righting reflex (Barnes et al, 1978).

## 2 Aim

The goal of this paper was to examine the correlation of the function of the vestibular sense at birth on the one hand, and a certain degree of speech-language development of the same sample of children, but at the age of 5 on the other hand.

## 3 Research methodology

The research of speech-language development was carried out on the sample of N=54 children, 5.0 to 5.4 years of calendar age, out of which N=29 examinees were males and N=25 examinees were females. In all children from the sample, the testing of a group of reflexes related to the function of the vestibular sense was previously performed on the third day after birth.

The evaluation of speech-language maturity of five-year olds, was carried out at the Institute for Experimental Phonetics and Speech Pathology (IEPSP), and at the Life Activities Advancement Centre (LAAC) in Belgrade, whereas testing of vestibular reflexes on the same sample of children at birth was carried out at the Institute of Gynecology and Obstetrics, Clinical Centre of Serbia (IGO-KCS) at the neonatology department. The results obtained at birth and at the age of 5 were then correlated.

For the evaluation of the function of vestibular sense of newborns (Adamović, 2012), on the tested sample of children, 3 days after birth, we applied clinical testing of the group of reflexes: Moro reflex (MOR), vestibulo-ocular reflex (VOR), asymmetrical tonic neck reflex (ATNR) and head righting reflex (HRR). Each test consisted of three attempts, during which it was recorded whether the reflex was present, incomplete or absent. The duration of the pause between each attempt was 5 seconds. Testing of these reflexes in all newborn babies from our sample was performed exclusively by trained medical personnel, while the examiner performed instructing, observing and recording of data.

The obtained data were documented by means of a digital camera, then scored and statistically and descriptively processed.

For the evaluation of speech-language development (SLD) of five-year olds included in this study the test with the same name or subscales was used (test for the evaluation of SLD) within the standardized Scale for the evaluation of psychophysiological abilities of a child aged 0 to 7, by the author Neda Subota. This scale is an integral part of the IEPSP battery of tests and enables relatively

quick and accurate evaluation of overall abilities of a child compared to its calendar age. The results on this subscale are expressed as a percentage of success.

## 4. Results and discussion

The data in Table 1 show that minimal presence of MOR was recorded in 27 babies (i.e. 50%) and it was 1.00 points on the scale of 0 to 2 points, whereas the absence of this reflex, i.e. the score of 0 points, was not recorded in any of the newborns.

Maximum presence of MOR of 2 points was recorded in the total of 50% of newborns. The average value of MOR presence is 1.50 points, with the standard deviation of 0.50 points. Median value was 1.50 points, which indicates that the distribution of the results moved to the right - towards higher scores.

HRR is absent in 20.4% of the newborns and the score is 0 points. Incomplete HRR was recorded in 24% of the tested sample, and its maximum presence of 2 points was recorded in 55.6% of newborns. The average value of HRR presence is 1.35 points, with the standard deviation of 0.80 points. Median value is 2.00 points, which also indicates that the distribution of the results moved to the right - towards higher scores.

The absence of ATNR in total (ATNR right and ATNR left) i.e. the score of 0 points was not recorded in any of the newborns. Incomplete ATNR in total was recorded in 64.8% of the tested sample, and its maximum presence of 2 points was recorded in 35.2% of newborns. The average value of ATNR presence is 1.35 points, with the standard deviation of 0.48 points. The median value is 1.00 points, which also indicates that the distribution of the results moved to the right - towards higher scores.

**Table 1.** Basic results of MOR, HRR, ATNR, VOR and reflexes in total (MOR+HRR+ATNR+VOR)

| | **MOR** | **HRR** | **ATNR** | **VOR** | **REFLEXES in total** |
|---|---|---|---|---|---|
| Min | 1,00 (50,0%) | 0,00 (20,4%) | 1,00 (64,8%) | 1,00 (61,1%) | 2,42 (1,9%) |
| Max | 2,00 (50,0%) | 2,00 (55,6%) | 2,00 (35,2%) | 2,00 (38,9%) | 8,00 (11,1%) |
| Med | 1,50 | 2,00 | 1,00 | 1,00 | 6,04 |
| AM | 1,50 | 1,35 | 1,35 | 1,39 | 5,93 |
| SD | 0,50 | 0,80 | 0,48 | 0,49 | 1,46 |
| N | 54 | 54 | 54 | 54 | 54 |

Incomplete VOR in total was recorded in 61.1% of examinees, and its maximum presence of 2 points was recorded in 38.9% of newborns from the defined sample. The absence of VOR in total (VOR right and VOR left) i.e. the score of 0 points was not recorded in any of the newborns. The average value of VOR presence is 1.39 points, with the standard deviation of 0.49 points. Median value is 1.00 points, which also indicates that the distribution of the results moved to the right - towards higher scores.

The results shown in Table 2 indicate that the average achievement of five-year olds with an incomplete MOR at birth, in terms of speech-language development is 79.30 points, which is for 7.84 points less compared to the examinees with MOR completely present. The difference between average values for two subgroups of examinees was not statistically significant, which is indicated by t-test values of 1.82. Therefore, speech-language development of five-year olds in the tested sample was not conditioned by the degree of the development of Moro reflex at birth.

Observing the results of the comparison of the degree of presence of vestibulo-ocular reflex at birth with the results of speech-language development of the same children, but at the age of 5, it is noticed that the difference between the arithmetic means on the subscale for the evaluation of speech-language abilities in children is not only statistically significant, but is also very far from significance criteria, which is clearly indicated by the obtained t-test value of 0.69. Therefore, there are no statistically significant differences in the speech-language development of children at the age of 5, who differed at birth in the degree of presence of vestibulo-ocular reflex.

Children with labyrinthine righting reflex present at birth achieve 87.64 points on average on the scale for the evaluation of speech-language development, which is a significantly higher achievement compared to the average result of children with absent or incomplete HRR (AS= 77.69) at birth. The difference of 9.95 points is statistically significant on the level of 0.02. With 98% confidence we conclude that the degree of speech-language development of children at the age of 5 is significantly lower in children with absent or incomplete HRR compared to children with completely present HRR.

**Table 2**. Speech-language development with regard to individual representation of MOR, ATNR, VOR and HRR

| | incomplete MOR (27) | | present MOR (27) | | t-test and significance |
|---|---|---|---|---|---|
| | AM | SD | AM | SD | |
| speech-language dev. | 79,30 | 19,40 | 87,14 | 11,31 | t = 1,82 (not signific.) |
| | absent + incompl. ATNR (35) | | present ATNR (19) | | t-test and |
| | AM | SD | AM | SD | significance |
| speech-language dev. | 81,84 | 18,62 | 85,75 | 10,43 | t = 0,84 (not signific.) |
| | absent + incompl. VOR (33) | | present VOR (21) | | t-test and |
| | AM | SD | AM | SD | significance |
| speech-language dev. | 81,99 | 17,64 | 85,15 | 13,87 | t = 0,69 (not sifnificant) |
| | absent + incompl. HRR (24) | | present HRR (30) | | t-test and |
| | AM | SD | AM | SD | significance |
| speech-language dev. | 77,69 | 19,39 | 87,64 | 11,70 | t = 2,33 (*level 0,02*) |

The children who succeeded in positi#;oning their head upright right after birth, achieve 86.92 points on average on the scale for the evaluation of speech-language development at the age of 5. Their achievement is statistically significantly higher as opposed to the average result of 75.81 points, which is achieved by children who could not position their head upright right after birth. The difference is significant on the level of 0.02. so with 98% confidence we conclude that the degree of speech-language development in children at the age of 5 is significantly higher (for 11.11 points on the scale of 0 do 100 points) if these children could position their heads upright after birth, as opposed to children who could not.

**Table 3.** Correlation between speech-language development and reflexes in total at birth (N=54)

| | speech-language development |
|---|---|
| reflexes in total immediately after birth | r = + 0,51 (level *0,01*) |

In accordance with previous analyses in our study, correlation analysis was performed, regarding the correlation of the development of all four reflexes in total (MOR+ATNR+ HRR+VOR) at birth on

the one hand, and the results from the subscale for the evaluation of speech-language development of children, obtained on the same sample of children, but at 5 years of age.

Pearson coefficient of linear correlation, shown in Table 3, is statistically significant on the level of 0.01 and has a positive sign. With 99% confidence, we conclude that there is a *medium* degree of positive correlation (r= +0,51), between speech-language development on the one hand and development of reflexes in total (MOR+ATNR+HRR+VOR) on the other hand.

## 5. Conclusion

The results obtained in this research led to the following conclusion:

1 By crossing the data on the individual presence of reflexes at birth and the results on the SLD in five-year-olds, it was found that there was no statistically significant correlation between these variables.

2 Between the presence of four reflexes in total (MOR+HRR+ATNR+VOR) at birth on the one hand, and SLD of children at the age of 5 on the other hand, there is a *medium* degree of positive correlation, statistically significant on the level of 0.01. Thus, children who had a higher number of reflexes immediately after birth, have a significantly more advanced degree at the age of 5, and vice versa - children with lower SLD at the age of 5, had a lower number of reflexes at birth.

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## Procena vestibularnog čula na rođenju kao rana intervencija u predikciji govorno-jezičkog razvoja deteta

Uticaj vestibularne funkcije na razvoj govora i jezika, još uvek se smatra nedovoljno istraženim pitanjem. Cilj ovog rada je bio da se ispita povezanost funkcije vestibularnog čula na rodjenju, s jedne strane i određenog stepena govorno-jezičkog razvoja u istom uzorku dece na uzrastu od 5 godina, s druge strane. Ispitivanje govorno-jezičke razvijenosti, sprovedeno je na uzorku od N=54 dece, kalendarskog uzrasta od 5.0 do 5.4 godina, od kojih je N=29 ispitanika bilo muškog pola i N=25 ispitanika ženskog pola. Kod sve dece iz pomenutog uzorka, testiranje grupe refleksa vezanih za funkciju vestibularnog čula, prethodno je sprovedeno trećeg dana po rođenju. Klinički su ispitani: Moroov refleks (MOR), vestibulookularni refleks (VOR), labirintarni refleks ispravljanja glave (LRIG) i asimetrični tonični refleks vrata (ATRV). Testiranje pomenutih refleksa kod svih novorođenih beba iz našeg uzorka, izvodilo je isključivo obučeno medicinsko osoblje, dok je ispitivač vršio instruiranje, opservaciju i beleženje podataka. Za procenu govorno-jezičkog razvoja (GJR), petogodišnjaka obuhvaćenih ovom studijom, korišćen je istoimeni test ili podskala (test za procenu GJR) u okviru standardizovane Skale za procenu psihofizioloških sposobnosti deteta od 0 do 7 godina, autora Nede Subote. Rezultati istraživanja su ukazali da između prisutnosti četiri refleksa ukupno (MOR+LRIG+ATRV+VOR) na rođenju, sa jedne strane, i GJR dece na uzrastu od 5 godina, sa druge strane, postoji statistički značajna povezanost. Dakle, deca koja su neposredno posle rođenja imala prisutan veći broj refleksa, imaju značajno razvijeniji stepen GJR na uzrastu od 5 godina, i obratno – deca kod koje je na uzrastu od 5 godina zabeležen niži stepen GJR, na rođenju su imala prisutan manji broj refleksa.
*Ključne reči*: vestibularno čulo, novorođenče, govor, jezik, dete

# Personal narratives from students experiencing emotional and behavioural problems: consciousness and cognition the procrastination and withdrawal

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**Abstract.** The purpose of this study is to present narratives from students who have difficulty studying under academic obligations. The psychosomatic expression of the emotional state is considered as a behavioural problem under the light of understanding narrative. In the methodology we worked with recordings of spoken word. The study involved 50 students. Of these (N - 30) had an average age of 22.6 years, attended special education and training courses and had the role of coordinators or study groups at the School of Humanities and Cultural Studies at the University of Peloponnese. Also took part (N-20) students with an average age of 24.6 years attending the interactive memorial workshops at the Agricultural University of Athens. The results verified that the ability to relate narratives about their own experiences is unique and fundamental. Through such narratives the students managed to present themselves to others as they are a means of exchange with which common meanings are created. Finally, the way in which "experiential history" speaks, as well as the way in which the students choose and construct it, reveal and create themselves.

## 1 Introduction: Students Experiences And Psychosomatic Emotional And Behavioral Problems.

### 1.1. Individual study method and memory skills

The research for personal study method and the neurobiology of memory is another interdisciplinary issue (Kandel[15], 2008). Theoretically discussed issues related to the neurobiology of memory which until the mid-20th century, the view prevailed that the memory was general status of cortical cerebral hemisphere as a whole (Griffin, and Pollak, 2009). The question about the memory skills is whether it is a separate mental capacity or is a function auxiliary other cognitive processes (Roussos, 2011). Neuroscientists began to study the problem of cognitive processes of generalization, attention, object permanence, consolidation from 1950 indicating that this function of specific brain systems where mnemonic processes found in most systems.

The memory connects the events of our mental life (Farrell, 1995; Clough, 2005; Christakis, 2011). We are what we are, to a great extent thanks to what we learn and remember. Our memories are a kind of mental travel in time, which frees us from the limitations of time and space. The researchers study the how the memories come into the brain, describing the spiritual history of emerging biology of mind (Giovazolias, Karademas, and Kalantzis - Azizi, 2008; Norwick, 2008). According the Eric Kandel, who explains the determinants of modern biology and sheds light on how behavioural psychology, cognitive psychology, neuroscience and molecular biology converge in a powerful new science of mind. Kandel's effort to understand memory is closely linked to this exciting spiritual story, beginning with childhood memories of experiences from psychoanalysis as the exploration of neurobiology to his pioneering research on cellular and molecular memory processes (Kandel[16], 2008).

The individual study method of students is defined as the academic one way in which they choose as adults to study in order to have successful results and for this to be driven to their target (Buss,

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1980; Farrell, 1995; Christakis, 2011; Ministry of National Education and Religious Affairs, 2009). The way chosen criteria sometimes consciously through experiences from the academically career and sometimes unconsciously without defined characteristics of the study. Current needs for planned study emerge through the experiences they have from early childhood and their contact with the texts to the adult student relative to academically writings. The students experiences contain some psychosomatic emotional and behavioural problems. So, the individual study method of the students (Drossinou, 2005; 2006; 2009; 2017 a; b) refers to when, how and the need to deepen the knowledge of the scientific article, which motivates them to develop some design strategies. Even the academic mode of study includes the elements developed by the student to face difficulties either refer to diagnosed specific learning difficulties (dyslexia) (Drossinou, 2015 a; b) or terminological difficulties in understanding and operating withdraw (Jamieson, and Morgan, 2008).

The individual study method of students with dyslexia does not is known in the phenomenology and the social sciences (Natanson, 1989) despite the common knowledge we share (Pino, & Mortari, 2014; American Psychiatric Association, 2013). The dyslexia ia a common learning difficulty, affecting 4–12% of the general population (Cooper, 2009; Pollak, 2005), but research indicates that representation in universities may be much lower. In a Greek study, 0.16% (Stampoltzis & Polychronopoulou, 2008) refer that equitable educational access is a moral and humanitarian imperative, and this is enshrined in legislation in many countries. It is therefore important to identify factors that could contribute the experiences of dyslexic students in higher education and seek appropriate solutions. According Olofsson, Taube, and Ahl (2015) the academic achievement of university students with dyslexia was found that approximately one-fifth of Swedish university students with dyslexia required additional time to complete their degrees (MacCullagh, Bosanquet, and Badcock, 2017).

### 1.2. Language and self-narratives skills.

The language is the fundament of development the self-narratives skills because they are important, complicated and challenging tool for understanding and connecting with each other. The language emerges during the second year of an infant's life and in the process the senses acquire new attributes. The language skills make parts of our known experiences easier to share, and allow opportunity to create mutual experiences of meaning previously unknown. Also permit the students to construct a narrative of his or her own life and the difficulties (Pollak, 2005).

However, the narratives language skills affect as a form of personal knowledge is very difficult to verbalise and communicate. The self-narratives language skills referred in the spoken speech with words label for the internal state are not among the first to be used by students, though presumably they are closely familiar with their own internal state. The language skills are ideal medium for dealing with categorical information, for example "high degree of difficulty in study (7-8)", "moderate degree of difficulty in study (5-6)", "low degree of difficulty in study (3-4)" or feeling 'sad' or 'happy', and this, to a certain degree, is what naming is all about.

The self-narratives language skills are nonetheless a double-edged sword. It covers only a part of the conglomerate of feelings, sensations, perceptions and cognitions that constitute global non-verbal communication. This means that several different relationships can exist between global non-verbal communication and the part of it that has been transformed into words (Peterson, 2013; Stern, 1998). Another aspect of the double-edged sword is the effects of languages on self–other relatedness. In the verbal interaction between students and teachers, as well as between adults and their peers, there are ongoing interpersonal negotiations of what can be agreed upon as shared. The exact relationship between thought and word 'is not a thing, but a process, a continual movement back and forth from thoughts to word and from word to thoughts' (Vygotsky, 1962). Such mutually negotiated meanings grow, change, develop and are worked out between two people, and thus are ultimately owned by them. In this negotiation process, definitions and meanings emerge that are unique to the dyad or to the individual: 'good student', 'bad student', 'boring student', 'diligent student' and a host of other such definitions of value and internal state. The tendency to view oneself as inadequate is one of the most important difficulties of students with specific difficulties as dyslexia who experience under as withdrawn behaviour and the procrastination. Shame-related labels and other negative definitions interfere with the ability to challenge distorted thinking about social situations and assumptions about

others' reactions. This may contribute to consequences such as withdrawn behaviour in social settings, and the procrastination.

On the one hand, the self-narratives language skills are a major step in the achievement of separation and individualisation, while on the other, it is significant in the service of union and togetherness. For the students displaying psychosomatic emotional and behavioural problems (Christakis, 2011; 2012; Clough, 2005; Pollak, 2005; Stern, 1998; Farrell, 1995), there are several challenges concerning the attempt to share their words with others. Lacking the right words, possessing low self-esteem and fearing others' evaluations, they lose much of the natural daily practice that everyone needs in the challenging communication process. The self-presentation the specific learning difficulties through narratives the stories the students tell, the words they use and the way they act comprise part of their way of telling the world who they are and how they want others to regard them. The self presentation with the self-narratives language skills (Irwin, 1996; Gibson, & Kendall, 2010; Schlenker, 2012) refers to the processes people use to monitor and control how they are perceived by others.

A well-known the self verbal and physical withdrawal and the procrastination referred the dys - behaviour (Pollak, 2005) for this group and it is as a mode of the narratives language skills. It has been suggested that persons with dyslexia will 'bide their time' in innocuous ways and remain removed from the ebb and flow of social interactions (Drossinou, 2005; 2006; Pollak, 2005). Only when the students have figured out a safe conversational territory will they enter the interaction as an active participants. By remaining neutral at the outset of a social encounter, dyslexic students can avoid disapproval for the moment, and can later adopt the position advocated by others and gain approval for being similar, or through allowing these other persons to enjoy the rewards (Cooper, 2009; Jamieson, and Morgan, 2008; Buss, 1980).

### 1.3. The narratives for the psychosomatic emotional and behavioral problems

The psychosomatic complaints of students' narratives were presented with a series of health symptoms as headache, abdominal pain, sleeping problems, feeling tense, feeling tired, dizziness (American Psychiatric Association, 2013). The psychosomatic emotional and behavioural problems refer that they did not have the cognition for the procrastination and withdrawal with the frequencies of symptoms. The ability to relate narratives about our own experiences about symptoms is unique and fundamental because through such narratives we present our problems to others, as they are a medium of exchange with which to create shared meanings about the procrastination and withdrawal (Clough, 2005; Ainscow, and Miles, 2008). Everything we say and do when we are together in the university classroom is an ongoing personal and memory story to which we contribute and belong (Gibson, and Kendall, 2010; Griffin, and Pollak, 2009). The manner in which one tells the memory story, as well as the manner in which the students select and structure it, narratives for the self and the psychosomatic emotional and behavioural problems (Irwin, 1996; Weissberg, and Elias, 1993).

According the scientists and thinkers (Schlenker, 2005; Polkinhorne, 1991; 1988) the students narrative their experiences and psychosomatic emotional and behavioural problems describing as follows:

*'the ways individuals construct private and personal stories linking diverse events of their lives into a unified and understandable whole. These are stories about the self. They are the basis of personal identity and self-understanding and provide answers to the question: Who am I?'*

Also, according the researchers (Sheehan, Flaskas, and McCarthy, 2007; Kinchin, Cabot, and Hay, 2008) the narrative knowing, in contrast to scientific knowing in the positivist tradition, is concerned more with human intention and meaning than with discrete facts or events, more with coherence than with logic, and more with understanding than with predictability and control.

So the personal narratives from students experiencing a psychosomatic emotional and behavioural problems as the procrastination and withdrawal. The intervention with special education narrative approach focuses more on the impact of unanticipated changes, and less on the search for ordered change. The study of personal narrative is the study of the way humans see the emotional and behavioural problems as the consciousness and cognition the procrastination and withdrawal, a view in which the individual's life-world is highlighted Exams can stimulate, mobilize the brain and lead it to cognitive sufficiency, as shown by magnetic neurosciences (Roussos, 2011; Griffin, Pollak, 2009).

The test program as depicted electronically on the mobile and the computer is another code of mnemonic techniques that help mapping and analyzing complex and complex information (Drossinou, 2005; 2006; 2015 a; b; Cooper, 2009; Pollak, 2005). The mental imagery of the program limits the manifestations of procrastination and withdrawal behaviours because the cognitive language is based on an unconscious, inherent symbolic representation system for each subject being studied. Mapping with virtual representations is another mnemonic technique where images work and give meaning to the texts and descriptions of the lessons (Kinchin, et al., 2008; Drossinou, 2015 b; Drossinou- Korea, 2015 b; 2017 b). With the help of the computer the students can "run" digital images from the lectures and slides given in the lessons and make sense according to the theory of the mind where the mind is the software of the brain with the mnemonic techniques to mediate and assume a computational function. The the dyslexia debate about the psychosomatic emotional and behavioural problems (Elliot, and Grigorkenko, 2014) have continued for the inclusion of students with dyslexia in higher education under the systematic review using narrative synthesis (Pino, and Mortari, 2014; Pollak, 2005) according the phenomenology and the social sciences (Natanson, 1989).

## 2. The Methodology

### 2.1. The purpose and the working hypothesis

The purpose of this study is to present narratives from students who have difficulties studying under academic obligations. The research aims on the personal memories of students who have difficulty talking about what they are really experiencing as dyslexics. The psychosomatic as language expression of the emotional state is considered as a behavioural problem under the light of understanding narrative. So, the paper investigate whether the topics discussed in the small narrative group mnemonic workshops affect the students' vocabulary request for help. Moreover, if through them can be modified the procrastination and withdrawal behaviours developed in the course study process. One of the working hypothesis was focused on whether participation in micro-lab works affects learning readiness (Drossinou, 2009; 2015 a; Pollak, 2005; Farrell, 1995). It also studies whether interactive theoretical, practical and experiential discussion of memorial functions and techniques helps students to manage specific learning difficulties (dyslexia) (Cooper, 2009; Jamieson, and Morgan, 2008; Pino, and Mortari, 2014) and effectively integrate into the university community (Ainscow, and Miles, 2008; Giovazolias, et al., 2008; Norwick, 2008; Zoniou - Sideri, 2000). Another objectives are explored if participation in the monthly interactive small narrative group with memory techniques workshops helps students to cope with specific learning difficulties (dyslexia) and participate in the final written examinations. The individual objectives investigate whether specific training in metacognitive skills teaches them to control procrastination and withdrawal behaviours. Skills are developed with some exercises of awareness of the individual mode of study. In the workshops, the students are exercising into practices that teach them to choose and discuss the individual time they spend on the levels of difficulty in memorizing matter. Also, exercising if the students have understand and accept the total of difficulties as the dyslexia and the psychosomatic and emotional problems. In addition they are engaged in thinking about strategies and learning to adapt the individual study method to the polymorphic needs of the lessons.

### 2.2. The Research methodology and data

The methodology is defined as mixed because it is based on quantitative and qualitative data and this study is diachronic and examined data from 2004 until 2017. Research methodology was conducted in the field of Special Education in Greece. The data based on the special pedagogical principles of non-classification and non age stigmatization according the philosophy of the framework of the Special Education Curriculum (Ministry of National Education and Religious Affairs-Pedagogical Institute, 2009). The data collection process we collected data according to the observation methodology of the students with specific learning difficulties (dyslexia) and the intervention methodology according to the protocols mentioned in the Targeted, Individual,

Structured, Inclusion Programme for students with Special Education Needs (TISIPfSENs) (Drossinou - Korea, 2017, p. 320-330). In this study applied the research tools with the participatory observation checklists basic Skills in the learning readiness, the records with personal narratives from students experiencing a psychosomatic emotional and behavioural problems narratives.

Also, we worked with recordings of spoken speech and have been used Data from written observations and interventions were gathered with TISIPfSENs' records and protocols into computer. The sample has been compiled by two educational institutions and involved 50 students. Of these (N - 30) had an average age of 22.6 years, attended special education and training courses and had the role of coordinators or study groups at the School of Humanities and Cultural Studies at the University of Peloponnese, in Kalamata. Also took part (N-20) students with an average age of 24.6 years attending the interactive memorial workshops at the Agricultural University of Athens.

The small group interactive narrative meetings could support two to ten students in each two-hour memory technique lab that took place once a month with a physical presence in the universities. The number was limited because it seeks to interact with the experiential mnemonic techniques and practical references of all the students who come to them. This was a key rating criterion for observing the learning readiness of students who chose to leave another academic activity to attend memory techniques workshops discussing for psychosomatic emotional and behavioural problems.

The data analysis focused on our meetings with a certain theoretical theme of the mnemonic functions, techniques and practices used in the individual study method with regard into personal narratives to: -the definition of criteria of degree of difficulty in class study and memory techniques, metacognitive skills in organizing the time, -the writing skills of research, -notes and new technologies, and the peculiarities of special learning difficulties (dyslexia) and special educational needs or disabilities.

On a practical level, the data analysis, has been working with exercises of awareness of the memory functions of sensory memory with regard to visual and acoustic perception and their exploitation in the efficiency of the study. Also, it has attempted to decode during the reading process the individual way in which the student studies and enters into the mnemonic the new knowledge. The discussion about the personal narratives from students experiencing has focus in some psychosomatic emotional and behavioural problems. The special reading difficulties were discussed with empirical documentation and memo functions in texts from the taught subjects comprehension under the consciousness and the cognition what means for them the procrastination and the withdrawal. Examining factors in the examinations discussed the learning readiness and the characteristics of long-term memory in the understanding of basic cognitive processes (Roussos, 2011: 220-225).

## 3. The Results

### 3.1.Personal narratives for the degree of difficulty in studying the lessons.

The results verified that the ability to relate narratives about their students experiences is unique and fundamental (Irwin, 1996; Polkinhorne, 1988) Through such narratives the students managed to present themselves to others as they are a means of exchange with which common meanings are created (Gibson et al., 2010; Peterson, 2013; Pino, and Mortari, 2014). Also the results verified that the personal narratives for the degree of difficulty in studying the lessons contain information's about psychosomatic emotional and behavioral problems. This is the result of this data from a big part of the exercises on individual lessons. The students narrative emphasized the way information is held either by handwritten notes from the student himself or by electronic notes from professor lectures and slides in order to limit oblivion and memory failures (Roussos, 2011: 238-243). But the same time they have been narrative for the emotional difficulties (Farrell, 1995; Clough, 2005; Sheehan, et al., 2007) through the exercises of awareness. The students concentrated into the personal narratives from experiencing and have focus in comprehension some of the psychosomatic behaviors under the consciousness and the cognition what means for them the procrastination and the withdrawal. (Gibson,and Kendall, 2010; Olofsson, et al., 2015).

So, from the individual mode of study have demonstrated the operation in the central control system of both the vocabulary and acoustic memory information of the courses in the auditorium or the laboratory, as well as the psychosomatic information about the learning readiness and the well being as the emotional and behavior status. In the table (1) was included exercises of Personal Narratives from Students for the degree of difficulty in studying the lessons. awareness of the personal study method, focusing on memory techniques with regard to psychosomatic behaviors (1), emotional difficulties (2), behavior of the procrastination (3) behavior of the withdrawal (4) of knowledge.

**Table 1.** Personal narratives for the degree of difficulty in studying the lessons

| Serial number/ compulsory lessons to be examined in the winter semester N = 13 | Degree of difficulty in study: High (7-8), Moderate (5-6) , Low (3-4) | Laboratory (Lab) = 6 Theory (Th) = 7 | Personal Narratives for emotional difficulties and psychosomatic behaviors |
|---|---|---|---|
| 1 | 8 | Th | procrastination |
| 2 | 8 | Th | withdrawal |
| 3 | 8 | Th | procrastination |
| 4 | 8 | Lab | procrastination |
| 5 | 6 | Lab | procrastination |
| 6 | 5 | Lab | procrastination |
| 7 | 5 | Lab | procrastination |
| 8 | 4 | Th | withdrawal |
| 9 | 7 | Th | withdrawal |
| 10 | 7 | Th | procrastination |
| 11 | 3 | Lab | withdrawal |

The results verified from the empirically recognizing the degree of difficulty in studying the lesson (table, 1) through the awareness exercises of the cognitive language using the autobiographical memory (Roussos, 2011: 231-234) in the personal study method. Also, the degree of difficulty in terms of individuality, diversity and the other, has took into account the emotional life of the groups as individuals and others and how the students have organized of knowledge and the basic cognitive processes.

### 3.2.Personal narratives for the degree of difficulty in studying the lessons.

The Personal Narratives for emotional difficulties and psychosomatic behaviours have took from the application of the TISIPfPSENs ensure more functional teaching goals and more precise evaluation of the learning process. Specifically, it was proved that TISIPfSENs (Drossinou, 2009; Drossinou- Korea, 2017 a) contributed positively to strengthening the emotional skills of reading of the student. Despite the language deficits, have been point out that students in the universities with specific learning difficulties (dyslexia) (Drossinou, 2005; Drossinou- Korea, 2015 b) can learn metacognitive reading skills, such as decoding the psychosomatics problems, as long as teachers find the way to support them to express through the personal narratives and words that they feel(Vygotsky, 1962; Stern, 1998; Pollak, 2005). So, everything the students say and do when they are together is a continuous story in which they participate and belong in this way are aware of the psychosomatic problems of procrastination and withdrawal and the consequences for the studies (Buss, 1980; Weissberg, and Elias, 1993;Griffin, and Pollak, 2009).

The Personal Narratives for emotional difficulties and psychosomatic behaviours have took from the protocols of the TISIPfPSENs as the below:

Nikos, (aged 22,4) remembers and narrates : ‘My thoughts and my words stopped someplace along the road to university ’. ‘*It is better to go the coffee and non study my lessons. When I stay quiet into my home even if I do not know the answer, I feel safe than it is risk for me being laughed at in class. I can do that'.*

Fifteen out of 50 students in my sample explain their procrastination and withdrawal in the context of university. They have recalled in their memory that it is a phenomenon which started from

the primary school with the fear of being laughed at, or ignored and/or negatively evaluated by others.

Sofia (aged 21,8) remembers and narrates : *'I learn to withdrawal from the age of ten years every time when I feel fear for my answers because that my reticence is misperceived by others as disinterest in interacting or as snobbishness'.*

Twenty seven out of 50 students in my sample discuss their procrastination in the context of university. They have it is well documented with personal narratives from the memories in their minor age who they have been as dyslexic children and they are more exposed to bullying than others and the negative comment*s.*

Kostas, (aged 19, 7) remembers and narrates *: 'I have difficult to speak up for myself in difficult situations because I have lack the necessary courage to do so. 'I don't know why they started to tease me all that. Maybe it was because I was dyslexic? I was different from the others.'*

Interviewer: *'Do you mean that being the specific learning difficulties as dysorthograpia is the reason why they were teasing you?'*

Kostas: *'It sounds silly, but yes, I think so. And then I was a good students.....'*

Interviewer: *'So they said bad things to you, and you became procrastination.'*

Kostas: *'Yes. And even a former friend called me bad names. Maybe she didn't mean to be like that? But there was no one to help me. It was terrible, really I didn't dare to say anything to anyone because then I knew that they could say something critical and ignore me more often. It is easier to do nothing and avoid being hurt'.*

Panos (aged 18, 9) is very talkative and reflective with diagnosis as student with dyslexia. Words used to come easily to Panos , but as he described his withdrawal behaviour, snaps and tears. He remembers and narrates *'the words stopped when I left my home to arrive in the university. It is so difficult to me to understand the big city....'*

Mary (aged 25) is also one of the student in my research who states that the reason for her withdrawal behaviour having been the target of negative feeling at the university, the professors and the others . As an example she remembers and narrates the following situation: 'One of my other classmates shouted out in class: *Talk louder, we can't hear you. Turn on the microphone!" Then the professor took a microphone and put it on my desk while all the others looking me with curiosity and laughed'.*

Twenty of the fifty students I observed in the universities explained that their psychosomatic problems of procrastination and withdrawal and the consequences for the studies was caused by negatives comments from the parents, professors and the others. During the observation period in university, I cheque some episodes that could easily be classified as instances of stigmatization, ten of them in relation to peers, and five in relation to a professor . An understandable consequence of being teased and neglected can be silence and social withdrawal. When no one seems to care about your narratives, opinions and words, and you are even made fun of when you try to take initiative, displaying withdrawn behaviour is a method of coping with this unhappy situation. Thus, there is a dilemma of difference, inclusion and specific learning difficulties (Norwick, 2008) on the one hand, these students with want to step forward and participate like the others do on the other hand, their insecurity and fear of negative evaluation hinder them from daring to be visible and raising their voices. This dilemma for the academic achievement of university students with dyslexia (Olofsson, et al. 2015) becomes an inner struggle between fear and the desire to be a part of the conversation, between expectations from others and disadvantageous recollections from previous negative experiences. So, enhancing young people's social competence and health behaviour appear as an important challenge for educators, scientists, policymakers, and funders (Weissberg, et al., 1993).

## 4. Conclussions

This research conclusively demonstrates that the mnemonic skills are highlighted in the personal narratives for understanding the incentives for organizing and studying at an individual level is linked to performance and the goal of completing and getting the coveted degree. Furthermore, the awareness of the peculiarities of special learning difficulties (dyslexia) and the psychosomatic emotional and behavioral problems are discussed and distinguished in terms of memory functions and

their functionality in adaptation to the environment. Additionally, the reading memory difficulties of special educational needs or disabilities are distinguished. The behavior of students with dyslexia is influenced by digital supported teaching in individual. Many of them do not agree to share with the other members of the narratives as to the individual mode of study. We found that the students from their search for a coherent self, are often morbidly preoccupied with how they appear in the eyes of others. The behaviour of procrastination and withdrawal in the course study checked when students themselves have a request for help. Concluding this longitudinal study, we come to two points according to the methodology of observation of students with special learning difficulties (dyslexia) and the methodology of intervention according to the protocols mentioned in the TISIPfPSENs (Drossinou - Korea, 2017: 320-330).

The participation in small group meeting affects learning readiness (Drossinou, 2009; Pollak, 2005; Farrell, 1995) because the students come voluntarily without expecting a fee with a degree to "pass" the lesson. Through their participation, this highlights the student's healthy motivation for learning, the need to talk about their difficulties and to spell out the request for help.

In the second conclusion we point that with the interactive discussion at the theoretical, practical and experiential level regarding the memory functions and techniques helps the students to manage the difficulties individually and in groups. Finally, it seems to help them integrate into the university community (Ainscow, and Miles, 2008; Giovazolias, et. al. 2008; Norwick, 2008). The first refers to the fact that students learn to think and plan strategies to overcome learning obstacles by discussing their successful and less successful or failed attempts in guided lessons. The second understanding results from the fact that students are reconciled with the "dark side of specific learning difficulties and gradually develop reading self-esteem skills that they integrate into the individual study method. Finally, the way in which "experiential history" the students speak, as well as the way in which the students choose and construct it, reveal and create themselves.

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# Asimetry in tone-hearing threshold and speech detection threshold in the left and right ear among children with speech and language disorders

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**Abstract:**This paper analyses the middle values of tone-hearing threshold and speech detection threshold in the left and right ear among children with speech and language disorders (n = 60) and among children with normal speech and language development (n = 30). The sample included children of both genders between the ages of 5 and 7. Tone-hearing threshold testing was performed using Maico tonal audiometer, and speech detection threshold testing was done using KSAFA-m device. The results showed that the children with speech and language disorders have a somewhat better hearing threshold in the left ear compared with the right, but this result was not statistically significant. Contrary to this result, a statistically significant superiority of the right ear related to the hearing threshold at the frequencies of 0,125 kHz and 4 kHz was noted among the children with normal speech and language development. A statistically significant superiority of the left ear related to the speech detection threshold at 0,125 kHz was noted among the children with speech and language disorders. A slight superiority of the left ear was noted among the children with normal speech and language development, but without statistical significance. Comparison of asymmetry results between left and right ear (hearing threshold in the left and right ears) showed that the children with normal speech and language development have statistically more significant asymmetry than the children with speech and language disorders at 0,125kHz, 4kHz, 6kHz when considering the overall results. Based on these results, it can be concluded that the children with speech and language disorders in comparison to the children with normal speech and language development: have worse tone-hearing threshold and speech detection threshold in both left and right ear, show better results in the left ear and have less pronounced asymmetry of the left and right ear in hearing threshold.
*Keywords***:** hearing threshold, speech detection threshold, speech and language disorder, asymmetry

## 1 Introductory considerations

Auditory perception is the ability to subjectively experience a particular acoustic stimulus that can be different (tone, murmur, noise, speech). Auditory perception and memory imply the procedure which consists of receiving, processing and storing auditory stimuli. The sense of hearing is a requisite for the precise speech perception. Its role begins in the prenatal period, and it fully develops a few years after the birth. The process of auditory perception includes four basic stages:

**(1)** The first stage consists ofthe mechanical transfer of acoustic stimulation to sensory cells in the cochlea.

**(2)** The second stage encompasses the conversion of a mechanical sound stimulus into a sensory stimulus, i.e. the transformation of the energy from one form to another.

**(3)** The third stage includes the transmission of electrical impulses through the hearing nerve to the brain.

**(4)** The fourth stage implies the psychoacoustic and psycholinguistic level of listening. The conscious processing of the sound stimulus takes place during this stage, i.e. the decoding of acoustic information (Ostojić, 2004).

An absolute threshold of sensitivity is a minimal stimulus required for the appearance of a barely noticeable sensation. The lower auditory threshold is an auditory stimulus of a minimal energy sufficient to register a barely noticeable sound. The upper threshold is the highest intensity of a stimulus which is being differentiated. The sensation does not change with the further increase of the intensity. The upper threshold is an intensity of the auditory stimulus which does not change the awareness of sound level by thefurther increase. The differential threshold is the smallest change of

the auditory stimulus intensity whichnecessarilyleads to the first change in perception of the above-mentionedintensity (Brajović, 1997).

Binaural perception is based on the perception of differences between signals (stimuli) delivered to the left and right ear. In the acoustic environment, these differences occur due to various sound propagation paths from the source of the sound to the ears of the listener. These differences occur due to the influence of the listener's body, head, and earlobe, as well as other objects in the environment, and with the help of these factors, people are able to locate the sound source in space or perform a useful detection of sound in the environment full of different sources of interference (Durlach, Colbrun, 1978, Jovičić, 1999).

When it comes to the threshold of audibility, its value is lower in binaural than inmonaural listening conditions. Differences between the levels of monaural and binaural stimulus are defined by the advantage of binaural listening. Minimal interaural differences are defined as the interaural sensitivity (or resolution). The most important interaural differences are found in the interauralamplitude, phase, and time differences, in the interaural correlations, as well as in spatial interaural differences related to the localization of the sound source (Jovičić, 1999).

Asymmetries in the audiogram can lead to diagnostic and procedural uncertainties in the practice of otology and audiology. Clearly, this phenomenon is evident when a disorder of the middle ear and conductive hearing loss are present. A probable reason for the asymmetry can also be asensorineural hearing loss, which is caused by head injury or a nearby explosion. This can lead to a severe unilateral damage. In situations in which there is no obvious cause, further analysis should be performed in order to check the existence of the more serious conditions, such as vestibular schwannoma. The American and British procedures rely on this information in deciding whether patients should seek otologic opinion. These facts raise the question: In what extent can asymmetry be considered physiological? Minimal asymmetries can simply arise as a result of the audiometer's inaccuracy when the test-retest difference from 5 to 10 dB is a common occurrence (Lutman, Coles, 2009).

Findings that show the pure-tone hearing threshold is, on average, weaker in the left than in the right ear, particularly in the frequency range from 3 to 6 kHz, cause confusion among the researchers since broad-bandwidth questionnaires (surveys, tests) became available. Although the statistical significance related to poorer hearing in the left ear was not considered in most studies of this type, it can be noted that hearing in the left ear, particularly among adult males, is 2 to 4 dB lower than in the right ear. A similar, but milder effect is also noted among women who are exposed to noise. Among children, this asymmetry is minimal. (Pirilä, Jounio-Ervasti & Surri, 1992).

## 2 Aim of the paper

The aim of this paper is to determine whether there is an asymmetry between left and right ear among children with speech and language disorder, based on measuring pure-tone hearing threshold and speech detection threshold. Also, this paper compares the results of the children with speech and language disorder and children with normal speech and language development, with an aim to establish whether there are certain differences between these two groups.

## 3 Research methods

The research was planned and carried out in a way that ensured the collection of statistically representative data. The research took place at the Institute for experimental phonetics and speech pathology and Defectology-speech and language cabinet "Plećević" in Belgrade.

The sample included 60 children with speech and language disorders and 30 children with normal speech and language development between the ages of 5 and 7. The average age of children with speech and language disorders expressed in months was 72,8 months, while the average age of children with normal speech and language development was 74,8 months. Fundamental anamnestic data was taken from the medical records of the subjectswith the prior consent of the responsible people in the institutions where the research took place, as well as the subjects' parents. Forming

criteria for the group of subjects with speech and language disorders included: thepresence of speech and language disorder, exclusion of hearing impairment and average intellectual ability. Forming criteria for the group of children with normal speech and language development were: normal development of speech and language skills, exclusion of hearing impairment and average intellectual ability. The group of children with speech and language disorders consisted of 38 boys (63,33%) and 22 girls (36,67%), while the group of children with normal speech and language development included 15 boys (50%) and 15 girls (50%). Distribution of the subjects according to gender in the group of children with speech and language disorders reflects the real relation between boys and girls in different aspects of speech and language disorders.

In order to carry out an adequate examination of the observed children's abilities, the following instruments and techniques were used: tonal liminal audiometry and ksafametry.

Tonal audiometry is a hearing measurement technique during which the subject actively cooperates with the examiner, by giving him a sign when he hears the tone.This method is not the best choice for examining auditory perception among children at the earliest age, i.e. under three years of age. Tonal audiometry is usually used with children older than three,because they are able to understand the requirements necessary for the implementation of this procedure. The aim of audiometry is to find the lowest intensity of a stimulus sufficient to evoke the first, barely noticeable sensation, i.e. lower limit or liminal threshold (Brajović, 1986).

This type of measurement is performed using an audiometer. It is necessary that the device has certain characteristics that provide adequate conditions for airborne and bone conduction of sound to the subject's ear. The device should be calibrated and it is required that the examiner is well aware of the test procedure and techniques. The essence of tonal audiometry is the examination of airborne and bone tonal perception. The examiner plays tones of a certain frequency and decibel level, and the subject is asked to show a sign upon hearing the tone. During the hearing tests, if the errors are greater than 10 to 15 dB, it is acceptable to suspect the correct operation of the device, or an insufficient engagement of the subjects or examiners. The difference from 5 to 10 dB is considered to be acceptable.

For the reception of voice messages, the most important frequency range is from 500 to 4000Hz, therefore Fowler-Sabin (Brajović, 1982) suggest that hearing assessment should be performed based on the average decibel level in the frequency range from 500, 1000, 2000 and 4000Hz. Tone hearing threshold testing was performed using MAICO-MA 53 tonal audiometer.

Ksafametry is a specialized diagnostic hearing test which is performed using KSAFA-mdevice and it determines the hearing threshold, that is, detects the complex signal. Ksafametry differs from speech audiometry because the subjects are not required to understand and repeat words. The stimulus that is used in ksafametry is *1, 2, 3, 4, 5, 6, 7, 8, 9, 10, 100, 1000,* or *nice*, and its choice was based on the phonological analysis and acoustic structure of sounds in the Serbian language.

KSAFA method and KSAFA-m device are based on the division of speech spectrum into a larger number of frequency bands, and their parameters can be changed if desired. This makes speech perception possible and makes maximal use of child's hearing potential.

By using KSAFA-m device, it is also possible to examine detection of the speech signal in the frequency range predicted for examination of tonal perception by using tonal audiometry. For the purposes of our research, we made use of this particular feature of KSAFA-m device. Therefore, it is possible to compare the values obtained by means of tonal audiometry with the values obtained by means of ksafametry.

The results were statistically processed using the following methods: descriptive statistics and t-tests.

## 4 Research results

### 4.1Tone hearing thresholds and asymmetries

Table 1 shows the results of tone hearing thresholds for each ear (right-left) among children with speech and language disorders (CSLD) and children with normal speech and language development (CNSLD). Among CSLD, the worst hearing thresholds were detected in the low-frequency range

from 0, 125 to 1kHz, and in the high-frequency range from 6 to 8kHz. Somewhat better results were recorded among CSLD in the frequencyof 2 and 4kHz. Children with normal speech and language development, unlike children with speech and language disorders, showed better hearing threshold results in the right earin most frequency ranges, except in the frequency 1 and 8kHz. In addition, it is noted that hearing thresholds were also the worst in the low-frequency range from 0,125 to 0,500kHz among these children, but unlike CSLD, thresholds in the middle and high range were approximately similar. Among both groups of children, the worst perceived frequency was 0,125kHz. CSLD best heard the frequency of 4kHz and CNSLD the frequency of 6kHz. Statistically significant differences in pure-tone thresholds between left and right ear occurred only among CNSLD at the frequencies of 0,125 and 4 kHz (Table 1).

**Table 1.** Hearing threshold level in the right and left ear among children with speech and language disorders (CSLD) and children with normal speech and language development (CNSLD)

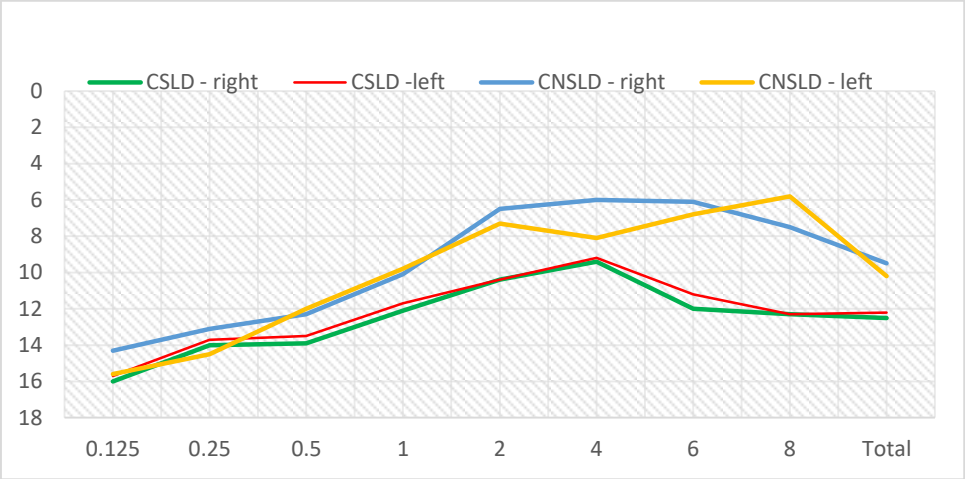
| | CSLD | | | CNSLD | | |
|---|---|---|---|---|---|---|
| Frequency kHz | Right | Left | p< | Right | Left | p< |
| 0.125 | 16,0 | **15,7** | | **14.3** | 15.6 | 0.017 |
| 0.250 | 14,0 | **13,7** | | **13.1** | 14.5 | |
| 0.500 | 13,9 | **13,5** | | 12.3 | **12.0** | |
| 1 | 12,1 | **11,7** | | 10.1 | **9.8** | |
| 2 | 10,4 | **10,4** | | **6.5** | 7.3 | |
| 4 | 9,4 | **9,2** | | **6.0** | 8.1 | 0.010 |
| 6 | 12,0 | **11,2** | | **6.1** | 6.8 | |
| 8 | 12,3 | **12,3** | | 7.5 | **5.8** | |
| Average | 12,5 | **12,2** | | **9.5** | 10.2 | |

Comparison ofthe hearing thresholds for the right ear between CSLD and CNSLD, showed that there is a statistically significant difference in most of the tested frequencies (p<0,05), except in the low ones, i.e. at 0,125 and 0,500 kHz (Table 2). Statistically significant differences are noticed in the left ear at the frequencies of 0,500, 1 and 6 kHz, and also taking the complete results into consideration (p<0,05).On the basis of this data, it can be concluded that the results recorded among CNSLD showed better statistical significance for the pure-tone hearing thresholds in the right ear, and in the left ear only at individual frequencies (Table 2, Chart 1).

**Table 2.** Statistical significance for the hearing threshold differences in the left and right ear between children with speech and language disorders (CSLD) and children with normal speech and language development (CNSLD)

| Frequency kHz | Right | | | Left | | |
|---|---|---|---|---|---|---|
| CSLD - CNSLD | Mean | SD | p< | Mean | SD | p< |
| 0.125 | 0,3 | 7.3 | | 2.3 | 7.1 | |
| 0.250 | 2.3 | 7.9 | | 2.6 | 7.5 | |
| 0.500 | 4.0 | 7.4 | 0,003 | 5.5 | 9.2 | 0,007 |
| 1 | 4.3 | 8.6 | 0,001 | 6.0 | 8.5 | 0,011 |
| 2 | 1.3 | 8.8 | 0,008 | 4.6 | 8.9 | |
| 4 | 1.0 | 10.4 | 0,018 | 3.6 | 7.9 | |
| 6 | 5.1 | 9.6 | 0,005 | 5.5 | 9.8 | 0,007 |
| 8 | 2.1 | 8.6 | 0,034 | 3.3 | 8.1 | |
| Average | 7.3 | 4.8 | 0,000 | 8.3 | 4.6 | 0,000 |

**Chart 1.** Tone-hearing thresholds in the left and right ear among CSLD and CNSLD




The results of asymmetry were simply calculated by subtracting right ear hearing thresholds from left ear hearing thresholds. The sign in front of the number indicates the ear with a worse hearing threshold. If the sign is (+), it means that the hearing threshold is worse in the right ear, and if the sign is (-), it means that the hearing threshold is worse in the left ear (Table 3). Among CSLD, the asymmetries were not pronounced and they ranged from 0 to +0,8 dB. The highest average asymmetry was noted at 6 kHz, and no asymmetries were detected at the frequencies of 2 and 8 kHz. Among CNSLD, the asymmetries were significantly more pronounced, and they were present at all tested frequencies, ranged from -3 to +0,3 dB. The highest asymmetries were detected at the frequencies of 0,125 kHz -3 dB and 4 kHz -2,1 dB. The least average asymmetries were noted at 0,500 and 1 kHz +0,3dB.Comparison of the asymmetries between CSLD and CNSLD provided the results which show that there are statistically more pronounced asymmetries among CNSLD at the frequencies of 0,125, 4, and 6 kHz, compared to CSLD, since p-valueis ≤ 0,050. Also, in the total average results of the asymmetry, the results among CNSLD were statistically more significant (Table 3).

**Table 3.** Statistical significance of the differences between right-left ear (asymmetry) among children with speech and language disorders (CSLD) and children with normal speech and language development (CNSLD).

| Frequency kHz | CSLD | | CNSLD | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | p< |
| 0.125 | +0,4 | 4,0 | -3,0 | 6,5 | 0,008 |
| 0.250 | +0,3 | 4,8 | -1,4 | 5,2 | |
| 0.500 | +0,4 | 4,8 | +0,3 | 4,5 | |
| 1 | +0,4 | 5,7 | +0,3 | 4,9 | |
| 2 | 0,0 | 4,0 | -0,8 | 4,3 | |
| 4 | +0,2 | 6,6 | -2,1 | 4,2 | 0,009 |
| 6 | +0,8 | 6,3 | -0,7 | 5,8 | 0,050 |
| 8 | 0,0 | 6,2 | +1,7 | 5,4 | |
| Average | +0,3 | 2,8 | -0,7 | 2,9 | 0,014 |

### 4.2 Speech detection threshold and asymmetry

Table 4 shows the results of speech detection thresholds among CSLD and CNSLD in the left and right ear. CSLD showed better speech detection threshold in the left ear, while CNSLD had an approximately similar distribution of better speech detection threshold results in the left and right ear. The distribution of better speech detection thresholds at certain frequencies among both CSLD and CNSLD was very similar to the distribution of pure-tone hearing thresholds. Among CSLD, at all frequencies, speech detection threshold was better in the left ear, except at 0,125 and 6 kHz. Among

CNSLD, at the frequency of 0,125, 1 and 8 kHz, speech detection thresholds were better in the right, and at other frequencies in the left ear (Table 4). Statistically significant differences in speech detection thresholds between right and left ear occurred only among CSLD at the frequency of 0,125 kHz (Table 4).

**Table 4.** Speech detection threshold levels in the right and left ear among children with speech and language disorders (CSLD) and children with normal speech and language development (CNSLD)

| | CSLD | | | CNSLD | | |
|---|---|---|---|---|---|---|
| Frequency kHz | Right | Left | p< | Right | Left | p< |
| 0.125 | **16.4** | 18.1 | 0.003 | **12.6** | 13.5 | |
| 0.250 | 16.8 | **16.3** | | 11.3 | **10.0** | |
| 0.500 | 15.9 | **15.0** | | 10.3 | **9.3** | |
| 1 | 15.2 | **14.5** | | **8.8** | 9.6 | |
| 2 | 14.6 | **14.1** | | 10.1 | 10.1 | |
| 4 | 14.3 | **13.6** | | 11.0 | **9.6** | |
| 6 | **15.5** | 15.7 | | 9.5 | **8.5** | |
| 8 | 15.5 | **14.6** | | **8.5** | 9.5 | |
| Average | 15.5 | **15.3** | | 10.2 | **10.0** | |

Comparison of the speech detection thresholds in the right ear between CSLD and CNSLD shows that there is a statistically significant difference at the level p=0,000, at all tested frequencies (Table 5). CNSLD showed better statistical significance for the speech detection thresholds in the right ear, at all tested frequencies. The almost identical result was obtained in the left ear, the difference is only in the value of p, which is $p \leq 0{,}001$. On the basis of this, it can be concluded that children with normal speech and language development show better, statistically significant results in speech detection than children with speech and language disorders (Table 5, Chart 2).

**Table 5.** Statistical significance of the differences in speech detection thresholds in the left and right ear among children with speech and language disorders (CSLD) and children with normal speech and language development (CNSLD)

| Frequency kHz | Right | | | Left | | |
|---|---|---|---|---|---|---|
| CSLD-CNSLD | Mean | SD | p< | Mean | SD | p< |
| 0.125 | -5.1 | 7.8 | 0,000 | -5.0 | 6.2 | 0,001 |
| 0.250 | -6.8 | 7.8 | 0,000 | -7.8 | 6.9 | 0,000 |
| 0.500 | -7.1 | 6.9 | 0,000 | -6.5 | 9.0 | 0,000 |
| 1 | -7.6 | 8.2 | 0,000 | -5.8 | 5.8 | 0,000 |
| 2 | -5.6 | 6.7 | 0,000 | -4.5 | 5.6 | 0,000 |
| 4 | -3.6 | 5.5 | 0,000 | -4.5 | 6.0 | 0,001 |
| 6 | -7.6 | 5.6 | 0,000 | -6.6 | 6.0 | 0,000 |
| 8 | -8.0 | 6.1 | 0,000 | -5.3 | 5.7 | 0,000 |
| Average | -6.4 | 4.5 | 0,000 | -5.7 | 4.4 | 0,000 |

**Chart 2.** Speech detection thresholds among CSLD and CNSLD in the left and right ear

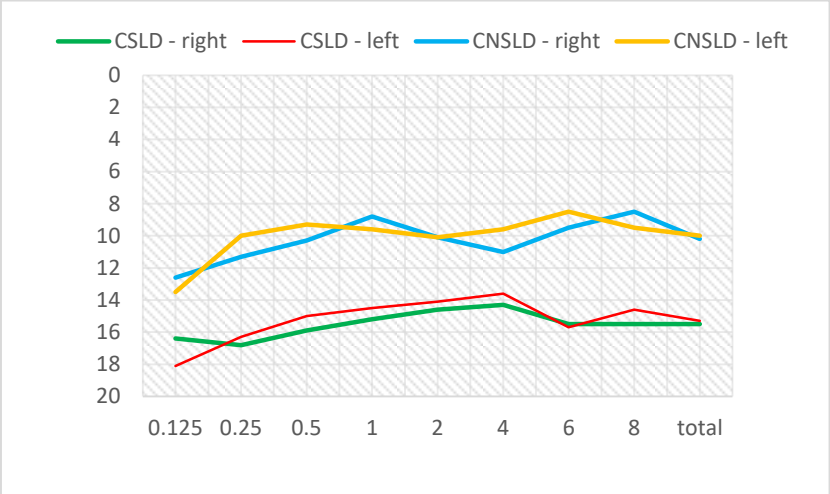



**Table 6.** Statistical significance of the differences between right-left ear (asymmetry) among CSLD and CNSLD in speech detection thresholds

| Frequency kHz | CSLD | | CNSLD | | |
|---|---|---|---|---|---|
| | Mean | SD | Mean | SD | p< |
| 0.125 | -1,7 | 4.3 | -0,9 | 6.5 | |
| 0.250 | +0,5 | 5.3 | +2,3 | 5.4 | |
| 0.500 | +0,9 | 5.7 | +1,0 | 4.2 | |
| 1 | +0,7 | 5.5 | -0,8 | 3.4 | |
| 2 | +0,5 | 5.6 | 0,0 | 3.9 | |
| 4 | +0,7 | 6.5 | +1,4 | 3.9 | |
| 6 | -0,2 | 5.6 | -1,0 | 3.8 | |
| 8 | +0,9 | 5.6 | -1,0 | 3.0 | 0,018 |
| Average | +0,7 | 2.9 | +1,05 | 2.3 | |

Unlike the asymmetry found in pure-tone hearing thresholds, which showed a lot of statistically significant differences between CSLD and CNSLD, there was not a lot of such differences in speech detection thresholds. When it comes to the asymmetries of speech detection thresholds, a statistically significant difference was found only at the frequency of 8 kHz (Table 6). The asymmetries among CSLD ranged from -1,7 to +0,9 dB, and among CNSLD from +2,3 to -0,9 dB. Although CNSLD had more pronounced asymmetries of speech detection thresholds than CSLD, those were not statistically significant (Table 6).

### 4.3 Comparison between tone-hearing thresholds and speech detection thresholds

**Table 7.** Statistical significance of the differences between tone-hearing thresholds and speech detection thresholds in the left and right ear among children with speech and language disorders (CSLD)

| Frequency kHz | Right | | | Left | | |
|---|---|---|---|---|---|---|
| CSLD | Mean | SD | p< | Mean | SD | p< |
| 0.125 | -0,3 | 7,4 | | -2,5 | 5,6 | 0,001 |
| 0.250 | -2,7 | 7,7 | 0,008 | -2,5 | 6,6 | 0,004 |
| 0.500 | -2,0 | 6,7 | 0,026 | -1,5 | 7,4 | |
| 1 | -3,2 | 7,3 | 0,001 | -2,8 | 6,6 | 0,002 |
| 2 | -4,2 | 7,2 | 0,000 | -3,7 | 6,6 | 0,000 |
| 4 | -4,9 | 7,6 | 0,000 | -4,4 | 8,6 | 0,000 |
| 6 | -3,4 | 7,1 | 0,000 | -4,5 | 8,2 | 0,000 |
| 8 | -3,2 | 8,1 | 0,003 | -2,3 | 8,0 | 0,029 |
| Average | -3,0 | 5,3 | 0,000 | -3,0 | 4,8 | 0,000 |

CSLD showed better tone-hearing thresholds than speech detection thresholds at all tested frequencies in both ears (Table 7). The differences between tone-hearing thresholds and speech detection thresholds detected in the right ear ranged from -0,3 to -4,9 dB, and in the left ear from -4,5 to -1,5 dB. Statistically significant differences were found at all frequencies, except at 0,500 kHz in the left ear. It can be concluded that children with speech and language disorders have better tone-hearing thresholds than speech detection thresholds both in the left and the right ear.

**Table 8.** Statistical significance of the differences in asymmetries between tone-hearing thresholds and speech detection thresholds among children with speech and language disorders (CSLD)

| Frequency kHz | Asymmetry between tone-hearing threshold and speech detection threshold | | |
|---|---|---|---|
| | Mean | SD | p< |
| 0.125 | -1,3 | 6,0 | |
| 0.250 | -0,3 | 8,6 | |
| 0.500 | 0,1 | 7,0 | |
| 1 | 0,1 | 7,8 | |
| 2 | 0,0 | 7,3 | |
| 4 | -1,5 | 8,3 | |
| 6 | 0,0 | 8,7 | |
| 8 | 1,1 | 8,3 | |
| Average | -0,2 | 4,0 | |

Table 8 shows the differences in asymmetries between pure-tone hearing thresholds and speech detection thresholds among CSLD. At the frequencies of 0,125, 0,250, 4 kHz the differences in asymmetries were bigger in tone-hearing thresholds. At all the other frequencies, the differences were bigger in speech detection thresholds. The biggest difference between these thresholds was detected at 0,125 and 4 kHz. Statistical analysis showed that the difference between asymmetries in tone-hearing thresholds and speech detection thresholds was not statistically significant at any frequency among CSLD (Table 8).

**Table 9.** Statistical significance of the differences between tone-hearing thresholds and speech detection thresholds in the left and right ear among children with normal speech and language development (CNSLD)

| Frequency kHz | Right | | | Left | | |
|---|---|---|---|---|---|---|
| CNSLD | Mean | SD | p< | Mean | SD | p< |
| 0.125 | +1,6 | 7,2 | | +3,8 | 7,8 | 0,012 |
| 0.250 | +1,8 | 4,9 | | +4,5 | 6,6 | 0,001 |
| 0.500 | +2,0 | 4,2 | 0,016 | +2,6 | 6,6 | 0,036 |
| 1 | +1,3 | 4,9 | | +0,1 | 6,0 | |
| 2 | -3,6 | 5,2 | 0,001 | -2,8 | 5,2 | 0,006 |
| 4 | -5,0 | 5,5 | 0,000 | -1,5 | 6,0 | |
| 6 | -3,3 | 6,7 | 0,011 | -1,6 | 7,3 | |
| 8 | -1,0 | 6,2 | | -3,6 | 7,4 | 0,011 |
| Average | -0,7 | 4,0 | | +0,1 | 4,7 | |

Unlike CSLD, who exclusively showed better pure-tone hearing thresholds, CNSLD had mixed results (Table 9). Both on the left and the right ear, from low to partially mid-range frequencies, that is, at the frequency of 0,125, 0,250, 0,500 and 1 kHz, children with normal speech and language development (CNSLD) had better speech detection thresholds than pure-tone hearing thresholds. At other frequencies, this group of children better perceived pure-tone than speech. The differences between pure-tone hearing thresholds in the right ear ranged from -5 to +2 dB, and in the left ear from +4,5 to -3,6 dB. Statistically significant differences occurred in the right ear at the frequencies of 0,500, 2, 4 and 6 kHz ($p<0,050$), and in the left ear at 0,125, 0,250, 0,500. 2 and 8 kHz ($p<0,050$) (Table 9).

**Table 10.** Statistical significance of the differences in asymmetries between tone-hearing thresholds and speech detection thresholds among children with normal speech and language development (CNSLD)

| Frequency kHz | Asymmetry between tone-hearing threshold and speech detection threshold | | |
|---|---|---|---|
| | Mean | SD | p< |
| 0.125 | +2,1 | 7,8 | |
| 0.250 | +2,6 | 7,0 | 0,047 |
| 0.500 | +0,6 | 6,6 | |
| 1 | -1,1 | 6,2 | |
| 2 | +0,8 | 6,0 | |
| 4 | +3,5 | 5,2 | 0,001 |
| 6 | +1,6 | 6,4 | |
| 8 | -2,6 | 6,5 | 0,033 |
| Average | +0,9 | 3,5 | |

Table 10 shows the results of differences in asymmetry for tone-hearing thresholds and speech detection thresholds among children with normal speech and language development. At 0,125, 0,250, 0,500, 2, 4 and 6 kHz, the differences in asymmetry were bigger for tone-hearing thresholds than for speech detection thresholds. The differences ranged from +2,6 to -2,6 dB. The biggest difference was detected at 0,250 and 8 kHz (Table 10). Statistically significant differences were found in asymmetries at 0,250, 4 and 6 kHz among CNSLD (Table 10).

## 5. Discussion

The results obtained from this research in relation to better tone-hearing thresholds in the right ear among children with normal speech and language development correspond with the ones found in similar studies. (Pirilä, Jounio-Ervasti&Sorri, 1992; Chung, Mason, Gannon &Willson, 1983;

Axelsson& Lindgren, 1981; Roberts & Huber, 1970; Đoković, Slavnić&Ostojić, 2003). Statistically significant differences in favor of the right ear at the frequency of 4 kHz were found in the abovementioned studies, which was also confirmed in this research. Statistically significant difference in pure-tone thresholds was found at the frequency of 0,125 kHz, among children with normal speech and language development. Unlike them, children with speech and language disorders showed better tone-hearing threshold in the left ear, which confirmed the results obtained in similar research papers (Maksimović, 2011; Pantelić, 2010; Plećević, 2007).

Speaking of the results in relation to speech detection thresholds among children with speech and language disorders, it can be stated that they are similar to the tone-hearing threshold results. Namely, among these children, better results were detected in the left ear in most of the tested frequencies. Slightly different results were recorded among children with normal speech and language development in comparison to tone-hearing thresholds. Among these children, the right ear was not as dominant as in the tone-hearing thresholds, and the results indicated consistency in the distribution of better speech detection thresholds, both in the left and the right ear. It should be pointed out that there were no statistically significant differences between right and left ear among children with normal speech and language development.

The results gained from this research point to better tone-hearing thresholds and speech detection thresholds in the left ear among children with speech and language disorders.This cansomewhat explain the difficulties that arise in the auditory processing of their speech. It is a well-known fact that a sensation which comes from one side of the body is controlled by the opposite side of the brain. Information gained from the right ear is directly transmitted to the left hemisphere which is responsible for speech and language. This does not mean that information that comes from the left ear can't be used for speech and language understanding because the two hemispheres communicate with one another and they are connected by the structure named corpus callosum. Left and right hemispheres are not entirely separated entities and they cooperate with one another. However, the information derived from the left ear must be first transmitted from the right hemisphere to the language area of the left hemisphere, in order to be processed. This results in somewhat longer neural processing of language if speech or sounds are received through the left ear. This could explain, above all, prolonged reactions and responses of children with speech and language disorders in relation to verbal or other audio tasks.

Statistically significant differences were recorded by comparing the results of tone-hearing threshold in the left and right ear between CSLD and CNSLD. Children with normal speech and language development had better tone-hearing thresholds in mid-range and high-frequency ranges in both ears compared to children with speech and language disorders, while statistic difference was not detected in low frequencies. Similar results were found in other studies, such as the one conducted by Pantelić (2010; 2011) and Bishop (1999). However, their results were not statistically significant. Another research that was also carried out on children with speech and language disorders showed a statistically significant difference in hearing thresholds compared to children with normal speech and language development (Plećević, 2007).

The results of comparing speech detection thresholds between CSLD and CNSLD indicate that children with normal speech and language development show statistically better results than children with speech and language disorders at all tested frequencies. On the basis of this, it can be concluded that bigger differences occur between these two groups of children in speech than in tone perception. This would mean that acoustic complexity or a type of sound phenomenon affects the perception among CSLD. In addition, this result could be interpreted as a weaker specialization of the receptor cells in the cochlea for the reception and transmission of the voice signal among CSLD.

Asymmetries of tone-hearing thresholds between right and left ear are present in both groups of children, but they are more pronounced among children with normal speech and language development. Statistically significant differences in asymmetries were detected at the frequencies of 0,125, 4, 6 kHz and taking into consideration the overall results. Asymmetries in speech detection thresholds were neither much pronounced among CSLD nor among CNSLD. But even considering these results, the asymmetries were more pronounced among children with normal speech and language development. Statistically significant differences occurred only at the frequency of 8 kHz. These results indicate that children with speech and language disorders who have worse tone-hearing and speech detection thresholds, show less pronounced asymmetry. One of the explanations for this

phenomenon is given by Chung et al. (1983). They noticed that an average ear asymmetry, "the ear effect", first increases as a function of thehearing threshold level, but it begins to decrease when hearing threshold reaches the level of 30 to 50 dB (Chung et al., 1983). This research did not show a continuous increase of the asymmetry with thedeterioration of hearing threshold, and particularly not upon measuring speech detection thresholds. Larger asymmetries were detected in some better hearing thresholds than in the worse ones. In particular, this explanation could not be applied to the group of children with normal speech and language development. Pirilä et al. (1992) had a different view about this matter and theypaid more attention to the methodological explanation in the consideration of asymmetry. They point to the lack of analysis in relation to the average asymmetry of the left and right ear and direct attention to the importance of observing anasymmetry in the individual hearing thresholds. When the average thresholds in the left and right ear are presented as threshold levels of each individual, the curve forms an artificial tip. When the average ear threshold is low, the thresholds of both ears have a tendency to be low and thus, there is a small difference between the ears. However, when the average ear threshold increases to its highest value, then the threshold levels of both ears become generally high. The difference between the ears begins to decrease after reaching the highest values, somewhere between the highest and the lowest values of the average threshold in the left and right ear.

Statistically significant difference was found between tone-hearing and speech detection thresholds among both groups of children. Both groups have better tone-hearing thresholds than speech detection thresholds. Among children with speech and language disorders, the difference is more pronounced and statistically significant at almost every tested frequency on both ears. Among children with normal speech and language development, it is interesting to notice that statistically significant difference in the mid-range and high frequency was detected in the right ear, and in the low frequencies in the left ear.

Comparison between the asymmetries that occur in tone-hearing thresholds and speech detection thresholds showed that there were no statistically significant differencesamong children with speech and language disorders. The difference among children with normal speech and language development was slightly more pronounced – the asymmetry was more pronounced in the tone-hearing thresholds than in the speech detection thresholds, at the frequency of 0,250, 4 and 8 kHz.

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# Examining the association between restricted, repetitive and stereotyped behavior and sensory response in minimally verbal children with ASD

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**Abstract.** Some theoretical frameworks, such as over- and under-arousal theory, have tried to offer an interpretation of restricted, repetitive and stereotyped behavior and its link to sensory dysfunction in children with ASD. There is limited examination of this link in subpopulations of children with ASD, such as those who are minimally verbal. This relation was examined on a clinical sample of children with ASD aged 3 to 6. Parents or caregivers answered the Sensory Profile 2. The participants were placed into categories according to their level of expressive language development. Results show that minimally verbal children with ASD have consistent difficulties in their sensory responses in everyday life, linked to greater severity of RRS symptoms. However, no unique sensory profile was found. This can be explained by the heterogeneity of this clinical group. The results are in accordance with earlier studies of RRS and sensory dysfunction in children with ASD. Systematic examination of subtypes within the spectrum is needed in order to create fully adequate treatment approaches for children with ASD.

## 1 Introduction

Recently, there is increased interest in sensory features in the population with autistic spectrum disorders (ASD in further text), as the new DSM – V draws more attention to the diagnostic category of restricted, repetitive and stereotyped behaviour (Donkers et al., 2015, Brock et al., 2012). This line of research has been neglected in the literature for some time, even though it can be found in the earliest descriptions of symptomatology of ASD. A number of empirical studies have shown sensory sensitivity in samples of children with ASD (Klintwall et al. 2010, Boyd et al. 2010,). Sensory processing (SP) refers to the way that sensory information is managed in the cerebral cortex and brainstem for the purpose of enabling adaptation to the environment and engagement in everyday activities (Johnson-Ecker & Parham 2000). Reviews of theories which are focused on sensory symptoms show that these issues have been examined as early as the sixties and seventies (Rogers and Ozonoff, 2005). Over-arousal theories claim that individuals with ASD are more likely to be overwhelmed with environmental stimuli and are slower or fail to habituate to them, when compared to the typical population.

One of the key questions, both in the clinical and research area is the connection between sensory features and repetitive and stereotyped behaviour. Restricted and repetitive behaviours form a class of behaviours characterized by high frequency, repetition in an invariant manner, and desire for sameness in the environment (Kanner, 1943). Most authors agree that one of the functions of this behaviour is inducing a sensory experience or reacting to sensory experience. However, there is sparse empirical evidence in this area so it is still too early to make certain assertions. There are complex reasons involved in this type of behavior – as some authors claim, with time, some behaviours become independent of the conditions that created them (Turner, 1999).

Research shows elevated results in sensory responsivity in clinical samples of children with ASD, compared to other groups, as well as wider dispersion of scores within possible score ranges (Ben-Sasson et al., 2008, Watling, Deitz & White, 2001, Baranek, David, Poe, Stone, & Watson, 2006; Rogers, Hepburn, & Wehner, 2003, Dunn, 2014).

Two studies examined the connection between sensory profiles and repetitive and stereotyped behaviour. In a study on school-aged children with ASD, Boyd and colleagues (2009) found a correlation of RBs and sensory features. Their sample consisted of high functioning individuals with ASD (IQ ≥70). Gabriels et al. (2008) also found significant co-occurrence between abnormal sensory responses and RBs in a subsample of children with ASD. This sample, however, had a wide age range: from 3 to 19 years, with relatively high IQ scores (average IQ of 81). Their sample also

consisted of participants who used psychoactive medications and had co-morbid diagnoses. However, they showed a significant correlation between abnormal sensory response and RBs, regardless of IQ and psychotropic medication. There are also some older studies which have not found a connection between stereotypies with increase of experimentally induced sensory stimulation. The same was found in a situation of under-stimulation (Bernal & Miller, 1971; Frankel et al., 1976). However, these findings are methodologically quite different in comparison to previously described studies which used data received by parent questionnaires.

The aim of the current study was to examine parent-rated sensory profiles in a clinical group of young children with ASD and their association with restricted, repetitive and stereotyped behaviour and see if this relationship changed in connection with cognitive and language level of development. We also wanted to examine differences between sensory processing in children with different clinical diagnoses: ASD vs. specific language impairment (SLI in further text) in order to delineate the diagnostic distinction between ASD and SLI in the younger population of children.

## 2 Methodology

Two groups of participants were recruited for this study. The first group included children with ASD (N = 25) and children with specific language impairment (N = 21). Both groups were aged 3 through 6 (from 3 years 0 months to 6 years, 10 months). Inclusion criteria for the ASD group included a cut off of 55 as an autism index measure on the GARS scale (Gilliams, 2013). The study was carried out at the clinic of the Institute for Experimental Phonetics and Speech Pathology. The groups were matched according to chronological age. Exclusion criteria for both groups was the presence of comorbid conditions such as cerebral palsy, visual or hearing impairment, seizure disorders, prescription of pharmacological treatment or any type of syndrome. Most of the children in the sample have either started or were continuously included in speech therapy or occupational therapy (minimum of 3 months to maximum of 3 years). The ASD and SLI groups were matched group-wise, according to CA (chronological age).

### 2.1. Measures

#### 2.1.1. Diagnosis

The diagnosis of autistic spectrum disorder was established by a child psychiatrist using CARS and DSM–V (American Psychological Association, 2013). This documentation was part of the obligatory medical documentation within the patient's dossier which is created upon submission at the IEPSP. The diagnosis of specific language impairment was established by an experienced speech and language therapist. The diagnosis was also confirmed by cognitive assessment resulting in a clinically indicative discrepancy between verbal and nonverbal cognitive abilities.

#### 2.1.2. Cognitive measure

Our ASD sample can be characterized as being at "the lower end of the spectrum", most of the children were difficult to assess either due to lack of cooperation, or low language abilities. We adopted a protocol, based on research studies carried out on similar samples (Anderson et al., 2007, Norrelgen et al., 2015). A developmental hierarchy of cognitive tests was created. The child was given a psychological test according to his/her chronological age. If this test was too difficult, another test, lower in the hierarchy was used. The testing was complete when the child could achieve maximal results. The following tests for cognitive assessment, standardized on the Serbian sample, were used: The Brine-Lezine scale (1973), The Bine-Simone scale (1985) and REVISK (1997). The SLI sample was tested according to chronological age. All the participants showing a discrepancy between verbal and non-verbal abilities were placed in the SLI sample (elimination criteria, according to Stark & Tallal, 1981).

### 2.1.3. Language measure

The estimation of the level of language development was based on information given by the interviewed parent. While giving the general and demographic information, the parent was asked to estimate the size of the child's vocabulary and level of language development by selecting the following categories: 1 to 5 words, 5 to 100 words, uses a few simple phrases, uses sentences from 3 to 4 words, but lacks grammar, uses long sentences.

### 2.1.4. Sensory profile

The Sensory Profile (Dunn, 2013) is an 86-item, 15 to 20-min, standard caregiver questionnaire of the effect of sensory processing on the child's ability to function in daily life. Item responses occur on a five point Likert-rating scale from 5 (always occurs) to 0 (does not apply). Normative data for the Sensory Profile were obtained from 1791 typically developing children ages 3–14 years. The developers of this measure have collected data with 78 children with ASD. The Sensory Profile provides two sets of standard scores depending on how the items are clustered: (1) domain scores (Sensory and Behavioral sections) and the sensory quadrants (Seeking, Avoiding, Sensitivity, Registration).

### 2.1.5. GARS – 3

This is a norm-referenced screening instrument used to identify persons who have autistic spectrum disorders. Its content is based on the definitions of autism from the American Psychiatric Association. For the purpose of this study, we have used one of its subscales measuring repetitive and stereotyped behaviour.

## 3 Results

Initial analyses of sensory variables resulted in a non-normal distribution of scores, which is why non-parametric statistics were used in further analysis. Table 1 shows descriptive statistics for both the samples, pointing to differences in both verbal and cognitive abilities. The non-verbal IQ was somewhat higher for the SLI sample and the t-test revealed statistically significant differences between the two groups ($t = -4.73$, $p < .001$). Also, while the largest percent of the sample with ASD was characterized by their parents as having phrase speech, the sample with SLI mostly used sentences, although with underdeveloped grammatical structures.

**Table 1.** Chronological age, non-verbal IQs and verbal abilities for samples with ASD and SLI

| | **Mean CA in months**<br>**SD**<br>**Range** | **N** | **Mean non-verbal IQ**<br>**SD**<br>**Range** | **Verbal ability** |
|---|---|---|---|---|
| ASD | 57.44<br>14.14<br>36 – 83 | 25 | 73.72<br>11.5<br>56 – 100 | 28% few words<br>24% up to 100<br>32% phrase speech<br>16% sentences |
| SLI | 60.62<br>10.40<br>83 – 47 | 21 | 89.57<br>11.09<br>74 – 117 | 38.1% phrase speech<br>61.9% sentences |

Further analysis points to differences between the groups, in some sensory sections of the sensory profile (see table 2). Specifically, differences were found for the behavioral sections of the sensory profile. The sensory quadrants showing differences were Seeking, Avoiding, Sensitivity and Registration.

**Table 2.** Group differences in dimensions of the sensory profile between the sample with ASD and SLI calculated using the Mann-Whitney U

| **Sensory sections** | **Mann-Whitney U** | **P value** |
|---|---|---|
| Auditory | 257.00 | .903 |
| Visual | 211.00 | .253 |
| Touch | 182.00 | .075 |
| Movement | 231.00 | .486 |
| Body position | 248.00 | .748 |
| Oral | 177.00 | .059 |
| Conduct | 172.00 | .046* |
| Social Emotional | 127.00 | .003* |
| Attentional | 31.500 | .000* |
| **Sensory quadrants** | | |
| Seeking | 163.000 | .028* |
| Avoiding | 152.500 | .015* |
| Sensitivity | 144.500 | .009* |
| Registration | 187.500 | .098 |

Another level of analysis consisted of correlations between specific sensory sections of the Sensory profile and repetitive and stereotyped movements or repetitive behavior (RB) estimated by the GARS-3 scale. Spearman's rho revealed statistically significant correlations between RB and some sensory aspects such as the Sensitivity quadrant (.314, $p = .034$), the Avoiding quadrant (.428, $p = .003$) and the behavioral sections such as Attention (.617, $p < .001$), Social Emotional (.312, $p = .035$).
Correlation also existed between the non-verbal abilities and RB (-.613, $p < .001$).

## 4 Discussion and Conclusions

The aim of our study was to examine a small, but precisely defined sample of children with ASD and compare them to a sample with a developmental disorder, SLI. The focus of our study was sensory profiles of children with ASD. The study confirmed findings on irregular sensory response in this clinical group, in the areas of sensory quadrants or specific profiles of sensory responses, as defined by Dunn (2013). According to this author, these profiles are processing patterns. Dunn's concept combines the neurological thresholds and self-regulatory responses. Examination of our sample has shown differences between the samples in responses in the area of high neurological threshold with active self-regulation, as well as two profiles with low neurological thresholds. More detailed examinations shows that children with ASD tend to have abnormal responses in these quadrants (those that differed 1 or 2 standard deviations, either in the negative or positive direction).

We have also shown that higher scores on the RB scale were connected with abnormal sensory responses. This leads to the assumption that these two categories of symptoms could be connected due to specific properties of the CNS, either over- or under-arousal, perhaps causing more frequent stereotypes in children with relatively underdeveloped speech and borderline IQ status. We have to agree with a number of authors that it is still too early to make any general conclusions in this field of research. Most of the conclusions need to be accommodated to characteristics of the samples examined, as well as data sources that are used. In the case of our study sample, these conclusions could be specific to youngest groups of children with ASD which are still in the process of developing speech. Studies show that abnormal sensory responses tend to alleviate with age and cognitive and language development. In delineating the differences between younger age groups within ASD and SLI, we can conclude that children with ASD have more frequent and more intense sensory responses than children with ASD, so this could be one of the important markers in differential diagnosis. However, this needs to be confirmed on larger clinical samples.

Finally, studies need to broaden the data sources by using both physiological and observational data when examining sensory responses as they tend to vary in different situations.

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## Ispitivanje veze između repetitivnih, restriktivnih i stereotipnih ponašanja i senzornih odgovora kod minimalno verbalne dece sa SAP

Neke teorije su pokušale da ponude interpretaciju restriktivnog, repetitivnog i stereotipnog ponašanja i vezu sa senzornom disfunkcijom kod dece sa SAP. Ova veza je slabo istraživana, posebno u podgrupama ove kliničke kategorije, posebno onim koji su minimalno verbalni. Ispitali smo ovu vezu na kliničkoj grupi dece sa SAP, uzrasta 3 do 6 godina. Roditeljima je dat upitnik koji ispituje senzorni profil deteta. Ispitanici su svrstani u kategorije prema nivou jezičkog razvoja. Rezultati pokazuju da deca sa slabije razvijenim jezičkim statusom imaju teškoće u sensornim odgovorima u svakodnevnim situacijama, a takođe je pokazana veza ovih teškoća i učestalosti repetitivnih i stereotipnih ponašanja. Nisu pronađene teškoće u okviru određenih pojedinačnih profila. Ovi rezultati potvrđuju nalaze prethodnih studija o vezi između repetitivnih ponašanja i senzornih odgovora kod dece sa SAP. Sistematičnija ispitivanja podtipova u okviru spektra su neophodna kako bi se oblikovali što adekvatniji tretmani za decu iz ove kliničke kategorije.

# Lexical and semantic abillities in children with SLI

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**Abstract**. Children with specific language impairment (SLI) show deficits in different domains of speech and language development. The most often are sintaxic, semantic and lexical disabillities, and usually they are emphasized. There is an evidence that lexical and semantic development appears later in children with SLI than in tipically developing children. The object of this study is lexical and semantic abilities. It was investigated in group of children with SLI (n=20) and in group of tipically developed children (n=20) aged 5 years old. Methodology is consisted of 40 children and 3 tests taken from IEPSP battery test: Test for noun assessment of the first and second levels of abstraction (D.Kostic) and Test for examing speech and language development (S.Vasic).
Results showed that in group of children wih SLI have been more errors in resolving tasks than in children with normal speech and language deleopment. Conclusion is that children with SLI demonstrated lexical-semantic abilities comparable to age-matched children with normal speech and language development.
*Keywords*: specific language impairment, semantic abilities, lexical abilities

## 1 Introduction

Children with specific language impairment (SLI) have documented deficits in the semantic domain ((Brackenbury et al., 2005). For example, the first sign of SLI is often the late onset of vocabulary acquisition (Bishop 1992). Also, evidence abounds that children with SLI test lower than age-matched peers on static measures of receptive and expressive vocabulary, indicating a deficit in the breadth of their lexicons. Previous studies have indicated poor learning of the semantics of new words in children with SLI. For example, Alt and colleagues (Alt et al., 2006) found poorer learning of semantic attributes (i.e., color, pattern, eyes, animacy) of novel objects in children with SLI than in age-matched peers. Other authors (Nash et al., 2005) found inferior learning of the meanings of low-frequency real words (e.g. *polka*, *gauntlet*). If there is a link between word retrieval and richness of semantic representation, one would expect that children who have known deficits in word retrieval to demonstrate poor semantic knowledge. According to children with SLI produced fewer semantic responses, more clangs, and more errors. Relative to the VM children, fewer semantic responses and more errors in the children with SLI were found in by-item analyses. Across elicitation trials, semantic responses decreased in the age-matched children but remained stable in the SLI children(Sheng et al., 2010).

The language is adopted by imitation, practice, and encouragement. If the child is not exposed to the speech during the critical period for the language acquisition, it will never be able to adopt the speech fully in functional terms. On the other side, we point to the importance of different sensory modalities among which auditory and visual attention have a special role in language acquisition. According to this, auditory attention in its developmental context unavoidably leads to the major developmental issues of language acquisition, (Nenadovic, et al., 2011).

Some older studies documented that children with SLI and altered EEG findings have poorer memory, attention deficits, and deficits in word processing than typically developed children, and all of these are unrelated to their speech perception abilities. Children's difficulty with word recognition tasks can be attributed to immature general cognitive abilities rather than to qualitatively different lexical representations. The evidence is emerging from studies of children's speech perception abilities, their speech production abilities, and their patterns of lexical development showing that children with SLI are indeed sensitive to the fine-grained acoustic phonetic detail that is characteristic of the lexicon from children in control group (Fatic, et al, 2014).

Phase of speech beginning belongs to the period from the end of the first year, and represents the first occurrence of the word socialized, that a child knowingly appoint object or creature, by building a number of phonemes and phonemic components, ie. when he discovered that his voice can mark objects and phenomena (Ćordić et al, 1992). The first type of words that occurs in children's vocabulary is a noun while the other types of words associated with it. Early language development began with a noun, which appears as the nucleus of the functioning of language, expanding its associations with verbs and other parts types of word.

In parallel with development of native speech sounds, vocabulary is going to be formed. Vocabulary has a changeable shape, due to the effects of various factors, such as age, experience, social background, intellectual ability (Maksimovic, et al., 2011).

## Methodology

Research aim of this study was to investigate lexical and semantic abilities in children with SLI and to compare differences between children with SLI and age matched children with normal speech and language abilities.

Research sample is consisted of 40 children divided into two groups: children with SLI (n= 20) and typically developed children or age matched (AM)(n=20). Speech pathologist performed testing with each child individually following exactly the same procedure meaning that all results are collected in the same way. The methodological procedure included 3 tests taken from IEPSP battery test: Test for noun assessment of the first and second levels of abstraction (D.Kostic) and Test for speech and language development (S.Vasic). All tests are part of a battery of tests which are used in the Institute for experimental phonetics and speech pathology (IEPSP Tests Battery) in Belgrade (Sovilj, et al. 2003).

Test for noun assessment of the first level of abstraction is consisted of 20 pictures, indicated 20 categories (birds, fish, bugs, vegetables, dishes, furniture, clothes, shoes, toys, animals(poultry), animals (livestock), tools, weapons, pictures, jewellery, flowers, glasses, books, fruit, houses. Procedure for evaluating the active vocabulary-on the question: "What is it ..?" The subject has to identify with a word-item related to that category. For evaluating a passive vocabulary, on the question: "Show toys ...?" subject has to recognize and show a spoken word. If subject answers correct, it will be estimated by positive point (+). The answers also could be rated with point (+), or with negative point (-).

Test for noun assessment of the second level of abstraction examines two linguistic levels, active-expressive, and passive or impressive level. It is consisted of 20 pictures which are showing 20 terms: young, old, worthy, lazy, healthy, sick, happy, sad, beautiful, clean, dirty, strong, weak, poor, hungry, full-fed, male, female, easy, heavy (nine pairs of opposite terms). Evaluation is the same as the pervious test, that we gave an explanation.

For testing speech-language development, we used the following test: "Test for speech development" by Smiljka Vasic. The purpose of this test was to evaluate the children's answers that provide information on the development of children's vocabulary, the level of semantic content included in the defined term, as well as the quantitative and qualitative nature of the definition. In the same test, there is a subtest of opposites which has the goal to collect the data of the creative side of the children's vocabulary, as well as an indication of their semantic development. Thus, this part of the test evaluates a) developmental sequence of acquisition of the meanings of adjectives opposites b) the pace of adoption of contrary adjectives with concrete and abstract meaning. Answers are evaluated scoring from 0 to 5 points. Subtest of opposites consists of four adjectives that are included in the top 50 busiest in our language (big, good, black, free). This test requires the child to say what the opposite adjectives are. Answers are scored from 0 to 5. Answers 1 to 3 is typical for children aged 4 or 5. For preschool children, the responses are usually estimated by point 4, sometimes point 5.

For the statistical analysis, it is used One-way ANOVA to determine the differences between two group of examination.

## Results

Test for speech development contains two parts: a subtest of definitions and subtest of opposites, and the results will be separately presented. Subtest of definitions contains five tasks (items), and the responses of the children were evaluated scores of zero (omission of speech) to eight points (logical definitions with specific characteristics).

First, it was examined the differences in the subtest of definition (Table 1). The average number of point in children with SLI is from 0 to 7, for all items together. The most successfully defined terms for children with SLI were sun and mother. The answers in the form of echolalia and omission were in the question: what is life? Or what is a man? In the normal population, there is a significantly lower omission and echolalia type of answers.

**Table 1**. Correlation between the results of subtest of definition in both group

| | | Mean | SD | S.Error | Min | Max |
|---|---|---|---|---|---|---|
| Man | SLI | 1.7000 | 1.34164 | .30000 | .00 | 5.00 |
| | AM | 3.2000 | 1.47256 | .32927 | 1.00 | 5.00 |
| | Tot | 2.4500 | 1.58438 | .25051 | .00 | 5.00 |
| Mom | SLI | 2.2000 | 1.82382 | .40782 | .00 | 7.00 |
| | AM | 3.7000 | 1.94936 | .43589 | 1.00 | 8.00 |
| | Tot | 2.9500 | 2.01214 | .31815 | .00 | 8.00 |
| Sun | SLI | 3.3500 | 1.66307 | .37187 | .00 | 5.00 |
| | AM | 4.8000 | 1.67332 | .37417 | 3.00 | 8.00 |
| | Tot | 4.0750 | 1.80295 | .28507 | .00 | 8.00 |
| House | SLI | 3.3500 | 1.84320 | .41215 | .00 | 6.00 |
| | AM | 4.6500 | 1.75544 | .39253 | 3.00 | 8.00 |
| | Tot | 4.0000 | 1.89466 | .29957 | .00 | 8.00 |
| Life | SLI | .9000 | 1.07115 | .23952 | .00 | 3.00 |
| | AM | 2.3500 | 1.78517 | .39918 | 1.00 | 7.00 |
| | Tot | 1.6250 | 1.62808 | .25742 | .00 | 7.00 |

Subtest of opposites showed differences between SLI group and AM group (Table 2). Subtest of opposites contains four tasks (items), and the responses of the children were evaluated scores of zero (omission of speech) to 5 points (correct answer- opposites). In this test, correct answers for mentioned items are: big-small, good-bad, black-white and free- busy. The most frequent correct answer was for term big- the answer is small. All children from normal population gave a correct answer. Children with SLI, as the table showed had answers in form of echolalia, omission or wrong answer for adjective black and free. The typical answers for term black were: yellow, not black, not night, and for term free, answers were: engaged, taken, closed, jailed etc.

Table 3 showed the results of Test for noun assessment of the first level of abstraction. We showed only the active level of the mentioned test. There is a significant difference between groups. A greater number of correct answers are in AM children. The most common terms that children with SLI could not define were: animals (poultry), animals (livestock), jewellry and weapons.

**Table 2**. Results of opposite subtest for SLI and AM group

| | | Mean | SD | S. Error | Min | Max |
|---|---|---|---|---|---|---|
| Big | SLI | 4.0500 | 1.76143 | .39387 | .00 | 5.00 |
| | AM | 5.0000 | .00000 | .00000 | 5.00 | 5.00 |
| | Total | 4.5250 | 1.32021 | .20874 | .00 | 5.00 |
| Good | SLI | 2.4000 | 2.01050 | .44956 | .00 | 5.00 |
| | AM | 4.4000 | .94032 | .21026 | 1.00 | 5.00 |
| | Total | 3.4000 | 1.85085 | .29264 | .00 | 5.00 |
| Black | SLI | 2.0000 | 1.94666 | .43529 | .00 | 5.00 |
| | AM | 4.2000 | 1.05631 | .23620 | 2.00 | 5.00 |
| | Total | 3.1000 | 1.90546 | .30128 | .00 | 5.00 |
| Free | SLI | 1.2500 | 1.68195 | .37609 | .00 | 4.00 |
| | AM | 3.4000 | 1.53554 | .34336 | .00 | 5.00 |

Table 4 showed the results of nouns of the second level of abstraction. Children with SLI had problems in defining terms from this test, in regards to age-matched children. Most common errors were in the nomination of these following terms: worthy, lazy, strong, weak, poor etc.

**Table 3**. Results for Test for noun assessment of the first level of abstraction

| | Mean | SD | S. Error | Min | Max |
|---|---|---|---|---|---|
| SLI | 9.8500 | 2.43386 | .54423 | 6.00 | 16.00 |
| AM | 15.0500 | 1.84890 | .41343 | 12.00 | 19.00 |
| Total | 12.4500 | 3.38890 | .53583 | 6.00 | 19.00 |

**Table 4**. Results for Test for noun assessment of the second level of abstraction

| | Mean | SD | S. Error | Min | Max |
|---|---|---|---|---|---|
| SLI | 7.0500 | 4.03243 | .90168 | .00 | 13.00 |
| AM | 15.6000 | 2.47939 | .55441 | 9.00 | 19.00 |
| Total | 11.3250 | 5.44618 | .86112 | .00 | 19.00 |

Performance in these two tests of vocabulary has a correlation with the test of speech development. Lower performance in all free test was in children with SLI. According to Scheng and colleagues (2010), we can conclude that they gave similar results in their studies. Examination of individual performance in the SLI group revealed that poor semantic performance was associated with a deficit in expressive vocabulary and a gap between receptive and expressive vocabularies. Children with SLI require as many as two to three times the number of exposures to novel words in order to make gains comparable to their age matched peers (Gray 2003).

## Conclusion

Based on these results it can be concluded that children with SLI have difficulties in defining terms, especially abstract terms, and also errors in naming some terms that could be also abstract for children in this group. They have difficulty in learning abstract concepts and words, despite, often used words. Children with SLI can recognize and define those terms that are very frequently in their vocabulary and in communication from the social environment.

Since the presence or absence of phonological forms has been shown to impact semantic category learning in typically developing children, it is possible that factors primarily related to phonological learning underlie difficulties learning lexical-semantics. It is possible that a primary difficulty with

phonological word forms results, over the course of the development, in degraded semantic representations. The explanation of these difficulties is not clearly defined. It may be that in elementary school age children, primary phonological difficulties present themselves as a difficulty attending to relevant lexical processes. It is conceivable that poorly defined lexical representations result in poor attention. This, in turn, may result in poor learning of word semantics. However, before we declare that deficits in attention underlie lexical semantic deficits in SLI, future investigations should take a developmental perspective on the issue.

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## Leksičke i semantičke sposobnosti kod dece sa specifičnim jezičkim poremećajima (SJP)

Deca sa specifičnim jezičkim poremećajima (SJP) imaju teškoće u različitim domenima govorno-jezičkog razvoja. Najčešće su prisutni sintaksički, semantički i leksički deficiti. Postoje dokazi da leksički i semantički razvoj kasni kod dece sa SJP-ima u odnosu na decu tipičnog razvoja. Cilj ove studije je ispitati leksičke i semantičke sposobnosti. Navedene sposobnosti su ispitivane u grupi dece sa SJP (n=20) i u grupi dece normalnog govornog-jezičkog razvoja (n = 20) uzrasta 5 godina. Metodologija se sastoji od 40 dece i 3 testa iz IEPSP baterije testova: Test za procenu imenica prvog i drugog nivoa apstrakcije (D.Kostić) i Test za ispitivanje govorno- jezike razvijenosti (S.Vasić).
Rezultati su pokazali da u grupi dece sa SJP ima više grešaka u rešavanju zadataka nego kod dece sa normalnim govorno-jezičkim razvojem. Iz rezultata se zaključuje da su deca sa SJP-om pokazala leksičko-semantičke sposobnosti uporedivo ispod uzrasta u odnosu na decu s normalnim govorno-jezičkim razvojem.
*Ključne reči*: specifični jezički poremećaj, semantičke sposobnosti, leksičke sposobnosti

# Fricatives and developmental speech-language disorders

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**Abstract**: The aim of this study is to determine the fricative articulation in children with developmental verbal apraxia (N=15), developmental dysphasia (N=15) and developmental phonological disorders (N=15). The research was done at the Institute for Experimental Phonetics and Speech Pathology and the Department of Psychophysiological and Speech Disorders in Belgrade. The entire sample was selected in relation to the requirements of the research problem that consisted in the fact that the lower and upper age limits ranged from 4.0-5.0 years of age. The results showed that disorder in fricative articulation have children with developmental dysphasia followed by children with developmental verbal apraxia and children with developmental phonological disorders.
*Key words:* developmental verbal apraxia, developmental dysphasia, developmental phonological disorders, articulation, speech-language development

## 1 Introduction

Through communication with the environment, the child develops the language. The development of speech and language enables the child to achieve an increasing number of communication roles. Knowing the development of speech and language, as one of the types of learned man's behavior, enables understanding of his disorders.

Language development consists of significant audio experience and motor-expressive behavior. The communication depends on the right articulation of voices and the ability of their discrimination. The development of articulation is a continuous process, and the progress in articulation is constant and is characterized by a continuous increase in general articulation collection (Vasić, 1971).

The articulation of individual groups of voices reaches the level of maturity at different ages. The child first adoptes vocals and plosives, and the hardest to say are laterals, fricatives and africates. Until the articulation is matured, one voice is articulated in different ways, depending on whether the words in which the voice is, was learned sooner or later. It is not possible to predict the order in which the child will begin to use new voices, because many variations are possible in relation how target voices are being articulated. The articulation of one voice is over only when the child correctly pronounces it in the initial, medial and final position.

The development of voices, through words and sentences, leads to the development of speech that is conditioned by many factors and represents the most complex ability of a man in which morphological, neurological, audiological and linguistic dimensions are associated. The fact that over 85% of people with any kind of speech-language deviations have more or less serious problems in verbal communication, points to the importance of well-developed speech-language abilities.

Developmental dysphasia is a developmental linguistic disorder, that is, a disorder of the ability to understand, structure and express language thought. It is at the same time a complex syndrome of physiological, neuropsychological and linguistic deficits and educational and social disorders, with the impossibility of pronouncing a large number of voices, difficulties in memorizing words, improper use of grammatical forms and general incapability of verbal expression. It is a developmental linguistic disorder, or a disorder of the development of expressive (linguistic production) and receptive speech (linguistic understanding), with a specific pathological pattern of expression (distortion and substitution of phonemes and words that take the form of parafrazic productions) that do not occur in any stage of normal linguistic development, and which remain very long, while the social development of these children is relatively normal, with no loss of hearing, mental retardation, autism or other disorders (Golubović, 2004).

Knowing the importance of phonological maturity for the development of verbal communication, we are entering a multi-system which extends from the receptor to the integrative part, with a special emphasis on an auditory sensory system whose undevelopment or insufficient development (Holm, Crosbie, 2006) results with disorder in the auditory perception and discrimination of the phonemes with partially or totally undeveloped awareness of the voices of a word (phonological awareness). In addition to numerous language disorders in children with dysphasia, phonology occupies a special place (Hayden, 2006) because they range from perception through formulation to speech production.

Children with developmental verbal apraxia have normal or below average ability to understand the language, but delayed linguistic expression. Children with developmental verbal apraxia have a reduced phonemic capacity limited to voices that occur early in development and contain simple combinations (nasals and plosives), while more complex voices that require complex articulation settings such as, for example, fricatives and affricates, are pronounced improperly. Apraxia may also be a sign of cerebral paralysis, mental retardation, and hearing impairment. It occurs independently and it is best seen as a symptom and as a constellation of deficit. When a group of symptoms develops separately from other disorders, it is categorized diagnostically as developmental verbal apraxia. In consideration of neurological evidence for determining etiology and the inconsistency of diagnostic criteria, there are great variations in the approach to the treatment of this disorder (Đorđević, Panić, 2015).

## 2 The aim

The aim of the research is to determine the deviations in the articulation of fricative in developmental verbal apraxia, developmental phonological disorders and developmental dysphasia.

## 3 Research methodology

The research was carried out at the Institute for Experimental Phonetics and Speech Pathology and at the Department of Psychophysiological and Speech Disorders in Belgrade.

### 3.1 The sample

An adequate diagnosis conducted by the professional team: speech therapist, clinical psychologist, neurologist, a selection of children whose speech and language disorders were diagnosed as developmental verbal apraxia, developmental dysphasia and developmental phonological disorder were performed. The sample of examination consisted of 45 children aged 4-5 years. The first group (N=15) were children with diagnosed developmental verbal apraxia, the second group (N=15) children with diagnosed developmental dysphasia, and the third group of subjects (N=15) included children with diagnosed developmental phonological disorders. Groups are equal according to age. The research was carried out individually, in separate rooms. Each child received the same instructions before testing. The children were tested with the Global Articulation Test (Kostić, Vladisavljević, 1983) to assess the quality of pronunciation of the fricative. The test consists of words in which the examined voices are in the initial, medial and final positions. In 7 columns with grades 1-7, the quality of pronunciation of fricative in the given words is estimated. Good voices are rated 1, 2 or 3 depending on the degree of their quality. They are not an area of pathological speech. Score 4 gets voices that cannot be classified either in good or bad. This rating is given to voices which barely perceptibly deviate from the normal. Voices rated by grade 5 exist but they are distorted. Score 6 gets voices that are so damaged that they cannot be identified out of the context. The articulation of such voices is much distorted. Score 7 receive voices that have been omission or substitute.

## 4 Results of research with discussion

Table 1 shows the results obtained by the study of fricative articulation in children with developmental speech-language disorders and in table 2 are the results of the study obtained by examining articulation disorders (omission, substitution and distortion) in children with developmental speech-language disorders.

**Table 1**: Research results obtained by fricative articulation in children with developmental speech-language disorders

| *Gr* | ***V*** | | | ***F*** | | | ***S*** | | | ***Z*** | | | ***Š*** | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **o** | **s** | **d** | **o** | **s** | **d** | **o** | **s** | **d** | **o** | **s** | **d** | **o** | **s** | **d** |
| (1)% | | 16.6 | | | | | 1<br>6.6 | 2<br>13.3 | 7<br>46.6 | 1<br>6.6 | 1<br>6.6 | 7<br>46.6 | 1<br>6.6 | 1<br>6.6 | 7<br>46.6 |
| (2)% | 1<br>6.6 | 3<br>20 | | | 7<br>46.6 | | 2<br>13.3 | 4<br>26.6 | 3<br>20 | 1<br>6.6 | 6<br>40 | 4<br>26.6 | 1<br>6.6 | 9<br>60 | 3<br>20 |
| (3)% | | 2<br>13.3 | | | 2<br>13.3 | | 2<br>13.3 | 1<br>6.6 | 8<br>53.3 | 2<br>13.3 | 1<br>6.6 | 9<br>60 | 3<br>20 | 5<br>33.3 | 4<br>26.6 |
| | ***R*** | | | | | | ***J*** | | | ***H*** | | | ***Ž*** | | |
| | **o** | | **s** | **d** | | | **o** | **s** | **d** | **o** | **s** | **d** | **o** | **s** | **d** |
| (1)% | 3<br>20 | | 3<br>20 | 2<br>13.3 | | | 1<br>6.6 | 3<br>20 | 7<br>46.6 | | 2<br>13.3 | 1<br>6.6 | 1<br>6.6 | 3<br>20 | 7<br>46.6 |
| (2)% | 6<br>40 | | 6<br>40 | 2<br>13.3 | | | 1<br>6.6 | 11<br>73,3 | 1<br>6.6 | 2<br>13.3 | 4<br>26.6 | | 1<br>6.6 | 11<br>73.3 | 1<br>6.6 |
| (3)% | 9<br>60 | | 2<br>13.3 | 3<br>20 | | | 4<br>26.6 | 5<br>33.3 | 6<br>40 | | 1<br>6.6 | | 4<br>26.6 | 5<br>33.3 | 6<br>40 |

In children with developmental phonological disorders, the most present is the distortion of voices S, Z, Š, J and Ž (46.6%), substitution of voices R, J and Ž (20%), omission of voice R (20%), substitution of voices S and H (13.3%), distortion of voice R (13.3%), substitution of voices V, Z and Š (6.6%), omission of voices S, Z, Š, J and Ž (6.6%) and distortions of voice H (6.6%).

In the developmental dysphasia, the most common is represented substitution of the voices J and Ž (73.3%), V (60%), F (46.6%), Z and R (40%), omission of voice R (40%), substitution of voices S and H (26.6%), distortion of voice Z (26.6%), substitution of voice V (20%), distortion of voices S and Š (20%), omission of voice S and H (13.3 %), distortion of voice R (13.3%), omission of voices V, Z, Š, J and Ž (6.6%) and distortions of voices J and Ž (6.6%).

**Table 2**. Results of the study obtained by examining articulation disorders (omission, substitution and distortion) in children with developmental speech-language disorders.

| **FRICATIVES (V, F, S, Z, Š, Ž, R, J, H)** | | | | |
|---|---|---|---|---|
| **Group** | **Omission** | **Supstitution** | **Distortion** | **Total** |
| Develop. Phon.disor. (1) | 7<br>5.2% | 13<br>9.6% | 31<br>22.9% | 51<br>37.7% |
| Develop. dysphasia (2) | 16<br>11.8% | 50<br>37.1% | 13<br>9.6% | 78<br>57.7% |
| Develop. Verbal apraxia (3) | 20<br>14.8% | 20<br>14.8% | 30<br>22.2% | 70<br>51.8% |

In the developmental verbal apraxia, the most common is distortion of voice Z (60%), omission of voice R (60%), distortion of voice S (53.3%), distortion of voice J and Ž (40%), substitution of voices Š, J and Ž (33.3 (26.6%), distortion of voice Š (26.6%), omission of voices J and Ž (26.6%), omission of voice Š (20%), distortion of voice R (20%), substitution of voices V, F, and R (13.3%), omission of voices S and Z (13.3%) and substitution of voices S, Z and H (6.6%).

By qualitative analysis of the results, we found that the disorder of fricative articulation has 57.7% of children with developmental dysphasia, followed by 51.8% of children with developmental verbal apraxia and 37.7% of children with developmental phonological disorders. Children with developmental phonological disorders have the most distorted voices (22.9%), followed by developmental verbal apraxia (22.2%) and developmental dysphasia (9.6%). The developmental dysphasia has the most substituted voices (37.1%), followed by developmental verbal apraxia (14.8%)

and developmental phonological disorders (9.6%). Developmental verbal apraxia has the highest omission (14.8%), followed developmental dysphasia (11.8%) and developmental phonological disorders (5.2%).

## 5 Conclusion

One of the symptoms of developmental verbal apraxia is an articulation deficit, so it is not surprising that the disorder of articulation was also established in this research. Namely, it was found that the frequency of fricative articulation disorders is greatest in children with developmental dysphasia, followed by children with developmental verbal apraxia and at the end in children with developmental phonological disorders. We assume that children with developmental dysphasia and developmental verbal apraxia have a common disorder of fricative articulation with different causes. In children with developmental dysphasia, the cause is in poor auditive perception, resulting in inadequate auditory voices. In contrast, in children with developmental verbal apraxia there is an inadequate motor performance of the word.

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## Frikativi i razvojni govorno-jezički poremećaji


Cilj ovog istraživanja je utvrditi artikulaciju frikativa kod dece sa razvojnom verbalnom apraksijom (N=15), razvojnom disfazijom (N=15) i razvojnim fonološkim poremećajima (N=15). Istraživanje je obavljeno u Institutu za eksperimentalnu fonetiku i patologiju govora i Zavodu za psihofiziološke poremećaje i govornu patologiju u Beogradu. Celokupan uzorak je selektovan u odnosu na zahteve istraživačkog problema koji se sastojao u tome da se donja i gornja starosna granica kreće od 4.0-5.0 godina starosti. Rezultati su pokazali da poremećaj artikulacije frikativa u najvećem procentu imaju deca sa razvojnom disfazijom, slede deca sa razvojnom verbalnom apraksijom i deca sa razvojnim fonološkim poremećajima.


*Ključne reči:* razvojna verbalna apraksija, razvojna disfazija, razvojni fonološki poremećaji, artikulacija, govorno-jezički razvoj

# Analysis of gross motoric movements in phonetic correction based on verbotonal method

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**Abstract.** Movement in speech is present on different levels – form micromovements during articulatory processes to more visible movements such as gestures. In this paper, gross motoric movement in speech correction has been analysed. Gross motoric movement in the Verbotonal method is described as unique, depending on individual aim and possibilities, used in order to improve pronunciation. It should not be replaced with gestures or signs. Although unique and individual, movements are connected with speech sounds on the basis of different elements: height, tension, duration etc. For that purpose basic movements, prone to variations, were recorded in the era of VTM „expansion". The material used in this research were descriptions of movements made by students whose task was to perform ten lessons of speech correction, respectively, with adult foreign students learning Croatian as L2. The described movements were grouped mainly according to the corrected speech sounds and the variations within the group were compared. Furthermore parts of the body, direction, tension, as well as some other elements were used in movements were observed. The descriptive analysis of the obtained remarks is partly based on Laban Movement Analysis (LMA/LBMA). The results are compared with the material (movements) recorded for each speech sounds in Croatian and discussed in the light of self awareness when it comes to movement. Usage of movement in the verbotonal method is compared with recent work on movement and speech in foreign language learning through dance, emotions and memory.
*Key words:* gross motoric movement, phonetic correction, verbotonal method

## 1 Introduction

Human body moves constantly even when we are not aware of the movements. First, physiological processes in our body ensure our vital functions to be maintained (Guyton and Hall, 2017). Functions such as blood flow or breathing engage whole systems of organs that move in adequate rhythm. Some organs are multifunctional, i. e. some of organs engaged in breathing, which is their primary function, are also part of a larger group of speech organs. Second, our body performs movements of smaller range and sometimes we are not aware of them either, although we may become aware of them and influence them. Such movements are eye blinks, feet shuffling etc (Studd and Cox, 2013). Finally, we perform movements of different range and different purposes voluntarily. The three groups of movements are intertwined not only by physiological ability to be performed but also within different functions, states or situations. Some movements or changes in postures are purposefully made for emotional regulation (Shafir et al., 2013, Shafir, 2015; Shafir et all, 2016).

Although it seems that the range of human body movements is interminable, it can be described with a set elements used to describe charachteristics of movements. Many different analyses and descriptions are present throughout history. Some of the most well-known description of movements are those in classical ballet where each movement is determined by the initial position, direction, specific hand and feet position, movement itself, final position etc., (Vaganova, 1949), kinetography for different types of dance (i.e. for folk dance: Knežević, 2005), non-verbal communication (Knapp and Hall, 2002), etc. One of the most widely used and useful (in terms of different purposes such as therapeutic intervention, arts and architecture, coaching, training, comparative analysis, anthropology, animation, movement capturing etc.) is Laban Movement Analysis System (LMA) or Laban/Bartenieff Movement Analysis System(LBMA). Nowdays lot of research are focused on improvement of different applications aiming at use motor capture data (Bernstein et al, 2015).

Rudolf Laban was a dancer and a choreographer ($19^{th}$/$20^{th}$ century) who formed his highly detailed description of human movements on the basis of human movements in different situations, professions, emotions, age etc. His work was later continued by his protégé Irmgard Bartenieff. In Europe and USA slightly different aspects of Laban's work are referred to a as Labanotation or

Kinetographie Laban. This paper will be based on Labanotation and LBMA (Studd and Cox, 2013, http://user.uni-frankfurt.de/~griesbec/LABANE.HTML#Introduction).

In LBMA, human movement is broken down into four primary components which are linked to questions what, where, how and why. Four primary components are *Body*, *Effort*, *Shape* and *Space*. Each of components in LMBA has a graphic representation (symbol). Signs will not be used in this paper since thorough description is not needed. Primary components will be described up to the degree needed for purposes of this work although the division into more detailed components will not be presented (Studd and Cox, 2013).

*Body* as component is *what* in LMBA. It represents the organization of the body, what is emphasized and which specific part of the body is in action. Categories within this component are: Basic Anatomy/physiology, Body Parts, Patterns of body organization, Basic body actions, Bartenieff Fundamentals (each or the principles is related to all the rest – Part/Whole but the detailed description will not be made within this paper), Body Connections and Body Rhythms (Studd and Cox, 2013).

*Effort* as component is *how* in LMBA representing how movement is performed. Phrasing is effort in constant flux and modulation with effort factors combining together in different combinations. Besides Effort Factors, other components of Effort are Effort Elements, States, Drives and Phrasing Types. Effor Factors are Flow, Weight, Space and Time. Effort Elements are : divided into Indulging (Free, Light, Indirect and Sustained) and Condensing (Bound, Strong, Direct and Quick). States, combination of two Effort Factors are Dream (Weight/Flow), awake (Time/Space), Rhythm – aka Near (Weight/Time), Remote – aka Far (Space/Flow), Mobile (Time/Flow) and Stable. There are four Drives: Action (Weight/Time/Space), Spell (Flow/Weight/Space), Vision (Flow/Time/Space) and Passion (Flow/Weight/Time) (Studd and Cox, 2013).

*Space* refers both to the environment of a person and personal space. Its components are Directions, Kinesphere Reach Space, Polyhedral Forms, Scales of the Polyhedra and Approach to Kinesphere and Pathways 8Studd and Cox, 2013).

*Shape* describes *how* the changing form of the person who moves (a mover) relates to himself/herself and to the environment. Shape Components are Still Shape Forms (Wall, Ball, Pin, Screw and Tetrahedron), Models of Shape Change (Shape Flow, Directional Movement – Spoke-like or Arc-like and Shaping or Carving) and Shape Qualities (Rising, Advancing, Spreading, Sinking, Retreating and Enclosing) (Studd and Cox, 2013). Although further more detailed classification can be made, for the purpose of this work it is important which components and why were mostly used in verbotonal method (and not to give the most complete insight in Laban's work).

During his work on phd thesis Petar Guberina understood the complexity of speech utterances not only on semantic level. Studying the importance of prosody he entered the sphere of bilingual communication and transferred the challenge even on phonological level. Studying the system of errors in adult Croatian bilingual students of French and later connecting the patterns to hearing-impaired people (again through the systems of errors), Guberina (2010) defined place and manner of articulation as well as height and tension of speech as crucial elements in defining errors. Verbotonal method perceives human body as a Whole so it is evident that only slight change in manner of articulation changes body posture or tension. Although not perceived at first sight, during continuous work on movement both the students and patients learned how to help themselves in pronunciation with changes of body posture or movement. Guberina collaborated with dancers of contemporary dance during 1970s and 1980s as well as with medical doctors (Pansini, 1989) to find the patterns of movements usefull in speech and hearing rehabilitation which is documented on several documentary films. One of the films is dedicated to movements for all Croatian consonats and vowels. Further adaptations were made during rehabilitation sessions and used in everyday work in SUVAG Polyclinic. Guberina's collaborators were mainly trained phoneticians and speech therapists who were also educated as contemporary dancers and their education included some knowledge of Laban's work. If analysed in details, it can be perceived that all four main components are often used in hearing rehabilitation with younger patients.

Movement in phonetic correction within verbotonal method is used somewhat differently and a lot of Guberina's texts on correction are more dedicated to some other elements such as speech material, forms of speech signal etc. (Guberina, 2013). Speech correction is in this form dedicated mainly to individuals or very small groups who listen to the speech material through headphones and usually sit during phonetic correction.

In the era of globalisation, challenges of foreign language learning are great. Great deal of literature in foreign languages is easily available and most courses will mainly train a person more to write than to speak in foreign language, therefore speech remains somewhat left behind. It is rather unpleasant task to involve students in speech process during foreign language classes because speech is a very personal manifestation of ourselves (Škarić, 1991). Most of students are rather shy or not very motivated to speak due to a large number of errors that can occur on different language levels. Phonetic correction is therefore a necessary part of the process but organizing individual lessons is almost impossible. Since the teacher is not able to organize speech material for each student individually and modify/filter signal, some other possibilities must be used in the group work. The answer to the need for pronunciation improvement in a class might be in greater usage of movement since we involve our body in different aspects when communicating. Instead of concentrating exclusively on speech signal, type of prosody patterns or elements describing speech sounds should be perceived and worked on through gross motoric movement (Dobrić and Bićanić, 2013). In that case common errors for the group should be defined and worked on. Still, a lot of individual classes of phonetic correction are valuable assets in determining overall main characteristics for some types of errors or some specific speech sounds. This type of group work does not involve gross motoric movements in the same way as in some other methods of foreign language teaching (Kiviaho-Kallio and Berazhny, 2015) or teaching other subjects (Geršak and Geršak, 2016).

In this paper gross motoric movement in phonetic correction based on verbotonal method is observed and discussed through descriptive analysis. Quantification of parameters, although sometimes useful in movement analysis, will not be used since not all movements linked to speech sounds belong to the same, coherent group.

## 2 Aim

The aim of this paper is to analyse and discuss type of movements and parts of the body engaged in gross motoric movements during individual sessions of phonetic correction using the verbotonal method. Furthermore, the movements are defined and explained through LMBA basic components to be more understandable for practitioners of the verbotonal method in larger groups of foreign language students.

## 2 Materials and methods

51 written student reports were collected during ten lessons, respectively, of individual phonetic correction sessions using the verbotonal method. The remarks were gathered in three groups depending on lessons they described. First group described lessons 1-3, second lessons 4-7 and the last one lessons 8-10. Although the purpose of the reports were remarks on every type of progression of their work (mainly pronunciation and speech material), collateral remarks were made on usage of gross motoric movement which proved to be valuable data. Remarks described movements of both 49 female and two male students of phonetics who were ‘teachers’ and 37 female and 14 male students from abroad who learned Croatian as foreign language during everyday language classes. Native language of foreign students who studied Croatian as foreign were: English (5), Spanish (17), Chinese (3), Japanese (2), Tigrinya (1), Slovakian (2), German (9), Cebuano (1), Czech (1), Arabic (1), Brasilian Portuguese (1), Russian (2), Korean (1), French (1), Hungarian (1). Two students were native speakers of Croatian who studied Italian (1) an French (1) and correction was done in foreign language. Targeted speech sounds were /z/ (3), /ʎ/ (26), /ɲ/ (3), /ts/ (2), /t/ (3), /ʃ/ (1), /r/ (6), /l/ (2) and /ʒ/ (2). Native Croatian student who studied French worked on pronunciation of /ʁ/ and the other who studied Italian worked on distinction between open and closed Italian vowels /e/ and /o/. Sessions of phonetic correction were bonus lessons and foreign students as well as Croatian students (both ‘teachers’ and students) participated voluntarily. Both language classes and phonetic correction lessons were held at the Faculty of Humanities and Social Sciences during several years.

## 3 Results and Discussion

In most cases (26) pronunciation of /λ/ was worked on. Foreing speakers tend to pronouce this sound as two separate sounds /l/ and /j/ or pronounce just one of them. In the case when the two sounds are produced instead of one, duration is longer and tension is not adequate. The aim of correction in this case is to work in opposite direction: to obtain one speech sound with shorter duration. For both segments of error more tension is required and short gross motoric movement is the type of movement should follow pronunciation. One person (working with Hungarian students) reported snapping fingers was movement used in sessions 1-3. Other 21 people reported using short movement with hand or feet such as clapping hands or stamping feet, and tapping the desk or knee. In one case stamping feet while standing was reported. One wave-like movement was described during last session. When used in unstressed syllable short and strong movement was a problem for all the students. The phenomenon was rather odd for most of the students but it became less odd when discussed in terms of music (waltz rhythm). In those cases it was suggested to accompany every syllable with the movement and then to change the movement to half-moon (‿ ) to connect all syllables of the word. Speech material followed each utterance. Overall remarks were that gross motoric movements were used during first three lessons or up to the 7$^{th}$ lesson. During the second group of lessons usage was almost coherent although in 4 cases reported that it was used less toward the 7$^{th}$ lesson. Two 'teachers' reported that their students used movement spontaneously even when the movement was not suggested. Kinesthetic memory (although used primarily in profession that engage body such as dancers, athletes, divers etc.) played extremely important role in spontaneous usage of movement and achieving the same improved results (Sheets-Johnstone, 2012). Only 2 people used movement during last three sessions. Recordings of 13 native Spanish speakers were used for acoustic analysis in a previous study and improvement was reported both in duration and quality of pronunciation after correction session (Dobrić and Bićanić, 2013).

Aspirated pronunciation of /t/ ([t$^{h}$]) was, according to the reports, accompanied by progressive hand movement to influence place of articulation. This movement was not the optimal one since the aspirated sounds are more tensed. During lessons it was found out that slightly regressive movement pretending to catch something with hands was far better option because it was accompanied by silence instead of plosive sound. In further steps in all cases pronunciation improved.

Gross body movement linked to correction or obtaining of /r/ was in four cases described as "running with fingers" or sometimes rolling the hands in order to obtain vibrations. In two cases usage of movement was stated but no description was given.

Croatian student who was trying to improve pronunciation of /ʁ/ used relaxed regressive movement (like opening a big drawer). Results of perceptive test showed progression both in pronunciation and spontaneity in speech.

In all other cases usage of movement was reported but no description was given on type or direction of movement used in correction. No specific references to speech material (except following prepared speech material) was reported.

No reports on movements were made in six cases (Russian /l/; English – 2 people, Spanish and Chinese – 1 person each / λ/, Italian vowels in Croatian native speaker), therefore there is no general rule for language or speech sound to be defined.

Just one of all students-"teachers" who worked with female Spanish speaker on pronunciation of / λ/ reported standing up. All other people performed correction while sitting.

Two basic things can be discussed from the obtained results: type of movement and body posture. Movement used in almost all cases of correction was performed with a hand (rarely with arm) and in one case with fingers (snapping fingers). Combining hand and leg was also present (tapping the knee instead desk). In terms of LBMA it can be seen that certain Body Parts were used (limbs) while the rest of the body was not used at all. Pattern used was Right-Left (none of the students used i.e. left hand to tap right knee but used left hand to tap left knee). Effort Factors, namely Flow and Time, were the components most prone to change. Impulsive Phrasing Type was used in all reported cases (students who used movement) in the first stages of correction of / λ/.

As for the body postures, we could refer to Still Shape Forms to describe the sitting position of all participants. The Shape present during all sessions was Tetrahedron which is usually described as

pyramidal shape with wider base (such as Meštrović's portrait in marble "My mother"). Only one person stood up during correction and therefore change the Shape to Pin (classic standing position).

No movements of whole body were reported. The evidence show reference to negative emotions towards movement in the beginning of the lessons. Although most of the students later engaged in movement and used it by themselves some time was needed for them to understand movement as integral part of speech. The whole process is even more interesting since it is well known how inherent movement is to human being from birth through childhood and on (Dobrić, in print). More concentration on movement sometimes led to less attention on pronunciation or repeating only movement and without speech material. In those cases students were kindly asked to repeat both elements together. Some of the students were more resistant to "teacher's" intentions to engage them in movement. Since students were culturally different, different were the range and type of movement they performed. The intention in this process is to use spatioception as integratory brain function to improve speech process using our body as a Whole (Pansini, 1989; Leisman et al., 2016). Usage of movement tends to get more serious and awkward when correction is performed in group. Although Guberina's in his work implies usage of different technical aids, even in the era of computers, group work requires getting to the beginning and basics as well as usage of simple and natural aids such as gross motoric movements. Adaptation of movement, as well as material, to immediate requirements and directions means having well prepared teacher who is very well acquainted with the postulates of the verbotonal method and prone to use it as new circumstances and demands occur. Although mainly in francophone world, it can be seen that the verbotonal method is still used and has been slightly modified following the requirements of the 21st century (www.verbotonal-phonetique.com/geste-parole)

## 4 Conclusion

Although some modifications in speech material using filters were made during phonetic correction classes described in this paper, basic "aid" in improving pronunciation seems to be usage of gross motoric movements. Since some time was needed to engage students in movement, it can be seen that we culturally tend to lose some things normally inherent such as liberty in movement. Overall analysis of movements using LBMA showed that instead of using most of the body (as we unintentionally do when speaking), students used just parts of their bodies (limbs) during correction. Changes in posture were almost none (present in only one person). Although benefits of movement in phonetic correction are clearly visible, it is not always a simple task to incorporate movement in lesson. It is even harder to achieve usage of movements in group classes (sometimes with different cultural background of students in the group) which is necessary because institutionally organized individual language classes are rare and expensive. Using movement more intensively in group work rather than leaning only on technical support will establish the verbotonal method as a valuable asset in language teaching methods of the 21st century.

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# Vowels in Croatian as foreign language – example of native slavic speakers

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**Abstract.** Foreign language speakers are often recognized as „foreign" on the basis of rhythm and intonation of their speech and only later by more or less inadequate phonology, vocabulary or syntax. Vowels play important role in both rhythm and intonation and therefore their role and characteristics are of great importance in foreign language learning. In this paper, changes in vowel systems in adult foreign language learners were compared on initial and advanced level of learning and for that purpose native Polish speakers studying Croatian as foreign language were recorded. The obtained material was used for measuring F1, F2 and F3 of Croatian vowels in foreign speaker as well as for comparison with F1, F2 and F3 of their native Croatian peers to obtain information on interphonology. Furthermore, a perceptive test was performed to establish whether the differences between native and foreign speakers, as well as between intial and advanced levels of knowledge of foreign learners, can be perceived. Differences in values of F1, F2 and F3 were obtained for all vowels for both groups of Polish speakers. The results for F1, F2 and F3 in Polish speakers were compared with those obtained for their native Croatian peers but also with results of some previous studies. Results of the perceptive test showed clear distinction between foreign and native speaker but not as much between the two groups of foreign learners.
*Key words:* foreign accent, vowels, perceptive test, acoustic analysis

## 1 Introduction

Foreign language speakers are usually recognized at first glance - or utterance. Foreign accent, although not strictly defined in literature usually refers to some inconsistencies on phonological, morphological, lexical or syntactical but above all on differences in rhythm and intonation of the utterance when compared to a native speaker. Studies of different language levels thorughout 20th and 21st century showed that the age of learner plays an important role in learning process since younger learners (who were up to six years old when started learning second/foreign language) tend to acquire second/foreign language with more success than adult learners. Foreign language is usually refered to as the second langauage while native language or mother tongue is refered to as the first language (Jelaska, 2005).

Paradis (2009) claims that all of the language levels cannot be mastered equally well and inconsistencies on at least one of the language levels (such as phonological, morphological, syntactic or lexical) will reveal this person as a foreign language speaker. Desnica-Žerjavić (2006) states that listeners perceive even small differences in pronunciation (in comparison with standard speech) and it leads to negative (or less positive) evaluation of social status and personal characteristics of the speaker.

In the mid 20th century a very common and popular way of language error analysis was contrastive analysis having as the aim prediction of possible errors comparing the first and the second/foreign language of the learner (Medved Krajinović, 2010). Since for this papers phonological level, namely vowels, is of more importance than other language levels, it is necessary to mention that in the light of contrastive analysis foreign accent was considered the consequence of the interference of two phonological systems. Desnica-Žerjavić (2006), referring to some earlier authors such as Weinreich (1953) and Jakobson (1939), explains that interference happens due to identification of foreign phonemes as the phonemes in native language and four types of errors can occur as the result of this interferention: *dephonemisation*, *phonemisation*, *transphonemisation* and *phoneme substitution. Dephonemisation* refers to pronunciation of the most similar speech sound from the native language instead of the target sound in the foreign language. *Phonemisation* is described as using new oppositions by coping distinctive features from native language into foreign language when those features do not exist in this foreign language. *Transphonemisation* is the term used to describe reinterpretation of differences by considering redundant features as relevant. Finally, *phoneme*

*substitution* is switch of phonemes that are equally defined but differently pronounced in native and foreign language. Although some predictions on possible errors can be made, parallel analysis of two phonological systems without realization, that is speech act, cannot guarantee valid insight in real errors of foreign language learners (Desnica-Žerjavić, 2006). Since contrastive analysis was based on behavioral approach in language learning, Chomsky's idea of language learning as creative process changed somewhat language learning theories. Furthermore, a number of errors cannot be explained by contrastive analysis postulates (Medved Krajinović, 2010). Distinction of errors by Burt and Kiparsky in 1975 on global and local (Desnica Žerjavić, 2006) refers to the errors present on larger segments of speech act (i.e. multi-word prosodic units) and those that influence an isolated segment. Perceptive tests and analysis are valuable means for description foreign accent in language learning but the subjectivness of the participants who listen to the speakers or recordings might be questioned or discussed to a certain degree since the whole process depends on various factors concerning listeners (training, motivation, current mood, native language and other languages they speak etc.) Therefore acoustic analysis on different levels should be added to the description of foreign accent when possible. Acoustic analysis is one of the most widespread method or set of methods of speech analysis in phonetics because recorded acoustic signal is physically closest to the complete speech material and acoustic analysis is very economical both financially and methodologically (Horga and Liker, 2015). Languages, dialects and varieties are often described in terms of their vowel spaces areas calculated manually or automatically, based on obtained values for first two or three formants (F1, F2 and F3). The relationship between the articulation, the dimensions of the resonating cavities and the acoustic features can be seen in the frequencies of the first two formants, the dimensions of the oral and pharyngeal-nasal cavities as well as the traditional descriptions of the tongue, jaw and lip positions. Tongue height affects pharyngeal space and it is connected with F1. More pharyngeal space and small mouth opening means lower F1. Changes in oral cavity, such as tongue retraction, is correlated with F2: more retracted tongue produces a lower F2. Some rather research (i.e. Kent and Read, 2002; Scobie et al., 2012; Harrington, 2013) show that this articulatory-acoustic relationship is not that simple or linear and further investigation should be made on this field (Horga and Liker, 2015). According to Stevens (1998), when defining a vowel in terms of its backness the analysis of relative ration of F2 and F3 should be considered (Horga and Liker, 2015). Broad and Wakita (1977) state that F3 primarily cues rhoticity (Monhan and Idsardi, 2010). F1 and F2 values are often presented in terms of vowel quadrilaterals or in tables when F3 values are also mentioned. Formants also depend on individual differences of a speaker (articulatory apparatus, gender, age etc.).

In this paper, cardinal vowels in Croatian (one of Southern Slavic languages) pronounced by native speakers and foreign learners (on initial advanced level of Croatian language courses) were compared taking into consideration vowel systems in both languages, respectively. Values of first three formants for five Croatian vowels (/a/, /e/, /i/, /o/, /u/) obtained on different subjects are presented parallelly (such as in Kent and Read, 2002) in Table 1. Since different subjects or subject groups participated in different studies, results obtained for male participants are presented in blue, female participants in red and children in yellow. Results for unknown test group are presented in white and those for the synthesized material in orange.

**Table 1.** Formant values (F1, F2 and F3) obtained for native Croatin speaker in different studies: (1) Škarić (1991), (2) Bakran (1996), (3a) Bakran and Stamenković (1990), (3b) Bakran and Stamenković (1990), (3c) Bakran and Stamenković (1990), (4) Bakran and Stamenković (1980), (5a) Varošanec-Škarić and Bašić (2015), (5b) Varošanec-Škarić and Bašić

| | | Vowel | | | | |
|---|---|---|---|---|---|---|
| | | i | e | a | o | u |
| F1 | 1 | 360 | 500 | 700 | 450 | 380 |
| | 2 | 250 | 450 | 670 | 440 | 320 |
| | 3a | 282 | 471 | 664 | 482 | 324 |
| | 3b | 302 | 493 | 884 | 576 | 353 |
| | 3c | 375 | 500 | 984 | 585 | 463 |
| | 4 | 245 | 480 | 815 | 470 | 260 |
| | 5a | 295 | 494 | 707 | 511 | 344 |
| | 5b | 370 | 577 | 835 | 580 | 403 |
| F2 | 1 | 2200 | 1800 | 1400 | 1150 | 750 |
| | 2 | 2200 | 2000 | 1220 | 770 | 700 |
| | 3a | 2192 | 1848 | 1183 | 850 | 717 |
| | 3b | 2623 | 2360 | 1393 | 980 | 758 |
| | 3c | 3033 | 2569 | 1581 | 1095 | 962 |
| | 4 | 2270 | 1990 | 1140 | 750 | 600 |
| | 5a | 2177 | 1811 | 1221 | 1069 | 799 |
| | 5b | 2375 | 2112 | 1395 | 1151 | 907 |
| F3 | 1 | 2850 | 2500 | 2250 | 2300 | 2450 |
| | 2 | 2900 | 2600 | 2550 | 2350 | 2150 |
| | 3a | 2713 | 2456 | 2433 | 2472 | 2544 |
| | 3b | 3246 | 2930 | 2709 | 2776 | 2764 |
| | 3c | 3487 | 3255 | 3024 | 2173 | 3224 |
| | 4 | 2760 | 2500 | 2500 | 2540 | 2360 |
| | 5a | 2725 | 2427 | 2417 | 2405 | 2410 |
| | 5b | 2832 | 2704 | 2449 | 2499 | 2567 |

Vowel system of Polish (Western Slavic Language) has seven oral (/a/, /e/, /i/, /y/, /o/, /ó/, /u/) and two nasal vowels (/ą/, /ę/) (Pintarić, 2002). Phonemic characteristics of the last two vowels are questioned lately due its restricted positionally caused variability. Since nasal vowels are not the aim of this paper, further discussion will be concentrated on oral vowels and their influence on pronunciation of Croatian vowels (pronunced by Polish learners of Croatian).

In Table 2 average values of standard oral Polish vowels are presented.

**Table 2**. Average values of formant frequencies (F1, F2 and F3) of oral Polish vowels (Encyklopediajęzykapolskiego, 1999)

| | F1 | F2 | F3 |
|---|---|---|---|
| i | 215 | 2410 | 3050 |
| y | 325 | 2060 | 2680 |
| e | 570 | 1900 | 2650 |
| a | 800 | 1310 | 2570 |
| o | 560 | 900 | 2620 |
| u | 285 | 675 | 2580 |

Results for /ó/ were not available in consulted sources (http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.595.6211&rep=rep1&type=pdf).

## 2 Aims and Hypotheses

The aims of this study were to estimate how successfully native Polish speakers can be identified while speaking Croatian (in comparison to native speakers of Croatian) as well as to compare two groups of Polish speakers (on different language levels). Acoustic analysis was performed in order to support findings of the perceptive test and quantify them to some extent. Basic hypotheses were that: native and foreign speakers can be successfully recognized, levels of knowledge of Croatian as foreign language can be successfully defined up to a certain point and greater differences in vowel formants are present in the group on initial levels of learning.

## 3 Materials and Methods

Materials obtained for perceptive test were recorded by seven adult native Polish speakers on initial levels and eight on advanced levels of courses of Croatian as foreign language who volunteered for this experiment. Language level for each of the participants was defined according to CEFRL or CEF (Common European Framework of Reference for Languages, ZEROJ, *Cro.*). None of the speakers previously attended classes of phonetic correction. Due to a small number of available participants further distinction in group were not made (gender, specific age etc.). Each speaker recorded a short text out of which one sentence containing all Croatian cardinal vowels was extracted and use for the perceptive test. A set of ten words (CVC for each of Croatian vowels) was recorded. Ten native speakers of Croatian recorded the same material as well. All recordings were made in the quiet chamber of the professional acoustic studio.

The recorded material (sentence) was presented to 34 native speakers of Croatian, students on the Department of Phonetics with the task to evaluate each of the speakers as native or foreign. If evaluated as foreign, further distinction between initial and advanced level was required. Listeners listened three times to each recorded example in random order. Evaluation has been based primarily on pronunciation of vowels although influence of other factors cannot be completely excluded. Some remarks on recordings made by listeners have been mentioned but they are not consistently included in this paper.

Acoustic analysis was performed on ten monosyllable words (for each participant, respectively) using PRAAT programme. Seven words consisted of a vowel between two plosives (*kap, kut, kit, keks, kip, kup, kat*), two of vowel between a plosive and a fricative (*kos, koš*) and one of a vowel between a plosive and an affricate (*kec*). Each vowel was recorded twice in different environments. Each word was recorded three times, all recordings were analysed and average values of F1, F2 and F3 in steady state of each vowel were measured in one point. Further statistical analysis was not performed since acoustic analysis is used only to support findings of the perceptive tests.

## 4 Results and Discussion

In perceptive test 66.8% of listeners recognized native Polish speakers on initial level, 39.3 % of listeners recognized native Polish speakers on advanced levels, and 89.6% participants recognized native Croatian speakers. The highest score in recognition of native speakers among the whole group of speakers confirms the first hypothesis although one native speaker was evaluated as a foreign one. Misleading factor, according to the evaluator, was speech rhythm as well as to some extent palatalized pronunciation. Apart from the individual differences, the participant's recent stay in Poland might have influenced her pronunciation of native language (Croatian). Rather high score can be observed for false alarms – 32.6% listeners evaluated Polish speakers on initial levels as advanced learners, and *vice versa* 60.63% listeners evaluated advanced learners as beginners. Some listeners reported that they had heard something different in pronunciation of vowels although they could not define it. In both groups of Polish speakers some speakers were successfully evaluated with greater accuracy than the others. The most accurately evaluated beginners (99% listeners) reported on longer stay or having relatives in Croatia. Rather high percentage of advanced speakers evaluated as beginners might be explained partly by lack of concentration during listening, poor motivation or individual ability

(Jelaska et al., 2005). Some of the poorly evaluated advanced learners reported on awareness of better acquisition of grammar or syntax than pronunciation which partly explains low percentage of correct answers. High score in false alarms confirms the second hypothesis. Since different strategies of language acquisition were randomly reported (spending time with relatives or attending language classes exclusively), it is obvious that pronunciation is acquired on different levels. Therefore, some of speakers on initial levels performed better than advanced learners. It can be concluded that more listening and verbal tasks and exercises during classes, as well as session of phonetic correction, should be included in language courses.

Acoustic analysis was performed in terms of comparison values obtained for native Polish speakers and compared to values for standard Croatian. As mentioned earlier, rather restricted pool of speakers was available for testing so the participants were not divided according to gender and age (although all speakers were younger adults 20 to 30 years of age). Therefore some basic references (Škarić, 1991) were used for comparison. In Table 2 formant values obtained for Polish speakers on initial levels are compared with average formant frequencies obtained by Škarić (1991). As one of the measures for comparison, differences higher than 100 Hz for each formant are marked in the table (Banković-Mandić, 2012).

**Table 2.** Comparison of average formant values obtained for Polish speakers on initial levels and in standard Croatian (Škarić, 1991)

| | Average values of formant frequencies obtained for Polish speakers on intial levels | | | Average formant frequencies for standard Croatian (Škarić, 1991) | | | Differences between obtained values and values for standard Croatian | | |
|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 |
| i | 332 | 2424 | 3228 | 360 | 2200 | 2850 | -28 | +224 | +378 |
| e | 551 | 1859 | 2558 | 500 | 1800 | 2500 | +51 | +59 | +58 |
| a | 740 | 1396 | 2379 | 700 | 1400 | 2250 | +40 | -4 | +129 |
| o | 550 | 1041 | 2428 | 450 | 1150 | 2300 | +100 | -109 | +128 |
| u | 361 | 875 | 2557 | 380 | 750 | 2450 | -19 | +125 | +107 |

Since significant difference was not calculated in this paper, in further text marked differences will be referred to as greater differences.

Greater differences between F1 frequency values obtained in this research and for standard Croatian are not observed. Still, 100 Hz of difference for vowel /o/ indicates more open pronunciation than standard. Lower F2 values refers probably to greater tongue retraction. Positive and greater differences for F2 in native Polish speakers can be seen for /i/ and /u/ which will be shown as with more anterior place of articulation for both vowels. Greater differences in F3 refer to more rounded pronunciation of all vowels except /e/ then expected.

In Table 3 formant values obtained for Polish speakers on initial levels are compared with average formant frequencies obtained by Škarić (1991).

**Table 3**. Comparison of average formant values obtained for Polish speakers on advanced levels and in standard Croatian (Škarić, 1991)

| | Average values of formant frequencies obtained for Polish speakers on advanced levels | | | Average formant frequencies for standard Croatian (Škarić, 1991) | | | Differences between obtained values and values for standard Croatian | | |
|---|---|---|---|---|---|---|---|---|---|
| | F1 | F2 | F3 | F1 | F2 | F3 | F1 | F2 | F3 |
| i | 335 | 2495 | 3133 | 360 | 2200 | 2850 | -25 | +295 | +283 |
| e | 653 | 2065 | 2686 | 500 | 1800 | 2500 | +153 | +265 | +186 |
| a | 853 | 1596 | 2571 | 700 | 1400 | 2250 | +153 | +196 | +321 |
| o | 618 | 1148 | 2689 | 450 | 1150 | 2300 | +168 | -2 | +389 |
| u | 395 | 888 | 2673 | 380 | 750 | 2450 | +15 | +138 | +223 |

Greater differences can be observed for vowels /e/, /a/ and /o/ in F1 values which refer to more open pronunciation of those vowels. More front pronunciation, except for vowel /o/, can be defined on the basis of rather higher values of F2. More rounded pronunciation than in standard Croatian can be described on the basis of F3 (Horga and Liker, 2015).

In Figures 1 and 2 vowel space areas for Croatian vowels in native Polish speakers on initial levels (1) and on advanced levels (2) are compared to vowel space ares of standard Croatian.

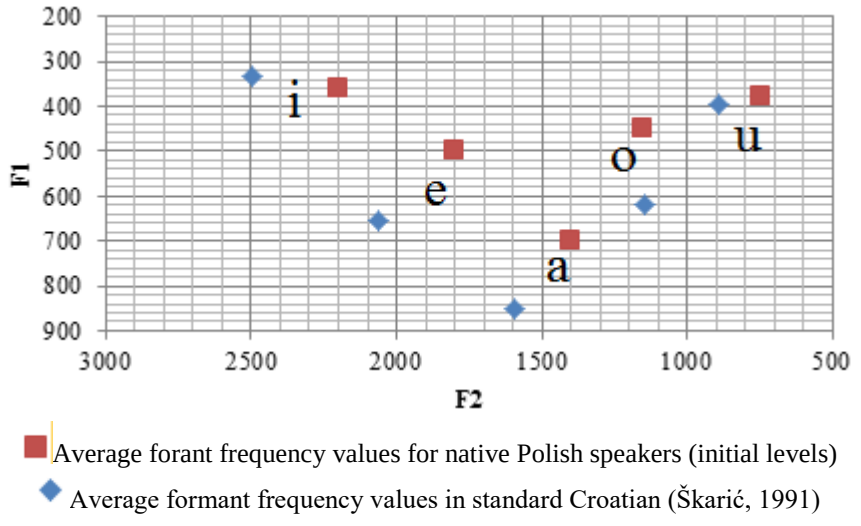


**Fig. 1.** Vowel space areas for Croatian vowels in native speakers of Polish on initial levels

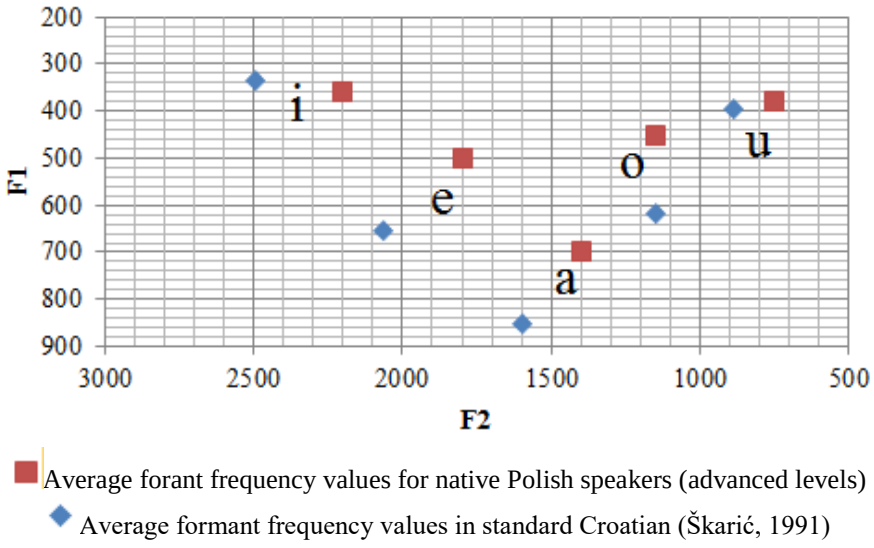


**Fig. 2.** Vowel space areas for Croatian vowels in native speakers of Polish on advanced levels

Except for the F3 frequency value obtained for Polish students on initial levels, all values differed more from values in standard Croatian for the advanced foreign learners. The high F3 value for vowel /i/ in the group of beginners can be partly explained by the existence of three vowels of three levels of backness (/i/, /y/, /u/) in Polish. Therefore, this rhoticity (Monhan and Idsardi, 2010) should be considered as sort of phonemisation (Desnica-Žerjavić, 2006) occurring in the process of pronunciation improvement. Third hypothesis was not confirmed since apart from the case of F3 of

/in/ in the group of beginners almost all formant frequency values differed greatly in advanced group of learners and those differences can be seen for almost all formants in almost all vowels. Those results tend to stress the lack of awareness of the importance of speech and its different layers. Pronunciation should be trained in different situations and through different sets of exercises during language courses.

In perceptive part of this research more detailed questionnaire should be made to obtain some notions on a great number of false alarms in advanced group of speakers. Remarks of listeners on the speech material and not only the multiple choice type of answering sheet should be taking into consideration when discussing the results.

In further acoustic investigation some more detailed measures should be performed such as calculation standard deviation and statistically importance. Furthermore, relative ratio of F2 and F3 should be considered as well dispersion of F1-F3 values with respect to gender of speakers. For more detailed analysis data several more speakers should be recorded and analysed and groups should be balanced according to gender. In that case data obtained by Varošanec-Škarić and Bašić (2015) should be used for comparison.

## 5 Conclusion

In this paper perceptive test and acoustic analysis partly confirmed three hypotheses that were the basis of this research. Foreign language learners tend to differ (apart from individual differences) on different language levels in utterances in foreign language. In pronunciation native speakers established clear difference between native and foreign speakers but the level of knowledge estimated on the basis of pronunciation was not very successful. Acoustic analysis confirmed that pronunciation of vowels in advanced group of learners was poorer than on initial levels. Formant frequency values (F1-F3) showed greater difference between the values obtained for all vowels for the advanced than for the initial group except for F3 value for /i/ in initial group. Apart from individual differences in language acquisition, overall conclusion is that different approaches and more exercises for automatization of pronunciation in language courses are needed. Further analysis of results of both perceptive tests and acoustic analysis should be done on larger number of speakers.

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# The role that speech and language plays in the medicines of ancient people

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**Abstract.** Medicines of ancient people regarded diagnosis as very important part of the healing process. Such view has been articulated through an old saying: ″Diagnosis is a part of the treatment as well as treatment is a part of diagnosis“. In order to obtain the syndrome 证 (zhèng), a generalized clinical result of the health status, physicians of Traditional Chinese medicine (TCM) perform specific anamnesis by means of looking, asking, hearing, smelling and palpation of the patient. Their aim is to read language of the body that can especially be observed on the face, on the abdomen, feet, the earlobe… This is because TCM is based on holistic understanding of health, as well the holistically approaching a person as a part of the Universe. On a small surface as a part of the whole system we can ″read ″ and understand the state of the whole system from its' “physical, energetic, mental and emotional” point of view. In medicine of ancient Mayan people joints were considered as very important parts of the human body, where a lot of information can be perceived and read, especially about the physical and emotional state of the patient. Ancient Mayan doctors have understood the importance of the time cycles and that it can influence the better outcome of the treatment. Since everything is cyclic in nature, by following its rhythms they could influence body's health and even prevent disease. Keeping harmony within their own body, in society, and with nature was the language of communication in medicine of ancient people. ″Wisdom is Harmony, and Harmony is Wisdom. ″ is one of the sayings of ancient Mayan people.

## 1 Introduction

Language and speech are fundamental in diagnostic procedure of traditional medicine, not only during conversations with patients, listening about their symptoms, will power, moods, rhythm of their speech and voice gesticulations; but also it is essentially significant that doctor knows how to read patients' body signs, as they are a language in itself. In the context of the medical significance and meaning of language and speech, there are some similarities (common denominators) in the medicines of ancient people. From it we can generalize universal holistic framework that is not just relevant for health, but it also can serve for our modern self-understanding. The most profound is how ancient Chinese and Mayan people were delicate observers of signs and hidden patterns of nature and life which they incorporated into their own languages, especially applied and entangled in their medical anthropology. Mind pictures in their languages are used for communication with reality. Symbols of their words (characters), thinking and speaking in pictures, have appeared from their artistic experience, close relationship with nature. For them language is inseparable from being. Our European civilization has almost lost this intuition in language. That is why many people rediscovers ancient Mayan and Chinese way of understanding reality as a new paradigm of consciousness. It is remarkable that their anthropological and cosmological principles are congruent with modern science and biomedicine. Thus, we are introducing here some complementary analogies between TCM and Mayan medicine that were not much elaborated in earlier research. As a starting point, the role of speech and language in their medicines are in focus of our attention.

## 2 The role of speech and language in Traditional Chinese Medicine

Theoretical system of Traditional Chinese medicine (TCM) has mainly two cardinal characteristics , and they are : concept of holism and treatment determination based on syndrome differentiation. Concept of holism –the so called ″wholeness″ signifies the unity and integrity of a thing. TCM holds that the human body is an organic whole in which all constituent parts are structurally inseparable, functionally coordinative and interactive, and pathologically inter-influencing. They are thinking

about integrity of the body itself and the unity of man's internal and external environment is the conception of holism of TCM. Physicians of TCM do diagnostics by means of 4 methods:

1) 望诊望诊 (wàngzhěn), visual inspection of tong, outside look, behaving of patient etc;

2) 闻诊(wénzhěn), auscultation (listening of the patient);

3) 问诊(wènhěn), verbal inspection (interview);

4) 切诊 (qièzhěn), Palpation (pulse detection by fingers).

In general, these techniques they use to observe systematic or regional changes in **vitality** of qì. It is reflected through view of eyes, consciousness, color of the skin, movements, sweating, hearing of the voice, breathing, cough, smell. Then they perform detailed conversation with patient about his/her social circumstances, natural environment etc. In this way they collect signs, "diagnostic parameters" about state of qì, blood and organs. In the end all symptoms, signs, details from history of patient are forming clinical result (pattern) of the disease (health status) that is called 证 (zhèng) [1,2]. Differentiation is to analyse, differentiate and recognize the syndrome of disease; and treatment determination is to consider and formulate the corresponding therapeutic principle and method according to the result of syndrome differentiation.

Mainly TCM distinguishes two types of zhèng:

- ***cold zhèng***: Cold (chill, coldness); cold pain; tastelessness; clear abundant urine (clear urine in large amounts); loose stool; pale tongue; white fur (white moss); *tight pulse (stringy pulse)* and

- ***hot zhèng***: Fever; heat (hot); diaphoresis; flushed face; burning pain; deep-coloured urine; red eyes; thirst; desire for drinking; constipation; red tongue; dry tongue; thin fur (thin moss); yellow fur (yellow moss); *rapid pulse.*

Zhèng is not a name for the disease. It is rather used for disease classification and then for recommendation of therapy. Some disease may be characterised by different zhèngs in different patients and some certain zhèng may be present in different diseases [3]. However, according to TCM, diseases might be arbitrarily classified as yīn or yáng diseases [1]

The main theories which are used in Chinese medicine are theories of yīn and yáng ,theories of five elements, theory of qì and blood.

On another side, in medicine of traditional Mayan people, a lot of attention was given to a posture of a body, position of the body joints , as well where the symptom of disease were present . Each position on the body, and ankles especially , had their own meaning . As they where consider that humans are the part of the nature , and that all answers are inside of our body.

### 2. 1. Sound of voice and speech

Hearing is one important of diagnostic methods. Hearing includes listening to a patients voice, speech, respiration, coughing, vomiting, signing, sneezing…Changes of voice reflect the physiological and pathological changes of the zàng-fǔ organs ( yīn-yáng organs, full and hollow organs..).

### 2. 2. Listening to the Sound of Voice

The sound and tone of the voice can also be used in diagnostics [4]. A loud, coarse voice is indicative of an Excess Pattern; a weak and thin voice is indicative of a Deficiency pattern. A reluctance to talk usually indicates either a Cold pattern or Lung Qì deficiency, whereas incessant talking indicates a Heat patterny.

The type ofvoice can be also diagnosed according to the five element scheme of correspondences. If someone tends to shout a lot in anger it indicates an imbalance in the Wood element. If someone laughs a lot without apparent reason, it indicates an imbalance in the Fire element. A singing tone of voice indicates an imbalance in the Earth element. Crying is related to Metal and its often indicating the deficiency of Lungs (whose emotion is grief). A very thin and weak , often ″weepy″ voice also indicates weakness of Lung-Qì. A groaning or husky voice indicates an imbalance in Water. Sudden loss of voice indicates invasion of Wind-Heat.

According to TCM, the lung controls qì and it is viewed as the motive power of voice, which is created by vibration of air. The kidney aids the lungs in breathing and producing voice. Other zàng-fǔ organs influence the lung and kidney through channels and collaterals. By listening to the sound of voice, physicians can know the pathological changes of the vocal organs as well of zàng-fǔ organs. In general, a load and sonorous speech sound with talkativeness and irritably often implies the yáng syndrome , excess syndrome and heat syndrome, while a law and feeble speech voice off and on, weak breathing and disinclination to talk are attributable to yīn syndrome, deficiency syndrome or cold syndrome.

Situation which are often seen during clinical practice are - hoarseness and aphonia are usually due to yīn deficiency of the lung and kidney and injury to the lung by deficient fire, leading to consumption of body fluids. Low muffled voice is caused by external contraction of wind-cold, retention of phlegm-dampness, obstruction of lung qì and blockage of air paths. In general, Wood element is connected with shouting, Fire element with laughing ,Earth element with singing, Metal element with weeping, and Water element with groaning [5].

### 2. 3. Speech

Speech is the result of complex processes involving brain function to control the voice box and tongue. One´s overall vitality or spirit and mental state are reflected in one´s voice, which is thought to be dominated by the heart [6]. Important vessels supplying the tongue and the brain belong to heart distribution vessels. The oldest TCM handbook “Inner Canon of the Yellow Emperor” (黄帝内经, huángdì nèijīng) notes that the sound of the voice is the result of the air passing through the voice box , and it was understood that the brain controlled the process of speech. The function of speech is further discussed in loss of voice due to grief and rage, where ancient physician Shao Shi, regarded the tongue as the engine of the voice. Arteries supplying the tongue are collateral vessels assigned to the heart. Thus collateral vessels and nerves of the tongue are related to the heart.

Abnormal speech is often related to pathological changes of the mind. In general, if patient is talkative or raving sonorously, it indicates the excess syndrome, heat syndrome and yáng syndrome, and if a patient is not talkative or speaks in a feeble voice intermittently, it suggest the deficiency syndrome , cold syndrome and yīn syndrome [7].

Farther more, there are 3 fundamental TCM principles related to speech. Those are:

1) **Paraphasia-**caused by deficiency in the heart and spleen or phlegm clouding the mind due to blood stasis and qì stagnation.

2)**Raving-**caused by heat turned from fire due to qì stagnation or mental agitation from phlegm-fire. It can be seen in mania or blood retention.

3)**Dysphasia and stiff tongue** are seen together, usually caused by collaterals obstructed by wind-phlegm , found in patients with precursors of apoplexy or apoplectic sequel. Clinically ,it may be seen in patients with bad speech habit or congenital ankyloglossia.

## 3 The role of speech and language in medicine of ancient Mayan people

Medicine of ancient Mayan people is attracting a lot of attention nowadays. As well as Chinese ancient people, they believed that we are strongly connected with nature, that human personal consciousness and the consciousness of human body are one. Body language was well known and practiced by ancient doctors, as well as shamans. It is based on the usage of Mayan Calendar. In Mexico today there are more that 20 different calendars, and some of them are especially used for healing purposes. A calendar that looks at the relationship between the Sun and the Moon with the human body is the Mayan 13 Moons 28 Days Calendar [8]. It makes the connection between the Moon cycles, that control the waters of Planet Earth and cycles that occur in human body, since our bodies are 80% water. The tool that is helping us understand the cycles in nature as well as the cycles in human body is Tzolkin, the harmonic module. Recently it has been called bio-electromagnetic battery and sense-field matrix. It is a galactic pattern of energetic codes. The 20 Solar Seals and 13 Galactic Tones describe a process of cosmic creation. When combined, they make 260 positions. The

13 and 20 number codes demonstrate the most fundamental organisational pattern of the synchronic order. Thirteen numbers represent primal patterns of radiant energy. Thirteen is the code of cosmic consciousness. These numbers can be thought of as radio-pulses. Twenty symbols represent frequency cycles–range of possibilities that each of these radio –pulses may undergo.

The significance of 13:20 matrix can also be seen in our bodies. We have 13 main articulations and 20 fingers and toes. Articulations are connected with the meaning of 13 Galactic Tones and fingers and toes with the meaning of 20 Solar Seals. Originating in ancient times up to modern times reading body language was always a very practical tool in seeking the cure for not only physical, but also mental and emotional bodies. Ancient Mayan healers considered joints and spine to have their own language of communication. Those thirteen joint are: ankles, knees, hips, wrists, elbows, shoulders and neck. Except the position of the neck (and spine as its prolongation), all others are symmetrical and mirror each other. Each articulation is on a specific position that is marked by a number, but in this case numbers are represented with names of tones. Listed below are the names for each articulation position and the core meaning.

**Table 1**.13 Galacting Tones

| | Articulation | Name | Essence | Power | Action |
|---|---|---|---|---|---|
| 1 | Ankle (r) | Magnetic | Purpose | Unify | Attract |
| 2 | Knee (r) | Lunar | Challenge | Polarize | Stabilize |
| 3 | Hip (r) | Electric | Service | Activate | Bond |
| 4 | Wrist (r) | Self-Exist | Form | Define | Measure |
| 5 | Elbow (r) | Overtone | Radiance | Empower | Command |
| 6 | Shoulder (r ) | Rhythmic | Equality | Organize | Balance |
| 7 | Neck | Resonant | Attunement | Channel | Inspire |
| 8 | Shoulder (l) | Galactic | Integrity | Harmonize | Model |
| 9 | Elbow (l) | Solar | Intention | Pulse | Realize |
| 10 | Wrist (l) | Planetary | Manifestation | Perfect | Produce |
| 11 | Hip (l) | Spectral | Liberation | Dissolve | Release |
| 12 | Knee (l) | Crystal | Cooperation | Dedicate | Universalize |
| 13 | Ankle(l) | Cosmic | Presence | Endure | Transcend |

Note – Abbreviations: (r) - right, (l) - left;

We cannot learn from nature if there were no patterns [9]. Nature is organized so that everything supports everything else. The same process that creates nature, creates humans. We recognize patterns because they are coded into structure of our organisms, in DNA and genes. As well known, molecular basis of life (the genetic code) is comprised from two alphabets:

1) 4-letter alphabet that generate 64 3-letter-words (codons)

2) 20-letter alphabet that generate amino acids (61 codons plus 3 nonsense codons equals 64) [10].

Analogous with genetic code, “atomic base of life” is formed by 84 stable elements, from which 61 is poly isotopic with 3 unstable poly isotopic (64 in total). So, it can be called chemical code [11].

Both, genetic and chemical codes are one and the same universal code of nature [11]. Much before modern genetics and chemistry these natural patterns were discovered in ancient Chinese “Book of Changes”, 易经 (yìjīng). Letters of yìjīng alphabet are whole and dashed lines. They form trigrams; 8 trigrams connected by 2 make 64 connections, or 64 stages of changes in cosmic energy. Those are stages in nature and stages in human life equivalently, which is assumption for designation of man as a microcosm. Giving a renewed and cosmic meaning to time becomes a starting point where through our bodies we perceive the reality differently, which further influences and changes the way we communicate. Using the Harmonic Module as the template of the circuitry of the light body, and the understanding the light body to be the true skeleton of the physical body, we can assert that the diseases and plagues which ail us- cancer and AIDS – are not cellular in cause but instead direct result of radical blockages in our collective bio- electromagnetic field [12].

As much as the Tzolkin gives us a blueprint of the individual light body that animates each one of us, it also describes the patterned flow of solar energy and intelligence, the ceaseless stream of universal creative spiritual energy itself.

## 4 Conclusion

In medicine of ancient people, speech and language are playing significant role. The main topic of this paperwork was, in a certain way, *familiar* approach of Traditional Chinese medicine and ancient Mayan people. In both, it is important to consider body as a holistic system, as a part of nature. Beside the conversation with patient, additional and equal important part of examination are: looking, asking, hearing, smelling and palpation. The articulations represent intersections on the human body. Meridians, as pathways of vital qì are passing through joints, as well the very potent and often used acupuncture points are located near or on the biggest articulations. Medicine of ancient Mayan people states that position of each of 13 articulations has its own meaning, essence and power, and it might provide deep insights about mental state of a person. Therefore, it could be essential to consider ourselves, humans, as a part of Universe, and through us the language of Universe is expressed.

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## Uloga govora i jezika u medicini starih naroda


Mnoge drevne civilizacije smatrale su da je dijagnoza važan deo procesa isceljenja i da je tretman deo dijagnoze. Kako bi se dobio 证 (zhèng), tj. generalizovani klinički rezultat zdravstvenog stanja, lekari tradicionalne kineske medicine (TKM) izvode specifičnu anamnezu putem gledanja, postavljanje pitanja, slušanja, mirisanja i palpacije pacijenta. Cilj toga je čitanje jezika tela koji se naročito može registrovati na licu, stomaku, stopalima, ušima... To je zato što se TKM zasniva na holističkom shvatanju zdravlja, a holistički posmatra i čoveka kao deo Univerzuma. Na maloj površini, kao delu celog sistema, možemo pročitati i razumeti stanje čitavog sistema sa fizičke, energetske, mentalne i emocionalne tačke gledišta. Za drevne Maje, zglobovi su predstavljali veoma važne delove ljudskog tela, u kojima se mogu očitati mnoge informacije, posebno o fizičkom i emocionalnom stanju pacijenta. Majanski doktori su razumeli važnost vremenskih ciklusa, da mogu da utiču na bolji ishod lečenja. Pošto je sve ciklično u prirodi, praćenjem njenih ritmova mogli su uticati na zdravlje tela i sprečavanje bolesti. Održavanje harmonije unutar sopstvenog tela, društva i prirode, bio je glavni postulat u drevnoj medicini. Otuda i izreka drevnih naroda: "Mudrost je harmonija, i harmonija je mudrost".

# Валеологический туризм, как один из методов восстановления энергетики горлового центра *(на примере посещения пирамид и туннелей в г. Високо Босния и Герцеговина, валеологического питания и применения технологий Сознания)*

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*Ключевые слова:* валеология, форум, конференция, семинар, тренинг, фестиваль, коллективное управление, валеологический туризм
*Key words:* valeology, forum, conference, seminars, trainings, festivals, collective management

В настоящее время общеизвестным является наличие биополя-ауры вокруг тела человека. Аурические поля изменяют свои параметры в зависимости от внешних воздействий, а также физического и психического состояния человека. Нарушение энергетики в какой-то из зон организма в конечном итоге по прошествии определенного времени может привести к тому уровню патологии, которую фиксирует медицина.

Гармоничное функционирование речевого аппарата связано с горловой чакрой (5-я чакра). Она расположена сзади между 6 и 7 шейными позвонками, спереди-у основания горла и взаимосвязана с шейным нервным сплетением, с щитовидной и паращитовидной железами, миндалинами, слюнными железами, вилочковой железой, верхними дыхательными путями, глоткой, голосовыми связками, горлом-т.е. со всем речевым аппаратом. Это также центр взаимопонимания, коммуникации, творчества, красоты и умственных способностей.

На основании многолетних личных исследований ауры выявлено, что практически все исследуемые (до 95%) имеют в разной степени нарушения горлового центра. Из них до 50% можно считать значительными (недостаток более 20 единиц). Если искажение ауры системно не восстанавливать-это может приводить к различным заболеваниям, связанных с перечисленными выше органами и системами, в том числе и к дисфункции голосового аппарата в разных проявлениях.

Для восстановления нормы голосового аппарата, кроме всех апробированных методов и технологий, необходимо параллельно устранять причины, которые находятся в тонкоматериальной структуре человека. Существует много методик, которые можно применить для восстановления ауры, в частности и для нормирования 5-й чакры. Один из методов, который можно использовать-это валеологический туризм.

Существует много мест на Земле, воздействие которых благотворно влияет на Человека. Если соединить это с безмясным питанием, медитациями и управлениями на основе технологий Сознания, а также с позитивными чувствами, которые испытывают валеотуристы, то всё это вместе нормирует энергетические центры.

Исследуемая группа в количестве 19 человек в течении 5 дней участвовала в валеотуре, посетив г. Високо, Босния- пирамиды и туннели, открытые доктором Семиром Осмараджичем. По программе участники посещали пирамиды, туннели, проводились специальные занятия по технологиям «Учения о Спасении и гармоничном развитии» Г.П. Грабового, все эти дни было гармоничное безмясное питание. Все мероприятия дали очень хорошие результаты по восстановлению энергетики ауры у всей группы, а также конкретно по восстановлению энергетики 5-й чакры .

С помощью диагностики ауры можно определить энергетические резервы организма, выявить предрасположенность к ряду заболеваний в случае блокировки или нарушения

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циркуляции энергии в какой-то части организма, а также отслеживать обратный процесс-восстановление ауры и поддержание её в норме.

Были проведены измерения ауры перед началом и по окончании валеотура. Применялась разработанная болгарскими учеными методика графической визуализации состояния биополя человека с помощью прибора «Гармония». Ученые Международного научно-исследовательского Центра «Булсоф» (София) под руководством академика А. Влахова объединили современные представления о наличии ауры и торсионных полей, понятие индийских йогов о чакрах, систему меридианов из китайской медицины, принцип подобия кисти всему телу из корейской Су Джок-терапии, а также метод измерения электропотенциала биологически активных точек немецкого рефлексотерапевта Р.Фолля. При этом они использовали возможности современной компьютерной техники. Замеры производились на кистях рук в точках, которые соответствуют проекциям чакр.

## Результаты исследования

Энергетический потенциал горловой чакры увеличился по направлению к норме и выше нормы у 100% исследуемых в среднем по группе на 43%.

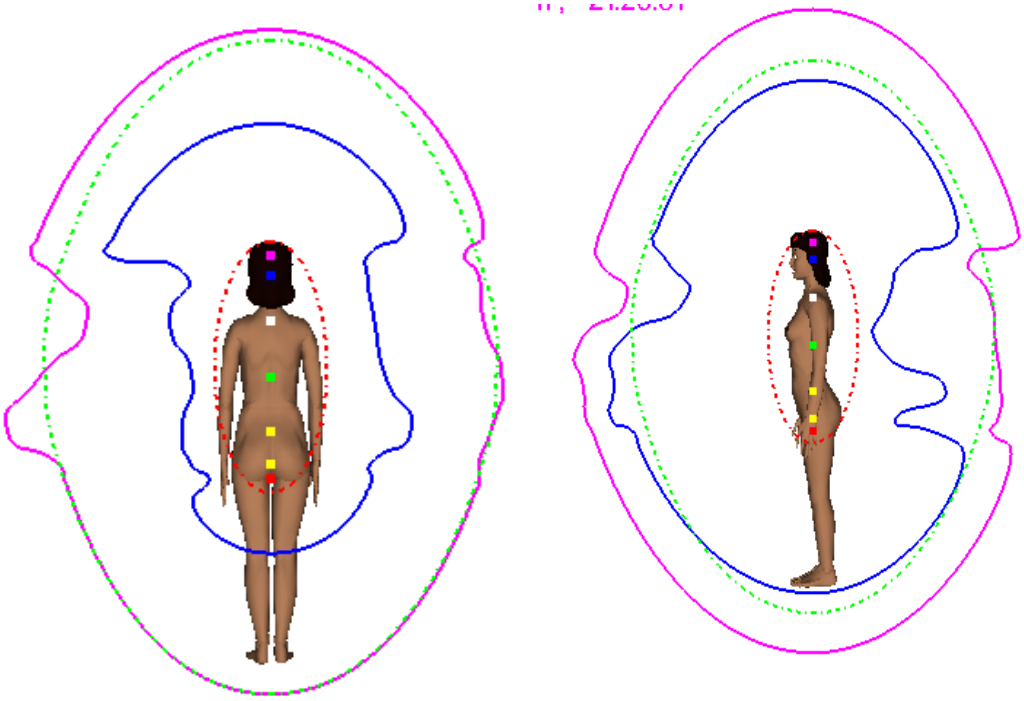

**Рис.1.** Пример.Аура «до» (внутренняя линия) и «после» (внешняя линия) валеотура.

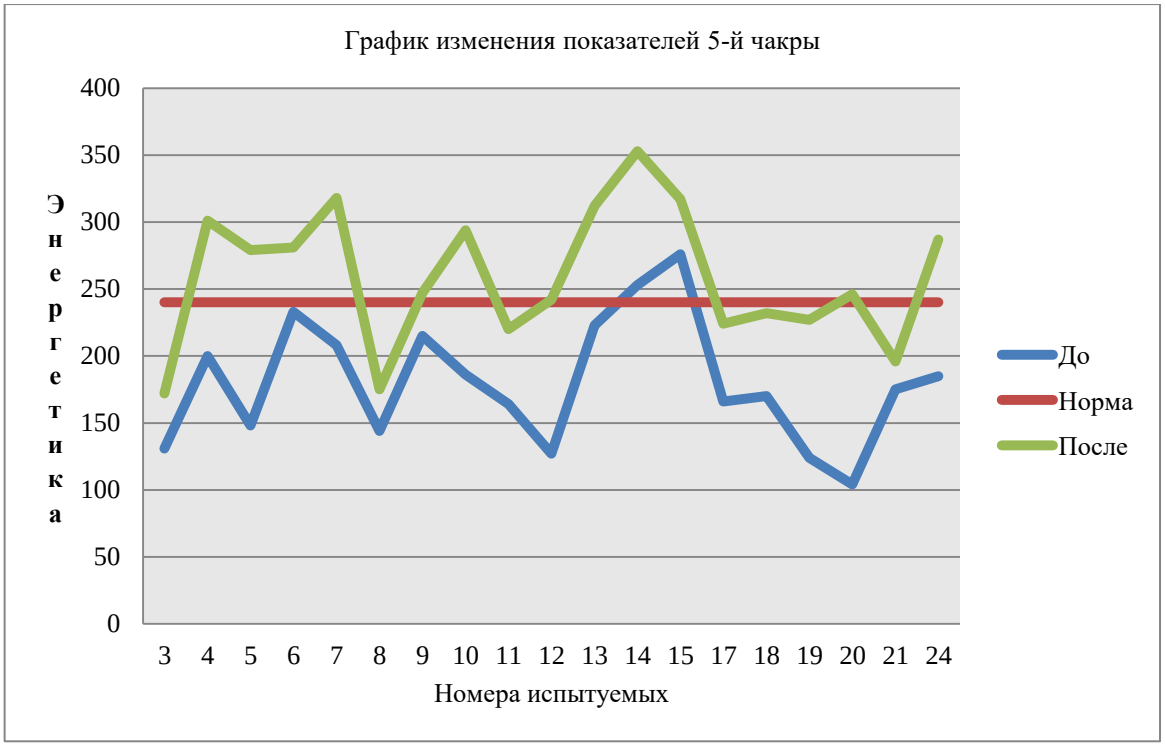
График изменения показателей 5-й чакры
Энергетика
400
350
300
250
200
150
100
50
0
3 4 5 6 7 8 9 10 11 12 13 14 15 17 18 19 20 21 24
Номера испытуемых
До
Норма
После

**Рис.2**

Суммарное изменение энергетики 5-й чакры исследуемой группы
Энергетика
5000
4500
4000
3500
3000
2500
2000
1500
1000
500
0
Показатели группы
1
2
3
1 "До"
2 Норма
3 "После"

**Рис.3**

## Выводы

1. При работе с пациентами, которые имеют дисфункции голосового аппарата, кроме апробированных методов применять валеологический подход к нормированию ауры и отслеживать динамику 5-й (горловой) чакры.

2. Разрабатывать, популяризировать и внедрять валеологический туризм, как один из методов восстановления энергетики и состояния организма для пациентов разных возрастов. Применённый метод дал результат увеличения энергетики у 100% исследуемых в среднем по группе на 43%.

3. Внедрять и пропагандировать валеологическую гигиену для общего поддержания здоровья человека.

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# Neurocardiological anamnesis: development from complementarities with syndrome differentiation of Traditional Chinese Medicine

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**Abstract.** Cardiologists that are examining patients with ECG monitoring devices for years may get clinical experience from which they are sometimes able to closely evaluate type of autonomic nervous system (ANS) in patients, not just through overview of ECG parameters, but even before: during introduction conversation with patients, from their symptoms, will, mood, voice gesticulations. All of them can be differentiated in two types: hyperactive versus phlegmatic behavioral manners. These energetic types are often matching with sympathetic and parasympathetic ANS predomination, respectively. This is very similar to diagnostic methods of observation 望诊 (wàngzhěn) and auscultation 闻诊 (wénzhěn) in Traditional Chinese Medicine (TCM). From specific patterns in the voice, tong, mimics of the face, eyes, gesticulation and history of patient, TCM physicians are obtaining syndrome 证 (zhèng), a generalized clinical result of health status; briefly, it is characterization of the state of 气 (qì) in patient. Very sophisticated and complex zhèng is basis for successful administration of therapy. After drawing complementary analogies of yang and yin excess/deficit with sANS and pANS predomination/failure, and extracting main principles of TCM diagnostic procedures we can use it for development of algorithm for neurocardiological anamnesis in the form of simple expert system. Its purpose would be the software support to cardiologist in order to get synoptic health report of patient useful in further ANS analysis and recommendation of therapy. In other words, it would do mimetic of expert knowledge of experienced neurocardiologist. That could be a basis in neurocardiology for greater and fruitful personalized medical approach, that is otherwise practiced for centuries in TCM.

## 1 Introduction

As it is well known, autonomic nervous system (ANS) represents neural system of networks that are innervating all internal organs [1]. Through neural interplay they are enabling correct physiological functions, for example, blood vessels (blood pressure), airways (breathing), heart (pulse), sweating glands (sweating and thermo regulation), intestines and urogenital organs (contraction, secretion and absorption) [2] etc. Control and functioning of these organs are performed involuntary [3]. Usually, sympathetic ANS (sANS) is increasing physiological functions (heart rate, blood pressure), whereas parasympathetic ANS (pANS) is decreasing it. As a rule, sANS and pANS in most of the situations are acting antagonistically, synchronously, synergistically; they never act independently, action of one is always fallowed with inhibition of other [4]. Since invention of monitoring instrumentation these ANS system regulation concepts have started to be taken into account as significant assumptions for health status and administration of therapy. Autonomic imbalance is often associated with various pathological conditions [5]. Changes in the heart rate variability (HRV) patterns are stil not useful as indicators of health status. Yet, high heart rate variability (HRV) is a signal of good adaptation and characterizes a healthy person with efficient autonomic mechanisms. Whilst lower HRV is frequently an indicator of abnormal and insufficient adaptation of the autonomic nervous system, causing the subject low physiological function, this decrease is consistent with a dysfunctional vagus [6]. According to literature, disease is usually characterized by reduced complex variability in the temporal patterns of HR [7]. It has been shown

that attenuation of HRV complexity characterizes, among others, cardiovascular and metabolic diseases [8].

This is a field of research in new interdisciplinary science called Neurocardiology. In general, Neurocardiology could be defined as a combination of insights from neurology and cardiology with support of engineering and information technology. Its fundamental concepts are cardiac ANS patterns that can be determinate and characterized after ECG and blood pressure parameter analyze. Cardiac ANS patterns are evaluated in various medical conditions and diseases, for example as risk predictors, and as mentioned they are used for administration of optimal drug therapy.

## 2 Complementary analogies between Neurocardiology and Traditional Chinese medicine (TCM)

Beside obtaining by ECG monitoring devices, ANS patterns are all the time reflected through facial expressions of inner feelings, subjective experience, vocalization, temperamental reactivity, emotionality [9][10]. Facial expressions and vocalization are mainly regulated by cranial nerves that are connected with vagus (a part of the pANS). Cranial nerves and vagus regulate stratial muscles of the face, larynx and pharynx [11]. They also regulate heart and they are significantly influenced by self-regulation of emotions, outside environment, social interconnections [12], exchange of energy. Since long time ago, it was experimentally confirmed that voluntary facial activity can generate emotion-specific autonomic patterns [13]. Based on this observation we are able to conjecture a hypothesis that physicians in Traditional Chinese Medicine (TCM) with their methods of anamnesis are detecting mainly these ANS patterns in facial expressions, vocalization, gestures, mood, social behavior etc. During ages of life experience, they remarked the significance of ANS patterns for health and quality of life. Their insights are just expressed in different medical terminology. Now, if we study etymology of TCM concepts, obvious similarities with concepts of Neurocardiology could be found. It is remarkable that neurocardiac concepts (ANS patterns and ANS regulation principles) are consistent with explanations of Cang Fu 脏腑 (zàngfǔ) theory of inner organs in TCM [14, p. 23]. It is giving insights about physiological functions, inner relationships and pathologies of internal organs by observation of manifestations that are reflected outside on the body. It is important to know that organ in TCM is not the same thing as in biomedicine. Organ in TCM is identified with function and symptoms. Zàngfǔ organs could be considered as complex functional systems. 脏 (zàng) organs are „solid“ organs that performe main functions like production, transformation, regulation of vital substances: qì 气, blood 血 (xuè), body liquids 津液 (jīnyè) and essence 精 (jīng). There are 5 zàng organs: heart, lungs, kidneys, liver and spleen. 腑 (fǔ) organs are „hollow“ organs; they are functionaly connected and have roles in processes of digestion, absorption and secretion. There are 6 fǔ organs: small intestine, big intestine, gall-bladder, stomach, triple wormer (regulates qì in body, its circulation and activity). These internal organs have their own separate functions, but they are connected with all other organs by means of acupuncture meridians. Every zàng organ is connected with certain fǔ organ. Beside them, atypical fǔ organs exist as well:uterus, brain, medula oblongata, bones, blood vessels, gall-blader, again. They are „hollow“ like fǔ organs, but their function is collecting vital substance in the same manner as zàng organs. Every pair of zàngfǔ organs are relating to each other in agreement with 阴 (yīn) and 阳 (yáng) shifting. They are balancing each other and together they are influencing on general health status. Usually TCM physicians can detect disbalans between two organs, in other words disturbed yīn- yáng relationship [14, p. 22].Thus, sANS and pANS are suitable to be modeled as yīn and yáng. In the same way that TCM physicians interpret diseases and health problems as yīn and yáng excess/deficit, in Neurocardiology we can also determine sympathetic and parasympathetic predominance by means of HRV signal analysis. This is especially notable in power spectral analysis of HRV. Thus, translated to language of Neurocardiology, TCM principles could have the following explanation:

- organic dysfunctions and syndromes 证 (zhèng) are related to impairment of ANS control over involuntary functions;
- qì vitality (energy) could be represented by means of total power (TP) in HRV spectrum;
- qì congestion could mean impairment of autonomic regulation (very low value of TP in HRV spectrum);
- yáng excess can be regarded as sympathetic predominance (high value of low frequency band in TP spectrum of HRV);
- yīn excess as parasympathetic predominance (high value of high frequency band in TP spectrum of HRV) [15].

HRV analysis that we obtain with ECG monitor recording, TCM physicians do using pulse palpation. Thus, fingers of TCM physicians have the same function as sensors and electrodes in Neurocardiology. By means of the pulse palpation, TCM physicians are able to detect 28 types of pulse all of which possess diagnostic indices.

## 3 Establishing neurocardiac anamnesis

We have to point out that in Neurocardiology, anamnesis is not yet defined. It might have great significance just as in TCM it has. First off all, neurocardiac anamnesis could and should be systematized because of great diagnostic potential it possesses. In that aim, process of neurocardiac anamnesis of several physicians should be fallowed and noted.[18]Afterwards, their questions, insights and conclusion should be well documented. The most significant relationships in context of diagnostic assuming and prescription of therapy are needed to be valued. Then, noted insights of physicians can be generalized for getting simple rules that lead to conclusion about autonomic patterns in concrete person. More simplified, these clues can be scored. For notion of specific autonomic pattern physician needs several signs in mimics, gestures, vocalization, facial expressions. Besides, testifying about way of life should be taken into account: for example, early getting up, dynamics, speed, multiple activities, meeting, joining with many people, stress etc, versus late getting up, slow rhythm of life, long preparation for getting out from home etc. These two ways of life could be generalized as hyperactive and phlegmatic manners. They correspond to sympathetic and parasympathetic type of ANS predomination [16]. Evidences for such analogy are studies in which was shown that depression is related with impairment of ANS (increased heart rate, low HRV). Thus, physician may obtain confirmation about autonomic patterns through observation and conversation about usual daily activities and social circumstances of patient. Accordingly, it would be great achievement to create neurocardiac anamnesis through original insights in neurocardiac clinical practice, but more elegant is to borrow some principles from TCM. Their physicians do diagnostics by means of 4 methods:

1)望诊望诊 (wàngzhěn), visual inspection of tong, outside look, behaving of patient etc;

2)闻诊 (wénzhěn), auscultation (listening of the voice of a patient). This method have arrisen from the insight of TCM that states of yin and yang correspond to changes in the viscera function and afterwards lead to changes in the voice;

3)问诊 (wènhěn), verbal inspection (interview);

4)切诊 (qièzhěn), palpation (pulse detection by fingers).

In general, they use these techniques to observe systematic or regional changes in *vitality* of qì. It is reflected through observation of eyes, consciousness, color of the skin, movements, sweating, hearing of the voice, breathing, cough, smell. This observation they perform during detailed conversation with patient about his/her social circumstances, natural environment etc that are also taken into account. In this way they collect signs, "diagnostic parameters" about state of qì, blood and organs. In the end all symptoms, signs, details from history of patient are forming clinical result (pattern) of the disease, a health status that is called 证 (zhèng) [14, p. 22-23]. Correct differentiation

[18]In this paper we have insights of one neurocardiologist that he shared with us during our research. But, we need more like that, for better generalization.

of zhèng is most important for further recommendation of therapy. Mainly TCM distinguishes two types of zhèng:

- ***cold zhèng***: Cold (chill, coldness); cold pain; tastelessness; clear abundant urine (clear urine in large amounts); loose stool; pale tongue; white fur (white moss); *tight pulse (stringy pulse)* and
- ***hot zhèng***: Fever; heat (hot); diaphoresis; flushed face; burning pain; deep-coloured urine; red eyes; thirst;desire for drinking; constipation; red tongue; dry tongue; thin fur (thin moss); yellow fur (yellowmoss); *rapid pulse*.

Farther more, Zhèng is not a name for the disease. It is rather used for disease classification and then for recommendation of therapy. Some disease may be characterised by different zhèngs in different patients and some certain zhèng may be present in different diseases [17]. However, according to TCM, diseases might be arbitrarily classified as yīn or yáng diseases. Also, we can make complementary analogous classification on diseases with sympathetic or parasympathetic type of ANS predomination. In both classifications there are exceptions. It happens that those are people with atypical ANS regulation. Therefore, with ANS predomination patterns we can introduce hypothetic concept of neurocardiac zhèng analogous with zhèng in TCM therapy.

## 3 Establishing neurocardiac anamnesis

Even if neurocardiac anamnesis would already been invented, its application in clinical practice seems hard to fulfill. Just like in TCM, much time of training for learning anamnesis procedure would be needed and afterwards it would consume time for making reports for anamnesis. As well known, time in cardiological cabinets is often a lacking resource. Without effective and simple way to perform neurocardiac anamnesis, it would be predisposed to stay a theoretical ideal. Thus, it is very suitable to employ computer technology for development of an expert system for neurocardiac anamnesis. Its designation would be mimicking expert knowledge of neurocardiologists. However, in any situation, role of neurocardiologist is not meant to be replaced with this computer technology. More precise, purpose of neurocardiac expert system would be supporting assistance to neurocardiologist in making clinical decisions. Despite of that, sometimes physicians may get impression that such technology reduces direct relationship with patients. But in contrary, one of main goals of neurocardiac expert system is to support personalized medical approach of neurocardiologist. It might be accomplished with development of neurocardiac anamnesis procedure analogous with TCM methods of it that are fully personally oriented. Before it, for better clearance in algorithm expert mimesis we need to get introduced with expert systems that have already been developed for neurocardiac analysis.

## 4 Expert systems for neurocardiology and Traditional Chinese medicine

The basic idea of expert system (ES) is to transfer expert knowledge of human to computer system. It is then manipulated by certain algorithms aided by artificial intelligence aiming to mimic process of making decision of human, an expert in some field [18]. Thus, ES in medical application should help physician to get diagnosis or prescribe therapy significantly more effective, precise and faster or to get useful information for concrete cases in own medical practice. In that way, ES is serving to physician in process of (fast) making medical decision that is based on starting symptomatic (for example cardiological problems, hypertension, pain in chest, arrhythmia etc) suggesting the most relevant questions related with type of a health problem. Then, from the answers which can be effectively inputted and evaluated, it gives the clues on diagnostic hypothesis. After that, for final diagnosis, from expert dataset ES suggests possible therapeutic solutions. To develop such system engineering strategy of defining ES structure and algorithm functions is needed.

In that purpose, some classifiers with use of neurocardiac parameters were designed. Here we are suggesting an overview of these machines:

*Lee HG et al*used LFnu, HFnu, LF/HF, SDRR, SDSD (linear parameters), SD2/SD1, SD1SD2, ApEn (nonlinear parameters (HRV complexity)) for classification of coronary artery disease. After

trial of several classification techniques they found that Support Vector Machine had the best accuracy of 90 % [19].

*Heitmann A et al* were using 17 HRV indices (TD: sdNN, rmssd, pNN50, pNNL10, renyi4; FD: LF/HF, HF/TP; DFA: α1; CE: $H_c^{3,3}$; PPA: SD1, SD/SD2; SD: SDShannon, Forbword, wpsum2; STSD: arpf, ppf, plpf) for classification of healthy participants from heart disease patients (Myocardial infarction (MI), Heart failure with peripheral arterial disease (PAD), Heart failure without PAD (HeF)). They made 4 tests in which was shown that there is great dependance of gender and age on classification results (20 % diference) [20].

*Acharya UR et al* performed classification of ischemic/dilated cardiomyopathy, complete heart block, sick sinus syndrome, atrial fibrilation (AF), ectopics and normal subjects by using ANN and fuzzu equivalence relation. They fed ANN with: average heart rate, Ener 1 [energy content in the band (33.3–100Hz)]/[energy content in the band (0–33Hz)], Ener 2 [energy content in the band (66.7–100Hz]/[energy content in the band (0–66.7Hz)], correlation dimension factor (HRx-axis(k) vs HRy-axis(k+m)). They obtained mean accuracy (for diseases and normal) of 86 % [21].

*Noh K et al* conducted an experiment for the associative classifier (with multiple rules and pruning and biased confidence) to classify coronary artery disease from normal coronary arteries in total of 670 participants. For inputs they used: TP, VLF, LF, HF, LFnu, HFnu, LF/HF, SDNN [22].

*Pecchia L et al* designed and realized algorithm for recognising heart failure (HF) based on classification and regression tree (CART) method. For detection of HF they extracted more excerpts of 5 minute HRV. Each excerpt was classified as normal or abnormal basing on HRV features: SDNN, LF/HF, RMSSD. The subjects were considered as suffering from HF if more than 30 % of the excerpts were classified as abnormal. And they developed and trained several classification trees using LF/HF, TP and RMSSD to get diference betveen mild from severe HF. The patients were considered as suffering from severe HF if 40% of the excerpts were classified as severe. The system developed achieved accuracy and a precision respectively of 96.39% and 100.00% in detecting HF and of 79.31% and 82.35% in distinguish severe versus mild HF [23].

*Bilgin et al* presented 32 new sub-bands of LF and HF that can be used for classification and evaluation of some diseases. They verified their findings with successful classification of ventricular tachyarrhythmia dataset by means of multilayer perception neural networks [24].

*Hosseini GH et al* made artificial neural network (ANN) classifiers for distiguising 6 diseases (premature ventricular contraction, paced beats, right bundle branch block, atria premature beat, fusion of paced and normal beats). They used 12 feature parameters of ECG for inputs in ANN: 12 ECG features: ST-segment area (STA), R-S interval (RSI), ST-slope (STS), R-T interval (RTI), QRS area (QRSA), Q-T interval (QTI), R-wave amplitude (RWA), heart beat rate (HBR), QRS energy (QRSE), mean of the power spectral density (MPSD), auto-correlation coefficient (ACC), and signal histogram (SH) and 13 compressed ECG sample parameters (52-sample interval centered at the QRS complex compressed with a compression ratio of 4). It had average classification accurasy of 93 % for all desaases [25].

*Chazal P et al* created algorithm of ANN automatic classification of normal beats, ventricular ectopic beat (VEB), supraventricular ectopic beat, fusion of a normal and a VEB, or unknown beat tipe. The best results of 79 % accuracy showed classifier with next inputs: pre-RR interval, post-RR interval, average RR-interval, local avg. RR-interval; QRS duration, T-wave duration, P-wave presence or absence, amplitude values of samples of ECG signal (for QRS segment – 10 samples, QRS-T wave segment – 9 samples) [26]. Two years latter they combined this type of classifier with certain local classifier (it involves adaptation stage in which previous classiffication of beats is validated and corrected if wrong output is determined, and then these corrected results are used for testing). This classifier reached high accuracy of 95,7 % [27]. *Gonin JM et al* found correlation between corrected Q-T interval (Q-Tc) prolongation and presence and severity of cardiac autonomic neuropathy (CAN) in diabetic patients: 92 % (23 of 25) patients with a Q-Tc>433 ms had evidence of CAN [28].

In one previous research we have used artificial neural networks (ANN) and heart rate variability signals for classification of autonomic predomination patterns [29]. It is just a part of an expert system that we aim to develop. With that part of ES algorithm, physician can automatically from ECG signal get results about type of ANS predomination in each patient and evaluate weather it is relevant for health issues and therapy that patient has to receive. A part concerning anamnesis is missing. Thus,

knowledge acquisition is needed to gain most significant attributes related with neurocardiological conditions. After that these attributes have to be scored. As such they can be inputs for ANN classifier. Just like TCM, neurocardiology represents wide area with great amount of expert knowledge and information. Therefore, if someone wants to practice TCM he/she needs many years of learning old Chinese theoretical concepts and practical procedures. In other words, whole life dedication in TCM is preferred. Rare physicians of biomedicine or neurocardiology can afford this. Something that can bypass this problem are expert systems. Many of expert systems for TCM have already been invented and they are in usage by western physicians. Because of great research potential and possibility of various medical application, expert system development for TCM became a huge world wide trend. Thus, alternative solution for neurocardiology is special systematization of its knowledge in agreement with TCM and making it available by means of information technologies.

## 5 Neurocardiac algorithms

Considering diversity of health issues and unique responses of every organism and personality on health conditions and medication, software should be oriented on personal healthcare approach. Technically, it means that it has to consist electronic questionnaire about patient health circumstances. In other words, it should help physician to get patient anamnesis. Beside general health information, electronic questionnaire needs to incorporate data about cardiological health issues, basic psycho-emotive state, habits like smoking, drinking, physical activities, taking medication and all factors that might affect autonomic nervous system (ANS) and cardiovascular system. In the same line, reasoning is leading to suggestion that it should have a certain subunit for evaluation of weather person is sympathetic, balanced or parasympathetic oriented from innate nature. So, there should be defined as much as possible precise markers and patterns of it in behavior and human character (hyperactive or phlegmatic manners). As mentioned, that can be achieved through TCM analogous observation of facial expressions, subjective experience, vocalization, temperamental reactivity, emotionality. Voice expressed during speech and conversation should be main indices for neurocardiac anamnesis. However, many expert systems were developed for TCM anamnesis with good ability of mimicking diagnostic methods of TCM, but not the one of auscultation of voice. It was noted that usually used parameters of voice like pitch frequency, power of the voice, speed of speech were useless for mimicking TCM auscultation of the voice. They were not applicable for characterization of qi in the way TCM physicians do [30]. Obviously, TCM physicians sense some hidden indices in voice, different than these objective that we mentioned. After all, we can assume that they actually detect emotion dependent patterns in voice. That is what should be in focus of our attention, because one meta analysis on 104 studies have proven that emotion-specific patterns of acoustic cues do exist. They were found in voice intensity, speech rate, spectral energy distribution, precision of articulation, duration and frequency of voice pauses etc [31]. By means of them basic emotions were successfully classified. In general, TCM practitioners trace, among other, these cues to construct picture about patient ‘s emotional behavior, since they are well aware of dependence between certain social positions of man, vocal expression of emotions, and organs that participate in generation of voice. That is how voice should be considered in wider context, rather then reduced and isolated to sound-mechanical features. Thus, we can conclude that specific acoustic features differentiated in respect to emotion reactivity reveal to TCM physicians physiological state of organism (vitality of qì). This ancient insight of TCM, western science only recently has discovered: “Vocal expression of emotions mainly reflects physiological responses associated with specific emotions that have a direct and differentiated impact on the voice organs” [30]. In other hand, modern research show that emotions are all the time affecting ANS and vice verse: generation and expression of emotions is mediated by ANS. Thus, as it turns out from these research studies, emotions are among main factors that organize and coordinate activity within the ANS (e.g., cardiac, vascular and electrodermal activities, vascular responses, facial expressions, subjective experience). Also, it proves that emotions activate different patterns of ANS responses [32]. Afterwards, these insights points that characterization of emotion specific autonomic patterns by neurocardiac anamnesis is possible and that neurocardiologists perform it from daily experience, but without systematization and establishing it as general method

like TCM practice has achieved it. ANS expertise through neurocardiac anamnesis should be used in combination with ANS analysis by means of ECG instrumentation and software. This may be important for distinguishing disturbed ANS from natural predomination and also for adjustment of therapy and recommendations for synchronization with native life rhythms (it could be also added as an option in software recommendation algorithm). Collected information should be than evaluated with prediction algorithm to give eventual predisposition for pathological development. These predisposition data are suitable for combination with clinical information in order to give notion of current health state and factors of risk for disease development and undesired events like stroke, heart failure, sudden death etc. Also, it might give evaluation of how much important factor is state of ANS in noncardiological diseases. It is necessary that software is user friendly and intuitive. For that purpose, there should be done certain observation of few experienced cardiologists during patient anamnesis. Thus, in that manner designed software could mimic physicians experience and methodology. It is possible to realise it by using new "deep learning algorithm". After that comes the challenge how this information technology can improve cardiologic examination. Briefly, this software should enable advanced cardiac ANS expertise that is easy to use in any clinical environment. All the mentioned information could be formed, stored and transmitted wireless as a part of electronic cardiac health records. That is since long time ago a world wide trend in healthcare systems. From our research we derived two parallel algorithms for neurocardiac analysis that are congruent with TCM expert systems. They are conceptual frameworks for development of machines with ANN based classifications. In processing we are presenting resume of them.

**Algorithm I**

1. Neurocardiac electronic health record (Initiatory inputs):
- basic information, family and personal disease history;
- neurocardiac anamnesis (marking and scoring symptom/s, energetic types signified from will, mood, gesticulation; e. g. hyperactive versus phlegmatic behavioral manners);
2. Import of ECG data from ECG recorder
3. Processing of ECG data

Artifacts removal:
- automatic cleaning (filtering) and/or
- visual representation of signals

Erratic rhythm removal (for autonomic predominance classification)

Extraction of time, frequent, nonlinear ECG features (Fourier transformation or Wavelet transformation)

4. Determination of health status

increased/decreased HRV, loss of HRV complexity (SDNN or α1 and α2) → health/disease

5. General neurocardiac zhèng: Multivariable scoring I -

determination of disease class (cardiovascular, pulmonary, oncology, other, etc):

Time domain parameters:

SDNN, rmssd, pNN50, pNNL10;

PR duration, QRS duration, QT duration, QTc duration, T-wave duration

Frequency domain parameters:

LF, HF, VLF, LF/HF, TP, LFnu, HFnu, LFnu/HFnu;

6. Specialized neurocardiac zheng: multivariable scoring II - determination of disease with minimal combination of parameters that gives highest prognostic accuracy.

Nonlinear parameters:

power-law slope (β), short-term scaling exponent (α1), intermediate scaling exponent (α2); HRT: turbulence onset (TO), turbulence slope (TS); CE: $H_c^{3,3}$; PPA: SD1, SD/SD2; SD: SDShannon, Forbword, wpsum2; STSD: arpf, ppf, plpf)

7. Risk stratification for myocardial infarction and sudden cardiac death

**Algorithm II**

1. Determination of type of ANS regulatory domination (using LFnu):
- sympathetic predominance,
- parasympathetic predominance.

2. Determination of autonomic patterns:
    - Level of autonomic predominance or/and ANS damage:

- 2, 4, 8, 16 and 3, 9 groups of ANS predominance (using LFnu)

    - Autonomic disturbance (related to disease):

- combination of LFnu and TP: 4, 16 groups,
- combination of other parameters: LFnu, TP, BRS, QRS, HR…: 4, 16, 32 groups.

3. Cardiovascular risk:
    - Summation of factors for cardiovascular risk: obesity, smoking, hypertension, lack of physical activities, pollution,
    - Evaluation of autonomic patterns for cardiac death (based on statistical significance and dependence of parameter combinations and ranges with mortality/survival).

4. Evaluation and recommendation of therapy:
    - *if/then* algorithmic rule

*if* part:
- previously determinate diagnosis,
- evaluated dependence of acupuncture/drug effect from autonomic patterns;

*then* part:
- recommendation of exact acupuncture nomenclature, type/drug that has the best effect for each patient.

    - Inference engine:

- user interface (intuitive and fast representation of results and decision recommendations),
- learning machine (mimetic of neurocardiologist expertise),
- expert database (database of all TCM methods/herbal remedies, classical drugs for each disease, indications, contraindications, dosages).

## 5 Conclusion

Analogies suggested in previous sections are signs that TCM and Neurocardiology have similar systematic approaches. It can further be confirmed by visual presentation and analysis of neurocardiac signals that was showed in our presentation for conference Speech and Language 2017. But, these are not just conceptual coincidences. It might have clinical and scientific significance in the sense of practical integrative approach of Neurocardiology and TCM. After recognizing mentioned analogies, more attention should be paid on anamnesis, especially to closely relate it with clinical results from ECG and HRV reports. Insights that physicians usually perceive as result of their intuition, practical experience and expertise, could be stored in electronic records and be easily available for any visit of patient for examination. That might probably enable possibility that physician, instead of several changes of therapy, give one precise drug and advice to patient to get more rest, recreation, deep breathing, herbal remedies in order to turn back to his/her natural autonomic patterns.

In all mentioned, language of understanding between Neurocardiology and TCM, neurocardiologists and TCM experts, in general physicians and patients is fundamental issue to work on. For each side that takes part in communication mutual reasoning should be established, at least good and adequate translation, adoption and scientific etymology of terminology. Thus, help of language sciences is desirable here and as it seems might give fruitful contribution to affirmation of holistic approach in healthcare.

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## Neurokardiološka anamneza: razvoj na osnovu komplementarnosti sa diferencijacijom sindroma u Tradicionalnoj kineskoj medicini

Dugogodišnjim pregledanjem pacijenata pomoću EKG monitoring uređaja pojedini kardiolozi su u prilici da steknu kliničko iskustvo kojim povremeno mogu da procene tip autonomnog nervnog sistema (ANS) kod pacijenata, ne samo kroz pregled parametara EKG-a, već i pre toga: tokom uvodnog razgovora sa pacijentima, iz njihovih simptoma, volje, raspoloženja, glasovnih gestikulacija. Približno, svi oni se mogu diferencirati u dva tipa: hiperaktivne i flegmatične. Ovi energetski tipovi se često poklapaju sa simpatičkom i parasimpatičkom ANS predominacijom, sledstveno. To je veoma slično dijagnostičkim metodama posmatranja 望诊 (wàngzhěn) i osluškivanja 闻诊 (wénzhěn) u Tradicionalnoj kineskoj medicini (TKM). Iz specifičnih obrazaca u govoru, jeziku, mimike lica, očiju, gestikulacije i istorije pacijenta, TKM lekari sačinjavaju tzv. sindrom 证 (zhèng), uopšteni klinički rezultat zdravstvenog stanja; ukratko, u pitanju je karakterizacija stanja 气 (qì) kod pacijenta. Veoma sofisticiran i kompleksan zhèng je osnova za uspešnu primenu terapije. Nakon iznalaženja komplementarnih analogija eksesa/deficita jina i janga sa sANS i pANS predominacijom/disfunkcijom i izvlačenja glavnih principa TKM dijagnostičkih procedura, možemo ih iskoristiti za razvoj algoritma neurokardiološke anamneze u formi prostog ekspertskog sistema. Njegova svrha može da bude softverska podrška kardiolozima u cilju dobijanja preglednog zdravstvenog izveštaja pacijenta korisnog u daljoj ANS analizi i preporuci terapije. Drugim rečima, vršio bi oponašanje ekspertskog znanja iskusnog kardiologa. To može biti osnova u Neurokardiologiji za napredniji i plodotvorniji personalizovani medicinski pristup, koji se s druge strane primenjuje već vekovima u TKM.

# Towards a homeopathic remedy by exploring the matrix of human being existance

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**Abstract.** “Respect your body, it is your representative in this universe. Its magnificence is no accident. It is the framework through which your actions must come; through which spirit and spirit commune with each other in spirit. The body and the spirit are two aspects of your reality. When one of them is ignored, chaos ensues…” – ancient Sumerian text: “Sacred covenant writings”.

If we start from the claim that each being is one whole, created with the harmony of electromagnetic field vibrations of certain substances, on right resonant frequency, which in turn is in constant interaction with the universe, then each disorder is to be seen as a temporary readjustment of the dynamus in the constant interaction, which is the impetus for progress in every sense. If we add to this the understanding that each creation in the universe is in absolute harmony with the whole, then it is only when we have the entire map in view that each detail can be understood.

Homeopathy offers precisely that system of looking at the fractal geometry in the human organism. Having researched and established principles and laws governing the self-preservation of the whole, this method can be applied when determining the treatment.

The symptoms of a disorder are viewed by homeopathy as a part which contains the information of the whole of the organism. A dysfunction of any cortical zone and the effect of this dysfunction in the behaviour of the person must contain the information for the entire existence of this human being, from conception onwards. Further understanding of this whole in interaction with the universe or the surroundings, must lead us back to the information of the part. From this point of view, when we observe a human being with their complex levels of consciousness, voice and speech are seen as a part that contains the information of the whole of their individual harmony.

*Key word*: homeopathy, fractal geometry, speech, vibration, frequency, resonance

## 1 Introduction

The starting point of holistic medicine is the understanding that the human organism is not an isolated, self-sufficient entity. Furthermore, there is the understanding that the laws governing the entire physical universe are not separate from those governing the functions of a living organism. This naturally lends itself to exploring the framework within which a human being is situated and the effects that this framework has on it, as well as its manifestations.

Up to the now, science has explored, on many different levels, this interaction between a living organism and its surroundings and it has concluded that the human organism is designed to function in harmony and be compatible with the surroundings. The perfect design of the dynamic plan, manifested in the continuous exchange of stimulus and response, brings forth the realization that each organism has an “inner intelligence” of sorts, which perpetuates homeostasis. Therefore, if the inner intelligence of an organism is weakened, the response to the environment weakens as well, and leads to a disorder. The question that this poses is: what is it that makes certain organisms more vulnerable or more resistant to outside influences? The answer lies in understanding the defence mechanism that always engages with the stimuli from outward or inward sources. This mechanism is responsible for maintaining a balance between the processes that strive to undermine the order and those that strive to maintain the order in an organism. The key point, the foundation of the entire system of homeopathic treatment, is the understanding of this defence mechanism. Any considerable weakening of the function of the defence mechanism leads to an imbalance and to symptoms we mistakenly see as disease. These are, in fact, the result of the defence mechanism fighting against the harmful stimuli. In fact, all symptoms are an expression of an imbalance, which has to be understood in connection to the entire organism that contains a certain dynamic on a physical, emotional and mental level. These

levels have their own hierarchy. The highest and most significant level at which a human being functions is the mental and spiritual level and they represent the true essence of a person.

The founder of homeopathy, DR Samuel Hehnemann (1755-1843), defined the level that is the intersection of all three planes (physical, mental and emotional) and named it Vital Force or Dynamic Field. In his monumental work, "Organon of the Art of Healing ", in aphorism 11, he wrote: "The vital force is primarily deranged by the dynamic influence upon it of a morbific agent inimical to life;"

Therefore, it is on the dynamic plane that disease originates and it is the source of the defence mechanism. It permeates all levels of an organism just as electro-magnetic field permeates matter and it is the source of all actions of the body in health and in disease. Each time the organism receives a stimulus through one or all three of the receptive levels, the primary effect is on the electro-magnetic field of a person (called vital force in homeopathy) and then the influence is distributed to all three levels according to the intensity of the stimulus and the degree of resilience of the organism.

Homeopathy establishes a direct connection with the resulting frequency of an organism through therapeutic agents or homeopathic remedies. This leads to a considerable strengthening of the defence mechanism on the dynamic plane. The law of similarities pairs the symptoms manifested on the dynamic plane in the patient with analogous symptoms of the therapeutic substance manifested in a healthy individual in order to establish resonance between the patient and the remedy.

## 2 The Human Being as Hologram

Considering that a human being is one whole, integrated at all levels, we can define it as a holographic system. At this level, we can decipher the matrix of its existence, i.e. the matrix by which the entire system and life of the human being functions. Today, physicists conclude that the universe is a hologram, therefore that each human being is a part of the holographic whole. Each part of the human body and psyche can be interpreted as perfect fractal geometry. Karl Pribram (1919-2015) said: "If each part of our body truly reflects the whole, there must be various mechanisms that control the events. At this stage, nothing is fixed."

Physicist, David Bohm, in his theory of undivided wholeness, claims that that "it is meaningless to view the universe as composed of 'parts', as it is to view the different geysers in a fountain as separate from the water out of which they flow."

It is on these principles of wholeness that homeopathy and all other holistic forms of medicine are founded. Healing consists of the process of discovering the totality (matrix) according to which human life unfolds and then searching for the energy information that will resonate with the matrix and thus urge the Vital force to increase the self-healing processes.

## 3 Homeopathic Remedies as Activators of the Human Being Hologram

Homeopathic remedies are explained by the discovery of quantum physics: if matter is broken into ever-smaller parts, in the end it is arrived at a point at which these parts (protons, electrons and other quantum particles) no longer poses the properties of the object they belong to and at the same time gain a very powerful energy. This energy can only be managed by setting it to the same frequency of vibration which leads to resonant frequency in relation to the given energy field. This constitutes the principal tenet of homeopathy: The resonance principle or Similia Similibus Curentur.

## 4 Application of Homeopathy in Communication Disorders (Matridonal Remedies)

Along with other types of disorder, homeopathy can treat neurological disorders and thus all types of communication disorders. Practice has shown that good results can be achieved when treating with what is known as Matridonal remedies. These remedies are prepared from healthy tissue such as: Vernix caseosa, Amniotic fluid, Placenta, Umbilical cord. These remedies can be prescribed for cases of developmental disorders resulting from complications at birth. The information for determining homeopathic remedies is received from all levels of existence of a child or an adult. The act of birth carries a range of information on the energetic template (matrix) according to which a human being lives. This manifestation of energy cannot be similar to any other and it is highly exact, much like a fingerprint.

The way we come to this world is the way we live out the rest of our lives. Sometimes this birth can leave consequences such as neurological disorders and various stages of developmental dysphasia. Thus far, it has been shown that all patients prescribed matridonal remedies have something in common. The thing in common is isolation and an absence of communication with the outside world. This matrix can be manifested as complete or partial absence of speech. Furthermore, there may be various motor dysfunctions as well as convulsion attacks. In order to determine the right homeopathic remedy for these cases, it is important to know all the details of the pregnancy and labour. As an example, let us consider a 4 year old with impaired speech, total absence of communication and frequent chest infections with constant lung secretions.

The child was born with a caesarean section because the amniotic fluid was cloudy with possible indication of hypoxia and the child breathed-in the amniotic fluid - we can consider that the resonant frequency of the condition of this child is a homeopathic remedy created with amniotic fluid. According to Hering's laws of hierarchy of the direction of pathology from the most vital to less vital organs in the process of healing with homeopathic remedy, we can determine the direction of the healing. In the first three months from the moment the potency of Amniotic fluid is given, we will first have the coughing out of the secretion from the lungs, and then the establishing of normal respiratory function. After three months the motor functions start to optimize. In practice, we have witnessed signs of communication appear from the first day of treatment: eye contact, responding to one's name. After 6 months, words and simple sentences start appearing. After a year, speech and understanding start to develop.

With adults, we can notice this matrix in certain themes which were proved by these remedies. Persons in need of this remedy will often show great affinity towards water or floating and will tend to isolate themselves or will express having always felt as if in a bubble, outside from the rest of the world. They will have an exaggerated need for protection and will be highly sensitive to outside stimuli (sensitivity to noise, skin sensitivity…) Therefore all the properties of the amnion and its fluid will be manifested in the behaviour of the person whose resonant frequency is the energetic information of amniotic fluid.

Persons who are in need of the Umbilical cord remedy will have felt a tightening around their neck throughout their lives or a disorder in the functioning of the thyroid gland and frequent tonsillitis. They will have nightmares of being suffocated or having ropes tied around their neck. In addition, it has been noticed that these people like to tie scarves or shawls around their neck in any season. They will have sensations of being cut or paralyzed.

In homeopathic application, the indication for these remedies must be far more precise and described in detail.

## 5 Conclusion

In order to affect the dynamic plane, we have to find the substance that is sufficiently similar to the resulting frequency of the dynamic plane, in order to achieve resonance. By careful study of the symptoms in their totality (on all three levels: physical, mental and emotional level) and especially searching for the individual properties representing the matrix according to which the person is perceived and which is manifested in their behaviour, we arrive at a resonant frequency which can be

used in treatment. In cases described, these would be Amniotic fluid and Umbilical cord. Homeopathy has tens of thousands proven homeopathic remedies. Each can be determined in the same way, by finding a unique matrix according to which a human being lives. The matrix can first be perceived through the dreams and delusions of a patent. The way a person comes to decisions and handles life situations also stems from their matrix. It is important to notice that a homeopathic remedy is determined in exactly the same way with all cases. Moreover, each case of a speech disorder and communication in general can be treated with a completely different homeopathic remedy. Therefore, the symptom of a disorder in homeopathy is viewed as a part which contains the information of the whole of the organism. A dysfunction of any cortical zone and the manifestation of this dysfunction in the behaviour of the person has to contain the information of the totality of existence of this human being, from the moment of conception and even the time before that.

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## Istraživanjem matrice postojanja ljudskog bića do homeopatske remedije


„Poštuj svoje telo, koje je tvoj predstavnik u ovom univerzumu. Njegova veličanstvenost nije slučajna. Ono je okvir kroz koji tvoja dela moraju izaći; kroz koji duh i duh u duhu govore. Telo i duh su dve faze tvoje stvarnosti. Ko i jedno ignoriše, propada u neredu...“ – drevni sumerski tekst: „Sveti zavetni spis“.

Ukoliko pođemo od stanovišta da je svako biće jedna celina sazdana od sazvučja vibracija elektromagnetnih polja određenih supstanci, koja je u konstantnoj interakciji sa kosmosom, onda ćemo svaki poremećaj posmatrati kao trenutno ispoljavanje podešavanja dinamusa u toj konstantnoj interakciji, koja podstiče progres u svakom smislu. Ukoliko tome dodamo razumevanje da je svaka kreacija u kosmosu u apsolutnom sazvučju sa celinom, onda ćemo svaki detalj jedino razumeti kada imamo celovitu mapu u vidokrugu.

Homeopatija upravo nudi sistem sagledavanja fraktalne geometrije u ljudskom organizmu. Istraživši i utvrdivši principe i zakone koji vladaju u samoodržanju celine, može da primeni isti način u određivanju terapije.

Simptom poremećaja homeopatija posmatra kao delić u kome se nalazi informacija o celini organizma. Disfunkcija bilo koje kortikalne zone i ispoljavanje te disfunkcije u ponašanju osobe, mora u sebi sadržati informacije o celini postojanja tog ljudskog bića, od samog njegovog začeća pa i ranije. Dalje razumevanje te celine u interakciji sa kosmosom ili okolinom, mora nas ponovo dovesti do informacija o deliću. Sa tog stanovišta, kada posmatramo ljudsko biće sa njegovim kompleksnim nivoima sveti, glas i govor možemo razumeti kao delić koji u sebi sadrži informacju celine njegovog individualnog sazvučja.



*Ključne Reči*: homeopatija, fraktalna geometrija, sazvučje, govor

# Prenatal roots of communication - a few cases of evidence

J. Jovanović, O. Vasić

**Abstract**. There is growing evidence that mothers and babies have the arrangements and numerous ways of communication as long as the baby is in the womb. The sound of mother's voice while: talking, singing , reciting , the music she loves and listens to during pregnancy are after birth recognizable and pleasant for the baby. It's not uncommon that mom and baby either "wait" or “hurry up” for some person close to mother coming to be present at birth, even when the intended term is completely different. Not to mention baby’s strong movements when mom is upset and the way mum touches the stomach to calm her baby. Here we will outline the case in which the baby clearly speaks to the mother conveying an important information during sleep in a dream. And an amazing case with the fractal drawing the mother made three weeks before delivery on which the baby passed the message of the present and future events with obvious roles of both participants in actions.

## Introduction

In contemporary science, we learn daily about the functioning of the body and the psyche. The new light bears the fact of the dual nature of everything material, which is at the same time wave and energy. In particular, evidence of Cells of the organism includes both biological and quasi-psychic information Pribram (1), Gurvich (2), Brechman (3).

The idea that brain is not producer of thoughts, but only acceptor is supported by numerous scientists Penfield (4) Grof (5) Bechtereva (6).

Prof Brecman (7) expires the complexity in unconscious of man. “Content of memory of both genes and cells in whole, and biofield as wave component of them includes unconscious of man, and seems to be related to such manifestations of unconscious as an intuition and without eyes vision” as Medvedev (8) sad. Also he points out that :” The person’s unconscious includes information obtained: a) From parents by their germ cells; b) During own prenatal and perinatal development; we can suppose that the images, pictures, ideas from the unconscious pregnant mother may periodically emerge from her memory - in reality or in a dream - and provided in the memory of the unborn child, which later reflected in his thinking and behavior. c) At any stage of life after birth.”

And in Prenatal psychology – the new aspect for understanding of receiving & perceiving of information. As Colter writes: ―…here, in the womb bathed in the fluid distillate of parental anxieties, hopes, ambivalence and fears - the basic shape of the personality is laid down. …Our developing mind absorbs unconsciously without question everything that comes to it. (7).

Dr. Olga Vasic and I observe and monitor the consequences of trauma in babies, children, mothers, families. Each of us from her own point of view. Olga as a physiatrist, and me as a pediatrician, both doctors of holistic medicine. The more obvious success in our treatment depends largely on how much attention we dedicate to the psychic plan of each patient, his family and collective unconscious combined with classical treatments. Here we present two picturesque cases.

CASE I Dream - "Mom, my name is Vukasin, and from now on everything will be fine"

Parents brought their second baby child, a newborn one month old. Their first son, Igor, was born 2 years before from a difficult labor, and then he had our own new "Baby Dance" method originated from previous treatments (9, 10) because he had birth injuries. Now he is doing great, but his parents have understood how much the pregnancy is important for the development of the baby and everything that mother goes through since that time. With the second child pregnancy was extremely stressful for the mother and the whole family.

The neighbors sued them with the construction commission and they were constantly threatened with the demolition of their home. Revenues were irregular, the father was out of work. However, mother was in a strange way protected during pregnancy. Now she just begun to have the need to throw out all the pain, sorrow, tension she had been experiencing for months. It is common for us to perform "Baby Dance" rhythmic movements and, while estimating cognitive functions, to monitor baby's reaction to everything that is happening around baby, in the field.

It was unusual that while Mom was talking about all the troubles very lively, crying, the baby was not at all interested in the emotions and stress that was coming out. Somehow the baby did not want to participate. He looked at the other side. I asked mom to close her eyes and count slowly, as we did at Pre birth Hypnosis Workshop by John RG and Troya GN Turner on PTPPA Congress in Belgrade in 2015.(11,12) Mom was sure that number 7 was significant. To my question whether anything significant happened in the 7th month of pregnancy, she did not have an idea. But it was obvious that the baby was suddenly alive, and he began to participate in everything. I noticed that all the suffering did not even touch baby , and my impression was that baby decided to take an active role in one moment, to stop the period of difficulties in life of those wonderful people chosen to be his parents .I explained that , and then mom remembered and told me her dream in which baby actually presented himself. **In a dream, there was a kind of a fair, and their family was sitting in the meadow, four of them, two years later ... Igor, the older son had been already four years old, and the younger completely opposite-black-haired boy was 2 years old. And people were approaching and being amazed with the beauty of the boys. They asked mother about their names. She said Igor first, and was astonished that she did not know the name of her younger son, so different from Igor. And he was already two years old. She felt shame and weakness. Then she heard the voice: "Mom, I'm Vukasin. Do not worry, everything will be fine from now on. "**

She said that she got up and told her husband that she was sure she would give a birth to a dark-haired boy and that he asked her to be called Vukasin. They agreed on the name. And everything really changed. The neighbor gave up the lawsuit and construction inspectors were no longer subjected to or threatened with demolition and eviction, the father received a safe and well paid job. Although doctors claimed that pregnancy was at risk because the baby had pelvic presentation, mom decided to get delivery at home with midwife.

I asked again when she dreamed a dream, and then father reminded her of the previous good events. It was unusual that they decided to call midwife and arrange a delivery in the apartment just in the 7th month, that dad got his employment, and how they patiently waited for baby to turn himself instead of being scared. And we realize that dream happened just in the 7th month.

Finally, we finished the "Baby dance" treatment with younger dark-haired baby Vukasin in a very active action, aware that he was finally completely with us. And that he has taught us that we should release all the bad events from the past and that this is necessary for his mother, family and general welfare.

The Fractal Drawing method

Fractal is a pseudo-energy drawing that is created by pulling an unbroken line within 60 seconds on A4-shaped paper using black pen. Beyond that, the fields that occur in the cross-sections of this line are painted, but the colors are also chosen the same way , with eyes closed . By turning off the senses of the sight, through which the information about the outside world is usually taken up more than 85 percent, in fact, we allow the internal creative principle to realize its power. At the same time, the exclusion of consciousness during the drawing has no control, so our own will and our soul will express the most authentic possible. In this way, we create a kind of abstract self-portrait of the inner world of personality. They have their frequency and vibration complete and correction of this state through the resonant action of the inner and outer fields. Fragmental drawing as a therapeutic method diagnosis and managing human health is established by Tanzillia Z. Polujahtova, clinical psychologist and psychotherapist (13).

CASE II The fractal drawing message

While I was holding a fractal drawing workshop in the group, there was a pregnant woman in 9th month of pregnancy. Her fractal drawing was unusual because at first glance, one isolated part was discovered, which we immediately concluded that it was a fractal drawing of the baby. The baby was even connected with an umbilical cord that was set to the future. Namely, there is a key which was established by the Psychologist T.Polujahtova according to which the fractal drawing is interpreted. At this moment, it was interesting for us to come out of the unconscious part of the mother and an abstract fractal drawing of a baby that was not born yet.

That is a confirmation that the consciousness of moms and babies can form a fractal drawing that represents the materialization of that awareness. What is invisible thus becomes visible. But that

invisible in still unborn becomes visible is a stunning fact! Or maybe it is not, if we know that .... everything exists in the field before it is realized in reality. It existed in the field even before the spermatozoid and the egg cells decided to meet at a quantum level in fractal form, in fractions of fractured /fractal/ reality that are similar to themselves.

## Conclusion

Dream comes from the subconscious and informs mother that everything changes for the good. Mother believes and the dream is realized.

And it is obvious and visible on the fractal drawing in case 2. Mama is radiating light, but also the baby through the fractal exhibits its light nature. The colors are light, vibration, frequency…

Do we realize how powerful the bond of mom and baby due to connection of love, faith and hope?

Because every energy information spreads non-localy, and the strongest positive emotions of the mother and the baby are attractors to the good (14, 15, 16, 17).

If each body has a wavy light emitting light- Mama is radiating light, but also the baby through the fractal exhibits its light nature. The colors are light, vibration, frequency…

And everything is understandable from the point of view of numerous scientific papers (18, 19, 20, 21).

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## Prenatalni koreni komunikacije, prikaz dva slučaja

Sve je više dokaza da mama i beba koju ona nosi u materici, imaju brojne načine dogovaranja i komunikacije. Mamin pokret, glas dok: priča, peva, recituje, muzika koju voli da sluša u trudnoći su sasvim prepoznatljive i opuštajuće za bebu i po rođenju. Poznato je i da očekivani termin bebinog rođenja može biti značajno pomeren baš onako kako mama najavi, a očigledno povezan sa dolaskom osobe koja je mami bliska i potrebna na porođaju. Očigledni su i snažni pokreti i reakcije bebe kada se mama uznemiri, kao i način na koji mama spontano dodiruje trbuh da umiri bebu. Ovde je prikaz slučaja u kome se beba direktno obraća mami u snu rečima, prenosi važnu informaciju za budućnost i menja način i tok porođaja, a porodično okruženje dovodi u sklad dva meseca pre porođaja, najavom prestanka stresnih događaja u okruženju, kao i naše svedočenje da se sve rečeno u snu po rođenju i desilo. Drugi slučaj pretstavlja zapanjujući fraktalni crtež majke tri nedelje pred porođaj, na kome se jasno vide poruke bebe kako se fraktalno okreće u materici, da će se roditi prirodnim putem, biti dojena, mažena. Pravi vizuelni dokaz prenosa poruke i trenutnih i budućih događaja zajedničkog života mame i bebe.

# The significance of dramatization for the development of adequate communication of mother and child

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**Abstract**. The document presents an experiment on the application of dramatization on the level of overtaking the mother-child role, in group therapy with mothers, whose children have disorders and difficulties of verbal communication, behavior, learning and socialization. We called this kind of experiment "Me mother, Me my child". The basic principle is identification.
The dramatization meant working in pairs, having one mother in the role of her child and the other one in the role of its mother. Each mother had, besides the role of a mother, the role of a child that requires communication with the mother and the third role as a child who denies communication with mother. The mothers were changing roles so that each mother, during the therapy sessions acted in all three scenarios. The mothers were previously instructed and were supposed to comply with it during the realization of the roles. The duration of the role was timed to 5 minutes. Through observation and analysis of the behavior of the mothers during re-enactments of different roles were determined:
1. Mothers in the role of the mother acquire very quickly and precisely the insight into their own behavioral patterns, both adequate and inadequate.
2. Mother in the role of her child gets a clear insight into the emotional reactions and the state of her child which quickly brings her into the state of empathy towards her child.
3. Mother acquires clearer insight into her own behavioral patterns that bring her child into different emotional reactions and states.
The use of dramatization, through playing different roles is an extremely efficient and fast therapy model for establishing adequate relations and communication mother to child. At the same time the mothers start to correct their behavior which brings to permanent improvement of communication with her own child, which also results in more adequate behavior of the child and successful results on the level of verbal communication and socialization.

## 1. The Advantages of Applying Dramatization

The basic and indispensable contribution of dramatization - the role play, is that the subject can change the role, identify with authentic feelings and states and follow changes that she cannot otherwise experience other than "entering the role", in this case, the "child" and / or the role of "mother".

"Masks" change very quickly and on the spot get an insight into their own behavior and survival of a particular situation.

The mother quickly returns to her actual role. This form of therapy allows spontaneity, imagination and a mixture of possible and impossible events, in particular the repetition of roles and the re-sharing of roles. This facilitates the identification of life problems, challenges, internal and external conflicts, and the ability to develop strategies for future adequate conflict resolution.

## 2. Aim

The aim of the experiment was to determine the efficiency of applying the dramatization playing different roles in group therapy sessions with mothers of children that have disorders in verbal communication, behavior, learning and socialization for the purpose of mother's self-development and improvement with intention to become an adequate support for her child. The aim is to return the faith in the ones' proper natural abilities, creativity, intelligence and intuition. To regain the faith to the mother herself as a human being that is able to enable her children for independent living.

## 3. Methodology

In order to support parents to be adequate support for the proper and successful development of their children, in IEPSP, group therapy for mothers are carried out regularly, and if necessary, the individual work with a psychotherapist and a social therapist. Therapeutic groups consist of 8-10 mothers.

After the division into couples, the roles are assigned: "mother", "child seeking contact" and "child who rejects contact". In our groups, the mother start the role spontaneously. They are instructed to follow each one's own (physical) experience, reactions, and feelings regardless of the role (mother or child), i.e. to exercise verbal and non-verbal behavior freely during dramatization. The duration of one of the roles is about 5min. Upon completion, each mother should comment on her own experience to the group and to answer the question "What did she personally get from this experiment?"

Therapists follow the verbal content in the communication "mother - child", emotional speech expression, body language (facial expression, mimics, gestures, movements, etc.). The aim of our group therapy was not to direct the behavior of the mother, but to gain a more complete insight into her own behavior and experienced emotions in all of the realized roles. This is why the aim of the therapy is directed towards the best understanding of the interrelationship and the interdependence of the mother-child relationship.

## 4. Results and Discussion

Observations and analysis of the behavior of mothers during group therapy "Me mother, Me my child“ noticed the following reactions and behavior:

1. Mothers, whose children did not develop speech and during the therapy themselves did not use speech, but non-verbal forms of communication. After the completed session, they themselves confirmed that their behavior as "child" was completely identical with the behavior of their own child, i.e. that they felt it very strongly.
2. Mothers in the role of "mother” get very quickly and precisely insight into their own behavioral patterns, both adequate and inadequate
3. The mother as a child, gives a clear insight into the needs, emotional reactions and the state of her child, which quickly introduces the state of empathy towards her child and a better understanding of the causes of his general behavior. The question was made to all of the mothers - "How do you feel in your child's role?" They all responded: "... terribly, horribly, helpless, now I understand how he/she feels" and so on.
4. The mother gets a clearer insight into her own patterns of behavior that bring her child into different emotional reactions and states. For her, her insight into what she is, is of great importance and it becomes her own truth. By insight, she changes her behavior, and hence the behavior of the child.
5. The application of dramatization, through playing different roles extremely efficiently and quickly establishes an adequate relationship and communication on relation mother - child.
6. The moments of deepening the awareness, the emotional and cognitive understanding leading to insight and change, are almost always accompanied by a change in the color of the mother's voice, its refraction, and change in the rhythm of speech.
7. At the same time, the mothers themselves begin to correct their behavior, which leads to permanent improvement of communication with their own child, which simultaneously results in more adequate behavior of the child, more successful results at the level of verbal communication and socialization. She also has to realize her own liability in two-way-relationship between her and her child.

## 5. Conclusion

Therapeutic application of dramatization - role plays (identification) really quickly and efficiently leads to acquaintance of one's own personality, discovering new parts of one's own character, which can condition current resolving of anxiety, conflict, emotional stress and thus re-integrate the establishment of adequate communication and relations, in our case, the relationship between mother and child. Although it is a role-playing experience, it is quite real and with increased motivation, as shown by mothers in our group therapies, acquired adequate insights and established adequate responses and behaviors of the mother can become permanent. Repeating 1-3 thematic group therapy leads to permanent positive changes in the quality and results of the mother-child relationship. Such insights help the mother to become aware of the relationship between mother and child in a new and enlightening way.

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## Značaj dramatizacije u razvoju adekvatne komunikacije majke i deteta


U radu je prikazana primena dramatizacije na nivou preuzimanja uloge majka-dete, u grupnom terapijskom radu sa mamama, čija deca imaju poremećaje verbalne komunikacije, ponašanja, učenja i socijalizacije. Ovu vrstu eksperimenta smo nazvali “Ja majka, ja moje dete”. Osnovni princip ovog eksperimenta je identifikacija.

Dramatizacija je podrazumevala rad u parovima, tj. jedna majka je bila u ulozi svog deteta a druga je bila u ulozi “njegove” majke. Svaka majka je pored uloge majke imala drugu ulogu deteta, jednog koje traži komunikaciju sa majkom, i treću ulogu deteta koje odbija komunikaciju sa svojom majkom. Majke su menjale uloge, tako da je svaka majka u toku terapijskog rada dramatizovala tri uloge. Majke su predhodno dobile uputstva kojih su trebale da se pridržavaju tokom realizacije uloge. Trajanje jedne uloge je bilo ograničeno na 5 minuta.

Opservacijom i analizom ponašanja majki tokom različitih uloga, uočeno je da primenom dramatizacije:

*1.* Majka u ulozi "majke" veoma brzo i precizno dobija uvid u svoje sopstvene obrazce ponašanja i adekvatne i neadekvatne. *2.* Majka u ulozi deteta dobija jasan uvid u emocionalne reakcije i stanje svog deteta, što je brzo uvodi u stanje empatije prema svom detetu. *3.* Majka stiče jasniji uvid u sopstvene obrazce ponašanja koji njeno dete uvode u različite emocionalne reakcije i stanja.
Primena dramatizacije, kroz igranje različitih uloga je izuzetno efikasan i brz terapijski model u uspostavljanju adekvatnih odnosa i komunikacije majka-dete. Istovremeno majke same počinju da koriguju svoje ponašanje, što dovodi do trajnog poboljšanja komunikacije sa sopstvenim detetom i istovremeno rezultira adekvatnijim ponašanjem deteta, uspešnijim rezultatima na nivou razvoja verbalne komunikacije i socijalizacije

# The influence of ultrasound on the speech and language development

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**Abstract.** The use of ultrasound in medicine is widespread today, with particular importance to the field of obstetrics and gynecology. Prenatal ultrasound scanning is used worldwide for beneficial medical purposes. The most pregnant women have at least 2-3 ultrasound examines, and in developed countries much more. In many countries almost all pregnant women are examined at least once.
Ultrasound is generally regarded as a safe imaging modality. However, as with any diagnostic test, there may be some risk. Currently, obstetrics and gynecology resident knowledge of obstetric ultrasound safety is low. Since ultrasound is a form of energy, it has the potential to produce biological effects that can constitute a risk for a health. Thermal and nonthermal mechanisms have been proposed as potential harmful biological effects from ultrasound exposure.
Ultrasonography in pregnancy may have unwanted maternal or perinatal and postnatal consequences. The emitted ultrasound energy can lead to disorders of physical or neurological development, increasing risk of malignancy in childhood, insufficient intellectual development, psychological disorders or psychiatric illness. Ultrasound can cause unwanted effects on growth and overall development during early childhood including speech disorders, dyslexia, autism and other autism spectrum disorders, hearing and visual impairments, school performance, behavior, and other neurological, psychological or mental functions. The central nervous system in development is especially susceptible to thermal influences, even after organogenesis, and to the impact of mechanical and other non-thermal mechanisms of ultrasound.

## 1. Introduction

The use of ultrasound in medicine is widespread today, with particular importance to the field of obstetrics and gynecology. Diagnostic ultrasound has been used for more than 50 years in these fields. Diagnosis is performed by a series of examinations before pregnancy (e.g., monitoring of ovulation induction), during pregnancy (early stages of gestation, first trimester and beyond) and after completion of pregnancy (directly or later as control examinations).

Diagnostic ultrasound is used for various purposes during pregnancy such as monitoring of fetal growth, risk factors for pregnancy, detection of possible complications of pregnancy, or routinely for the early detection of any disorder in early and/or late pregnancy.

Prenatal ultrasound scanning is used worldwide for beneficial medical purposes. The most pregnant women have at least 2-3 ultrasound examines, and in developed countries much more. In many countries almost all pregnant women are examined at least once.

Although it is officially considered that diagnostic ultrasound has no harmful effects on the mother and fetus, it is increasingly suspected of such a claim. The reason is not only the continuous increase in the power of ultrasound devices from 94 to 720 mW/cm$^2$ [1], but the use of ultrasound in the first trimester of development of the fetus, but also the monitoring of ovulation.

Human fetal growth is very sensitive to external influences, especially in the first 10-12 weeks of pregnancy. In this period of pregnancy, inadequate ultrasonography may have unwanted maternal or perinatal consequences which can lead to numerous disorders of physical or neurological development. The result of this can be insufficient sensomotor and intellectual development, psychological disorders or psychiatric illness. Particular importance are motor-sensory disorders including speech development, dyslexia, and behaviorally defined conditions such as autism and other autism spectrum disorders [2].

## 2. The influence of ultrasound on the speech and language development

There are many prenatal, perinatal, and postnatal physical, chemical and biological risk factors for speech and language development. These factors are including many changeable and unchangeable factors. The growth and development of the fetus is influenced by a multitude of endogenous and exogenous factors including physical, chemical and biological stress. Fetus is highly susceptible to the influence of external factors such as mechanical radiation of ultrasound.

### Autism and other autism spectrum disorders

Risk factors for autism and other autism spectrum disorders are numerous and include genetic, epigenetic and environmental factors such as maternal and paternal age ≥35 years, gestational age ≥36 weeks, various diseases, intoxications, drug use, infections, exposure to ionizing and non-ionizing radiations [3].

Epigenetic factors are environmental factors which perform a stable change in normal expression of the gene by affect the quality and quantity of gene expression without changing the DNA sequence through epigenetic mechanisms, including DNA methylation, changes in histone proteins, and expression of noncoding RNAs [4]. This way, they can be transferred to the next cellular generation or even the next organism generation [4]. As a result, exposure to harmful environmental factors can change the expression of developmental key genes in critical periods of embryo formation and increases the risk of genomic imprinting diseases such as autism [4].

Autism and other autism spectrum disorders (ASD) are behaviorally defined conditions, characterized by impairments in communication and social skills accompanied by repetitive and stereotypic behaviors [2]. Autism and ASD include a group of early-onset, lifelong, heterogeneous neurodevelopmental syndromes that account for more than 1% of the population [5]. Autism is characterized by atypical cognitive profile [6] including extensive disabilities in social and behavioral communications, language impairment or inability to speak, and strong tendency toward stereotyped and repetitive patterns of behavior [4]. ASD is characterized by cognitive, behavioral, and social dysfunction [3], that is associated with persistent functional impairments in adaptive abilities across multiple domains, including socialization, communication, daily living skills and motor skills, that become increasingly pronounced with development and are present regardless of intelligence **quotient** (**IQ**) [7]. ASD include two categories of core symptoms: (1) impairment in social functioning/ communication (atypical social cognition, language function, flexibility and sensory abnormalities); and (2) narrow and restricted/ repetitive behaviors and interests [5, 6, 8]. The behaviours that are common to ASD have been linked to differences in thinking ability [9].

*The etiology of autism and ASD* is insufficiently known. Autism and ASD are multifactorial diseases caused by the influence of genetic and epigenetic factors in the stage of growth and development of the child in the prenatal, perinatal or postnatal period of life. Genetic factors are causes of autism in 35-40% of cases, and 60-65% environmental factors [3]. The cause of autism is a combination of genetic, developmental, and environmental factors that often appears during infancy, typically in the first three years of life [10] Webb et al. (2017) [11] consider heterogeneity in ASD symptoms can be the result of exposure to diagnostic ultrasound in early prenatal development of children with specific genetic vulnerabilities.

Autism is 4–5 times more common among boys than girls [4], and boys are 80% diagnosed with an ASD [12]. Almost all of the symptoms and signs of ASD remain during aging, which progresses faster [13].

*The pathogenesis of autism and ASD* is complex and insufficiently explored. Inadequate use of ultrasound can alter the molecular environment of the treated system in prenatal development, including primarily the nerve and immune system. In the central nervous system in development, ultrasound can cause various disorders of signaling pathways (Wnt/β-catenin and others), secretion of various signaling molecules [nitric oxide (NO), prostaglandin E2, interleukin-8 (IL-8), basic fibroblast growth factor (bFGF or FGF2), vascular endothelial growth factor (VEGF) and others], neurotransmitters and their receptors [e.g., gamma-aminobutyric acid (GABA), glutamate], as well as hormones and their receptors [e.g., estrogen [14], corticotropin-releasing hormone (CRH) and adrenal

corticosterone (ACS) [15] and cortisol]. In this way, ultrasound can influence alone or in collaboration with other factors, on the processes of corticogenesis, neuritogenesis, and synaptogenesis [14].

Prenatal exposure to ultrasound is an additional stressor to genetically susceptible individuals during their time window of vulnerability [16]. Prenatal stressor such as ultrasound activates the hypothalamic-pituitary-adrenal (HPA) axis to secrete stress hormones. CRH produced by the hypothalamus initiates the HPA axis, which regulates the body's stress response.

Placental CRH synthesis increases in response to maternal stress signals [17]. Human fetal exposure to stress results in high concentrations of placental CRH that is associated with behavioral consequences during infancy and into childhood [17].

Increased levels of stress hormones, especially CRH, ACS and cortisol, affect synaptic transmission in the brain, including amygdala and hippocampus, which are responsible for learning and memory. The result of high levels of CRH and ACS is loss of long-term potentiation and significant memory damage [15], which is morphologically manifesting in retraction of dendritic spines of excitatory synapses and consequently loss of synapses [18].

ACS prevents the activation of the spine-actin regulator RhoA that is required for spine growth and synapse potentiation, and stress levels of CRH promote spine loss via activation of calpain, an enzyme that degrades RhoA [15]. These two stress hormones rapidly exhaust active RhoA from dendritic spine synapses, promoting their reduction [15].

Prenatal stress activate the HPA axis which results abnormalities in postnatal nervous and immune functions, including susceptibility to infections and autism [18]. Ultrasound is one of the external stress factors that can disrupt neuronal migration from 6-12 weeks' gestation until 32 weeks' gestation [19]. Autism parallel increase in obstetric ultrasound use! [19].

In autism, abnormalities of nervous development and overall neuronal association occur during embryogenesis, and become apparent even after the first year of life [20]. Autism includes early brain overgrowth and dysfunction of neocortical tissue [20]. In most children with autism, ages 2 to 15, in post-mortem samples, focal disruptions of cortical laminar architecture were found in prefrontal, temporal, and occipital neocortical tissues [20]. These changes are indicators of a possible dysregulation of layers formation and layer-specific neuronal differentiation in prenatal stages of development [20].

The early brain overgrowth and dysfunction are most obvious in the prefrontal cortex, whose cause is the appearance of excess neurons, which can be associated with abnormal cell type and laminar development, showing a disorder in prenatal development [20].

The increasing in the number of cortical minicolumns in autism may be due to an increase in the number of germinal cells in the paraventricular area below the neocortex in development, which can lead to a certain neuronal connectivity phenotype, one that prefers short-range arcuate fibers over longer-range white matter tracts [14]. The increase in neural stem cells will consequently leads to an increase in the number and density of neocortical tissue. This means that the cortical tissue adheres to general radial configurations and generates more minicolumns if there are no significant aberrations in processes such as migration or differentiation [14]. In addition, by autism there are an increase in the number and density of neuronal cells in other regions of telencephalon except for neocortex, including hippocampus, amygdala, and other parts of the limbic system. Thus, the total number of minicolumns in the local tissue can influence on neuropil width, brainwide connectivity patterns, and local patterns of neuritogenesis, synaptogenesis, and plasticity [14].

Brain enlargement has been observed in children with ASD [21]. Autistic children's brain has larger lateral ventricles, morphological hippocampal abnormalities, and increased dopaminergic activity (which causes hypoxia) [4]. Three brain regions, including basal ganglia, hippocampus, and lateral ventricles, are highly vulnerable to hypoxia [4]. Brain volume overgrowth was linked to the emergence and severity of autistic social deficits [21].

Individuals with ASD have atypical brain anatomical connectivity, gray matter volume, and resting-state functional activity/connectivity [22]. Disturbances in brain inter-regional networks are a key determinants of functional, behavioral, and clinical outcomes of ASD [5] In relation to the functional roles of these areas, fronto-temporal anomalies or structural changes can be responsible for significant damage in social cognition and for atypical language in autism [5, 23].

In adult adolescents and young adults with ASD, more rapid-age-related cortical thinning was found in temporal and parietal regions [5]. In individuals aged 3-39 years [24] and 14-24 years [25] was demonstrated accelerated cortical thinning (in portions of temporal and parietal cortex) [25] in ASD in adolescence. Ultrasound exposure leads to increasing levels of CRH which cause to a significant decrease dendritic branching [17]. These changes are probably basis for reduced cortical thickness that could contribute to the behavioral consequences observed in children exposed to high levels of CRH in utero [17].

Decreased structural connectivity and resting-state brain activity in the right occipital cortex is associated with social communication deficits in boys with ASD and may impair the integration of verbal and non-verbal communication cues, thereby impacting their social development [22]. The functional and structural alternations in this region may impair the integration of visual information, resulting in atypical social communication in individuals with ASD [22].

The abnormal cortical development in ASD undergoes three distinct phases: accelerated expansion in early childhood, accelerated thinning in later childhood and adolescence, and decelerated thinning in early adulthood [24].

**Dyslexia**

Dyslexia is a neurodevelopmental disorder with a specific reading and spelling disability arising from *difficulties with decoding* [26], then recognition and language comprehension of word or graphic symbols [27]. **These difficulties typically result from a deficit in the phonological component of language [28],** phonological awareness, verbal memory and verbal processing speed [29]. Dyslexia is not associated with cognitive disabilities, intelligence, lack of education, socio-cultural environment, or evident neurological deficits [30].

There are three types of dyslexia with a prevalence of 5–10% in the general population [31]: (1) trauma (acquired) dyslexia; (2) primary (hereditary) dyslexia; and (3) secondary (developmental) dyslexia [27]. Developmental dyslexia is a genetic-based disorder which occurs during fetal development, that arising from wider cognitive deficits that mainly affect the acquisition and processing of reading [32]. Dyslexia may result from poor development or deficit in the phonological component of language [27].

Ultrasound is likely to cause developmental dyslexia with direct or indirect damage of cortical and subcortical areas of the left hemisphere where prevalently is localized a universal reading network, which consisting of the left superior temporal gyrus, the left inferior frontal gyrus, the left occipito-temporal region, and the midfusiform gyrus [30]. There are specific lack of activation of the left occipito-temporal cortex in dyslexia particularly for reading and reading-like behaviors and for visuo-phonological tasks [33]. Additional deficits of motor and attentional systems relevant for reading may be associated with altered functionality of dorsal left fronto-parietal cortex [33]. Major tracts involved in reading include: (1) the left arcuate/superior longitudinal fasciculus, which connects frontal and temporal language regions; (2) the inferior longitudinal fasciculus, which connects occipital and temporal lobes; and (3) the corona radiata, which connects cortex to subcortical structures [34].

It seems that there are in left-handed individuals a functional mismatch of the cerebral hemispheres that represents basis of language disorders of different type, including specific learning disorder: dyslexia, dyscalculia, and dysgraphia [35].

This gives even greater significance to the influence of ultrasound, due to a more frequent occurrence of left- handedness in children with prenatal insonated [19]. There are increased prevalence of non–right-handedness in children with dyslexia, learning disabilities, and autism [19].

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# Pre-lingual monitoring of the speech apparatus development

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**Abstract.** Controlling the speech apparatus during the pre-lingual period in children is a specific task since standard speech therapist methods involving the "stimulus-response" procedure, can't be applied. Considering that children at that age don't speak, more "passive" methods must be used. This implies using all forms of sounds articulated by children during the earliest stage of development: crying, laughter, babbling, etc. It is a known fact that there is a direct correlation between the vocal tract shape and the pronounced phoneme. The pronunciation depends on the position of the articulation organs i.e., the vocal tract shape. This information is used in order to ascertain the articulation organs movement area in pre-lingual children. The pronunciations of the voiced phonemes are mostly analyzed and the maximal vowel space is drawn. Maximal vowel space and the range of fundamental frequency (pitch) are the criteria for assessing the development of the speech apparatus. In this paper, we analyze the vocal tract shape estimation problems, along with the maximal vowel space in children aged from six months to one year.

## 1 Introduction

Detection of everything uncommon regarding the development of speech and speech apparatus is of utmost importance. Early detection enables simpler, easier and more complete correction. There is a tendency to monitor speech development from birth onwards. It is considered usual during the child's growing up, to monitor the chronology of adopting certain phonemes, although this belongs to the early lingual development period. The only area investigated more thoroughly in the pre-lingual period, is the child's first cry immediately after the birth.

Standard speech therapist methods for detection and correction of matters uncommon during the development of speech, imply a speaking child, or at least it having adopted those phonemes, which are treated. Speech therapist treatment assesses the speech quality or the quality of certain phoneme pronunciation (fricatives, affricates, plosives, etc.). Cognitive abilities of a child are also estimated, i.e. generating sentences and understanding speech communication. Generating and percepting speech (speech chain) can be seen in three level: lingual, physiological and acoustic. All three levels are addressed during the lingual period, while acoustic and partly physiological levels are relevant in the pre-lingual period.

It seems obvious that standard speech therapist treatment is not suitable in the pre-lingual period during the child growing up. Pronunciation quality of a one-year-old child can not be ranked using standard methods since those sounds are not part of speech and they bear no information. During the pre-lingual period, there is no speech, rather single sounds which, more or less, remind of certain phonemes. During this earliest phase in child's development, only the articulation organs movement and activity of the vocal cord, can be assessed.

Generator-filter model of speech (Dudley, 1939.) implies generating primary speech (vocal cord oscillation, friction, bang, or any combination), filtering it after passing through the vocal tract and radiation in free space using the mouth or nostrils. When primary voice passes through the vocal tract, its resonant frequencies are imprinted. Vocal tract is shaped like an irregular tube of a certain length. The irregular shape means that the cross-section of the vocal tract changes axially. The shape of the vocal tract defines the position of the articulation organs. Central resonant frequencies of the vocal tract depend on its shape. There are solid causal relations between the vocal tract shape and its resonant frequencies. Changes in resonant frequencies depict the change in vocal tract shape, and also of the articulation organs' movement. Therefore, by analyzing the formant frequencies of the sounds pronounced by a child, the movement of its articulation organs can be estimated. Sounds articulated by a child during the pre-lingual period are similar to vowels and hence we use the term Maximal Vowel Space (MVS) (Boe, Perrier, Guérin & Schwartz, 1989.), (Ménard & Boë, 2001.). It should be

noted that it doesn't matter if the pronounced phoneme sounds like a vowel /*a*/, or /*e*/ or like any other vowel or phoneme. Discrimination and classification of the pronounced phoneme are not important, and only its formant frequencies are relevant. Based on the range of the estimated resonant frequencies, obtained from phonemes pronounced by a child over a longer period, the movement of the articulation organs can be assessed. This is the main difference between a standard speech therapist treatment and using MVS. In former, the pronunciation quality is estimated for each phoneme, and in the latter, it doesn't matter which phoneme was pronounced, only its formant frequencies matter. Most often, only the first three formant frequencies of a vowel are considered.

## 2 One-year-old Child Vocal Trach Shape Estimation

In order to use MVS in speech development diagnostics in pre-lingual children, some quantities must be known for comparison purposes. MVS of a normal and atypical speech apparatus (articulation organs) must be known, i.e. typical MVS. One of the ways to estimate it is by means of a statistical measurement on a large population of children having a normally developed speech apparatus. The main problem with this approach is deciding if the child has normal or atypical development of the speech apparatus.

Another way of estimating the typical MVS is to start with a vocal tract during a vowel pronunciation and to calculate the resonant frequencies for those acoustic structures. MVS is the area bounded by vowel formant frequencies in $F_1$-$F_2$ and $F_3$-$F_2$ diagrams. For a rough estimation of the MVS, it is sufficient to apply this procedure only for three boundary vowels: /*u*/, /*a*/ and /*i*/. Problems with this way of estimating MVS are related to knowing the shape of the vocal tract during the vowel pronunciation. Standard ways of obtaining an acoustical model of the vocal tract are MRI and X-ray (Fant, 1970.), (Fant, 2004.), (Flanagan, 1972.) and (Ladefoged, 1975.). Based on the X-ray of the vocal tract during the pronunciation of a steady vowel, an acoustical model made of cylindrical tubes of the same length (5 mm for adults and 2.5 mm for one-year-olds) and various cross-sections, can be constructed. The acoustical model is translated to an equivalent electric circuit (using the theory of analogies) used for calculating the transfer function of the vocal tract, i.e. its resonant frequencies.

Third way of assessing the typical MVS is by simulating the change in the vocal tract shape. Starting with a uniform cylindrical tube, with a length equal to that of a vocal tract in a one-year-old, all possible shapes can be simulated. The acoustical model of the vocal tract is created from 35 cylindrical segments each 2.5 mm long and with one from 16 possible cross-sections. There are potential problems with this approach also: how to reduce the number of possible vocal tract configurations. For 35 cylindrical segments and 16 possible cross-sections, the number of possible vocal tract configurations is $16^{35} \approx 1.4 \times 10^{42}$. With such a large number of combinations, it is impossible to calculate all transfer functions and resonant frequencies. The solution is to eliminate all those configurations that are not realistic. For example, the throat area is fixed, all configurations having large cross-section changes are omitted, certain segments of the vocal tract have limited change in cross-section, etc.

X-rays and MRI can't be used with one-year-old children. It was suggested in (Vojnović, 2013.a) that vocal tract shape of a one-year-old should be estimated starting with a vocal tract shape of an adult. Afterwards, vocal tract shape of a one-year-old is transformed according to anatomical and articulatory differences, with respect to the adult vocal tract. Main vocal tract differences in adults and one-year-olds are: length, cross-section, movability of the articulation organs, mouth-to-pharynx cavity size ratio, etc.

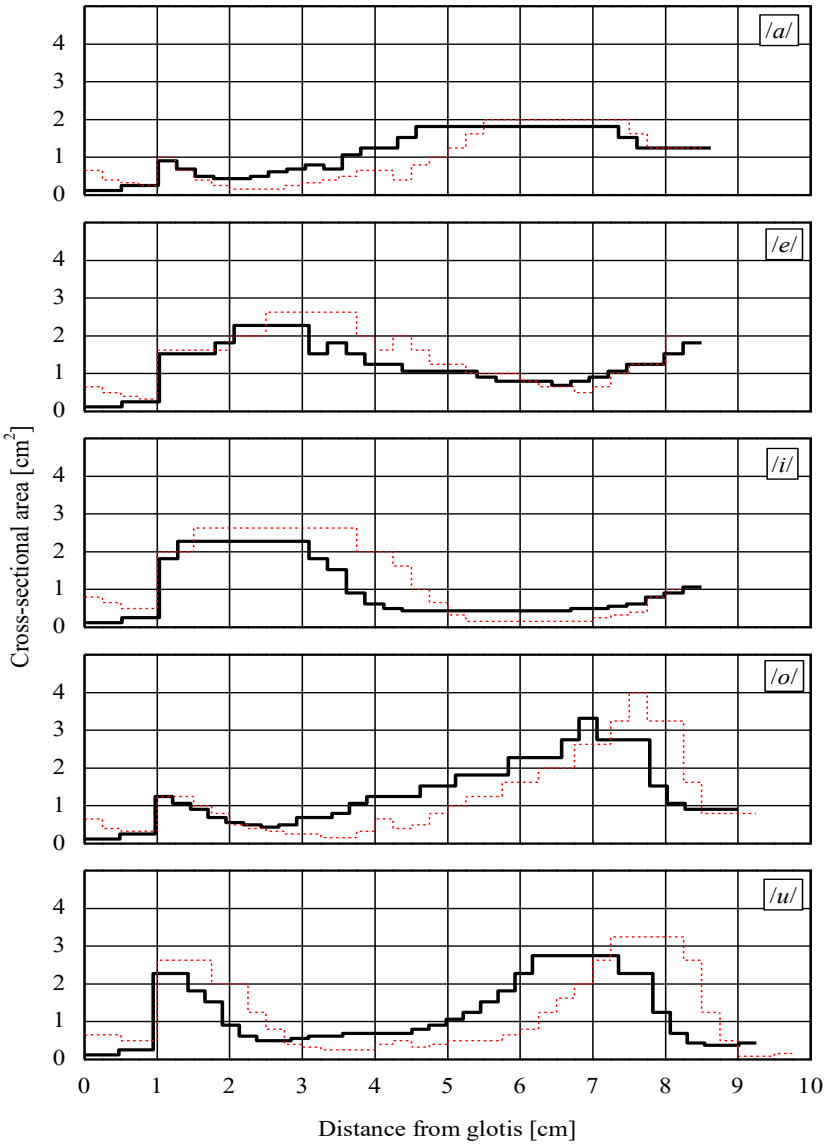


**Fig. 1.** Estimated shapes of the vocal tract in a one-year-old (solid line) and scaled vocal tract shapes in an adult (dotted line), for the case of vowel pronunciation.

Fig. 1 shows the vocal tract configurations of a one-year-old during the pronunciation of a vowel (solid line), and that of an adult (dotted line). The vocal tract shape of an adult is scaled in length (it is two times shorter) and in cross-section (downsized four times). This scaling is done in order to observe the vocal tract shape differences more clearly. Main differences seen in Fig. 1 are a consequence of different mouth-to-pharynx cavity size ratios. This ratio equals 1.1 in an adult and 0.5 in a one-year-old.

Estimated shapes of the vocal tract in a one-year-old child are similar to those presented in (Goldstein, 1980.). The biggest differences are in the cross-sectional area of the mouth cavity, and partly of the pharynx cavity.

**Table 1.** Vowel formant frequencies of a one-year-old child.

| Vowel | $F_1$ [Hz] | $F_2$ [Hz] | $F_3$ [Hz] |
|---|---|---|---|
| /*a*/ | 1244.9 | 2928.5 | 5035.6 |
| /*e*/ | 911.5 | 3746.6 | 5770.3 |
| /*i*/ | 689.7 | 3816.5 | 6161.7 |
| /*o*/ | 1090.0 | 2438.5 | 4669.1 |
| /*u*/ | 784.8 | 1876.7 | 5012.2 |

Formant frequencies relating the vocal tract configurations in Fig. 1, are presented in Table I. These formant frequencies can be used to obtain a rough boundary of the MVS area.

## 3 Estimating MVS Using a Simulation of the Vocal Tract Shape

In this case, the idea is to start with a uniform cylindrical tube 8.5 cm long, constructed from 34 cylindrical segments each of which is 2.5 mm long. Cross-section areas of those cylindrical segments can have one of 16 pre-defined values. Transfer function (and hence resonant frequency) is calculated for every configuration. Each of these configurations represent an acoustic model of the vocal tract. Bearing in mind the vast number of possible combinations, some constraints must be employed regarding the combinations to be simulated. These constraints imply omitting all the configurations which are not realistic. For example, the throat section can be fixed, and scenarios involving sudden changes in the acoustical model of the vocal tract, should be avoided. Simulating 50000 different vocal tracts three times, proved as sufficient in order to faithfully estimate the MVS. Three sets of simulated configurations are related to three vocal tract lengths regarding boundary vowels: /*u*/, /*a*/ and /*i*/. Fig. 2 shows the simulated MVS for a one-year-old child. Squares depict the formant frequencies of vowels given in Table I, which relate to the vocal tract configurations shown in Fig. 1.

According to the MVS simulation results (grey area in Fig. 2), first formant frequency of a vowel pronounced by a one-year-old child is in the range from 400 to 1600 Hz, second formant is from 1500 to 4800 Hz, and third from 2500 to 7500 Hz.

Fig. 3 depicts the estimation results for the formant frequencies of a realistic one-year-old child speech. Gray dots mark the simulated MVS, (Fig. 2), while black dots symbolize the resonances estimated for a recording of a child's speech. In addition, squares denote the formant frequencies from Table I. A good agreement can be observed for the acoustic model formant frequencies given in Fig. 1, for both simulated MVS and realistic speech of a one-year-old child. Partial disagreement is observed for frontal vowels /*e*/ and /*i*/.

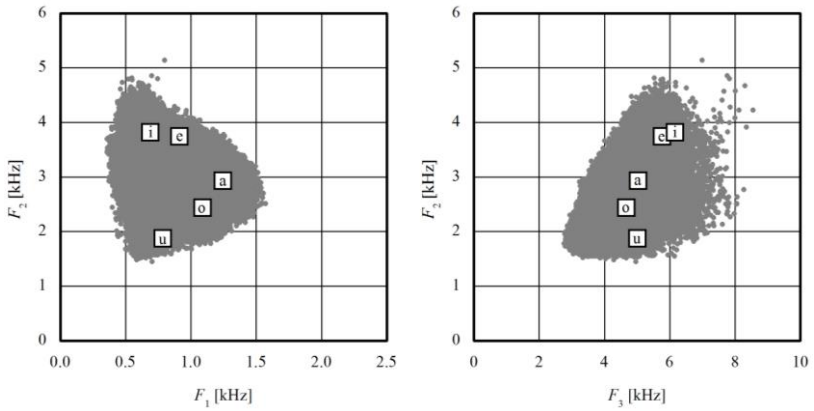


**Fig. 2.** Simulated MVS for a one-year-old child.

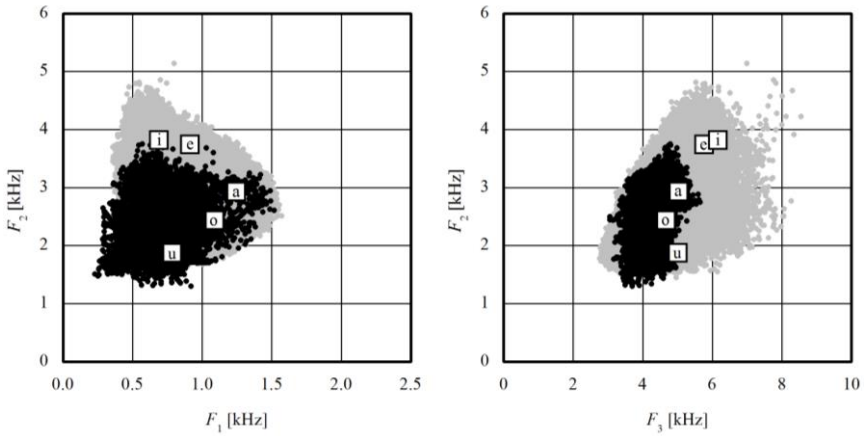


**Fig. 3.** Estimated formant frequencies for a one-year-old child's realistic speech.

Area of estimated child realistic speech frequencies for the first and second formant (left diagram in Fig. 3 - black dots) is shifted towards lower frequencies compared to the simulated MVS (grey dots). Better agreement on the $F_1$-$F_2$ diagram would be achieved if the vocal tract length were to be 5 mm shorter during the MVS simulation. A greater disagreement between estimated and simulated MVS is observed on the $F_3$-$F_2$ diagram (right diagram in Fig. 3). The realistic frequency area for the third formant is much narrower than that obtained by means of simulation.

## 4 Disscusion

According to the results given in Fig. 3, it can be said that MVS for children in pre-lingual period can be defined based on the shape of the vocal tract as suggested in (Vojnović, 2013.a), (Vojnović, 2013.b) i (Vojnović, Bogavac & Jeličić Dobrijević, 2014.). Also, it is possible to define MVS through simulation of the perturbation configurations for the vocal tract for three pre-defined lengths relating the pronunciation of the boundary vowels: /*u*/, /*a*/ and /*i*/. A good agreement is seen between the formant frequencies of a vowel pronounced by a one-year-old child, and resonant frequencies of the acoustic vocal tract model from Fig. 1. Slight differences in formant frequencies of the front vowels can be adjusted using the length of the acoustic models of the vocal tract from Fig. 1.

## 5 Conclussion

Detection of uncommon matters during the development of a pre-lingual child's speech apparatus implies determining the formant frequencies of all sounding phonemes pronounced by a child in order to create a realistic MVS. On the other hand, based on the acoustic vocal tract model of a one-year-old child, or by simulating the perturbation configurations of a uniform cylindrical tube, a theoretical MVS value can be obtained. After comparing these two estimated MVS values, it is possible to detect anything uncommon regarding the speech apparatus development. During that comparison, it is important that the ranges of realistic and theoretical MVS be as mush alike as possible.

Regarding the diagnosis of the vocal cord function, it is sufficient to analyze the histogram distribution of the cord oscillating frequency. These distributions should be similar to Gauss curves with a large enough standard deviation.

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## Kontrola razvoja govornog aparata u prelingvalnoj fazi

Kontrola razvoja govornog aparata kod dece u prelingvalnoj fazi je specifična, jer se ne mogu koristiti klasične logopedske metode koje podrazumevaju proceduru: stimulus-odgovor. S obzirom da kod dece u tom uzrastu nije razvijen govor, moraju se koristiti neke "pasivne" metode za kontrolu razvoja govornog aparata. To podrazumeva da se iskoriste svi oblici kreiranja glasova kod dece u najranijoj fazi razvoja: plač, smeh, brbljanje, gugutanje i sl. Odavno je poznata činjenica da između oblik vokalnog trakta i izgovorene foneme postoji direktna korelacija. Izgovor neke foneme zavisi od položaja artikulacionih organa, tj. od oblika vokalnog trakta. Ova činjenica se koristi da bi se konstatovala oblast pomeranjaartikulacionih organa kod dece u prelingvalnoj fazi. Najčešće se analizira izgovor zvučnih fonema i crta se maksimalna oblast vokala. Maksimalna oblast vokala i opseg promena osnovne frekvencije glasa su kriterijumi za procenu razvoja govornog aparata. U radu su analizirani problemi estimacije oblika vokalnog trakta i maksimalne oblasti vokala kod dece uzrasta od šest meseci do godinu dana starosti.

# Cognitive advantages of intensive second language acquisition

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**Abstract.** Acquiring two languages requires control or regulation of competition between them so as not to erroneously use the unintended one or lose fluency in each language. This activity requires executive control functions. Studies done so far have shown that bilinguals outperform their monolingual peers on inhibition, shifting and updating tasks, and show a significant advantage on tasks that require selective attention. Monolingual children in second language immersion programs also have the need to control two languages in a way that performance in one language can be achieved without intrusions from the other language.
Our study aimed to address the question whether monolingual children attending an intensive second-language immersion program for a period of one year show advantages in executive functioning similar to those previously found in bilinguals. This gives us an opportunity to investigate the effects of growing bilingual proficiency on executive control development.
Second grade Serbian-speaking children in the intensive immersion program (IG) exposed to the second language for five hours a day were compared to a similar control group (CG) of monolingual peers. The groups were compared in updating / working memory (WM), inhibition and shifting.
Significant group differences were found for two WM span tasks, with the IG group having better performance than the CG. Surprisingly, the two groups did not differ on the updating n-back task or in terms of shifting. There was also an unexpected advantage of the CG on the Stroop inhibition task.
Our findings extend previous research by demonstrating that early intensive second language acquisition can be advantageous for performance on working memory tasks that require a higher level of executive control.
*Keywords*: second language acquisition, immersion, executive functions, working memory

## 1 Introduction

Researchers argue that bilinguals show parallel activation of both of their languages as well as some interaction between them, even in contexts that clearly support only one of the languages (Francis, 1999; Kroll, Bobb, & Wodniecka, 2006; Marian, Spivey, & Hirsch, 2003; Rodriguez-Fornells, Rotte, Heinze, Nosselt, & Munte, 2002; Thierry & Wu, 2007). Consequently, the processes required in the linguistic and non-linguistic processing of bilinguals are argued to be the same set of cognitive processes required for general executive functioning, hence, resulting in better cognitive control skills in bilinguals compared to monolinguals (Bialystok, 2011; Carlson & Meltzoff, 2008; Martin-Rhee & Bialystok, 2008; Poarch & Van Hell, 2012; Poulin-Dubois, Blaye, Coutya, & Bialystok, 2011). Several studies indicate that bilingual speakers have a better performance on a number of tasks that engage cognitive control components such as selective attention (Bialystok, 2001), cognitive flexibility (Poulin-Dubois et al., 2011) and working memory (WM) (Morales, Calvo, & Bialystok, 2013). All of these cognitive control components fall under the umbrella term executive functions (EFs), which are now predominantly seen as three independent but related abilities: inhibition of prepotent responses or incoming interference or simply *inhibition*; mental set shifting or switching, i.e. *shifting*; and *updating*, which involves information updating and monitoring (Miyake et al., 2000). Updating can be seen as one aspect of *working memory*, and some authors argue that there are numerous different operationalizations, including updating tasks, which successfully tap the broad construct of working memory (Schmiedek, Lovden & Lindenberger, 2014).

### 1.1 Second language education and executive control

Recently some studies have investigated EF and dual language development of bilingual children immersed in different second language education programs. Poarch & Van Hell (2012) compared EF of four groups of children – monolingual, bilingual and trilingual, as well as in children in the process of learning a second language. Their findings suggested that the second language learners' executive control was enhanced compared to monolinguals but not as much as was observed for bilinguals or trilinguals. Another study investigating the relationship between age of L2 onset in bilinguals and EF found that the early bilinguals outperformed both monolinguals whereas late bilinguals did not (Luk et al., 2011). The results were interpreted in the light that "more experience in being actively bilingual is associated with greater advantages in cognitive control and higher language proficiency" (Luk et al., 2011: p.588). However, a study conducted by Pelham and Abrams (2014) demonstrated similar advantages in EF of two groups of bilinguals over their monolingual peers. The group of early bilinguals was fluent in L2 before 7 years of age while late bilinguals became fluent in the second language at the age of 13 years. It is thus possible that second language experience improves executive control in children regardless of length of exposure and ages of L2 onset.

A thorough reading of prior literature reveals a picture which is far from simple and raises the question when and how these advantageous effects on EF surface in the context of emerging bilingualism. Mixed results can be found with respect to the effect of the length of exposure in an immersion education program on executive functioning (Bialystok, Peets, & Moreno, 2014; Carlson & Meltzoff, 2008; Nicolay & Poncelet, 2013). Bialystok & Barac (2012) and Bialystok et al. (2014) demonstrate that the level of EF advantages is related to increased language experience in the immersion program. Similarily, Nicolay & Poncelet (2013) have shown that a three-year immersion program can bring about benefits on a number of cognitive control tasks, including alerting, auditory selective attention, divided attention and mental flexibility, when 8-year old children from the immersed program are compared to their monolingual peers. On the other hand, Carlson and Meltzoff (2008) did not find any differences in performance on tasks of inhibition, shifting and working memory between preschool children who had attended an immersion program for six months and monolingual children of the same age.

In the present study, we extend this line of research by examining whether children who acquire a second language in an immersion program for a period of one year show similar executive control to bilinguals. This gives us an opportunity to investigate the effects of growing bilingual proficiency on executive control development and determine whether it mirrors the need of full bilinguals to control two languages in a way that performance in one language can be achieved without intrusions from the other. Two groups of second grade Serbian-speaking children were compared on a number of executive function tasks. The intensive program group (IG) was exposed to the second language for five hours a day and the control group (CG) attended regular monolingual schools in Belgrade, Serbia. We hypothesized that the immersion group would outperform the monolingual group on EF tasks.

## 2 Method

### 2.1 Participants

The sample comprised two groups of typically developing, monolingual Serbian-speaking children – the intensive immersion group (IG) and the control group (CG). The 19 children in the IG had attended international schools in Belgrade for at least one year at the time of the testing. These schools organize classes in a second language (English or German), so that children are immersed in it for about five hours each school day. The CG consisted of 22 second-grade children attending mainstream monolingual Serbian primary schools in Belgrade. The groups had similar socioeconomic background and there were no differences in either age or fluid intelligence: $t(39) = .66$, $p > .05$ for mean age and $t(27) = -1.32$, $p > .05$ for intelligence scores. The mean age of the sample was $M = 94$ months ($SD = 7.7$).

## 2.2 Materials

Subjects were administered a battery of six EF tests as well as the Raven's Colored Progressive Matrices test (Raven, Court, and Raven, 1986). All EF tasks were constructed and administered using E-Prime software (Schneider, Eschmann, & Zuccolotto, 2002) and were presented to participants on Acer Iconia Tab computers. In order to better assess the updating / working memory construct, we administered one typical updating task as well as two other classical working memory tasks.

*Raven's Colored Progressive Matrices test* (Raven, Court, and Raven, 1986).

In this fluid intelligence test the children are required to choose a missing piece from a list of six possible choices in order to complete the presented geometrical figure. There are a total of 36 figures and each correct answer is scored as 1, adding up to a maximum score of 36. All scores were corrected for participant age.

*Counting recall task (working memory)*.

This task was taken from the Serbian adaptation of the AWMA[19] (Alloway, 2007). A varying number (four to seven) of red dots and blue triangles are presented on the screen and the participants' task is to count the number of red dots and memorize it for the recall phase. The number of presented images increases progressively over successive blocks. Each block has four trials and difficulty ranges from one to seven images that need to be memorized. Counting recall span is obtained as the longest number of items the child can repeat.

*Backward digit span task (working memory)* (Huizinga, Dolan, and Van der Molen, 2006).

In this task, participants are required to repeat a number sequence that they have heard in reverse order. There are four sequences in each block and blocks get progressively longer, ranging from two to eight numbers per sequence. Backward digit span is the longest sequence the child was able to repeat correctly.

*Nonverbal n-back task (updating)* (Lukács, Ladányi, Fazekas, and Kemény, 2016).

The stimuli in the nonverbal n-back task are images of fractals. Participants are presented with a sequence of images and their task is to respond by keyboard press whenever the presented stimulus is the same as the one presented "n" steps earlier. We used 1-back and 2-back conditions of the task, with 60 trials each. There were 10 "critical" stimuli in each condition that needed to be reacted to, adding up to a total maximum score of 20.

*Nonverbal Stroop task (inhibition)* (Lukács, Ladányi, Fazekas, and Kemény, 2016).

Participants are presented with arrows pointing upward, downward, left, and right and their task is to respond to the orientation of the arrow (by pressing the corresponding key on the keyboard), regardless of its position on the screen. The arrows can be presented either in the middle of the screen (control block), in their corresponding positions on the screen (congruent block), e.g. arrow pointing upwards presented in the upper part of the screen or on the opposite side of the screen (incongruent block), e.g. arrow pointing upwards in the bottom part of the screen. Each block has 60 trials. The inhibition cost is calculated as the difference in reaction times (RTs) for the congruent and the incongruent block.

*Local–global task (shifting)*.

This task was adapted from Huizinga et al. (2006) and uses four complex figures shown in Figure 1. The first block has 32 trials and the participants' task is to respond to the shape of the larger figure (determining whether it is a square or a rectangle). The second block also has 32 trials but the participants' task is now to respond to the shape of the smaller figures. Finally, the third (critical) block has 64 trials and requires participants to shift between the two response types depending on the position of the stimuli (above or below a horizontal line dividing the screen). The difference in RTs for the first two (nonshifting) blocks and the third (shifting) block represents the general shifting cost.

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**Figure 1.** Complex figures used in the local-global task Color–shape task (shifting).

In this task the stimuli are the following four figures: blue triangles, red triangles, blue circles and red circles. There are two non-shifting blocks with 32 trials each and one shifting block with 64 trials. The participants' task in the first block is to respond to the shape of the stimulus and in the second block to its color. In the third (shifting) block participants are required to alternate between the two types of decisions depending on the stimulus onscreen position (upper or lower half of the screen). General shifting cost is calculated as the difference between the average RTs for the first two blocks and the third block.

### 2.3 Procedure

Research design was approved by the ethics board and the schools gave permission for the testing to take place within their premises. Parents provided signed informed consent for their children to participate in the study. All tasks were administered in a predefined order in order to avoid participant - task order interaction and the order was such that two tasks referring to the same executive function were never directly one after another. The Raven's CPM test was always administered first in order to exclude children who did not satisfy the inclusion criteria; no children needed to be excluded due to their intelligence scores. In order to keep the children's vigilance and motivation high throughout the whole testing, we administered the battery in two 30-minute individual sessions including short breaks between each two tasks.

### 2.4 Data processing

Scores on both shifting tasks and the nonverbal Stroop task are differential time scores. Before calculating these scores, we trimmed the reaction time data. Firstly, only RTs for correct trials longer than 200ms were included in the analysis. Secondly, the data were trimmed between participants, so that values more than ±3 standard deviations away from the overall mean RT were replaced by the ±3 standard deviation values. Thirdly, we performed within participants trimming – we replaced all values outside the ±3SD from the individual participant's mean with the ±3SD values. Trimming was done separately for each task block as reaction times differed between blocks. For all three tasks, differential score values are expressed as negative numbers, such that higher values correspond to better shifting / inhibition ability.

## 3. Results

Group differences were tested by a series of t-tests and the results are presented in Table 1. As can be seen, the IG outperformed the CG on both WM span tasks, but not on the updating task. There was also a significant difference between groups on the nonverbal Stroop task, however the result was somewhat surprising as the CG showed better inhibition, as evidenced by a lower difference in reaction times between the congruent and incongruent blocks. No differences were observed for either of the shifting tasks.

**Table 1**. *t-test results comparing IG and CG on EF tasks*

| | CG | | IG | | |
|---|---|---|---|---|---|
| | M | SD | M | SD | t-test |
| Counting recall span | 3.95 | .90 | 4.74 | .87 | -2.82** |
| Backward digit span | 3.05 | .84 | 3.74 | .73 | -2.78** |
| Nonverbal n-back score | 14.45 | 3.16 | 14.68 | 2.31 | -.26 |
| Nonverbal Stroop differential RT (ms) | -205.95 | 128.00 | -291.55 | 130.04 | 2.12* |
| Local-global shifting cost (ms) | -174.10 | 178.54 | -190.25 | 144.83 | .315 |
| Color-shape shifting cost (ms) | -296.70 | 164.88 | -335.22 | 167.35 | .741 |

* $p < .05$, ** $p < .01$.
Note. M = Mean, SD = Standard deviation

## 4. Discussion

The current study seeks to test the underlying mechanisms of the bilingual cognitive advantage hypothesis amidst recent inconsistent findings of between-group performances of monolinguals attending regulary school and monolinguals attending a second language immersion programme. To stress again, bilinguals outperform their monolingual peers on inhibition (Poarch, & Van Hell, 2012; Carlson and Meltzoff, 2008; Poulin-Dubois, Blaye, Coutya, and Bialystock, 2011; Bialystok, 2001), shifting and updating tasks (Bialystok, 2010), and show a significant advantage on memory recall tasks involving proactive interference (Bialystok, & Feng, 2009), as well as on tasks that require selective attention (Bialystok, 2001).

In an effort to examine the effects of immersion experience on cognitive control, Carlson and Meltzoff (2008) showed that six months within a second-language exposure program was not enough to produce executive function benefits similar to those that can be found in bilinguals. On the other hand, results of Nicolay and Poncelet (2013) indicate that three years in an L2 immersion program do bring about benefits in EF associated with early bilingualism. Extensive studies done by Bialystok and collaborators (Bialystok and Barac, 2012; Luk, de Sa, & Bialystok, 2011) suggest that accumulation of experience in a bilingual setting contributes to the development of executive control in both children and adults.

In order to further contribute to this area we considered bilingualism as a continuous variable and examined whether second language acquisition in an immersion program for a year at an early age would have significant effects on some or all EF components. Three components of executive functions as described by Miyake et al. (2000) – inhibition, shifting and updating / WM were analyzed. Within the updating / WM construct we included a total of three tasks, one updating task and two WM span tasks. Interestingly, the advantage of the immersion group was obtained for both WM span tasks, but not for the n-back task, a typical measure of the updating function. It is possible, though, that the n-back task was relatively easy for participants in our study (as suggested by relatively high mean scores for both groups), and that differences between groups would emerge on a more difficult variant of the same task.

The obtained data confirmed our hypothesis by demonstrating that one year of immersion in a second language learning program is sufficient to produce an effect on tasks assessing WM. Working memory refers to the ability to simultaneously process and recall information and is a multicomponent, capacity-limited system (Baddeley, 1998). The central executive – a flexible system that is responsible for the control and regulation of cognitive processes – has been found to play an important role in higher-order language processing (Engel de Abreu et al. 2011; Seigneuric, Ehrlich, Oakhill, Yuill, 2000; Cain, Oakhill, Bryant, 2004; Gathercole, Alloway, Adams, 2006). Numerous studies have shown that WM task performance is strongly related to language acquisition and processing in monolingual and bilingual contexts (Engel de Abreu & Gathercole, 2012; Engel de Abreu, Gathercole, & Martin, 2011; Archibald & Gathercole, 2006; Majerus et al., 2006). Executive control has been argued to determine individual differences in complex working memory tasks that require storage and processing of information (Gathercole, Pickering, Ambridge, & Wearing, 2004).

However, we obtained no differences on either of the shifting tasks and a surprising result was also the advantage of the control group on the nonverbal Stroop task, a measure of executive inhibition. Our findings therefore propose that regular and extensive experience in controlling attention to their two language systems results in better executive functioning in some components, but not in other components such as inhibition to distractor or shifting. This component difference suggests that the impact of one year within the second language acquisition immersion program on executive control is function-specific and not function-general; that is, the effect may not exist across all components of EF.

Within their adaptive control hypothesis, Green and Abutalebi (2013) proposed that the processes of control adapt to the demands placed upon them. In the case of bilingual speakers, the interactional context in which they find themselves drives the adaptive response, which further instigates the processes that control (linguistic) representations in working memory to ensure the communicative goal (to be achieved). It is likely that in the initial period of intensive second language acquisition, the processes of forming the basic vocabulary and employing elementary syntactic structures of the second language primarily engage working memory (WM), similarly to the period of language acquisition in monolinguals, where scores on WM performance are strongly related to language acquisition and processing (Gathercole, Baddeley, 1990; Montgomery, 2003; Majerus et al., 2006). Various EF components may develop asynchronously. It is even possible that, at a certain stage, learning a second language can lead to a disadvantage in executive functions, such as inhibition. The level of fluency of L2 might play a significant role – with increasing proficiency in L2, the disadvantage in inhibition may disappear or even become an advantage. Consequently, WM may appear as the most important component in this early period of second language acquisition.

The most important limitation of our study is its relatively small sample size which reduces our power to register small effects. However, we did find group differences on three out of six EF tasks, indicating that the sample size was sufficiently large to discover at least the most prominent changes that occur at early stages of learning a second language. Future studies should attempt to replicate these findings on a larger sample and also investigate the impact of factors such as length / amount of exposure to L2 and fluency in L2 on executive functions. Future research should also attempt to discover at which stage of learning a second language the children in immersive programs show advantages in other EF, namely inhibition and shifting, over their monolingual peers.

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## Kognitivne prednosti intenzivnog učenja drugog jezika

Poznavanje dva jezika zahteva kontrolu i/ili regulaciju kompeticije između jezika kako ih osoba ne bi mešala u toku govora i, na taj način, izgubila fluentnost u okviru svakog od njih. Ova aktivnost zahteva egzekutivne kontrolne fnkcije. Dosadašnje studije su pokazale da bilingvali postižu bolji uspeh od monolingvala na zadacima inhibicije, premeštanja i ažuriranja, kao i na zadacima koji zahtevaju selektivnu pažnju. Monolingvalna deca uključena u intenzivne programe učenja drugog jezika takođe imaju potrebu da kontrolišu dva jezika tako da se korišćenje jednog jezika može odvijati bez intruzija iz drugog.
Cilj naše studije bio je da utvrdimo da li deca koja usvajaju drugi jezik (L2) po intenzivnom programu u periodu od godinu dana pokazuju prednosti u egzekutivnoj kontrolu slične onim koja su pronađene kod bilingvala. Ovo nam daje priliku da ispitamo uticaj porasta bilingvalne sposobnosti na razvoj egzekutivne kontrolne.
Istraživanje je obuhvatilo dve grupe dece drugog razreda osnovne škole čiji je srpski maternji jezik: grupu dece koja usvaja drugi jezik po intenzivnom programu (IG) od pet sati dnevno i kontrolnu grupa monolingvalnih vršnjaka (KG). Grupe smo poredili na zadacima koji procenjuju ažuriranje / radnu memoriju (RM), inhibiciju i premeštanje.
Značajne razlike između grupa su pronađene na dva zadatka raspona RM, pri čemu je IG imala bolje postignuće od KG. Iznenađujuće, grupe se nisu razlikovale na n-unazad zadatku ažuriranja, kao ni na zadacima premeštanja. Takođe, pronađena je neočekivana prednost KG na Stroop zadatku inhibicije.
Naši nalazi proširuju prethodna istraživanja pokazujući da rano intenzivno usvajanje drugog jezika može imati pozitivan uticaj na postignuće na zadacima radne memorije, koji zahtevaju viši nivo egzekutivne kontrole.
*Ključne reči*: učenje drugog jezika, intenzivno učenje, egzekutivne funkcije, radna memorija

# Requests as speech acts: the case of parliamentary requests

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**Abstract.** The main aim of this paper is to explore and compare the request realization patterns in the U.K. House of Commons and New Zealand House of Representatives. Transcripts of the interactions between the Members of Parliament (MPs) and the Speaker of the House are used as the main source of language information. The so-called CCSARP (Cross-Cultural Speech Act Realization Patterns) coding scheme was used to analyze the data. The paper focuses on request "head acts", whereas "peripheral" elements are beyond the scope of this study. The requests were analyzed in terms of their level of directness. The CCSARP coding scheme proved to be applicable to the analysis of this type of institutional requests, however with certain refinements, which were necessary in order to describe them more accurately. Not unsurprisingly, the results of the analysis show that the New Zealand MPs prefer to use direct requests in their interactions with the Speaker, whereas the U.K. MPs are predominantly indirect. The paper offers several possible explanations for these findings.

## 1 Introduction

Research on requests can generally be classified into two broad categories: research on requests in individual languages and research comparing requests in two or more languages. The studies of the latter type either explore requests from a cross-cultural perspective (see, for example, House and Kasper 1981, van Mulken 1996, Fukushima 2000, and other similar studies), or they compare learners' and native speakers' requests (see, for example, Trosborg 1995, Flores Salgado 2011, and many more similar studies). Recently, requests in different varieties of the same language have been explored from the perspective of variational pragmatics (for example, Barron 2008). All of these studies testify to the fact that, even after several decades of research into the subject matter, speech acts still remain a fertile ground for exploration of various social, psychological and other aspects of human verbal communication.

This overall purpose of this study is to explore "the effect of macro-social pragmatic variation on language in (inter)action" (Barron 2008: 36). More specifically, the paper explores potential similarities and/or differences in request realization patterns in the U.K. House of Commons and New Zealand House of Representatives. The study applies the Cross-Cultural Speech Act Realization Patterns (CCSARP) coding scheme to the analysis of parliamentary requests. The main reason this framework was chosen is because it is the single most frequently maintained framework by later researchers. As such, the framework remains a consistently used podium for the comparisons of the results of various studies across a range of diverse research settings (albeit not without criticism; see, for example, van Mulken 1996, Leech 2014),

## 2 Terminology and Definitions

There is already a wide range of literature on requests, and the terminology used in speech act studies has varied a great deal.[20] Due to space limitations, this issue cannot be addressed in this paper in any great detail. It is, however, important to clarify the object of the study. This section therefore is limited on covering the basic parameters of the term "request", as used in this paper.

[20] The CCSARP framework does not get into the issue of identification in great depth. Requests are characterized as pre-event acts that express "the speaker's expectation of the hearer with regards to some prospective action" (Blum-Kulka et al. 1989a: 11).

First, it is important to distinguish between "directives" and "requests". A large number of studies have adopted Searle's (1969, 1979) traditional approach (e.g. Pufhal-Bax 1986, Ervin-Tripp et al. 1990), which sees requests as a sub-type of directive acts, understood as attempts by the speaker to get the hearer to do something. Searle (1969: 66, 1979: 44) proposes a number of felicity conditions for directives in general. In order to distinguish between orders/commands on the one hand and requests, which are also attempts to get the hearer to do something, Searle introduces an additional preparatory rule for orders/commands, namely that S must be in a position of authority over H (also see Labov 1972, Bach and Harnish 1979). This theoretical distinction has practical consequences for the identification of the two acts, and many subsequent studies have adopted this criterion as an important distinguishing factor, with minor additions. For example, in her superb study on the discourse of power in New Zealand workplace situation, Vine (2004: 31) sums up three factors differentiating requests, directives (i.e. orders) and advice. In requests, the hearer's status is higher than the speaker's, the hearer has the right of refusal and there is benefit to the speaker from the desired act. As it will be seen further below, Searle's traditional approach was embraced in this study as well.

Another important problem in all studies of requests (and directives) concerns the issue of whether or not to consider questions as a separate type of requests or not. Searle sees questions as requests for information, and classifies them as directive acts (1979: 14). Other authors have been careful to distinguish between acts that require a physical response from those that require a verbal response (Sinclair and Coulthard 1975). For example, following Hassal (1999), Economidou-Kogetsidis (2002) makes a clear distinction between requests for action and requests for information, which she considers on a separate scale of in/directness. Vine (2004: 36) is careful to point out that she excluded requests for information and requests for any immediate clarification. However, more often than not, researchers do not specify whether limitations of this type were introduced in their studies. The issue is by no means irrelevant. Namely, the way this issue is resolved can significantly influence the quantitative results of any study on requests (see Hassal 1999: 594-597, for discussion).

This study follows Searle's (1969, 1975) view of requests as a type of directive speech act. Requests are seen as attempts by an MP, i.e. the speaker (S) to get the (Deputy) Speaker of the House, i.e. the hearer (H), to do something. Since the object of this study are requests in an institutional setting, therefore a context in which status differences are clear, and where H's and S's roles are defined by the rules and practices of parliamentary procedure, authority is taken to be a sufficient distinguishing factor for requests and orders/commands. In parliamentary settings, H has authority over S (that is, H>S), and thus MPs can only request that the Speaker do something (and not order). The source of H's authority over S resides in his/her legitimate and expert powers (see Spencer-Oatey 2008: 34-35). Furthermore, in this paper we do not consider requests for information (questions, "Asks", see Hassal 1999: 594-597). All other points of order the primary goal of which was not to obtain information were included in the data sets (for example, requests by MPs for the Speaker to investigate a certain matter, requests for an apology, reflection, confirmation, and so on).

## 3 Method

Section 3.1 describes the data that were used for the purposes of this study. Coding scheme that was used in the analysis of the examples, along with the most representative examples, is presented in section 3.2.

### 3.1 Data

A large number of other studies employing the CCSARP methodology rely on elicited data. The data that were collected for the purposes of this study were authentic, i.e. not elicited. The data comprises examples of requests made by the U.K. and New Zealand MPs to the Speaker of the House. The data were extracted from Hansard, the written record of parliamentary debates in the U.K. House of Commons (http://hansard.parliament.uk) and New Zealand House of Representatives (https://www.parliament.nz/en/pb/hansard-debates). It needs to be noted that Hansard is not a full verbatim record of parliamentary proceedings, and often changes are made to remove redundancies

and repetitions (see Chilton 2004). This is why the analysis of the written examples was complemented by the analysis of video recordings of the relevant parliamentary sessions.

The requests that were considered in this paper were all made as points of order. A point of order is a type of an appeal to the Speaker of the House or the Chair to clarify or to rule on a matter of procedure. There are other types of parliamentary requests (for example, requests that are made during ministerial statements, debates, or other sub-genres of parliamentary discourse; cf. Ilie 2006). It bears emphasis that the results of this study are not representative for all parliamentary requests.

### 3.2 Coding Scheme

As it was already noted, this study adopts the CCSARP segmental approach to the analysis of the speech act of request, which entails breaking the request sequence down into head acts and peripheral elements (alerter(s) and supportive move(s), see Blum-Kulka et al. 1989b: 275-276). This study focuses exclusively on head acts, whereas peripheral elements are beyond its scope. Head act is defined as "the minimal unit which can realise a request" (Blum-Kulka et al. 1989b: 275). Request head acts that were identified in the two datasets were analyzed according to their degree of in/directness. Directness is understood as illocutionary transparency, "the degree to which the speaker's illocutionary intent is apparent from the locution" (Blum-Kulka et al. 1989: 278).[21]

Based on the dimension of in/directness, requests were categorized as direct (impositive), conventionally indirect and non-conventionally indirect, as proposed in the original CCSARP coding scheme. The scheme was subjected to minor adaptations so as to accommodate the data used for this study. The list of strategies and sub-strategies in decreasing order of directness is provided in the sections below, followed by the most salient examples of the individual sub-strategies, as observed in our data.

#### *3.2.1 Direct level (impositive)*

On the most direct level, the requestive force is conveyed by purely syntactic means, such as the grammatical mood or performative verbs. There are six sub-strategies on this level. The first five sub-categories are all taken from the CCSARP scheme (their definitions can be found in the CCSARP coding manual, see Blum-Kulka et al. 1989b). An additional sub-strategy, *ability/possibility statements*, was introduced to capture those examples that could not fit any other CCSARP sub-category. Ability statements were added based on Leech, who lists them as the least direct category on his list of on-record indirect request strategies, right under prediction, strong obligation, weaker obligation and volitional statements (see Leech 2014: 148- 152). Our data registers examples of both speaker-oriented and hearer-oriented ability statements.

A particularly problematic part of on any study of requests is the sub-category of *want-statements*. The expression of speaker's wishes/desires/needs and hopes is classified elsewhere in literature in different ways. For example, Wang (2011: 75-77) lists *I hope* and *I need* statements under want statements. Trosborg, on the other hand, separates the expression of wishes and desires/needs into two separate sub-categories (Trosborg 1995: 205). In this study we opted for the former solution.

1. Mood derivable, imperative
() Gerry Brownlee: […] if the Prime Minister is wrong, please <u>tell her so</u> […] (NZH, 30/03/2004; vol. 616; p.12039)[22]

[21] One of the strongest criticisms leveled at the CCSARP taxonomy of requests concerns the linguistically inconsistent criteria that were used as its basis (see Leech 2014: 267-268).

[22] In order to separate them from peripheral elements, we underlined the head acts in all the examples. The shorthands NZH and UKH stand for New Zealand Hansard and the U.K. Hansard respectively. These are followed by a reference (volume column and/or page) to where a respective example can be found in the NZH and UKH.

2. Explicit performative
() Gerry Brownlee: […] I seek leave of the House to ask an urgent question of the Minister of Police now.
() Hon Rick Barker: […] I ask you to reflect on your ruling in respect of the privilege of free speech that we have as members of Parliament. (NZH, 14/10/2009, vol. 658; p. 6993)

3. Hedged performative
() Hon Trevor Mallard: […] I would ask you to consider that and to rule on it at some stage if you so wish. (NZH, 26/03/2013; vol. 688; p. 8896)

4. Obligation statement (Locution derivable)
() Hon Rick Barker: […] If you are to require people to take certain words off their boxes, then you should explain to us how that requirement is consistent with our privilege of free speech as members of Parliament. (NZH, 14/10/2009, vol. 658; p. 6993)

5. Want statement
() Hon Trevor Mallard: […] I want you to rule on a written question that the Office of the Prime Minister has twice turned down as not having responsibility for […] (NZH, 30/03/2010, vol. 661, p. 9887)
() Howard Stoate: […] I would like your guidance on whether a deliberate attempt to undermine the Bill reduces the authority of the House […] (UKH, 17/01/2001, vol. 361, col. 352)

6. Ability/possibility statement
() Steve Rotheram: […] Given the urgency of the situation, Mr Speaker, perhaps you can offer me guidance […] (UKH, 19/03/2012, vol. 542, col. 517)
() Valerie Vaz (): […] perhaps I could have your guidance on this. (UKH, 20/06/2013, vol. 564, col. 1068)

#### *3.2.2. Conventionally indirect*

Conventionally indirect strategies "realize the act by reference to contextual preconditions necessary for its performance, as conventionalised in a given language" (Blum-Kulka 1989: 47). The CCSARP coding manual includes the sub-category of *suggestory formulae*. No examples were found in the data used for this study, so this sub-category was not included in our taxonomy. The *query preparatory* sub-strategy is diversified into *volition*, *ability/possibility* and *permission questions* (following Trosborg 1995: 205).

a. Volition
() Norman Baker: […] Will you, Mr. Speaker, take the matter up with the Department for Transport to ensure that the record is available to all, not simply to the Member who asked the question? (UKH, 29/05/2008, vol. 475, col. 167)

b. Ability/possibility
() Stephen Timms: […] Can you give me advice or assistance in obtaining the information I seek? (UKH, 9/12/2014, vol. 589, col. 779)

c. Permission questions
() Paul Flynn: […] Paul Flynn (Newport West) (Lab): […], may I put it on the record that the BBC, The Telegraph and The Times have reported that on a visit to Camp Bastion, on 16 December 2013, the Prime Minister, talking about the Afghan war, described it as "mission accomplished"? (UKH, 20/11/2014, vol. 588, col. 433)

### *3.2.3 Non-conventionally indirect*

The CCSARP coding manual suggests the distinction between mild and strong hints. This distinction was dropped and the two sub-categories were merged into one in our taxonomy.

In non-conventionally indirect requests, we find partial reference to object or element needed for the implementation of the requested act. Significant percentage of hints in our data (see further below) is connected to the specific participation structure in the two parliaments. Namely, the Speaker is typically the addressee and not the recipient of an MP's request. Very often non-conventionally indirect requests are the least intrusive device for the MPs to get the Speaker to put pressure on the third party to do the desired act (for example, to get the relevant minster to submit a long overdue report to the House). Such requests exhibit dual requestive force, and such requests are conveyed by employing two different strategies. The strategy aimed at the Speaker, which is what we focused on in this paper, is typically the illocutionary opaque requestive hint (see Weizman 1989), as it can be seen in the example below.

() Mr Tom Watson [...]. I would be grateful if the Secretary of State found out who was masquerading as the chief executive, if that is possible. (UKH, 11/02/2013, vol. 558, col. 627)

## 4 Results

The overall results show significant variation in the levels of directness in the two data sets. These are outlined in Fig. 1 below.

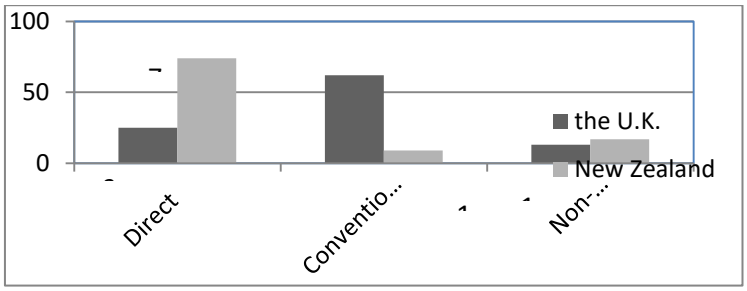


**Fig. 1**. Main request strategies employed by the U.K. and New Zealand MPs

As Figure 1 shows, direct requests account for the largest proportion of New Zealand data, whereas conventionally indirect request are the most common type of requests in the U.K. data. In NZ data set, the MPs used non-conventionally indirect requests (hints) more frequently than conventionally indirect strategies. The results are discussed in section 5.

**Table 1**. Frequency of the individual sub-strategies in the two data sets

| Strategy type | Strategy sub-type | U.K. | N.Z. |
|---|---|---|---|
| 1. Impositive | 1.1 Mood derivable, imperative | 0 | 3 |
| | 1.2 Explicit performative | 20 | 95 |
| | 1.3 Hedged performative | 2 | 18 |
| | 1.4 Obligation statement | 1 | 2 |
| | 1.5 Want statement | 12 | 18 |
| | 1.6 Ability/possibility statement | 8 | 7 |
| | Impositives: total | 43 | 143 |
| 2. Conventionally indirect | Query Preparatory (QP) | | |
| | a. Volition | 30 | 3 |
| | b. Ability/possibility | 52 | 12 |
| | c. Permission questions | 22 | 2 |
| | Conventionally indirect: total | 104 | 17 |
| 3. Non-conventionally indirect | | 21 | 31 |
| Total number of requests: | | 168 | 191 |

## 5 Discussion

As it was already underscored, all the examples of requests in this study were analyzed according to their level of directness, which is only one dimension of variation (see Blum-Kulka and Olshtain 1984, Blum-Kulka 1987). The fact that another important dimension, request modification, was not considered in this study could potentially explain the striking differences between the findings for the U.K. and New Zealand data. As we saw, as many as 74% of the NZ requests were of the direct kind. If it should be the case that requests in our New Zealand data were modified (internally and/or externally), then the sheer directness of the requestive force would be balanced out by such modification. This important aspect of parliamentary requests deserves further investigation.

The results of this study can also be explained by differences in the parliamentary practice in the two parliaments. In theory, MPs in both parliaments can seek to raise points of order at any time, but the Speaker has discretion as to when to hear them. In the U.K. House of Commons, MPs are expected but not required to give advanced notice of a point of order to the Speaker or the Speaker's Office. Furthermore, the Speaker will typically not hear any points of order until question time and any statements are completed (House of Commons Information Office, personal communication). On the other hand, in New Zealand Parliament, points of order can be raised exclusively at the time the matter of order to which they relate arises. If a member does not challenge a matter at once, the opportunity to raise a point of order on it is gone, even if the member was not present at the time the matter arose (House of Representatives Information Office, personal communication). This need for efficiency, as well as fear of losing the opportunity to raise a point of order may explain the use of direct forms in New Zealand Parliament (see Blum-Kulka et al. 1985: 129).

If we take a look at the results for individual sub-strategies (Table 1), we can notice that, out of all direct sub-strategies, explicit performatives were employed most frequently by New Zealand MPs. Procedural rules allow for New Zealand MPs to ask for a permission to do something without a single member present dissenting, which is done via the institutional performative formula *seek leave*. Almost half of the examples of explicit performatives in our New Zealand data were of this type. We found no such equivalents in the U.K. House, at least not when an MP was raising a point of order. This helps explain such high frequency of the sub-strategy among all other direct strategies. Furthermore, Table 1 shows that non-conventionally indirect strategy was used more frequently than conventionally indirect strategy in New Zealand data. As discussed in 3.2.3, the dual force of hints, enabled by particularities of parliamentary participation structure (see Murphy 2015), allows for an MP to be direct, while appearing non-conventionally indirect, which could explain New Zealand MPs' propensity towards hints as opposed the more propositionally and illocutionary clear conventionally indirect requests. Additional research is warranted to help support this claim.

Another possible interpretation of the differences in the results of the study could be found in macro-social factors. In research on requests and other speech acts, many studies have demonstrated the importance of the factor of power. Usually, the more power the speaker has, the more direct he or she is, and vice versa (Brown and Levinson 1987). Even though in our study the factor of power is held constant (in both institutions the Speaker is the more powerful participant), the results only partially confirm Brown and Levinson's hypothesis. As it appears, in/directness may also be affected by different perceptions of power (distance). The New Zealand egalitarian orientation, as opposed to the British respect for authority (see Ashkanasy et al. 2002: 33), may affect the choice of request strategy even in stable power relations.

## 6 Conclusion

The present study focused on request strategies in the U.K. and New Zealand parliaments. The CCSARP framework that was applied was, for the most part, able to accommodate almost all of the examples of parliamentary requests that were collected for the purposes of this study. New categories were added for those that could not fit any of the proposed sub-categories. One of the problematic aspects of the application of the CCSARP framework in this study is that it was unable to capture the specific properties of parliamentary requests pertaining to the participation structure in the two

parliaments (see Murphy 2015). This was particularly clear in the analysis of hints, which shows that parliamentary requests can be realized on two levels at the same time. The question remains how to classify such requests. Due to space limitations, this aspect could not be explored in any detail here but merits further investigation.

There still remains a great deal of work to be done on parliamentary requests. Modification needs to be explored further, as well as the potential effects of the participation structure on the form of parliamentary requests. Quantitative results of the study appear to challenge, in part, the findings of previous studies on the relations between in/directness and power. More research is, therefore, necessary on intralingual variation in requestive behaviour. The issue of politeness in institutional contexts, as an added dimension to the study of requests in parliamentary settings, is a completely unexplored area that warrants further research.

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# The potential link between digestive system and behaviour in children with autistic spectrum disorder

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**Abstract.** Significant number of children with autism spectrum disorder (ASD) in its base have problems with gastrointestinal tract. Fungus Candida Albicans appears as a normal habitant of gut flora but often it appears in very large quantities with children with ASD. By production of fungus sugar, arabinosa, the formation of neurogical sinapsis is being destroyed, and by this the problems appear in psychopsiciological development of a child. This paper presents the literature review regarding the origins of regular gastrointestinal function as well as the gastrointestinal dysfunction in children with ASD. It is emphasised that pathogenetic factors and pathophysiological mechanisms may possibly link ASD and gastrointestinal disturbances as shown by most recent studies. General conclusion and practical application of this paper is seen in concept of an overlapping the ASD syndrome and gastrointestinal disorders which may help in identifying those children with ASD who suffer from an alimentary tract disease. This may significantly improve the diagnosis and treatment commencement in children with ASD.
Key words: autism spectrum disorder (ASD), gastrointestinal tract, digestive system, psychophyisiological development

## 1 Introduction

The key to the mental development of the child lies in his digestive system. Human digestive tract is one long tube that is open to the outside at its both sides. Its entire length is covered with a layer of bacteria, which represents a natural barrier against intruders, undigested foods, toxins and parasites. Every healthy person has an average of about 1.5 kg of bacteria in their guts, which perform many important functions. The main purpose of the digestive tract is digestion and absorption of food. These functions cannot be performed without a healthy gut flora.

Normal gut flora is an important source of energy and nutrition for cells that make up the line of the digestive tract. Useful bacteria that live in the epithelium of the gut, digest the food they encounter and they convert it into substance that feeds the walls of the gut.

When the useful gut flora is damaged or it does not function as it should, the wall of the guts is without protection and is exposed to the invasion of anything that occurs: viruses, bacteria, toxins etc. All of them can damage the digestive system and lead to chronic inflammation of the gut walls. This triggers a chain of degenerative changes in the gut wall structure, further additionally stopping their digestive function and absorption of nutrients.

Protein digestion begins in the stomach by the action of pepsin, an enzyme that digest protein and which is produced in the gastric wall. Stomach acid is crucial for digesting proteins since it creates normal conditions for the activity of pepsin, which should expose proteins to shorter peptide chains. Due to poor gut flora, people with poor digestive system have low levels of stomach acid. Low levels of gastric acid affect negatively the formation of pancreatic enzymes, so this step in digestion is also disturbed. After that, the proteins come to the last stage in the digestion, which is performed in the gut wall. The gut wall is covered with enterocyte cells, which have many digestive enzymes on their surface that perform the final steps in digestion. These cells cannot make the last steps in digestion due to poor gut flora. Abnormal gut flora produces neurotoxins that are absorbed through the damaged guts into the bloodstream and that go to the brain.

A disturbed digestive system occurs with children who are with the autism spectrum disorders, ADHD / ADD, in problems with learning and behaviour, dyspraxia, dyslexia, and also in schizophrenia, depression, bipolar disorders.

## 2 Autism spectrum disorder and digestive system

Autism spectrum disorder (ASD) is a neurodevelopmental disorder with a strong genetic basis and encompasses various conditions with seemingly different phenotypes. ASD is clinically present before the age of 3 years with symptoms concerning mainly two areas which are restricted, repetitive patterns of behaviours, interests, or activities, and persistent deficits in social communication and social interaction (Lai, Lombardo & Baron-Cohen, 2014).

Children with ASD tolerate a narrower range of foods and exhibit more feeding problems than children without ASD (Schreck, Williams & Smith, 2004). Specifically, children with ASD refuse more foods and exhibit a more limited food repertoire than typically developing children (Bandini et al., 2010). Many parents complain that their children with ASD are selective eaters. Children with ASD reject foods for various reasons, including problems with the presentation of the food, the use of certain utensils, and the inclusion of different types of food on the same plate (Schreck & Williams, 2006). Compared with controls, children with ASD ingest fewer fruits, vegetables, and proteins and have a significantly lower daily intake of potassium, copper, folate, and calcium (Sharp et al., 2013; Malhi, Venkatesh, Bharti & Singhi, 2017). Food intake influences the composition of the gut micro biota (Wu et al., 2011).

Clinical manifestation of digestive tract diseases in children with ASD may differ as compared to children with typical development, and the diagnosis of a gastrointestinal (GI) disorder in children may be more difficult and delayed in time. Subjective symptoms such as pain, discomfort, heartburn, or nausea are very difficult to assess and interpret because of core ASD symptoms such as difficulties in verbal and nonverbal communication as well as an altered perception of pain (McElhanon, McCracken, Karpen & Sharp, 2014).

There is a connection between child's autism and a whole host of digestive problems, which these children suffer with. Whatever stool comes out of these children is an overspill, which seeps through a narrow channel in the bowel between large masses of compacted feces. These compactions provide a wonderful environment for all sorts of parasites, worms, bacteria, fungi, viruses to thrive in and to produce large amounts of various toxins, which get absorbed into the bloodstream and distributed around the body. As a result, the child becomes toxic. Our digestive systems are the roots of our health. A tree with sick roots is not going to thrive, it is likely to die. A child with a sick digestive system is not going to thrive and develop normally either. The digestive system in an autistic child instead of being a source of nourishment, as it is supposed to be, becomes a major source of toxicity" (Selakovic, Bojovic & Pavkovic, 2009).

Accumulating evidence demonstrates that gastrointestinal (GI) symptoms, such as abdominal pain, gaseousness, diarrhea, constipation and flatulence, are a common comorbidity in patients with ASD (Chaidez, Hansen & Hertz-Picciotto, 2014). A study by Gorrindo et al. identified constipation as the most common symptom (85%) in children with ASD according to parental reports and evaluations by paediatric gastroenterologists (Gorrindo, William, Lee, Walker, McGrew & Levitt, 2012). The prevalence of GI symptoms ranges from 23 to 70% in children with ASD (Chaidez et al., 2014). Furthermore, the observed GI symptoms are associated with the severity of ASD (Adams, Johansen, Powell, Quig & Rubin, 2011; Gorrindo et al., 2012). The gut consists of millions of micro biota, and we hypothesize that the micro biota and its metabolites might be involved in the pathophysiology of ASD.

Knivsberg, Reichelt, Høien and Nodland, 2002, reported that exacerbation of GI and behavioural symptoms in autism induced by certain foods, particularly those containing gluten and casein, has been shown through dietary intervention and their removal from the diet. Zagon and McLaughlin, 1991 hypothesized the increased passage of exorphins and/or opioids from the diet such as gliadomorphin and casomorphin into the body, where they may interact with the CNS, could play a role in inducing the behavioural features of autism. Opioid peptides and opioid receptors are important modulators of neural development, influencing migration, proliferation, and differentiation within the CNS. Peripherally, opioid peptides are contained and/or produced by the gut, lung, placenta, testis, lymphoid tissue, and immune cells, but also another important source of opioids is from the diet. The endogenous opiates and endorphins can directly influence the immune response,

enhancing generation of cytotoxic T cells and NK cells, and antibody synthesis and act as chemo attractants for monocytes and neutrophils (Weigent & Blalock, 1997).

Wakefield, Puleston, Montgomery, Anthony, O'Leary and Murch (2002) has been hypothesized that an excess of opioid peptides will have detrimental effects on brain development and behaviour, and that autism may result from abnormal levels or activity of opioid peptides. Casemorphine-7, an opioid exclusively of dietary origin, has been shown to be present in patients with psychoses including autism. Indeed, the beneficial effects on autistic behaviour following dietary exclusion therapy are thought, in part, to be a result of reduced opioid intake. Furthermore, therapeutic trials using the oral opioid antagonist naltrexone in some patients with autism have shown improvements in behavioural characteristics such as repetitive stereotypes, hyperactivity, social contact, and self-injurious behaviour (Symons, Thompson & Rodriguez, 2004).

Candida albicans is a yeast-like fungus which inhabits almost all humans. It lives on the moist dark mucous membranes which line the mouth, vagina and intestinal tract. Ordinarily it exists only in small colonies, prevented from growing too rapidly by the human host's immune system, and by competition from other microorganisms in and on the body's mucous membranes. Candida albicans can cause infections (candidiasis or thrush) in humans and other animals, especially in immunocompromised patients (Fugelsang & Edwards, 2010). When something happens to upset this delicate natural balance, candida can grow rapidly and aggressively, causing many unpleasant symptoms to the host.

Some studies showing that candida is able to produce toxins which cause severe long-term disruption of the immune system and may also attack the brain. In extreme cases, they claim, severe disorders, totally resistant to conventional treatment, can occur as a result of candidiasis. These include depression, schizophrenia and, in some cases, autism (Bernard, 1998).

Candida can releases ammonia and toxins that can induce autistic behaviours (Iovene et al., 2017). The alterations of the bacterial micro biota in ASD individuals result in the expansion of Candida, which would worsen the dysbiosis and induce the abnormal behaviours.

## 3 Association between gastrointestinal disorders and behaviour in children with ASD

The presence of GI disorders in children with ASD poses the question about a possible association between GI disorders and severity of ASD symptoms. Behaviour characteristics hypothesized to be expressions of GI problems are common in children with ASD. Facial grimacing, teeth gritting, excessive chewing (of food or items) belong to frequently observed facial expressions of GI symptoms in children with autism. Accompanying vocal behaviours such as sobbing, screaming, or delayed echolalia may also be present. Motor behaviours such as the child placing pressure on the stomach with their own hands or objects, including chairs or tables, may be associated with the abdominal area and are commonly reported by parents and/or caregivers. Such behaviours may be collectively described as abdominal behaviours. Facial expressions and abdominal behaviours may be present as separate entities or coexist with general motor behaviours. General motor behaviours typical for this group of children include self-injuries, increased repetitive/stereotypic movements, unusual posturing, or tapping/twitching. Stomach pain or abdominal discomfort in children with ASD may be indicative of motoric excitation which in turn may have an effect on the general state of the child expressed as irritability, oppositional behaviour, or sleep disturbances (Buie et al., 2010). Children with abdominal pain are more likely to present with these psychological disorders, anxiety, behavioural problems, or other psychological symptoms.

In a study by Gorrindo et al, GI dysfunction was significantly associated with sleep disorders and food intolerance but not with irritability or aggressiveness (Gorrindo et al., 2012). In their study, the most common type of GI disorder in children with ASD (85.0%) was functional constipation and was significantly associated with language impairment. Associations between behavioural problems and GI symptoms were also studied among children with varying subtypes of ASD (i.e. high-functioning autism, atypical autism with delayed neurodevelopment)

Extra digestive symptoms of the alimentary tract include difficulty falling sleep and difficulty staying asleep and have been found in 44%–83% of children with ASD (Horvath, Papadimitriou,

Rabsztyn, Drachenberg & Tildon, 1999; Schreck, Williams & Smith, 2004). Horvath and Perman reported disturbed sleep and night-time awakening in 52% of children with ASD who had GI symptoms.

## 4 Conclusion

According to current recommendations, children with ASD are at risk of having alimentary tract disorders. GI symptoms may overlap with ASD core symptoms through different mechanisms. Shared pathogenetic factors and pathophysiological mechanisms may possibly link ASD and GI disturbances as shown by most recent studies. ASD is a genetically determined developmental brain disorder; however, immune dysregulation, GI inflammation, malfunction of the ANS, genetic and metabolic activity of the micro biome, and dietary metabolites may contribute to brain dysfunction and neuroinflammation depending upon individual genetic vulnerability. ASD has a heterogeneous phenotype with different subphenotypes of which some reflect GI abnormalities. Practical use of the concept of an overlap syndrome of ASD and GI disorders may help in identifying those children with ASD who suffer from an alimentary tract disease. Unexplained worsening of nonverbal behaviours such as agitation, anxiety, aggression, self-injury, or sleep deprivation should alert caregivers, physicians, and other professionals about this possibility. This may speed up the diagnosis and treatment commencement, and alleviate both GI and ASD symptoms through reducing pain, stress, or discomfort by treating the comorbid disorder.

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## Veza između digestivnog sistema i ponašanja kod dece sa autističnim spektrom poremećaja

Značajan broj dece sa autističnim spektrom poremećaja (ASP) u osnovi ima problema sa gastrointestinalnim traktom. Gljivica Candida Albicans se pojavljuje kao uobičajeni stanovnik crevne flore, ali se često pojavljuje u vrlo velikim količinama kod dece sa ASD. Proizvodnjom gljivičnog šećera, arabinoze, uništava se stvaranje neuroloških sinapsi, i time se problemi pojavljuju u psihofiziološkom razvoju deteta. Ovaj rad predstavlja pregled literature u vezi sa poreklom pravilne gastrointestinalne funkcije, kao i gastrointestinalne disfunkcije kod dece sa ASP. Naglašeno je da patogenetski faktori i patofiziološki mehanizmi mogu dovesti u vezu ASP sa gastrointestinalnim poremećajima, a kako pokazuju najnovije studije. Opšti zaključak i praktična primena ovog rada vidi se u konceptu preklapanja sindroma ASP i gastrointestinalnih poremećaja, koji može pomoći u identifikaciji upravo dece sa ASP-om koja boluju od bolesti alimentarnog trakta. Ovo može znatno poboljšati dijagnozu i početak lečenja kod dece sa ASD.

# Applying phonetics in communication disorders research – perspectives in Bulgaria

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**Abstract.** Phonetics and its instruments are widely recognized as a very useful device in scientific research concerning communication disorders. The studies of this type in Bulgaria are very few. So this paper offers a review of the most explored acoustic features in studying communication disorders with no or a few experiments in Bulgaria. The clinical value of these measures in speech-language pathology is discussed. The results of conducted experiments with Bulgarian speaking peers are also presented.

## 1 Introduction

There is enough evidence for the necessity and use of applying phonetics in communication disorders research (Howell 1995; Baken, Orlikoff 2000; Crystal 2002; Powell and Ball 2010). The researchers and therapists in speech-language pathology are aware of this necessity and the phoneticians perceive this field as a challenge and a way to explore the possibilities of experimental phonetics (Kent and Read 2002). The link *phonetics-communication disorders* has a long history - more than half a century. The application of the phonetics and phonology principles in studying the nature of communication disorders has started since the middle of the 20th century (see Powell and Ball 2010).

Meanwhile the improvements of experimental phonetics lead to the progress of clinical phonetics - one of the fast developing scientific fields in the world (Howell 1995, Baken, Orlikoff 2000, Crystal 2002, Powell and Ball 2010). So for a relatively short period of time a great progress has been made but most of the experiments include English speaking peers (Crystal 2002). That is why Crystal appeals for more research conducted with subjects speaking other languages than English (Crystal 2002). This could enrich our knowledge for the nature of the disorders and would broaden the possibilities of studying their specificity. For Bulgarian this appeal is still current.

The Bulgarian scientists in Logopedy are aware of the importance of phonetics in studying communication disorders and there are studies, though very few, of applying phonetic principles (see Padareva-Ilieva 2015 for a review). On the other hand there are interesting phonetic experiments the results of which could be applied in speech-language pathology (Misheva, Tilkov 1976; Misheva 1980; Misheva 1987; Kurlova, R. 1991; Conev, P. 2007; Andreeva et al. 2013, etc.). But there is little evidence either for applying these results in studying communication disorders and in speech-language therapy or for a real collaboration between phoneticians and therapists. As a result, although there are some experiments (Padareva-Ilieva et al. 2012; Georgieva 2009; Simonska 2008; see Padareva-Ilieva 2015 for a review) applying acoustic phonetics in communication disorders, we must admit that they are too insufficient. So the field is not well developed but perspective and challenging.

The aim of this paper is to present the most explored acoustic features in studying communication disorders with no or a few experiments in Bulgaria. The necessity and the direct application of these measures in speech-language pathology are discussed. The results of conducted experiments with Bulgarian speaking peers are also presented.

The paper reviews mainly studies in stuttering and in voice disorders but also includes studies concerning hearing disorders, and disorders of speech and language: aphasia, apraxia and dysarthria.

## 2 Acoustic-phonetic Parameters in Segmental System

### 2.1 Formants and Formant Transitions Analyses

The formant analyses are informative especially in studying the nature of fluency disorders. They are important also in proving persistent stuttering indicating stability or instability in vocal tract configuring. For example, Brosch finds out that stuttering children getting more fluent demonstrate higher F2 in vowel duration (Brosch 2002).

Many experiments which analyze the formant structure actually concern formant transitions. Formant transitions are important because they reflect the dynamics of the articulation process. The variations in this parameter depend on the context of the vowel and this makes such experiments very difficult (Kent and Read 2002). A lot of studies are dedicated to F2 transitions in the past decades (Stromsta, 1965; Yaruss and Conture, 1993; Robb M. and Blomgren M. 1997; Robb, Blomgreen and Chen, 1998; Kowalczyk, P., Yairi, E. 1995; Savithri, S. R. 2002; Chang, Ohde, and Conture 2002; Sebramanian A. et al. 2003) and nowadays (Dehqan, A., F. Yadegari, M. Blomgren, Ronald C. Scherer 2016; Spray, G., J. Nitzkin, Soo-Eun Chang, M. Berardi 2016; Padareva-Ilieva et al. 2012). The studies prove that the pattern of second formant transitions is variable - sometimes absent or atypical and when they are appropriate they tend to be short in duration and adults with chronic stuttering tend to reveal appreciable variations in F2 transitions (Robb M. and Blomgren M. 1997; Yaruss and Conture, 1993; Namita and Savithri, S. R.2002; Chang et al 2002; Kowalcuzk and Yairy 1995; Padareva-Ilieva et al. 2012; Dehqan, A., F. Yadegari, M. Blomgren, Ronald C. Scherer 2016). During these experiments researchers pay attention to specific measures of F2 which give certain information about the articulation process and prove that this acoustic parameter is important for differentiating stuttered and nonstuttered speech and also as an indicator of stuttering chronicity.

A preliminary study, the first one in Bulgaria, focused on F2 transitions in stutterers and nonstutterers (Padareva-Ilieva et al. 2012) was presented at CPLOL 2012. Using Motor Speech Profile the experiment shows that F2 transition is a useful acoustic parameter with a high correlation to perception of intelligibility of a vocalization. Even though the results should be viewed with caution because the number of subjects and tokens is small, this experiment proves that there is a difference between stuttered and nonstuttered speech concerning F2 transitions.

With regard to using this parameter for measuring therapy effectiveness, I am inclined to express my doubts whether it is about adult stutterers. First of all, there is no evidence and, second, if we presume that F2 transition is an indicator for chronic stuttering and a differentiator of stuttered and non-stuttered speech even though it is fluent (Savithri 2002), I think that this parameter could hardly be improved after therapy. Still future experiments concerning this issue could confirm or deny this assumption.

### 2.2 VOT

One of the most explored acoustic parameters in segmental analyses in aphasia is voice onset time. This parameter is the most reliable acoustic cue for the distinction between voiced and voiceless stops in syllable onset. It is also useful to analyze mistakes in place of articulation. Subjects with aphasia produce equal VOT for voiced and voiceless consonants. This fact could be interpreted as misselected phonemic targets (Tuller 1984). The most important goal in acoustic measurements in speech disorders is the establishment of a correlation between the acoustic abnormalities and phonetic perturbation (Auzou et al. 2000). The critical review of the measurements of VOT in aphasia, apraxia and dysarthria reveals that VOT perturbations in aphasia have been interpreted as phonemic or phonetic errors, while VOT abnormalities in apraxia of speech and dysarthria reflect loss of motor control (Auzou et al. 2000).

VOT also is an indicator predicting stuttering. Brosch claims that the higher the values of VOT are, the higher the stuttering severity is (Brosch et al. 2002). It is also established that stutterers demonstrate variability in VOT producing voiceless stops (Kalveram et al. 1989). VOT is dependent on place of articulation and speech rate. So measuring VOT in different consonant-vowel combinations, in different word positions and in different prosody could change the results. De Nil

and Brutten (De Nil, Brutten 1991) prove that there is a difference in VOT between stutterers and nonstutterers when the speech rate is higher. Stutterers produce longer VOT especially in C+V than in C+C combinations. VOT is different between different languages too (Cho, Ladefoged 1999).

There are comparative studies in VOT for Bulgarian and other languages (Andreeva, Wolska 2011; Rangelov 2013; Dokokova 2015) but none of them includes peers with some kind of communication disorders.

### 2.3 Segment Duration

Many studies in communication disorders measure segment duration. They are interesting primarily because of their link to the perception – whether the speech is natural or unnatural. A part of these studies uses duration measurement as a distinction between stuttered and nonstuttered speech. Amir and Yairi (Amir, Yairi 2002) investigate vowel duration of a chosen repeated segment in disfluent speech as well as the duration between repetitions trying to verify the impact of temporal parameters on the perception of stuttered speech. The results show that both factors have an influence on the perception. But repeating short vowels and short intervals between them is rather rated as disfluent speech. Such experiments are important for understanding the specificity of perception of stuttered speech but also for possible application in therapeutic solutions.

Measuring duration is probably also important because of the *prolonged speech* technique. But prolongation is often perceived as unnatural. Schaeffer and Eichorn (2001) conduct such an experiment trying to reveal in what duration and what kind of context the listeners would perceive the speech as unnatural. However, I think that such kind of studies would be really useful for the therapists but some factors specific for different languages such as vowel length as a distinctive feature, standard vowel length (stressed and unstressed), standard speech rate, etc. should be respected.

Andreeva (Andreeva et al. 2013) conducted a corpus study concerning Bulgarian vowel system including vowel duration but still there is no sufficient evidence measuring duration of peers with communication disorders.

The duration of phonation time is usually measured in voice disorders. Maximum Phonation Time is the most reliable acoustic parameter in therapy of voice (Speyer et al. 2004). In Bulgaria Georgieva has an experience with voice disorders. She was exploring the role of the computerized speech lab (csl) in voice disorders' instrumental diagnostics (Georgieva 2009; Georgieva, D., A. Stefanovska 2007).

## 3 Suprasegmentals

### 3.1 Stress

Studying the stress as an effect which exerts influence on stuttering has a long history and lots of experiments are dedicated to it. Some of them are based on the statement that stuttering moments are categorically linked to the stressed syllables (Natke 2002; Wingate 2002). Moreover, because of the sufficient evidence for such a link and the popularity of the correlation, this factor is called *stress effect*. But we have to point out something important. It is established that stuttering is linked to the word initial position (Natke 2004; for Bulgarian – Georgieva and Alevizakis 1999; Simonska 2012; Padareva-Ilieva and Georgieva 2012) but in English as well as in German the stressed syllable usually is in word initial position (Natke 2004). In Bulgarian the case is different. The word stress does not have a particular position. Padareva-Ilieva and Georgieva prove that stuttering moments in spontaneous speech of adult stutterers are linked to unstressed syllables (Padareva-Ilieva and Georgieva 2012). This statement could provoke a discussion on the correlation *stuttering-stress* but it also asserts that experiments conducted with peers speaking different languages will improve our knowledge in communication disorders.

### 3.2 Pitch. Prosody Model

Pitch is usually measured in stuttering and voice disorders but it also has a great importance in hearing research. Many researchers accept that stuttering moments are linked to changes in tonal contour (Wingate 1979; Karniol 1995; Zmarich C., Farnetani 1997). It is established that the fluent speech of stutterers is more different than the fluent speech of nonstutterers. Fluent speech is variable in pitch but too many variations are unnatural. Studies measuring F0 of statements and questions spoken by stutterers and nonstutterers reveal that stutterers demonstrate significantly low F0 (see Baken, Orlikoff 2000 for a review). In Bulgaria Georgieva has conducted an experiment and reports higher values for spontaneous speech (Georgieva 2009).

Zmarich and Farnetani study the correlation between stuttering moments and prosody model in Italian. They claim that the frequency of stuttering is getting higher on the focused words (Zmarich C., Farnetani 1997). Such experiment in Bulgarian would be very interesting because it is proved that the change of a prosody model in focused words could cause a change in the semantics of the utterance (Padareva-Ilieva 2013).

Studies in prosody have been conducted with hearing impaired people too (Most, Peled 2007; Allen, Arndorfer 2000; Frank and Most 1991). No evidence was found for Bulgarian hearing impaired.

## 4 Conclusions

This paper confirms that acoustic-phonetic measures are absolutely necessary either in studying the nature of communication disorders or in speech-language therapy. But of course the results should be viewed with caution as they are not themselves a diagnosis. It needs deeper knowledge in vocal tract functioning and acoustic parameter clinical value as well as linguistic knowledge about the specificities of the language and ability to analyze these correlations. But having all these acoustic-phonetic measurements are invaluable when studying the communication disorders.

As the paper has showed, the studies of the type in Bulgaria are extremely insufficient. Anyway the available evidence from the conducted experiments in Bulgaria indicates good perspectives. Future studies including Bulgarian speaking peers will enrich our knowledge about communication disorders and of course the results could be applied in clinical practice.

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# The algorithm for the automatic detection of phoneme intensity disorders

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**Abstract.** Using the phoneme intensity variation fields for typical and atypical pronunciation that are defined based on the perceptual experiments, it is possible to form an algorithm for the automatic detection of phoneme intensity disorders. In order to measure the intensity of the phonemes, their boundaries within the spoken words are determined using the algorithm for the automatic segmentation. The algorithm is based on the dynamic time warping, and the speech signal is parameterized using the MFCC coefficients. The performance of proposed algorithm is tested on samples from the database of pathological speech.

## 1 Introduction

Qualitative and quantitative assessment of speech pathology is obtained by the means of tests and procedures that are used in speech therapy practice. A subset of tests is used to estimate the degree of speech disorders at different levels of articulation (Kostić, Vladisavljević & Popović, 1980). Traditionally, the existence of articulation disorders is determined based on the audio-visual assessment performed by the experts - speech therapists and it is based on the knowledge in the field of typical and atypical articulation and acoustic characteristics of the phonemes. This approach to evaluation is subjective and depends largely on the therapist's experience and other human factors that may vary over time. Development of the system for automatic evaluation of speech disorders would reduce the human factor effects and considerably improve clinical practice. With the development in the field of speech signal processing, especially in the area of automatic speech recognition and classification, the researchers recognized the potential of these methods and their application in the field of pathological speech detection (Maier et al., 2009; Danubianu et al., 2009; Pentiuc et al., 2010; Bilibajkic et al., 2016)

Variations in phoneme pronunciation are an inherent feature of speech communication. Nevertheless, when these variations become atypical (distortion) or fall into to the articulation field of another phoneme (substitution) then the pronunciation is considered to be pathological. Changes in the acoustic structure of produced phonemes can be manifested in the time, amplitude and frequency domain. The intensity of the phoneme as an acoustic feature is important for distinguishing between typical and atypical production. The existence of clear criteria in terms of the intensity of phonemes is important both for the development of speech technologies, as well as for logaoedic theory and practice (Plante & Beeson, 2007).

## 2 Method

In order to create an algorithm for the detection of the intensity disorders of phonemes, it is necessary to determine the boundaries within which pronunciation is considered to be normal (typical). Then, it should be determined whether the absolute values of the phonemes intensity can be used to differentiate the normal and pathological pronunciation, or they must be observed relative to the rest of the word. In section 2.1, the most significant results of statistical tests regarding the characteristics of the intensity of phoneme /ʃ/ (which is taken as an example for the implementation and testing of the proposed algorithm) are shown.

The first step in the automatic procedure for determining the intensity disorder of the phoneme is to determine the boundaries of the beginning and the end of the phoneme within the spoken word. This could be achieved using the algorithm for automatic segmentation, and the phonemes intensity can be

calculated as intensity of the audio signal between these two boundaries. By applying the criteria functions, which define the limits between normal and pathological pronunciation, the existence of the pathology in terms of intensity of pronounced phoneme could be determined. The proposed algorithm for automatic segmentation at the level of phonemes and the algorithm for automatic detection of intensity disorders are given in sections 2.2 and 2.3 respectively.

### 2.1 Intensity characteristics of frication for phoneme /ʃ/

For the pathological pronunciation of fricatives, regarding the quality of frication in terms of intensity, it is possible to differentiate between strong and weak frication (Punišić, 2012). Research in the field of speech pathology, based on the measurements and analysis of the intensity of normal and pathological pronunciation of phonemes, showed that there are areas of separation between typical and atypical production. For phoneme /ʃ/ measurements included 77 pronunciations, of which 43 were typically and 34 atypically articulated. The research was conducted using the word /ʃuma/ ("forest" in Serbian). The initial phoneme /ʃ/ was manually selected. The ratio R is defined as:

$$R = \frac{I_v}{I_f} \tag{1}$$

where $I_f$ represents the mean intensity of the initial fricative /ʃ/, and $I_v$ represents the mean intensity of the part of the adjacent vocal of same duration as the initial fricative. The mean intensities of the segments are calculated in *Praat* (Boersma & Weenink, 2017) aplication.

The distribution of the *R* value for the fricative /ʃ/ is shown in the Fig. 1 (R = Ratio /u/-to-/sh/ (dB)). The obtained data fits the normal distribution (Kolmogorov-Smirnov Goodness of fit test, P = 0.54827). The concentration of the values in the histogram ranges from -3 dB to 12 dB. Outside this range, the frication is considered to be atypical, i.e. weak frication for ratios below the -3 dB and strong frication for ratios above 12 dB (Punišić, 2012).

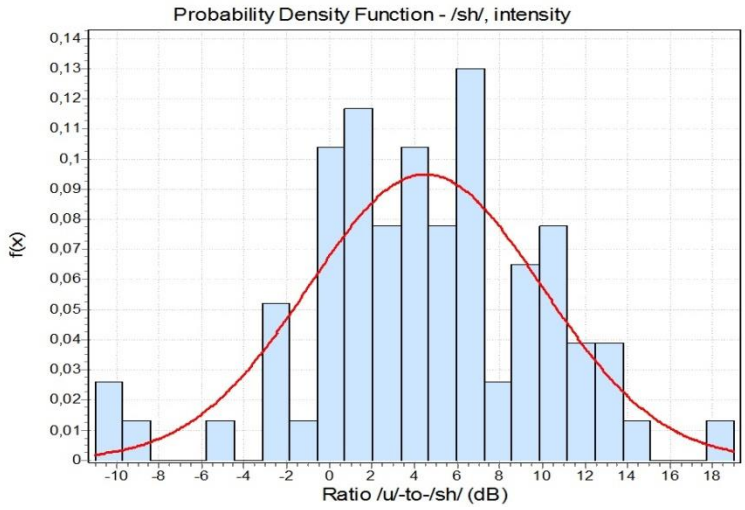


**Fig. 1**. Distribution of the ($I_v/I_f$) ratio (adopted from Punišić, 2012)

Similarly, the distribution of intensity ratio for other phonemes can be identified. In the (Punišić, 2012), the distributions are given for phonemes /ts/, /tʃ/, /ʒ/, /dʒ/, /r/ i /l/ an they could be implemented in the algorithm.

### 2.2 The algorithm for automatic segmentation

The boundaries of the phoneme of interest are determined using the automatic segmentation algorithm. The test word, to which the boundaries of the phonemes are to be set, is first parameterized by means of 12 MFCC (*Mel Frequency Cepstral Coefficients*) coefficients (Davis & Mermelstein,

1980). Analysis frames were 256 samples long, with 50% overlap. The speech was recorded with the sampling frequency of 44100 Hz, decimated to 11050 Hz. The filter bank consisted of 24 filters, covering the range from 110 Hz to 5512 Hz. Finally, the parameterization of each of the analysis frames was performed with 12 cepstral coefficients, i.e. coefficients from second to thirteenth. After the parameterization of the test sample, it is time aligned using the DTW (*Dynamic Time Warping*) (Rabiner & Juang, 1993) method with all representative reference samples from the GAT (*Global Articulation Test*) database. The GAT database was formed as a set of speech samples pronounced by 48 adult speakers (both sexes, various ages and speech pathologies). Each of the subjects pronounced the given stimulus, 30 of them, in the form of isolated stimuli - words from the list of Global Artuculation Test (Kostić, Vladisavljević & Popović, 1980), where each word contains a phoneme of interest for analysis. The examined phonemes are in the initial position in the case of the consonants, or in the inter-consonant position when testing the vocals. This speech database is manually segmented by trained experts using the audiovisual method. As a result of DTW procedure, for each pair of the test and corresponding reference samples from the database with the same phonetic structure, a set of values is calculated. Those values are: (1) the optimal path, (2) the optimal path weight (the total accumulated distance) and (3) the position of the boundaries.

It has been experimentally proven that the segmentation obtained by adopting the boundaries calculated by the reference model with the lowest value of the optimal path weight is not necessarily the best solution (Bilibajkić, Šarić & Jovičić, 2011; Bilibajkić, 2011). The final position of the boundaries is obtained based on the position of the corresponding boundaries of the K nearest neighbors. KNN (K-*Nearest Neighbors*) the procedure in this case was not used strictly for the classification of the samples. The process is modified so that it determines K nearest neighbors whose contributions are scaled so that neighbors with a lower value of the distance from the test sample have a greater influence on the assigned property, and those with a higher value of the distance, a lesser impact on the assignment of the property. The weight of the optimal path was taken as a criterion for the selection of neighbors. In this particular case, it was established that, in order to achieve the optimal value of the boundaries the position, 10 samples with the minimal optimal path weights should be used (Bilibajkić, 2011). The contribution of each of the neighbors is scaled with the coefficient $C_i$:

$$C_i = 1/S_i \quad , \qquad i = 1..K \tag{2}$$

where $K$ denotes the number of neighbors and $S_i$ optimal path weight of *i-th* neighbor.

### 2.3 The algorithm for the automatic detection of phoneme intensity disorders

Based on the experimentally determined limits for the intensity ratio for typical and atypical pronunciation of phonemes, and using the values for the boundaries of the initial phoneme (obtained by the algorithm for automatic segmentation), an algorithm for detection of phoneme intensity disorder can be formed. The block diagram of the algorithm is presented in Fig. 2.

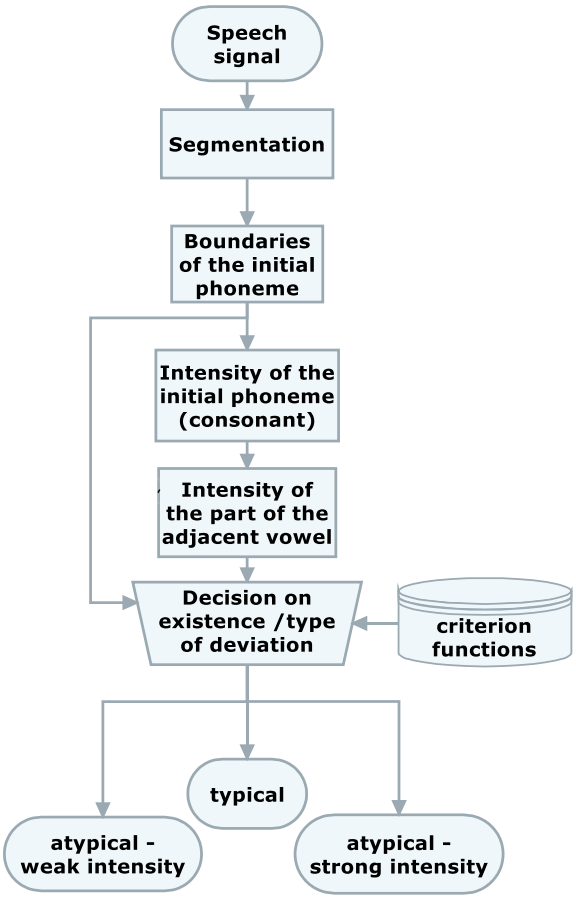


**Fig. 2** The block diagram of the algorithm for the automatic detection of phoneme intensity disorders.

The decision on the existence and a type of deviation in the form of pathological intensity of phoneme is made according to the criterion function. The criterion functions are derived from distribution of intensity ratio and define three areas:

1. Weak intensity - atypical
2. Typical
3. Strong - atypical

The result of the algorithm is the affiliation of the input speech signal with the one of the three areas based on the intensity ratio $R$ calculated for the input phoneme. Criterion functions for phoneme /ʃ/ are given in the Table 1, and they are formed using estimated distribution of the ratio $R$, shown in Fig. 1.

**Table 1**. Criterion functions for phoneme /ʃ/

| Criteria for ($R=I_v/I_f$) intensity ratio | Area |
|---|---|
| R≤-3 dB | Weak - atypical |
| -3 dB <R<12 dB | Typical |
| R ≥12 dB | Strong - atypical |

### 2.3 The algorithm for the automatic detection of phoneme intensity disorders

The proposed algorithm for the automatic detection of intensity disorders was implemented in MATLAB. It is tested on the recordings from the GAT database. Only the recordings for word /ʃuma/ were used.

Testing was performed using Leave One Out (LOO) cross-validation (Kohavi, 1995). Fig. 3 shows the results obtained for this set of subjects. Intensity ratios calculated for the manually segmented initial phonemes are represented with blue diamonds (real values), and the intensity ratios calculated using the automatically determined boundaries of initial phoneme are represented with red diamonds (measured values). It may be noted that two of the 48 samples from the database would be wrongly diagnosed using automatic detection. The sample no. 4 is situated just at the lower limit of the "typical" zone with the intensity ratio of -2.94 dB, and the difference between real and automatically measured intensity ratios of 0.87 dB. The other sample, sample no.38, with the intensity ratio of $R$=-2.53 dB is considered to be "typical", but the automatically determined intensity ratio of $R$=-3.01 dB associated it with the atypical pronunciation.

The presented algorithm can be used for other phonemes (Punišić, 2012) if the areas of the normal and pathological intensities are known.

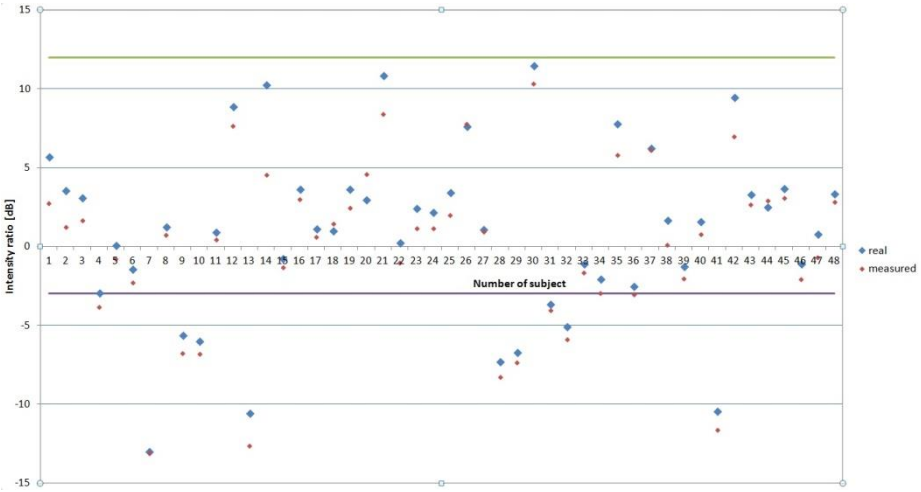


**Fig. 3.** Results for phoneme /ʃ/ - GAT database

## 3 Conclusion

In this paper we presented an algorithm for automatic detection of phoneme intensity disorders. Based on the automatic segmentation and distribution of intensities (that define the limits between normal and pathological pronunciation of phonemes) the algorithm makes a decision on the affiliation of the examined phoneme to one of the three areas that indicate weak (atypical), typical and strong (atypical) intensity. Proposed algorithm was tested on samples from the database of pathological speech. The results showed that algorithm correctly assesses the pathology of initial phoneme from the word /ʃuma/ in 95% of cases. The presented algorithm can be used for other phonemes with known intensity distributions for typical and pathological pronunciation.

**Acknowledgement** - This work was supported in part by the Ministry of Education, Science and Technological Development under Grant numbers OI-178027 and TR-32032.

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## Algoritam za automatsku detekciju poremećaja intenziteta glasova


Koristeći varijaciono polje karakteristike intenziteta fonema za tipičan i atipičan izgovor koji se definišu na osnovu perceptualnih eksperimenata, moguće je formirati algoritam za automatsku detekciju poremećaja intenziteta glasova. Da bi se odredio intenzitet glasova, njihove granice u okviru reči određuju se pomoću algoritma za automatsku segmentaciju. Algoritam se zasniva na algoritmu dinamičkog vremenskog usklađivanja, a govorni signal je parametrizovan koristeći MFCC koeficijente. Performanse predloženog algoritma testirne su na uzorcima iz baze podataka patološkog govora.

# The treatment of relative clauses through the explicit teaching of syntactic properties: two pilot studies on Italian cochlear-implanted children

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## 1 Introduction

Hearing impaired children show delayed and atypical comprehension and production of syntactically complex structures, such as relative clauses (Volpato & Adani, 2009; Volpato, 2010, 2012; Volpato & Vernice, 2014).

Relative clauses are subordinate clauses derived by WH-movement (Chomsky, 1995) which are acquired at different stages of language acquisition (Guasti, 2002; Utzeri, 2007; Volpato, 2010; Belletti & Guasti, 2015). For this study we analysed three types of relative clauses: subject relative clauses SRs (1a), object relative clauses with a preverbal embedded subject ORs (1b) and object relative clauses with a postverbal embedded subject ORps (1c), which distinguish themselves on the basis of which grammatical role the head of the relative clause has within the embedded clause.

(1) a. Mi piace il bambino che [<il bambino> pettina i cavalli]
I like the child that ___ combs the horses
b. Mi piace il bambino che [i cavalli pettinano <il bambino>]
I like the child that the horses comb ___
c. Mi piace il bambino che [pettinano i cavalli <il bambino>]
I like the child that comb the horses ___

In the examples in (1), the NP *il bambino* 'the child' is pronounced in a position that is different from the one in which it is interpreted with respect to the embedded verb. In (1a) *il bambino* is interpreted as the subject of *pettina* 'combs', whereas in (1b) and (1c) *il bambino* is interpreted as the object of *pettinano* 'comb'. The processing of these structures is characterized by clear asymmetries: SRs are easier than ORs and ORps; and ORs are easier than ORps.

Such asymmetries are much evident in the populations with language impairments such as children with Specific Language Impairment (SLI), agrammatic aphasics, and hearing-impaired children, even though they are also observed in (young) typically developing populations.

Previous studies have shown that it is possible to rehabilitate complex structures, such as relative clauses, through the explicit teaching of syntactic movement (Thompson & Shapiro, 1995; Levy & Friedmann, 2009). Following these studies, our study aims at applying the same strategy to two Italian-speaking cochlear-implanted (CI) children, who showed an impaired production and comprehension of relative clauses.

## 2 The experiment

The participants at this study are: S1, a boy aged 8;5, and S2, a girl aged 10;5. Both participants suffer from profound sensorineural hearing loss and are fitted with a CI[23]. They were born from hearing families, followed a speech therapy, and they do not use any sign language. They were selected and tested at the Ear Nose Throat Clinic Department of Neurosciences of the University of Padua (ENT Clinic, henceforth), where they passed a screening test for hearing and audio-perceptual tests, administered by a speech therapist.

[23] They received a CI at different ages. LB received his CI at the age of 2;7. ES received her CI at the age of 8;4.

We analysed the production and comprehension of relative clauses with two tests developed by Volpato (2010). The production of relative clauses was assessed with an elicited production task, while the comprehension of these structures was analysed with an agent selection task.

The results before the treatment showed for both children the typical asymmetry between SRs and ORs. More in detail, S1 showed an absent production of ORs, and S2 showed an impaired comprehension of SRs and ORps.

Given their difficulties with relative clauses, they were selected for a treatment approach based on the explicit teaching of the syntactic movement. However, the two interventions have different purposes: The intervention on S1 tested the efficacy of the explicit teaching of syntactic theory on a CI child and the duration over time of its effects, while the intervention on S2 examined generalization effects to untrained sentences derived from the same type of syntactic movement. In addition, generalization effects on narrative skills were also considered.

The treatment based on the explicit teaching of syntactic movement includes three stages. The first stage is focused on Verb argument structure[24] and Theta Criterion[25], in order to turn LB's implicit knowledge into explicit knowledge, which could be used as a support during the explanation of WH-movement (as in Levy & Friedmann, 2009). The second stage of the treatment aims at teaching the syntactic movement through a card game, which enabled the children to see and touch the syntactic movement. The third session comprised the review of the topics taught during the previous sessions.

The results collected after the treatment showed the participants' improvement for both tasks and in each sentence type assessed. The effects were maintained also several months after the end of the treatment.

## 3 Conclusion

We analysed the production and comprehension of relative clauses in two Italian-speaking CI children, in order to analyse whether a delay in the processing of these structures exists and whether it is possible to rehabilitate relative clauses through the explicit teaching of syntactic movement.

Before the treatment, the participants at our study showed an impaired production and comprehension of relative clauses. After the treatment and also several months after its completion, the participants showed an improvement for all the structures assessed. Therefore, the treatment based on the explicit teaching of syntactic theories is feasible also in CI children.

Concluding, the reliability of a treatment based on the explicit teaching of syntactic theory was confirmed also for CI children.

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[24] Verb argument structure specifies the number of obligatory arguments the verb requires. Depending on how many arguments the verb can assign, it is possible to distinguish four verb categories: zero argument verbs which take no arguments (*it rains*); intransitive verbs which only take one argument (*laugh*); transitive verbs which take two arguments (*break*); ditransitive verbs which take three arguments (*give*).

[25] The verb assigns to each argument in the sentence one and only one thematic role, which determines the semantic relationship between the verb and its arguments.

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# The production of Wh- questions in a group of Italian cochlear-implanted children

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**Abstract.** The acquisition of complex syntactic structures is problematic for children with hearing impairment, even for those who use cochlear implants. This study investigates for the first time the production of *wh*-questions in a group of 8 cochlear-implanted children, in order to compare their performance with that of 8 normal hearing children. Accuracy is lower in the group of cochlear-implanted children than in controls. However, individual performance variability was observed. Some cochlear-implanted children show good competence in Italian and use response strategies found in older children; other children produce ungrammatical sentences and sentences attested in young children's productions, which is evidence of the linguistic delay associated to hearing impairment, even when they are fitted with cochlear implants.

## 1 Introduction

Comprehension and production of complex syntactic structures are important abilities that allow to reach a good level of linguistic competence in the target language. These activities could be affected by preverbal sensorineural hearing loss, which blocks the transformation of the acoustic stimuli into neurological signals, causing a misprocessing of the auditory information by the brain (Aimar et al., 2009; Kral & O'Donoghue, 2010). Cochlear implants (CI, henceforth) are able to provide easy access to the sound and to the language, thus increasing the level of linguistic competence, even though previous research has shown that Italian-cochlear-implanted children have troubles with complex syntactic structures, namely relative clauses (Volpato & Adani, 2009; Volpato, 2010; Volpato, 2012; Volpato & Vernice, 2014) and sentences containing clitic pronouns (Guasti et al., 2012). Given the importance of early exposure to language in order to develop linguistic skills properly, this study investigates whether children who access language with delay due to hearing impairment are comparable to normal hearing peers in the use of interrogative sentences.

In this study, we test interrogative sentences introduced by *who* and *which* followed by a noun phrase (NP). Interrogative sentences are divided into subject and object *wh*- questions, depending on the grammatical function of the *wh*- element, either the subject (1a-2a) or the object (1b-2b) of the verb.

(1) a. Chi ___ lava i cani
Who washes the dogs?
b. Chi lavano ___ i cani?
Who wash the dogs?
Who do the dogs wash?

(2) a. Quale cuoco ___ saluta i calciatori?
Which chef greets the football players?

b. Quale cuoco salutano ___ i calciatori?
Which chef greet the football players?

In Italian, sentences like (1a-2a) are subject questions in which the singular verb agrees with the *wh*- operator and the NP in post-verbal position is plural. The sentence in (1b-2b) is an object question, in which the plural verb agrees with the plural subject in post-verbal position. In Italian, the *wh*- element *chi* ('who') which introduces an interrogative sentence is always singular. When the noun after the verb is plural, only verb agreement helps interpret a sentence either as a subject or as an

object question[26]. *Wh*- questions are characterised by a dependency between the *wh*- operator in sentence initial position and a gap (___) in the position in which this operator is interpreted. This dependency is short in subject questions, which follow the canonical Italian SVO (subject-verb-object) word order, and is longer in object questions, which show a non-canonical (OVS) word order.

Given that the structure of object *wh*- questions is more complex compared to that of subject *wh*- questions, in literature, an asymmetry between subject and object questions in both comprehension and production has been observed (De Vincenzi, 1991, De Vincenzi et al. 1999; Guasti et al., 2012; Del Puppo et al., 2016). In typical language development in Italian, subject questions are fully comprehended by the age of 4, while object questions are problematic until the age of 10 years. As for production, children produce high percentages of subject questions at the age of 4-5 years (88% for *who* questions; 80% for *which* questions), but the percentage of object questions is lower (71% and 73%, respectively) (Guasti et al., 2012). Even at an older age (6-9 years) object questions show lower percentages of occurrence than subject questions (Del Puppo et al., 2016). Various strategies are adopted for object questions, all of which were correct and appropriate for the context.

In populations with hearing impairment, the acquisition of *wh*- questions is delayed in hearing impaired speakers of English and Hebrew since they have difficulties understanding and producing complex syntactic structures, containing long-distance dependencies (English: Quigley et al., 1974; Hebrew: Friedmann & Szterman, 2011; Palestinian-Arabic: Friedmann & Haddad-Hanna, 2014). In production tasks, ungrammatical sentences are often uttered when *wh*- questions are targeted. No data on the acquisition of *wh*- questions are available for Italian hearing-impaired children. Therefore, it is important to test these syntactic structures also in this population in Italian, since *wh*-questions are very common in both spoken and written language and their comprehension and production is crucial from a pragmatic point of view both in daily communication and in classroom activities.

## 2 Methodology

In this section we describe the participants of the experimental and the control groups, the task, and we provide an analysis of the response strategies.

### 2.1 The experimental group

The experimental group is composed of 8 hearing impaired children fitted with a CI (CI-group, henceforth), ranged in age from 7;5 and 10;10 (mean age: 8;7). Seven participants suffer from bilateral sensorineural hearing loss, and one from bilateral mixed hearing loss. The participants were born to hearing parents and are hearing impaired since birth. They were diagnosed and fitted with a hearing aid (HA, henceforth) in a period comprised between the birth and 3;6 years. The participants received the CI between 0;7 and 8;8 years, therefore their experience with the CI varies between 1;2 and 7;1 years. Three participants receive a monaural stimulation through a CI. Five participants are binaurally stimulated, since they are fitted with a CI and a contralateral HA or CI. The participants have been exposed only to oral language. Six participants follow a speech therapy, while two participants have recently stopped it. All participants have been trained orally. None of them know or use any sign language. The participants were selected and tested at the Ear-Nose-Throat Clinic (ENT Clinic, henceforth), Department of Neurosciences, University of Padua.

The following table summarises personal and clinical data of the CI-group:

[26] When the noun after the verb is singular (*Chi lava il cane?* 'who washes the dog?') ambiguity problems should arise as to what interpretation is to be given to the sentence.

**Table 1:** Personal and clinical data of the CI participants. The "*" marks that some data are missing.

| ID | Age | Type Of Hearing Loss | Age HA | Age CI | Type Of Stimulation | Speech Therapy |
|---|---|---|---|---|---|---|
| **R.B.** | 9;10 | sensorineural | * | 8;8 | monaural | yes |
| **V.Z.** | 7;10 | sensorineural | 0;2 | 1;6 | monaural | no |
| **F.Z.** | 10;10 | mixed | 3;0 | 5;7 | binaural | no |
| **N.V.** | 8;1 | sensorineural | 0;4 | 2;7 | binaural | yes |
| **S.V.** | 7;8 | sensorineural | * | 1;2 | binaural | yes |
| **A.T.** | 9;0 | sensorineural | 3;6 | 7;10 | monaural | yes |
| **E.N.** | 7;5 | sensorineural | at birth | 0;7 | binaural | yes |
| **M.M.** | 9;9 | sensorineural | 0;4 | 2;8 | binaural | yes |

The results of the CI-group were compared with those of 8 typically developing children of comparable chronological age (TD-group, henceforth). TD-children ranged in age from 7;0 to 10;10 years (mean age: 8;5). Despite the age ranges of the two groups are slightly different, no significant difference was found between the age (in months) of the CI and TD groups (Mann-Whitney U=27.5, p=.636).

### 2.2 The task for the elicitation of *wh*- questions

The participants were administered the elicited production task developed by Guasti et al. (2012). The test includes 24 items, investigating the use of subject and object *who* and *which* questions, with six items for each condition.

The four conditions are summarised in the following table.

**Table 2:** Experimental design: conditions

| Question type | *Wh*-element | Test sentences |
|---|---|---|
| **Subject** | Who | *chi acchiappa gli gnomi?* |
| | | who catches the gnomes? |
| | Which | *quale gatto lava le scimmie?* |
| | | which cat washes the apes? |
| **Object** | Who | *chi sporcano gli elefanti?* |
| | | who the elephants dirty? |
| | which | *quali bambine seguono la signora?* |
| | | which girls follow the woman? |

For this task, 18 transitive reversible verbs, such as *bite*, *dirty*, *wash*, were used. The use of transitive reversible verbs prevents the child to derive the meaning of the sentence by relying on semantic or pragmatic cues, since being semantically reversible, these verbs can be compatible with both nouns. *Who*-subject questions always feature a singular verb, and *who*-object questions employ a plural verb. The following picture shows an example of an item used for the elicitation of a subject *who*-question.

As fig.1 was shown, the experimenter described the picture "Someone is catching the ghosts. Ask your mum/dad who.". The target sentence was "Who is catching the ghosts?".

Three subject *which* questions have singular verbs (Which cook is greeting the football players?) and three contain a plural verb (Which witches wet the man?); three object *which* questions have singular verbs (Which cows does the horse chase?) and three have a plural verb (Which child do the smurfs dream of?).

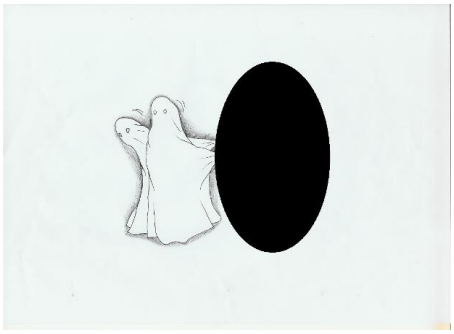

**Fig. 1:** Picture eliciting a subject *who*-question

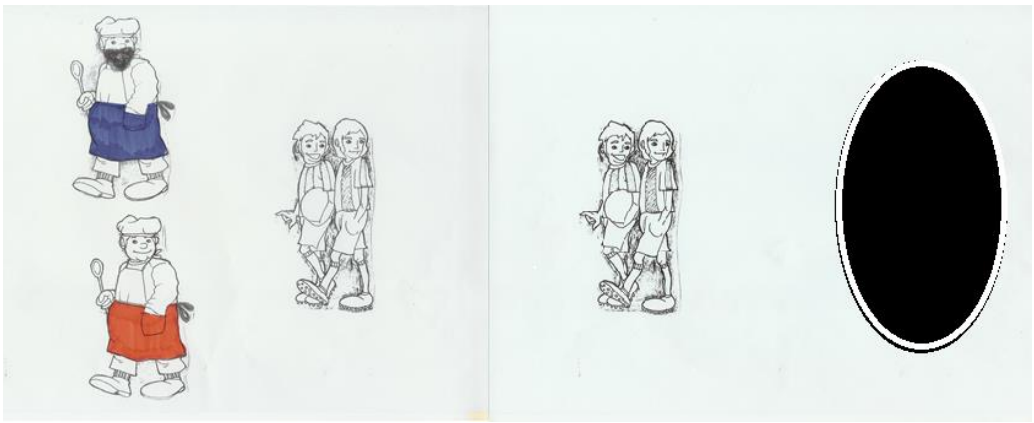

**Fig. 2:** Picture eliciting a subject *which*-question

For the item in fig. 2, the picture on the left was shown first, and the experimenter introduced the characters "There are a cook with a blue apron, a cook with a red one, and two football players.". When the picture on the right appeared, the experimenter described it "One of the cooks is greeting the football players. Ask your mum/dad which cook.". The expected answer was "Which cook is greeting the football players?".

The participants were assessed in a quiet room of the ENT Clinic. While in Guasti et al. (2012; 2015) the participants heard the stimuli by a recorded voice and then they were asked to make a question to a puppet, for this study all participants received the stimuli directly from the experimenter. This was due to the fact that in this way, hearing impaired children can rely also on lip reading. The children were asked to make a question to their parents, who did not know the correct answer, and had to guess pretending to be a magician.

The task was presented on a laptop computer screen and the stimuli were displayed through a Power Point presentation. The questions produced by the participants were audio recorded and transcribed by one of the experimenters.

### 2.3 Response coding

We considered as correct responses all *who* and *which* questions with the following structures: *wh*-questions with a final NP (*chi colpiscono i bambini?* 'who the children hit?'); *wh*- questions with the NP topicalization (*i bambini, chi colpiscono?* 'the children, who hit?'); *wh*- questions in which the final argument was not expressed (*chi colpiscono?* 'who hit?'); cleft *wh*- questions (*chi è che (i bambini) colpiscono (i bambini)?* 'who is that (the children) hit (the children)?'; passive *wh*-questions (*chi è colpito dai bambini?* 'who is hit by the children?'); *in situ wh*- questions (*la fatina tira quali bambini?* 'the fairy pulls which children?'); and *wh*- questions with a resumptive clitic pronoun (*quale cane i gatti lo stanno leccando?* 'which dog the cats are licking him?').

We analysed as incorrect the responses with the following structures: questions introduced by a *wh*-element different from the target *who* or *which* (*i gatti, chi leccano?* 'the cats, who lick?' instead of *quale cane leccano i gatti?* 'which dog lick the cats?'); questions with the inversion of the thematic roles (*che cuoco salutano i calciatori?* 'which cook greet.PL the football players.SUBJ?' meaning

'which cook do the football players greet?' instead of *quale cuoco saluta i calciatori?* 'which cook greets the football players?'); incomplete or ungrammatical sentences (*quale cuoco?* 'which cook?')[27]; sentences with a *wh-* element different from the target one (*che bambini sognano i puffi?* instead of *quale bambino sognano i puffi?* 'which child do the smurfs dream of?').

## 3 Results

The following table shows the number and the percentages of correct responses provided by each group:

**Table 3:** number and % of correct responses for the CI- and the TD-groups.

| | | **CI-group** | | **TD-group** | |
|---|---|---|---|---|---|
| | | No. | % | No. | % |
| **WHO** | subject | 43/48 | 90% | 43/48 | 90% |
| | object | 37/48 | 77% | 38/48 | 79% |
| **WHICH** | subject | 32/48 | 67% | 37/48 | 77% |
| | object | 25/48 | 52% | 32/48 | 67% |
| **TOTAL** | | **137/192** | **71%** | **150/192** | **78%** |

A lower level of accuracy is observed in the CI-group compared to the TD-group. However, both groups display the same pattern in the production of *wh-* questions. *Who* questions are more preserved than *which* questions, and subject *wh-* questions are easier to produce than object *wh-* questions.

The performances of the two groups differ in the strategies adopted to produce a question. The following table summarises the strategies adopted by each group:

**Table 4:** number and % of response strategies adopted by each group.

| | **CI-group** | | | | **TD-group** | | | |
|---|---|---|---|---|---|---|---|---|
| | **WHO** | | **WHICH** | | **WHO** | | **WHICH** | |
| | **subject** | **object** | **subject** | **object** | **subject** | **object** | **subject** | **object** |
| **NP-final** | 39 | 24 | 30 | 17 | 34 | 25 | 36 | 24 |
| **(*Wh* V N)** | 81% | 50% | 62% | 35% | 71% | 52% | 75% | 50% |
| **Topicalised** | 0 | 11 | 0 | 3 | 0 | 6 | 0 | 1 |
| | 0% | 23% | 0% | 6% | 0% | 13% | 0% | 2% |
| **Cleft** | 4 | 0 | 2 | 2 | 8 | 2 | 0 | 0 |
| | 8% | 0% | 4% | 4% | 17% | 4% | 0% | 0% |
| **Passives** | 0 | 0 | 0 | 2 | 0 | 2 | 0 | 6 |
| | 0% | 0% | 0% | 4% | 0% | 4% | 0% | 13% |
| **No Argument** | 0 | 2 | 0 | 0 | 0 | 2 | 1 | 1 |
| | 0% | 4% | 0% | 0% | 0% | 4% | 2% | 2% |
| **Other *Wh*-** | 0 | 1 | 5 | 13 | 4 | 4 | 6 | 12 |
| **operators** | 0% | 2% | 10% | 27% | 8% | 8% | 13% | 25% |
| **Ungrammatical/** | 3 | 8 | 8 | 9 | 1 | 5 | 4 | 3 |
| **incomplete** | 6% | 17% | 17% | 19% | 2% | 10% | 8% | 6% |
| **In situ** | 0 | 0 | 0% | 1 | 0 | 0 | 0 | 0 |
| | 0% | 0% | 0% | 2% | 0% | 0% | 0% | 0% |
| **Clitic pronoun** | 0 | 0 | 0 | 1 | 0 | 1 | 0 | 0 |
| | 0% | 0% | 0% | 2% | 0% | 2% | 0% | 0% |
| **Theta inversion** | 2 | 2 | 3 | 0 | 0 | 1 | 0 | 1 |
| | 4% | 4% | 6% | 0% | 0% | 2% | 0% | 2% |

[27] In this category, we included ungrammatical structures, questions with the only *wh-* element, incomplete sentences, and sentences which are the repetition of the last part of the sentence uttered by the experimenter.

## 4 Discussion & Conclusion

In this study, the production of subject and object questions introduced by *who* or *which* followed by a noun phrase (NP) was analysed in a group of 8 Italian-speaking CI-children, in order to determine whether these participants differ from 8 normal hearing children in the use of these complex structures.

For both groups, the typical asymmetry between the production of subject and object *wh*- questions, and between the production of *who* and *which* NP questions was observed. Subject *wh*- questions were easier than object *wh*- questions, and *who* questions were more preserved than *which* NP questions.

These asymmetries were found also in previous studies for other populations with typical and atypical language development (TD-children and adults: De Vincenzi, 1991, 1999; Friedmann et al., 2009; Guasti et al., 2012; Belletti & Guasti, 2015; children with developmental dyslexia: Guasti et al., 2015; patients with agrammatic aphasia: Garraffa & Grillo, 2008; hearing-impaired children: Quigley et al., 1974; Friedmann & Szterman, 2011; Friedmann & Haddad-Hanna, 2015). The subject/object asymmetry can be explained by the length of syntactic dependency between the sentence initial position of the *wh*- operator and the position in which it is interpreted. As proposed by the Minimal Chain Principle (De Vincenzi, 1991), the hypothesis is that subject questions are easier because the dependency is short, while object questions are problematic because the dependency between the two positions is longer. Long dependencies as those featuring object questions increase the computational load necessary to produce them. The preference for shorter dependencies is confirmed by the fact that one of the error made by the children when an object *wh*- question was elicited (*Chi lavano i cani?* 'who wash.PL the dogs.SUBJ.?') was the production of a subject *wh*- question (*Chi lava i cani?* 'who washes the dogs?').

The asymmetry between *who* and *which* questions is due to the structural complexity of the *which*+NP phrase. Sometimes, children fail in this operation and leave the *which*+NP in its original position (*La fatina tira quali bambini?* 'the fairy pulls which children?') or simplify the *which*+NP into *who* (*chi lava le scimmie?* 'who washes the monkeys?' instead of *quale gatto lava le scimmie?* 'which cat washes the monkeys?'). The avoidance of the *which*+NP question when pragmatically required is a strategy that makes it possible for the children to reduce the complexity of that kind of sentence.

Comparing the performances of the two groups, the data analysis showed lower percentages of correct sentences in the CI group as opposed to the TD one for all sentence conditions, except for subject *who* questions. This difference between hearing impaired and hearing individuals was previously showed by other studies carried out on other languages (for English: Quigley et al., 1974; for Hebrew: Friedmann & Szterman, 2011, for Palestinian Arabic: Friedmann & Haddad-Hanna, 2015).

In the present study, it is interesting to observe that the CI-children adopted a large number of strategies when both subject and object questions were targeted, and individual performance variability was observed. The most frequent (incorrect) strategy was the production of ungrammatical sentences, which were uttered by the youngest and by two of the older participants. In addition, most CI-children replaced the *wh*- element with one which was not appropriate for the context (for example, they used *chi* 'who' or *che* 'what' instead of *which*+NP). This strategy was observed for various children, regardless of their age. In some cases, children produced *wh*- questions with reversed thematic roles. However, some other CI-children who did not produced the target sentence used some strategies that were nonetheless pragmatically correct, such as topicalised sentences, cleft *wh*- questions. The CI-children who produced appropriate sentences displayed to have good competence in Italian and use response strategies found in TD children; other CI-children, who produce ungrammatical sentences, showed an atypical behaviour that is evidence of the linguistic delay associated to hearing impairment.

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# Phonotactic constraints in young cochlear implant recipients

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**Abstract.** Considerable attention has been paid to infant vocalization. The aim of the current research is to describe the prelinguistic vocal repertoire of seven young infants wearing cochlear implants and to argue for a strong relation between early developmental stages of speech, as cochlear implantation seems to trigger similar vocal performances to hearing peers. In contrast to previous studies based on typical development which argued for the existence of only one syllable type at each stage of prelinguistic speech, the present study recorded simultaneous co-existence of multi-syllable types of protophones in populations characterized as atypical. Results support a gradual transition from babbling stages into mature, more complex forms of vocalization that we meet on adult speech. Protophonic development is rapid during the first post-implant year. The findings are in agreement with other studies based on typically developing children. The difference is that current data broaden the results to disordered populations, like the infants with cochlear implants. The quantitative classification of protophones, through the combination of acoustic and auditory analyses provides a new reliable perspective for comparisons between populations with similar hearing experience. Speech pathology targets to explore the prelinguistic speech development and current methodology aims to contribute to this direction.
*Keywords*: phonotactic constraints, cochlear implant, protophones, prelinguistic repertoire

## 1. Introduction

The "discontinuity theory" of Jakobson (1968) arguing for a dissociation between infant speech productions and mature-adult speech. It is important to mention that Jakobson's studies influenced the literature of language development for many years, since his perspectives were considered as the established theory. The basic argument supporting his theory was the observations he made on babbling stage and the conclusions he draws from the non-existent role of hearing. According the "discontinuity theory" babbling contains sounds from the human vocal system repertoire. In contrast, young children use a rule-based mechanism to produce sounds with meaning (words). At the same decade, other studies came supporting the work of Jakobson (1941; 1968), from Lenneberg (1967) and Lenneberg, Rebelsky and Nicols (1965). Their basic argument comes from the deaf studies, mentioning that deaf infants produce vocalization with similar way as hearing infants do. Their conclusion was that hearing plays no role to language development and deaf vocalization is exactly the same as hearing peers. Curiously, this aspect about the same vocalization between deaf and hearing infants continuous to inspire even today.

The aim of the current study is to unravel data supporting that actually there is, a close relation, between pre-linguistic and mature-speech. These aforementioned data will come from the role of babbling, exactly the argument Jakobson and others used, to support the "discontinuity theory". Based on other similar methods of typical development, the current methodology provides, a detailed auditory and acoustical analysis of prelinguistic vocal repertoire of young infants wearing cochlear implants.

More recently, the study of De Boysson-Bardies and Vihman (1991) argued for a strong relationship between first vocals and words. Oller (2000) described these first vocals as protophones, supporting the theory of "gradual transition". Supporting data from normal hearing infants come based on the frequency of the place and manner of the consonant-like segments to the input language (De Boysson-Bardies & Vihman, 1991). Other data show a similar trend in the number of vocalization of first stages and latter-adult speech (Camp, Burgess, Morgan and Zerbe, 1987).

As can be seen, the study of the babbling period is of great importance since it describes the important stage of early speech development. This high importance of early speech development, it is underlined by the prognostic value that provides to diagnosis of future speech and language disorders. If actually there is a relationship among early vocalization and latter speech, it might be the case that a

late or deviant vocal development might be related to disordered language development. As Oller, Eilers, Neal and Schwartz (1999) stated "delayed onset of canonical babbling can predict delay in the onset of speech production" (p.223). Stoel-Gammon (1998) also mentions a transitional step to early language, while Ertmer and Melon (2001) mention that typical infants reach the canonical babbling stage, at 6-7 months of age producing protophones with the CV type form.

From a theoretical and clinical point of view, study of the outcomes of early vocalization of normal hearing infants or young cochlear recipients is a big dare. Many obstacles can arise decreasing the reliability among researchers. For example, there is variability in transcription process about the manner or place of articulation of consonants as well as specifying vowel identity. Oller and Lynch (1992) described the limitations of using IPA to transcribe infant speech, which is a common transcription practice for adult speech and they suggested an analysis via an infraphonological framework which the current study also follows.

## 2. Materials and method

Seven infants wearing cochlear implants participated with chronological age at the beginning of the recordings 1:10-4:0 years and post implantation age from 0:0-1:3 years. The infants completed the implantation criteria of the ENT AHEPA University Hospital of Thessaloniki. The participants were not diagnosed with any other developmental disorder or difficulty and had unknown deafness etiology. The families of the participants were characterized as typical median socio-economic class and they received detailed instructions and frequent face-to-face training during the process. All families provided written consent for the child's participation. The recordings of spontaneous productions performed based on digital equipment, a Sony PCM-D50 portable linear recorder with high recordings standards (sampling rate of 44.1 kHz and 16-bit precision. The results analysed through the classic methodological process of acoustical and auditory analyses. After this step, the number of protophones was classified based on the number of syllables of each protophone type via the wide band spectrography using the necessary analysis software Praat (4.110). Prior to implantation the children had an average unaided hearing loss of more than 90 dB HL in the better ear. A detailed description of participants wearing implants can be seen in Table 1.

**Table 1.** Participants wearing Cochlear Implant's detailed data.

| Name & Sex | Chronological Age (CA) -Start Recording- | CI Type | Post-Implant PTA | CA at Implantation | Post-Implant Age (PIA) -Start Recording- | Diagnosis Hearing Loss | Cause | Other Disorders | No. of Recordings & Recordings Duration (mo.) |
|---|---|---|---|---|---|---|---|---|---|
| GR F | 1:10 | Cochlear Contour Advance CI 24RE Freedom | 20 dB HL | 1:4 | 0:6 | N/S | Congenital | No | 5 0:6-0:11 |
| KB M | 2:6 | SONATA ti100 MEDEL OPUS 2 | 18 dB HL | 1:11 | 0:7 | N/S | Congenital | No | 4 0:7-1:3 |
| SE F | 2:1 | Cochlear Contour Advance CI 24RE Freedom | 17 dB HL | 2:1 | 0:0 | N/S | Congenital | No | 4 0:0-0:6 |
| BP M | 3:11 | Cochlear Contour Advance CI 24RE Freedom | 17 dB HL | 3:11 | 0:0 | N/S | Congenital | No | 5 0:0-0:6 |
| KM F | 3:0 | Cochlear Contour Advance CI 24RE Freedom | 13 dB HL | 2:10 | 0:2 | N/S | Congenital | No | 4 0:2-0:7 |
| BA M | 4:0 | Cochlear Straight CI 24 RE CP810 | 38 dB HL | 4:0 | 0:0 | N/S | Congenital | No | 4 0:0-0:7 |
| AK F | 3:6 | Cochlear Contour Advance CI 24RE CP810 | 17 dB HL | 3:4 | 0:2 | N/S | Congenital | No | 4 0:2-0:7 |

During the data collection audio recordings of approximately 40-60 minutes per session aimed to capture spontaneous interactions between caregivers-infants over a span of 6 months during the first-

year post-implant. During recordings, subsequent editing was done to remove what called “vegetative data”, specifically cries, gulping, sneezes, sudden loud sounds etc. The final corpus used for analysis was 15 minutes long per month and it involved all protophones during a given recording.

The vocalization types (protophones) that were classified into five categories and listed below (where C-consonant & V-vowel):

1. Isolated vowels
2. Monosyllables (CV-CCV-VC-CVC)
3. Disyllables (CVCV-VCV-CVCVC)
4. Trisyllables (VCVCV-CVCVCV)
5. Polysyllables (reduplicated/variegated babbling)

Each vocal type was defined and subsequently analysed independently by using spectrographic analysis via Praat. The current methodology following Oller’s infraphonological theory accepted that each syllable type reaches an upper limit of about 500 msec. Consonant-vowel boundaries were defined based on their formant energy structure. Thus, the onset of an utterance was defined to the first glottal pulse and the end to the loss of formant energy structure where is the point of the first cycle with decreased amplitude.

## 3. Results

In contrast to previous studies based on typical development and argued for the existence of only one syllable type at each stage of prelinguistic speech, the present results recorded simultaneous co-existence of multi-syllable types of protophones (Jakobson, 1968; Lenneberg, 1967). Table 2 depicts the overall number of recorded vocalizations and the respective number for each type separately. Figure 1 provides a visual depiction of the number of recorded protophones across post-implantation months. The figure shows a clear preference to disyllables structures. Based on current data, as can be seen in Table 2 and Fig. 1, these CI infants show a clear preference to open syllables, since there are not many productions with a consonant as suffix. Overall, 598 spontaneous vocalizations were recorded, classified and analysed via auditory and acoustical analyses.

Table 2. Classification of prelinguistic vocalization of seven CI participants.

| **Vocal Type** | **CIs** |
|---|---|
| V | 62 |
| Monosyllables | 119 |
| Disyllables | 297 |
| Trisyllables | 61 |
| Reduplicated | 28 |
| Variegated | 31 |
| **Overall** | 598 |

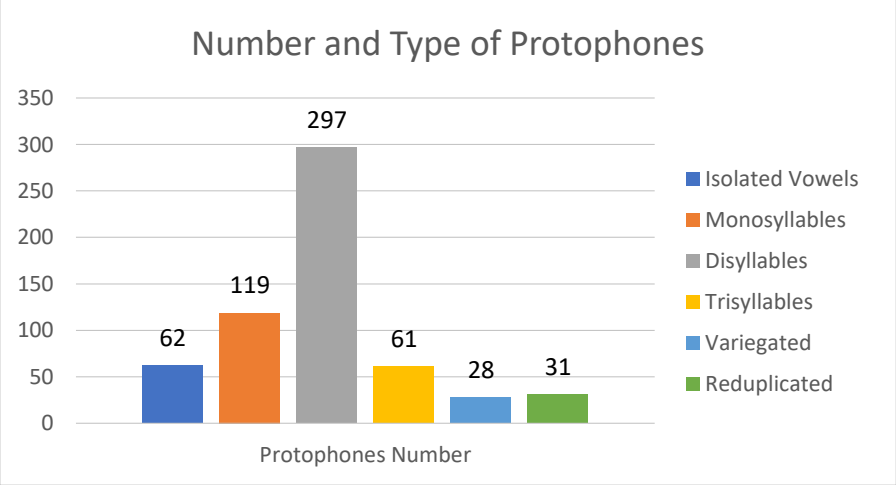


**Fig. 1**. Number of recorded protophones for each phonotactic structure during post-implant age.

Table 3 illustrates the vocal classification of two participants across the first 6 months post-operatively. It can be seen a gradual transition to more complex forms of vocalization. This example, of only two from the seven participants is still representative, to the team's similar gradual trend from simple to complex protophones. For example, for the participant GR, the analyses showed the existence of disyllable structures from the beginning to the completion of the first post-implant year or the continuous presence of multisyllable structures (reduplicated or variegated) from the beginning to 6 months after implantation for the participant SE.

**Table 3.** Vocal classification across the six months post-operatively of two CIs.

| SE | | Number of Protophones | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PIA | CA | v | cv | cvv | vcv | cvc | ccv | cvcv | cvcvc | vcvcv | cvcvv | reduplicated | variegated | |
| 0;0 | 2;1 | 2 | | 1 | | | | | | | | 1 | | |
| 0;1 | 2;2 | 4 | | | | 1 | | | | | | | | |
| 0;4 | 2;5 | | | | | | | 2 | | | | | | |
| 0;6 | 2;7 | 1 | 2 | | 1 | 4 | 1 | | 1 | 2 | 1 | | 2 | |

| GR | | Number of Protophones | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| PIA | CA | v | cv | vc | cvv | vcv | cvc | cvcv | vvcvcv | cvvcvv | vcvvcv | cvcvv | cvvcv | reduplicated | variegated |
| 0;6 | 1;10 | 22 | 7 | | 12 | | 1 | 31 | | 1 | | 1 | | 5 | 6 |
| 0;7 | 1;11 | | 1 | | 2 | | | 11 | | | | | | 2 | |
| 0;9 | 2;1 | | | | 1 | 1 | | 7 | | | | | | | |
| 0;11 | 2;3 | 2 | 5 | 1 | | 5 | | 21 | 1 | | 1 | | 1 | 1 | 1 |

## 4. Discussion

The current quantitative classification of protophones revealed the simultaneous existence of multiple vocalization types across the first post-implantation months. It is clear that each stage of language development contains mixed vocal types, in contrast to other views which argue for the existence of each type only. The results are in agreement with Oller (2000) and broaden the conclusions to disordered populations. This assumption is what new commits the current study to the babbling research based on Greek language. Expand previous results of typical development to populations with questionable deviant language development. Despite the fact that, it is not clear from what age hearing affects early speech and language development, we can expect that lack of hearing influences vocal development within the first year of life, especially for nowadays young cochlear implant recipients.

The presented classified vocalization of young cochlear implant recipients seems to contain similar vocal structures and similar babbling process that we meet at normal hearing peers. This assumption comes in contrast to studies argued for universal patterns of infant vocal behaviour. These studies, see the early vocal behaviour as a gradual maturational process despite the environmental factors affecting the input (Lenneberg, 19667; Lenneberg et al, 1965). As can be seen, current data show that cochlear implants trigger a similar performance radically different from deaf infants described in the past, since auditory perceptual ability affects vocal behaviour (Oller & Eilers, 1988; Stoel-Gammon & Ottomo, 1986; von Hapsburg & Davis, 2006).

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# Examination of articulation-phonological abilities of dysphasic children

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**Abstract.** The phonological development of the child implies the process of identifying and forming phonemes, which includes a period from appearance of the first word to the acquisition of the ability to manage the mechanisms of the effector system. The terms "articulation development" or "phonetic development" refer to the gradual development and acquisition of the ability to produce individual phonemes. The most common mistakes children make when they pronounce and learn to speak as adults, are called "phonetic deviations". They should disappear when child turns five years old. The aim of this research is to examine articulation and phonological abilities of children of different ages with the diagnosis of developmental dysphasia. A sample for the examination is made up of a total of 50 children with a diagnosis of developmental dysphasia, which are divided into two groups age-related. The ages of children of the first and second groups ranged from 4.0 to 6.0 years. The first group of children included 25 children aged from 4.0 to 4.11 years, while the second group consisted of 25 children aged 5.0 to 6.0 years. The methodology of work is based on the application of standard tests in the assessment of the pronunciation of the children's rayon. The results of the research are curtailing the degree of harmonization of the speech-based structures with the age of the child, as well as their deviation in the form of specific functions in relation to the speech-language pathology.
*Key words***:** articulation, phonemic hearing, phonological development, dysphasia

## 1 Introduction

The terms “articulation development” and “phonetic development” refer to the gradual acquisition of the ability to produce individual speech symbols. The normal development of speech implies well developed phonetic and phonological characteristics of speech.

The phonological development implies the process of identifying and forming phonemes, and it includes the period from the appearance of the first word to the acquisition of the ability to control mechanisms of the effector system, especially the articulatory mechanism in the eighth year of life (Keramitčievski, 1990).

Phonological development is manifested by an increase in the number and types of speech symbols produced by a child. Phonological development manifests the construction of the linguistic system. In order to be able to form the phonemes of a particular language properly, the child must improve the very complex function of the articulation and phonation mechanism, including correct perception and discrimination.

All children make mistakes in pronouncing voices when they learn to speak as adults. These mistakes are called "phonetic deviations". They should disappear when the child is five years old, although there are individual variations in phonetic and phonological development among children.

A five and a half year old child should pronounce all speech symbols correctly. Any deviation from the correct pronunciation in a child older than five and a half years of age requires help of a speech-language therapist, either in the form of speech and language treatment, either as counselling with parents with necessary control examinations (Golubović, 2012).

Normal phonetic-phonological development needs coherent function of all of the systems and subsystems in an afferent and efferent direction, including the integrator, transmitter, sensory, receptor and effector system. The effect is reflected in the correct pronunciation of all 30 phonemes and their quantitative companions, 4 accents and 2 lengths (Punišić, 2001).

## 2 Materials and Methods

The aim of this study was to determine articulation-phonological abilities at different age stages in children with diagnosis of developmental dysphasia. A sample for the examination was made up of 50 children with developmental dysphasia in total, divided in two groups and compared to their age, ranged from 4.0 to 6.0 years. The first group included 25 children aged from 4.0 to 4.11 years, while the second group consisted of 25 children aged from 5.0 to 6.0.

In accordance with the defined research objectives, the following tests were applied:

1. Oral practise examination Test (Radičević, Stevanković)
2. Global Test of articulation (Kostić, Vladisavljević)
3. Test for examination of Phonemic Differentiation/Phonemic Hearing examination Test (Kostić, Vladisavljević, Popović)

## 3 Results and Discussion

Statistical parameters used in data analysis were:

- Mean value, as a measure of the central tendency, or as a representative of the group from which it was calculated
- Standard deviation, as a measure of deviation of individual values from the arithmetic mean and
- Correlation coefficient – a measure of the degree of dependency when the signs are numerical.

Data processing was done using the program:
EXCEL 7 - for database, tables, for statistical analysis and graphic processing;
WORD 7 - for text processing.

### 3.1 Age of children

Analysing the age of both groups, it is examined that the average age of children of first group is ranged from 4 years and 6 months +/- 4 months; and the average age of children of second group is ranged from 5 years and 6 months +/- 4 months (Table 1.).

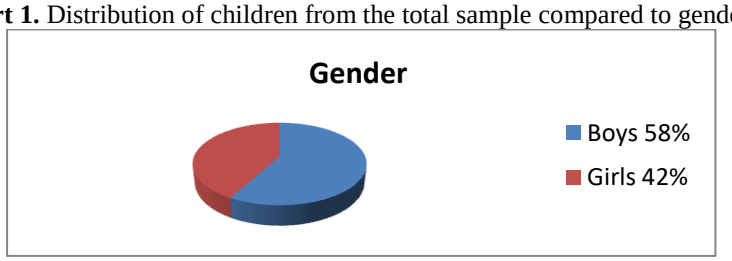
**Table 1.** Average age of children first (4-5 years) and other groups (5-6 years old)

| | Groups | | Total |
|---|---|---|---|
| | First group (4-5 years) | Second group (5-6 years) | |
| The number of children | 25 | 25 | 50 |
| Minimal age | 48 months | 60 months | |
| Maximal age | 59 months | 72 months | |
| Average age | 53.24 months | 64.88 months | |
| Standard deviations | 3.68 months | 3.81 months | |

### 3.2 Gender of children

Regarding gender, in the first group (4-5 years), 16 boys were represented, which is 64%; and 9 girls, which is 36%. In the second group (5-6 years), 13 boys were represented, which is 52%; and 12 girls, which is 48%. Following, the total sample consisted of 29 boys (58%) and 21 girls (42%) (Chart No. 1).

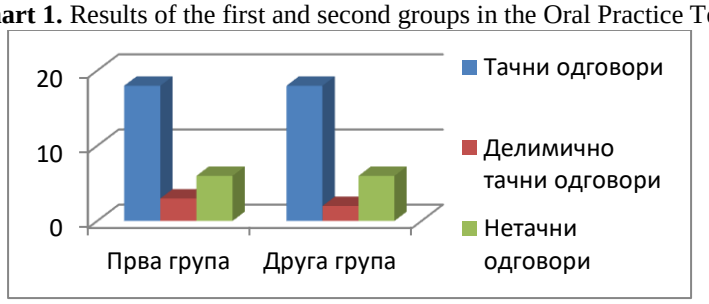
**Chart 1.** Distribution of children from the total sample compared to gender




### 3.3 Oral Practise examination Results

Regarding to the percentage representation of correctly derived models in the first and the second group, it is concluded that there is a tendency of differentiation of oral practice with age, which corresponds to the possibilities of proper pronunciation of phonemes. The ratio of correctly derived models in the first group (4-5 years) and in the second group (5-6 years) is 69% versus 71%, where this difference between two age groups is not significant, but testifies to the growth of the correctly derived models oral practice, according to age. Regarding to the percentage of partially derived models in the first group (10%) and in the second group (7%), there is a tendency of decreasing inconsistencies in the oral practice movement performances with the age of children. Regarding to percentage of incorrectly performed models in the first group (22%) and in the second group (21%), a slight decrease of 1% was recorded in incorrectly derived models; which notes that the linguistic deficit of dysphasic children nevertheless affects the achievements of the Oral Practice Test, with the minimal impact of age differences (Chart No.1).

**Chart 1.** Results of the first and second groups in the Oral Practice Test




### 3.4 Phonemic Hearing examination Results

Observing the results of dysphasic children on the Phonemic Hearing examination Test and the percentage representation of the correct answers in the first group (4-5 years) and in the second group (5-6 years), it is concluded that there is a tendency of positive/accurate responses increasing with age (from 66% in the younger group, 74% in the older group), and (by contrast) reducing the number of incorrect/negative responses (from 25% in the younger group, to 20% in the older group) (Chart No.2; Chart No.3). Observing the percentage of partially accurate answers (grade +/-) in the first and second group, there is a tendency of declining partially accurate answers with the age of children (from 9% in the younger group, to 6% in the older group).

**Chart 2**

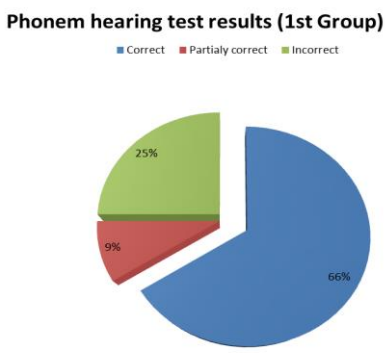
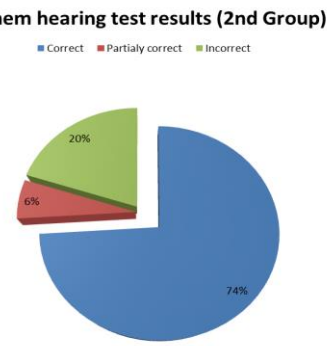



**Chart 3**




The articulation assessment was carried out by the Global Test of articulation. No child from the entire sample got the grade 1 neither the grade 2.

The other estimates are represented and shown within certain groups of phonemes as it follows.

### *3.5.1 Pronunciation of vocals*

The pronunciation of vocals in the children of the first and the second group is exposed to disorders in the type of distortion primarily. The order of frequency of damage in the first group (4-5 years) would be the following: vocal "E" in 52% of children; "I" in 44% of children; "O" and "U" in 32% of children; "A" in 12% of children. In the children of the second group (5-6 years), the frequency of vocal damage is significantly lower (32% for vocal "E", 28% for vocal "I", 20% for vocals "O" and "U" and 16% for vocals "A").

### *3.5.2 Pronunciation of the plosives*

The pronunciation of the plosives in children of the first and the second group was damaged by the type of distortion, substitution and omission. Within the first group (4-5 years), the high incidence of distortion occurred in the pronunciation of the plosive "D" (68%); then "T" (60%); following: "B" (40%); "G" (48%); "K" (36%) "P" (28% of children). The substitution occurred in a slight percentage of plosives B, D, G, and the omission was only found for plosive B. In the children of the second group (5-6 years), the prevalence of "D" (68% of children) and "T" (in 60% of children) is prevalent, and in terms of interdental pronunciation. The other phonemes pronunciation mistakes are in a small percentage: "B" (44%); "K" (32%); "G" (28%); "P" (24%).

### *3.5.3 Pronunciation of the affricates*

The affricates pronunciation analyses of the first and second group showed the presence of all types of deviations.

1. The percentage of distortions is as follows:

First group (4-5 years): C - 52%; Č - 40%; J - 36%; C - 36%; Đ - 28%; then F and V - 40%.

Second group (5-6 years): C - 48%; C - 40%; Đ - 32%; Č - 16%; Dž - 20%; then F and V - 28% and 20%.

2. The percentage of the substitutions is following votes:

First group (4-5 years): Đ - 40%; Č - 36%; J - 32%; C - 32%; C - 20%; F and V - 0%.

Second group (5-6 years): C - 44%; D - 40%; Đ - 40%; C - 24%; C - 28%; F and V - 16%.

3. Percentage of omissions is following:

First group (4-5 years): D - 16%; Č - 8%; Ć, Đ and C – 0%; F and V - 4%.

The second group (5-6 years): J - 12%; Č - 12%; C - 8%; C and Đ – 0%, F and V– 0%.

It can be concluded from the enclosure that the most common deviations are distortions; followed by substitution and omission.

#### *3.5.4 Pronunciation of the fricatives*

By assessing the quality of fricative pronunciation of dysphasic children, deviations were recorded for all types as it follows:

1. The percentage of fricative distortions:

First group (4-5 years): S - 68%; Z - 56%; Š - 40%; F - 48%; H - 36%; J - 28%; R - 8%.

Second group (5-6 years): S - 44%; Z - 32%; Š - 40%; F - 32%; H - 16%; J - 20% and R - 12%.

2. Percentage of fricative substitutions:

First group (4-5 years): S - 4%; Z - 12%; Š - 36%; F - 20%; H - 0%; J - 0%; R - 24%.

The second group (5-6 years): S - 24%; Z - 32%; Š - 24%; F - 20%; H - 0%; J - 0% and R - 16%.

3. Percentage of the omissions:

First group (4-5 years): S - 4%; Z - 12%; Š - 4%; F - 12%; H - 8%; J - 0%; R - 14%.

Second group (5-6 yrs.): S - 0%; Z - 0%; Š - 4%; F - 16%; H - 20%; J - 0% and R - 28%.

And in this group of voices, the most articular deviation is distortion. Both in one and the other group of deviations by type of distortion are specific for most fricatives (except F and J) and have 48% of children for voice Z, up to 36% for voices H and V. In the group, 24% of children had a substitution for voice R; 36% for Voice Z and Z and 12% for voice Z. The omission appeared at the level of votes S, Z, Š and Ž in the minimum percentage; and for voice R in 44% of children.

#### *3.5.5 Pronunciation of the nasals*

The results show that the pronunciation of nasal phoneme M distorted in 20% of children; voice N is distorted in 28% of children, while the deviations for voice Nj are 40%; In the same group of children the substitution of nasal Nj was 24%; while the omission was 4%. The pronunciation of the nasal in the other group is in similar frameworks; distortion occurred in 20% for voice M, in 24% for voice N, and in 28% for voice Nj, which indicates an improvement in pronunciation of this phoneme with age. In addition, there was no child that omitted any of nasal phonemes in the second group.

#### *3.5.6 Pronunciation of the laterals*

The pronunciation of the lateral phonemes in the children of the first group (4-5 years) was damaged by all types (distortion, substitution, omission). The results show that phoneme L distorts 28% of children; substitutes 20% of children, and omitted 36%. The phoneme Lj was distorted in 16%; substituted 36% of children, and 28% of children omitted this phoneme. In the second group of children (5-6 years old), phoneme L distorted 40% of children, it was substituted by 16% of children, and it is omitted by 20% of children; and regarding to the pronunciation of the phoneme Lj in the second group, distortion occurred in 12%, substitution in 48%, and omission in 12% of the children.

## 4 Conclusion

Based on the described objectives and research tasks, as well as the results obtained by research of phonetic - phonological development, it can be concluded:

1. Diagnosis of dysphasia affects articulation - phonological abilities.
2. In the speech of dysphasic children, all types of pathological pronunciation are present; the most frequent is an occurrence of distortion; followed by substitution and omission.
3. Dysphasic children manifest the greatest articulation - phonological defects in the pronunciation of the affricates, and then: laterals, fricatives, plosives, nasals and vocals.
4. The ability of audible perception and discrimination of phonemes (phonemic hearing) is directly related to the quality of phonemic pronunciation.
5. The age of dysphasic children affects the level of phonetic - phonological abilities.

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## Normalan razvoj govora podrazumeva i dobro razvijene fonetske i fonološke karakteristike govora

Fonološki razvoj deteta podrazumeva proces identifikovanja i formiranja fonema koji obuhvata period od pojave prve reči do sticanja sposobnosti upravljanja mehanizmima efektornog sistema, Termini „artikulacioni razvoj" i „fonetski razvoj" odnose se na postepen razvoj i sticanje sposobnosti produkcije pojedinačnih glasova. greške koje deca prave pri izgovoru glasova kada uče da govore kao odrasli, nazvane „fonetske devijacije" I one treba da nestanu kada dete napuni pet godina života.

Cilj ovog istrazivanja je bio ispitati artikulaciono/fonoloske sposobnosti na raylicitim uyrasnim nivoima dece sa razvojnom disfayijom.

Uzorak za ispitivanje artikulaciono-fonoloških sposobnosti sačinjavalo je ukupno 50 dece sa dijagnozom razvojne disfazije, koja su bila podeljena u dve grupe u odnosu na uzrast.

Uzrast dece prve i druge grupe kretao se od 4.0 do 6.0 godina. Prva grupa dece obuhvatala je 25 dece uzrasta od 4.0 do 4.11 godina, a drugu grupu činilo je 25 dece uzrasta 5.0 do 6.0 godina.

Metodologija rada yasnovana je na primeni tandardnih testova ya procenu govorno jeyickog rayvoja dece.

Rezultati istrazivanja ukayuju na stepen usaglasenosti govorno jeyi;kih struktura sa uyrastom deteta, kao I njihovo odstupanje u vidu iyistajanja specificnih funkcija u odnosu na govorno jeyicku patologiju.

# The ability of movement imitation and knowledge of their own body topography in children with developmental dysphasia

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**Abstract**. This paper presents the results of the study of the knowledge of body parts and the imitation of simple movements in children with developmental dysphasia. The results were obtained using the Scale of knowledge of body parts (Cordic, Bojanin 1992), and Test for imitation simple movements of the upper extremities (Ivkic, Govedarica 2000). The purpose of this research is to determine the ability of knowledge of body parts and ability to imitate simple movements of the upper extremities. The results of this study have shown that children aged 4 and 5 are not in accordance with their age in the ability to know parts of the body, while in the imitation of simple movements they were in accordance with their age. Children aged 6 years have shown an equal number of those who are in accordance with their age, and those who are not.
*Key words*: developmental dysphasia, knowledge of body parts, imitation of movement

## Introduction

Developmental dysphasia is linguistic disorder, a disorder of development of expressive and receptive speech, with manifestation of specific pathological pattern, with phonems and words distortion and substitution, which receive the form of paraphasic production, which do not occur in any normal-typical language stage of development, it's maintained for a very long time, while the social development of these children is relatively normal, and excludes hearing impairment, intellectual disability, autism and other disorders (Golubovic, 1998, 2001, 2006, 2007).

Developmental dysphasia is a speech and language disorder where childrens ability to speak or understand speech is below the expectation for his mental and chronological age. Children have:

- a deficiend dictionary
- word meaning is developing slowly
- words with multiple syllables are pronounced only with the initial or only with the final syllable
- words are shortened with supstitution of phonemes and syllables
- the sentence is short, agramatic
- speech is overall incomprehensible
- phonemes articulation is imapaired
- abstract words are difficult for understanding
- no gender differentiation
- difficulties in distinguishing plural and singular
- does not use tenses ( past, present, future tense)
- pronouns are used much later
- does not use adjectives, adverbs, prepositions, and conjunctions (Sovilj, 2013.)

The experience of physical integrity is a complex development that is progressively evolving. Its integrating the knowledge of body topography, lateralization in relation to himself, in relation to the other and in relation to the surrounding space, the discovery of others lateralization and space lateralization. These experiences blend into a unique experience of their physical integrity through movements that an individual tends to the social field (Ispanovic-Radojkovic 1986).

The gesture imitation test estimates the recognition of simple topographical relations in space (up-down, left-right, back-forth, up and under, front-behind) and the possibility of their construction with the upper extremities, in relation to the axis of the body as a reference point. It is very suitable for evaluating the physical integrity of the body, for the successful execution of tasks, it is necessary to properly identify the initated gestures, interpretation of detected gesture and reproduction of this

gesture by the parts of his body in the given time-space constraint(Nikolic 2011 by Ispanovic – Radojkovic 1986). The aim of this study was to determine the ability of knowledge of body parts and ability of imitation of simple movements of the upper extremities.

## Methodology

### Location and time of research

The research was conducted in the Institute for experimental phonetics and speech pathology "Djordje Kostic" in Belgrade in May 2017.

### Sample description

The research involved 16 children with diganosis of developmental dysphasia, both sexes, ages 4 to 6, who come for audiolinguistic treatments with KSAFA-m appliance at the Institute for Experimental Phonetics and Speech Pathology "Djordje Kostic" in Belgrade.

### Evaluation instrument

In this research was used scale for the assessment of knowledge of body parts (Cordic, Bojanin 1992.) for kids aged 3-14 and test of simple movements imitation (Ivkic, Govedarica 2000.) which is composed of 20 tasks that are performed by the upper limbs of large joints, or hand movements. With this task we estimated a sense of direction in space and the direction relation to his body. For their successful execution require a good knowledge of the body and lateralization on themselves and on each other. The results are evaluated according to age, below the age and above the age.

## The study results

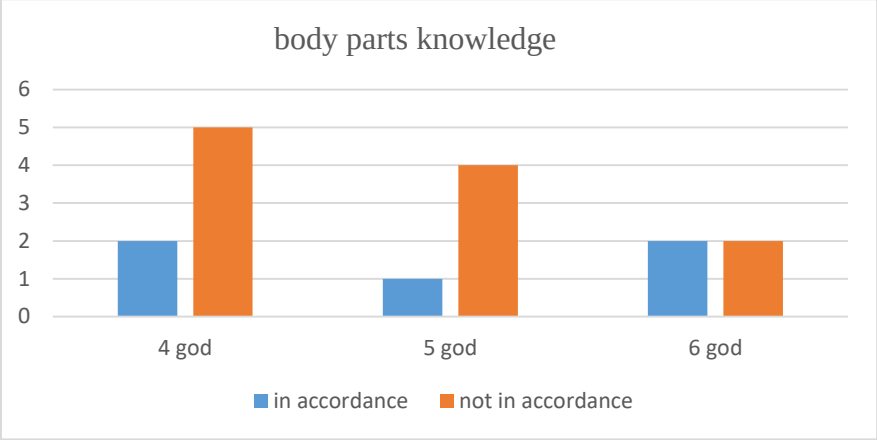


**Chart 1** Shows the results of knowing the parts of the body

This chart shows the results related to the knowledge of body parts in children with developmental dysphasia at the age of 4, 5 and 6. The obtained results show that a large number of children aged 4 and 5 years are not in accordance with the age, while in children aged 6 years have an equal number of those who are in accordance with their age, and those who are not in accordance with their age.

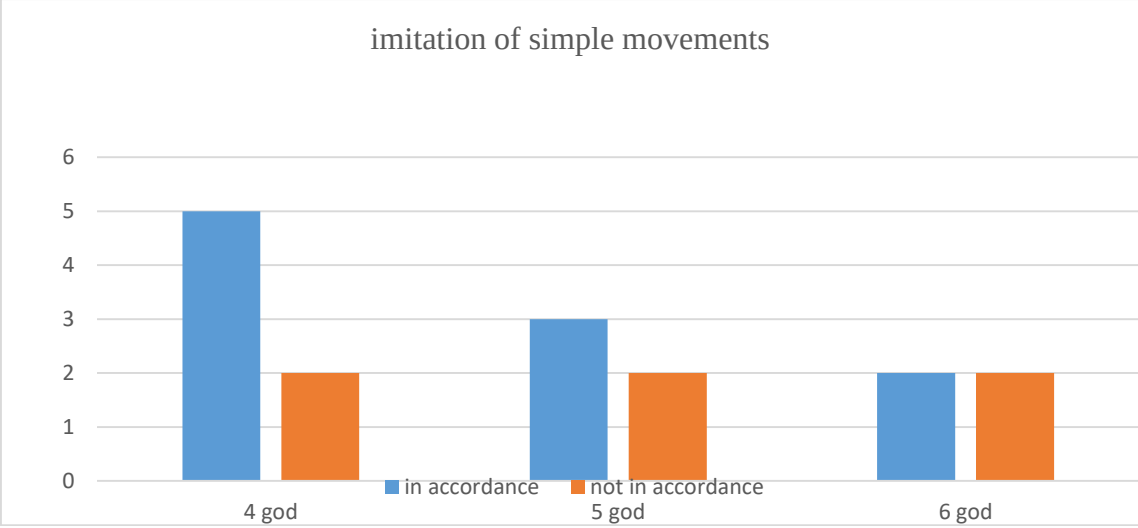


**Chart 2** shows the results of imitation of simple movements

This graph presents results related to the ability to imitate simple movements of the upper extremities of children with developmental dysphasia at the age of 4, 5 and 6 years. The obtained results show that a larger number of children aged 4 and 5 years are in accordance with their age, while in children aged 6 years, the number of those who are in accordance with age and those who are not in accordance with their age are equal.

## Discussion and conclusion

Children master the notions of the parts of their body in the order wich they mature and differentiate muscular structures and functions, each part of the body is sensitively perceived by a certain intensity and quality of sensory needs. By naming, concepts are created in the child's awareness about the existence of that part of the body about the relations between these named parts between themselves and the entirety of body. Imitation of movement is essential for learning topographic relations in space( up-down, left-right, back-forth) (Bojanin 1985).

The results of the research obtained on the scale of knowledge of body parts showed that a large number of children aged 4 and 5 years are not in accordance with their age, while in children aged 6 years showed an equal score of children on the knowledge of body parts that are in accordance with age and those who are not in accordance with their age.

Imitation of simple movements test has shown that children aged 4 and 5 years are in line with their age, while children aged 6 years have been given the number of those who are in accordance with age and those who are not in accordance with their age.

By knowing the body parts and imitating simple movements, there is awareness in children about their own body and spatial relation. This nourishes the nervous system, which enables an easier and faster way to learn new skills.

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## Sposobnost imitacije pokreta i poznavanje sopstvene topografije tela kod dece sa razvojnom disfazijom

U ovom radu su prikazani rezultati istraživanja o poznavanju delova tela i imitacije jednostavnih pokreta kod dece sa razvojnom disfazijom. Rezultati su dobijeni korišćenjem Skale za procenu poznavanja delova tela na sebi (Ćordić, Bojanin 1992) i Testa za imitaciju jednostavnih pokreta gornjeg ekstremiteta (Ivkić, Govedarica, 2000). Cilj ovog istraživanja je da se utvrdi sposobnost poznavanja delova tela i sposobnost simulacije jednostavnih pokreta gornjeg ekstremiteta. Rezultati ove studije pokazali su da deca uzrasta 4 i 5 godina nisu u skladu sa svojim kalendarskim uzrastom u poznavanju delova tela, dok su imitacija jednostavnih pokreta bila u skladu sa njihovim uzrastom. Deca uzrasta 6 godina pokazala su jednak broj pokreta koji su u skladu sa njihovim uzrastom na oba testa.
*Ključne reči*: razvojna disfazija, poznavanje delova tela, imitacija pokreta

# Relationship of grammar and EEG findings in children with specific language impairment

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**Abstract.** Specific language impraiment (SLI) describes a condition of delayed language development in children without intellectual disability, hearing impairment,visible neural damage. SLI has numerous clinical manifestation, because of that, there is need for grammatical analysis in SLI children. The aim of this study was to analyze and compare grammatical deficits in children with SLI and normal EEG findings and in children with SLI and abnormal EEG findings. This study included 20 children from Institute for experimental phonetics and speech pathology ''Djordje Kostic'' with specific language impairment who were divided in two groups. Parameter for classifying respondents were EEG findings. The instruments used for grammar assessment were Grammar in children and Test for language assessment of certain components of dysphasic syntax. The results were analyzed by methods of descriptive statistics. Results show that there is no statistically significant differences in the grammatical deficits between these two groups. When all the results are taken into account, it can be generally concluded that there is no significant difference in the grammar development between the children with SLI and abnormal EEG finding and children with SLI and normal EEG finding.
*Key words***:** specific language impairment, EEG, grammar

## Introduction

Language is an abstract system, and speech is its concrete realization. Languagesystem is a hierarchically arranged system consisting of several stratums: phonology, lexicon, grammar which include morphology and syntax, next stratum is semantics, and the highest level of language organization is pragmatics. Grammar is complex system of rules which allow making unlimited number of sentences of a limited number of words. The term specific language impraiment (SLI) describes a condition of delayed language development in children without intelectual disability, hearing impairment, visible neural damage, social deprivation, emotional disorders. Usually, children with SLI have delayed onset of speech, so they late in starting to speak in order to their peers. They do not late only in onset of speech, they also late in making sentences. Speech of these children is full of agramatism, what means that they miss functional words such as preposition, auxiliary verbs, suffix of number, gender, case. Speech of these children is known as "telegraphic speech". In many children with SLI understanding of language, or receptive language, is also impaired. This deficit may be subtle and not obvious unless the child has undergone testing. In the past, the terms "developmental dysphasia" or "developmental aphasia" were used to describe children with the clinical picture of SLI. These terms are wrong because they suggest parallels with adult acquired aphasia. This is incorrectly because SLI is not caused by brain damage. In children with SLI there is a delayed maturation of the nervous structures. In this sense, stagnation or delay in language development can be one of the indicators of the dysfunction of certain areas of the brain (Vuković et al., 2008). Jernigan, Hasselink, Sowel & Tallal (1991) analyzed the cerebral structures of children with speech and language disorders and control subjects. They noted that the group with disorder had an asymmetry of the prefrontal (left bigger than the right) and the parietal (right bigger than the left) region compared to the control subjects. Gauger et al. (1997), in a study of eleven children with developmental linguistic disorder and nine typical children, concluded that the disorder was the result of a basic neurobiological deficit in the brain region that serves linguistic functions.

Language development in children involves two different abilities: the ability to speak spontaneously and the ability to understand the speech of other people. Most often, about the syntax

development we conclude on the basis of spoken sentences. It is understood that understanding precede production.

It is commonly assumed that the adoption of grammatical elements ends around the age of five, when it is possible to identify the disorder in the development of the grammatical structure (agramatism). However, it should be kept in mind that the adoption of more complex grammatical structures continues during the early school age (Vukovic, 2015). Syntax development lasts from the second to the eleventh year. A decade requires a child to develop a holistic communication sentence from a holophase (one word that represents a global statement). There are two phases in syntactic developmental process. Active syntax development is called the phase between the second and the fifth year. The second phase of development (between sixth and eleventh years) refers to the expansion of syntax competence. The terms syntax development and language development are largely synonymous. About the functioning of the syntax level of the linguistic structure can be said only when the other language levels already operate - phonetic/phonological, morphological, lexical, and semantic. The first is speech is known as "telegraphic" speech. Children omit elements that indicate grammatical categories. In the initial phase of grammar development, sentences are made up of words that the child does not change, but uses them always in the same form. That's why the first combinations of the words seem to be agramatical.

The terms speech and language disorder, developmental language disorder, developmental dysphasia, and language impairment are commonly used to describe children whose communication skills are significantly delayed in comparison to their cognitive development (Nasr, Gabis, Savatić, and Andriola, 2001). Syntax deficits are a very common and noticeable sign of language development disorders. Milosevic and Vukovic pointed out that children with specific language impairment are significantly delayed in adopting a grammatical structure compared to children of typical development, and special difficulties appear in the adoption of syntax structures. Clinical features include the following types of deficiency: deficit of audible perception, phoneme perception deficit, verbal memory deficit, morphological and grammatical deficit, syntax deficit and so on. Kasic and Borota reported that language production of dysphasic children consist of twelve types of agrammatism. Also, the results of this study show that in normal syntax development in children at age between three and four years may occur some types of agrammatism. This phenomenon in children's statements in the fourth year reflects the level of syntax development. If a larger number of these types occur in a child of this age, then this may be an indicator of slower language development, but not developmental pathology. Because of that, its very important to make difference between pathology and normal language development.

Electroencephalography represents the detection of electrical activity of the brain by electrodes placed on the surface of the brain. EEG signals refers to the characteristic rhythmic activity of frequencies between 1 and 100 Hz and they are called "EEG waves". EEG waves came from the root of the telencephalon. According to the frequency, there are delta waves (0-4 Hz), theta waves (4-7 Hz), alpha waves (8-13 Hz), beta waves (14-30 Hz) (Kostic, S. et al., 2015).

The delta rhythm disappears in children older than four years, but the alpha rhythm stabilizes in the presence of the theta rhythm which is dominant until the fifth year. After six years, the alpha rhythm dominates. Electroencephalogram matures on average up to the age of eighteen in girls and up to the twentieth in a boys.

According to empirical data, in children with a specific linguistic disorder, changes in electroencephalographic activity are more frequent in order to children with normal language development. Recent studies suggest that changes in electroencephalographic activity can be found in 15% of children with a specific language disorder (Nasr, et al., 2001).

## Materials and methods

The aim of this study was to analyze and compare grammatical deficits in children with SLI and normal EEG findings and in children with SLI and abnormal EEG findings.

The methodology of this study is defined by the subject, the purpose, tasks and hypotheses of the research.

This study included 20 subjects between 4 and 6 years who are divided in two experimental groups. The sample was divided in two groups by the EEG findings. In each group were 10 subjects. Groups are balanced in both: age and gender. The first experimental group consisted of subjects who were diagnosed with a specific language impairment and who had abnormal EEG findings, while the second experimental group consisted of subjects with specific language impaiment and a regular EEG finding. The EEG findings of the children of the first experimetal group are very similar or completely the same. Most common, they were showing tightened theta and delta waves. Each subject who participated in this research is intense speech and language treatment in the Institute for experimental phonetics and speech pathology ''Djordje Kostic'' in Belgrade.

**Table 1.** Age of subjects with SLI and abnormal EEG findings- E1group and subjects with SLI and normal EEG findings- E2 group

| | Age in years | |
|---|---|---|
| Statistical parameters | E1 group | E2 group |
| N | 10 | 10 |
| Average age | 5,1 | 5,01 |
| Maximum age | 5,72 | 6,02 |
| Minimum age | 4,1 | 4,33 |
| St. deviation | 0,6 | 0,57 |
| t-test | 0,36 | |
| | p=0,72; p>0,05 | |

The data in Table 1. shows that the subjects of E1 and E2 group are balanced according to age (p=0,72, p>0,05). Average age of subjects in E1 group is 5,1 years, the oldest subject had 5,72, the youngest subject had 4,1 years, while in E2 group, average age is 5,01 years, the oldest subject had 6,02 years and the youngest subject had 4,33 years.

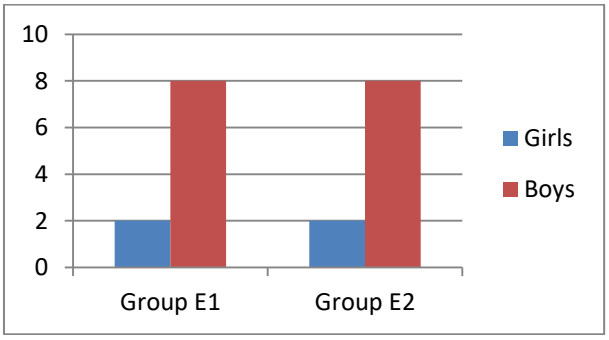


**Fig 1.** *Gender of subjects*

Picture 1. shows that the groups are balanced according to gender.

*Procedures and techniques* used in this study were Grammar in children (Vladisavljevic, 1983) and Test for language assessment of certain components of dysphasic syntax (Blagojevic, D. 1983). The test Grammar in children examines the ability to produce complex communicative statements and questionable sentences. The term complex communicative statements refers to two predicate sentences connected by a conjunction. The Test for language assessment of certain components of dysphasic syntax assess ability to produce predicate sentences.

The Mann-Whitney U-test for two small independent samples is used to compare these two children groups. In this study, statistically significance value is p-value less than 0.05.

## Results

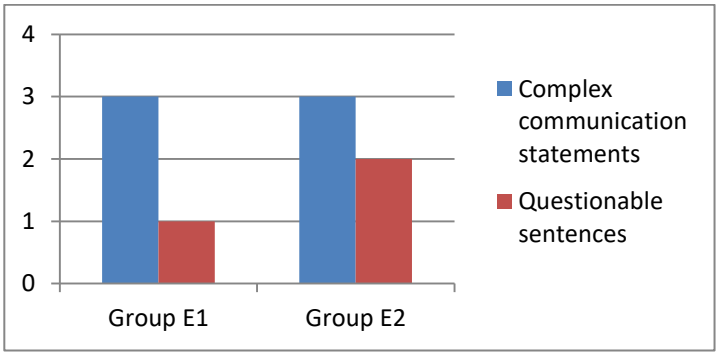


**Fig 2.** Complex communication statements and questionable sentences got by the test Grammar in children

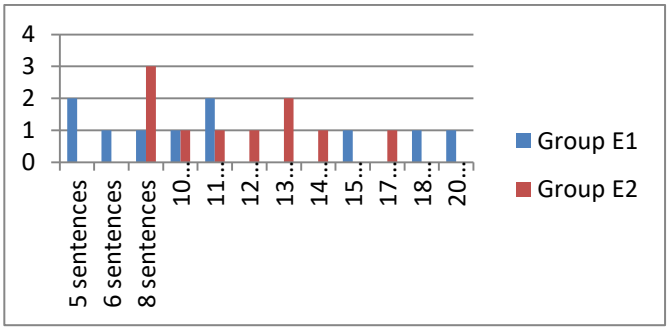


**Fig 3.** Grammatically correct predicate sentence got by the Test for language assessment of certain components of dysphasic syntax

The value of Student's T-test shows that there is no statistically significant difference in the age of these two groups of children, what gives the possibility of comparing these two groups according to grammatical abilities.

When it comes to the production of complex communication statements, the groups are balanced. In both groups 3 subjects correctly produced a complex statement. Only one or two subjects correctly produced questionable sentences.

By The Test for language assessment of certain components of dysphasic syntax received significantly more sentences than by previous test. The subjects of the first experimental group produced a total of 119 grammatically correct predicate sentences, while the subjects of the second experimental group were 114. One subject of the first experimental group produced as many as 20 correct predicate sentences, while the largest number of sentences produced by one respondent in another experimental group was 17.

The statistical analysis of the results obtained by testing subjects of the first experimental group (children with SLI and abnormal EEG findings )and the subjects of the second experimental group (children with SLI and normal EEG findings) showed the following.

The value of Mann-Whitney U test show that there is no statistical significant difference between groups regarding to number of produced complex communication statements and questionable sentences ($p>0,05$). In addition, it has been found that there is no statistically significant difference between groups, when it comes to the number of produced predicate sentences ($p>0,05$).

## Discussion and conclusion

The results of this study have shown that children with disability in language development have deficits in the use of grammatical categories, regardless of the EEG finding. Our results are in agreement with the results of other authors who are in favor of disrupting the development of grammatical structure in children with specific linguistic impairment (Vuković, M. Vuković, I, 2008; Kašić and Bortota, 2003; Vuković, M. Avramović and Vuković I, 2013 ). Further analysis of the results obtained revealed that there are no statistically significant differences in terms of the development of the linguistic structure among children with abnormal EEG findings and children with regular EEG findings. Our results do not coincide with the results of previous studies in this field. For example, Milošević and Vuković, 2011, found significantly better grammatical and syntax abilities in children with a normal EEG findings compared to children with abnormal EEG findings. These authors also point to qualitative differences in grammatical-syntax deficits between the tested groups (Milošević and Vuković, 2011).

However, it should be kept in mind that our research included a small number of subjects and that all subjects are in long and intense speech and language treatment.

Wide variation between studies leaves us without a clear understanding of the relationship between EEG and SLI. This can only be resolved by further studies that include the following criteria: concurrent control group, detailed assessment of controls, ascertainment, defined level of language disability, subjects with SLI who did not start speech and language treatment.

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# Odnos gramatičkih sposobnosti i eeg nalaza kod dece sa specifičnim jezičkim poremećajem

Specifični jezički poremećaj (SJP) je stanje koje podrazumeva kašnjenje jezičkog razvoja kod dece koja nemaju intelektualnu ometenost, oštećenje sluha, neuralno oštećenje. S obzirom da postoji mnogo kliničkih manifestacija SJP postoji potreba za ispitivanjem gramatičkih sposobnosti kod dece sa specifičnim jezičkim poremećajem. Cilj ovog istraživanja je analiza i poređenje gramatičkih deficita između dece sa SJP i urednim EEG nalazom i dece sa SJP i izmenjenim EEG nalazom. Istraživanje je obuhvatilo 20 ispitanika sa specifičnim jezičkim poremećajem iz Instituta za eksperimentalnu fonetiku i patologiju govora ''Đorđe Kostić'' koji su podeljeni u dve grupe. Parametar za razvrstavanje ispitanika bio je EEG nalaz. Za procenu gramatičkih sposobnosti korišćeni su testovi: Gramatika mališana i Jezičko ocenjivanje pojedinih komponenti disfazične sintakse. Rezultati su analizirani metodama deskriptivne statistike. Rezultati pokazuju da ne postoji statistički značajna razlika u pogledu gramatičkih deficita između ove dve grupe. Kada se svi rezultati uzmu u obzir, uopšteno se može zaključiti da ne postoji značajna razlika u razvijenosti gramatike između dece sa SJP i izmenjenim EEG nalazom i dece sa SJP i urednim EEG nalazom.
*Ključne reči:* specifični jezički poremećaj, EEG, gramatika

# Skills of word decoding: a case study of a student with intellectual disability (ID) in the middle school

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**Abstract:** The aim of this paper is to present teaching intervention to students with Intellectual disability (ID) to enhance reading skills. In recent years researches state that teaching reading skills to students with ID needs to follow the same direction with that of the students without special educational needs. However, this research needs further study. In this study we applied a Targeted, Individual, Structured, Inclusion Program (TISIPfSENs) for student with Intellectual Disability (ID, focusing in skills of word decoding (phonological awareness and letter – sound correspondence). Research methodology was conducted in the field of Special Education. It focuses on the case study of a 18 years old student, who was studying at general middle school in Greece. The results showed that students with ID can acquire reading skills, such as word decoding, as long as teachers find the way to teach them.

## 1 Introduction

Literacy is a fundamental ability of humans. It makes them independent in a literate society. It refers to the humans' ability to claim the basic linguistic abilities and because of that it is found in many fields of Curriculums in schools of basic education in Greece. Because of this, literacy is considered as a high educational priority for all the students with or without special educational needs (SEN) in inclusive schools. Allor et al. (2010) highlight that literacy is growingly renowned as an individual right in a global level when it is not accepted for students with SEN to quit school before acquiring the basic literacy skills. This means that teachers need to teach a full reading system addressing all students such as those with Intellectual disability (ID), achieving positive results, as reading is an element of fundamental importance to name a person literate (Stasinos, 2015; Allor et al., 2013).

According to foreign and Greek researchers reading consists a complex educational procedure that includes the ability of decoding writing symbols which are connected when they oblige to grammatical and syntax rules and they produce syllables, words and phrases and the ability of understanding (semantic content of word, phrase or text that someone hears or reads) (van Wingerden et al., 2017; Stasinos, 2015; Wood-Fields, Judge, & Watson, 2015; Porpodas, 2002;).

In greek language the ability of decoding includes the recognition of writing symbols and their translation to vocal representation as it consists of spelling normal words, where their vocal translation is made according to the principles of letter – sound correspondence, and words that include binary vowels (αι, οι etc.) or same sound words [θήρα (hunting) - θύρα (door)] the recognition of whom is not vocal and the orthographic word recognition is required (Porpodas, 2002).

In the research of van Wingerden et al. (2014) it is stated that linguistic factors and cognitive factors (memory abilities, thinking etc.) play an important role in the reading development for the students with or without ID. However, word decoding is the main determinant factor of reading. When with the pass of time decoding becomes an automated process the language understanding becomes the main determinant factor of reading. Because of that students with ID could follow a trajectory in reading education like that of students without SEN but in a slower tempo.

In refer with the decoding ability, it has been stated that the requirements for students to acquire it are abilities as the phonological awareness and the recognition of the relation between the voices and their corresponding letters (Elliott et al., 2008). Concerning the vocal information, the argument counts in the acceptance that understanding vowels is mandatory to arrange the letters in units which count on the voice and afterwards for the mixing of the vowels that come out of words which are fundamental to grow a decoding ability. The second requirement of acquiring the decoding ability

refers to the skill of spelling processing that includes recognition of visual motives and letters combined to create words (Channell, Loveall, & Conners, 2013).

However, comparatively to students without SEN those with ID may have important difficulties in the efficient transition of the decoding steps because they are late according to their chronological and mental age. The picture of slow evolution of these students is made clear with diagnostic tools as Diagnostic and statistical manual of mental disorders (DSM-V) (American Psychiatric Association, 2013). According to Christakis (2006) the difficulties of students with ID in reading are made by restrictions in the fulfillment of mental and learning procedures and the reading readiness. This team shows weaknesses in understanding abilities (acoustic and visual discrimination), lacks in memory abilities (weak short term memory), in the ability to orientate in spacetime and it lacks motion-visual coordination.

van Wingerden et al., (2014) claim that students with ID generally show restraints in learning and liguistic development. Achieving the decoding ability for children with ID is hamperedby the difficulties they face in processing vocal information. Finding and analyzing voices are abstract metalingual procedures that can be difficult for these children for many reasons: «a) production and hearing of the particular sounds can be unfamiliar b) voices that are individually produced may not hear the same as the voices used to create words c) some kids may not understand terms as "voices" or "part of the word" d) they may have difficulties in encoding vocal information in their memory e)t they may face difficulties recalling vocal codes from their memory» (Eissa, 2013, p. 16).

According to Alnahdi (2015) efficient reading behavior is affected by the intelligence (IQ). However intelligence isn't the only nor the most important prognostic factor of reading because this deter us to search a specific malfunction and furthermore to find ways to solve it. A study of Soltani and Roslan (2013) in 60 participants with mild ID showed that phonological awareness is a requirement for the ability of decoding independently of other phonological abilities and the IQ. In a similar way Ainsworth et al., 2016 examined letter – sound correspondence teaching in small groups of students with severe ID (IQ=45) and social communication disturbances. Results showed that IQ score is not an obstacle in acquiring literacy skills. Same goes for participants with different IQ levels. Teaches should not exclude students from literacy opportunities based on their IQ scores because if teaching is direct and systematic students with ID can show progress. These difficulties made researchers to traditionally focus in studying individual abilities such as reading sights words for the students with ID to memorize individual words suggesting that the team can't be benefited through phonological process because of the limited learning and linguistic difficulties (Browder & Xin, 1998). Bradford et al., (2006) claim that teaching of sights words is successful for the construction of a reading vocabulary, however students with ID don't have the skill to decode the unlearned words they come across. This can limit the prism of the reading skills (Wood-Fields, Judge, & Watson, 2015).

However in recent years researches focus on teaching methods to develop the reading behavior of students with ID, such as the ability to decode, similar with the methods for students without SEN (Hansen et al., 2014; Wise et al., 2010). Inside the results of Hills bibliography review (2016) it is high lined that researchers surpassed the typical approach based in sights words in students with ID by making reading interventions based in phonics and emphasized in the successful results of students reading (abilities letter-sound correspondence). In addition the bibliographic review showed there is a prejudice in the selection of the students with higher IQ scores and there weren't any studies in an incorporative environment. Finally many of the studies in this review were focused in the primal reading abilities for adolescents. This can be a sign that teaching of reading either is not sufficiently applied to students with ID during main scores or different reading interventions are required. Furthermore, Cohen (2008) used a decoding strategy of three steps for the teaching of word decoding in students with mild and moderate ID. In this study there were five participants of junior and middle school to whom the decoding strategy was applied. The steps of the strategy were as it follows: (a) the attention-getting step, (b) the decoding step, and (c) the reading-the-word step. The results showed that these five students learned how to read words using the three steps decoding strategy with constant time delay.

Finally there are studies which focus in methodologies that teach multiple reading abilities in students with ID or down syndrome (Dessemontet & de Chambrier, 2015; Lemons et al., 2012). Allor et al., (2010) examined the literacy progress of students with IQ scores between 40 and 69. The

intervention evolved according to the principles of direct teaching. The activities that were included in the study were the following: printing abilities, (finding the title, finding the text from right to the left etc.), abilities of Phonological awareness (clapping syllables etc.), abilities of matching letters-voices, abilities of word decoding (consonant - vowel - consonant), comprehension strategies, abilities of Vocabulary and oral language development etc. Results indicated that students with ID, learn the basic reading skills by taking clear and comprehensive reading instructions for a long time. In addition Bradford et al., (2006) examined the efficiency of letter - sound correspondence teaching in middle-school students with ID using the Corrective Reading Program. The intervention program was divided in four parts: word attacks kills, group reading, individual reading checkouts, and workbook exercises. After the completion of the study the students were able to (a) identify letter - sound correspondences, (b) sound out words, (c) blend sounds to read words, (d) decode irregularly spelled words, (e) read sentences, and (f) read short passages at the second grade level (p. 333). Finally Boyle (2008) helped students with ID to develop their vocabulary, fluency and their comprehension. The three methods he used were the strategy of phonological awareness, a graphosyllabic procedure, and the word recognition strategy. During the appliance of the phonological awareness strategy included segmenting and blending skills through memory «STOP», during the graphosyllabic procedure he explained and modeled the right way to analyze a word in syllables and finally during the word recognition strategy he used the DISSECT Strategy.

This study focuses to teaching word decoding skills to students with ID by using a Targeted, Individual, Structured, Integrated Program for Students with Special Educational Needs (TISIPfSENs). TISIPfSENs is trying every time to bring up the appropriate teaching methodology, the ideal models of teaching interventions, and the appropriate teaching strategies to enforce the linguistic skills of the students (Drossinou - Korea, 2017; Drossinou – Korea et al., 2016). According to Drossinou-Korea (2017), the structure of a program contains: (1) the individual recording of the students' history by his school and family environment through experience; (2) the informal pedagogical evaluation through participatory observation (Avramidis & Kalyva, 2006) based on the tables of the Checklists of Basic Skills (CBS). Participatory observation is conducted by the teacher of Special Education before the implementation of the educational program (primal observation) and after its ending (final observation); (3) the planning of the educational program; (4) the implementation of the educational intervention; and (5) the evaluation of the educational procedure according to the recordings of the final observation and the Form of the Teaching Interaction (FTI).

## 2 Purpose of research

Based on the above it's clear that we can use the same course to reading behavior in both students without SEN and those with ID. This can be achieved with a Curriculum which doesn't focus in the amelioration of only one skill but includes multiple basic reading skills. So this paper examines if the TISIPfSENs which focuses in the teaching of two basic word decoding skills (phonological awareness, letter – sound correspondence) improved the reading behavior of a student with ID and low IQ who is in middle school. There is the need of more studies referring to the teaching of multiple reading skills in general second grade education (Afacan, Wilkerson, & Ruppar, 2017) and there's the need to broaden the abilities of phonological awareness και letter – sound correspondence because they are mandatory for the development of the appropriate word decoding skills (van Wingerden et al.,2017).

## 3 Methodology

Methodology in this paper is to study a case of a student with ID who goes to the third grade of middle school of Greece. The tools that were used are the participatory observation and Checklists of basic skills (CBS) and the Form of the Teaching Interaction (FTI) (Drossinou-Korea, 2017).

### 3.1 Research tools

The tools of the methodology used in this study are the Lists of control of basic skills (LCBS) and the Form of the Teaching Interaction (FTI) (Drossinou-Korea, 2017.

In particular, LCBS include: (a) CBS of Informal pedagogical evaluation of the levels learning readiness: The informal pedagogical evaluation of levels of learning readiness includes the neurodevelopmental skills of the oral, the psychomotricity, the mental skills, and the emotional organization, (b) CBS of Informal pedagogical evaluation of the levels of the special educational needs as they depict to the Framework Curriculum for Special Education (FCSE) (**Fig**. 3): Inside the FCSE, the informal evaluation and completion of LCBS concerns the area of learning readiness, the basic academic skills, the social skills, the creative activities, and the pre-occupational readiness (Greek Presidential Decree: 301/1996), (c) CBS of Informal pedagogical evaluation of the levels of general learning difficulties according the Greek Curriculum of Language: The informal pedagogical evaluation of general learning difficulties is recorded according to the framework curriculum of general education, for every class and course according to the school manuals. In general learning difficulties, the informal pedagogical evaluation and the completion of CBS concern the linguistic skills, the learning readiness skills, the math skills, and the behavioral skills, and (d) CBS of Informal pedagogical evaluation of the levels of the specific learning difficulties (**Fig**. 4): In the area of special educational difficulties, the informal pedagogical evaluation and the completion of LCBS concerns the memory abilities, the abilities of graphic space, the basic reading skills, the mathematic skills, the understanding abilities and the behavioral skills.

The completion of CBS is done by excel tables as it follows (Drossinou-Korea, 2017): in the horizontal lines, we put the skills of every area that are evaluated according to interactive pedagogical relationship and experience for the students' performances in class and in behavior. In the vertical lines, we put the school semesters regarding the typical and mandatory education counting in ascending order from number 1 which corresponds to the first semester of attending kindergarten. A horizontal compact line that penetrates the horizontal lines is the "base line" which corresponds to the currents semester of the students according to their chronological and/or school age (In this study case of a student, the line is yellow and it was placed on the first semester of the third grade of middle school). The researcher should note with an x the table cell that he thinks it corresponds to the level of success for each skill. When this procedure is completed two broken lines, the first broke line (grey color) is formed that shows the disturbed or normal performance of the students in each skill during the initial observation (before to the implementation of the educational intervention) and the second broke line (red color) is formed that shows the disturbed or normal performance of the students in each skill during the final observation (after to the implementation of the educational intervention).

The FTI is about a means of evaluating the progress and the autonomy of a student during educational intervention (Drossinou-Korea, 2017). It is visualized in a table which includes the personal information of the student, the educational goal, the date of every educational intervention, and the recording of important crosstalk between teacher and student from the daily educational intervention. More specifically, it includes phrases of both teacher and student, as well as the commentary of their interaction that has as a goal the pedagogical reflection of the teacher and the resurgence of the educational intervention. The pedagogical reflection that is the main goal through the intervention is enforced by the self-observations and hetero-observations through the interaction with the student.

### 3.2 Methodology Procedure

According to the First phase of TISIPfSENs the student is 18 years old and he is diagnosed by the Centre of Differential, Diagnosis and Support (CDDS) with mental deficiency and immaturity (IQ=45) and he goes to the third grade of Middle school of general education, when in the same time he takes educational support from a teacher of special education. Generally the student could communicate, understand oral speech, he vocally recognized some letters of the greek alphabet and could write and recognize some words (sights words).

According to the Second phase of TISIPfSENs. the informal pedagogical evaluation of the student was conducted through the initial participatory observation (broke line with grey color) according to four Checklists of basic skills (CBS) focusing on the students' reading skills and reading subskills areas: (a) CBS of learning readiness: The student was evaluated in the area of «Mental Skill» and more specifically in the area of «Optical memory» and the area of «Syllogism» 16 semesters under the base line (First Grade of Primary school - First Semester), (b) CBS of special educational needs as the depict to the FCSE (**Fig**. 3): The student was evaluated in the area of Basic School Skills and more specifically in the area of «Reading» 16 semesters below the base line (First Grade of Primary school - First Semester) and in the area of «Writing» 16 semesters below the base line, (c) CBS of general learning difficulties: The student was evaluated in the area of language skills and more specifically in «Reading» 16 semesters under the base line and in comprehension 17 semesters under the base line, (d) CBS of Specific learning difficulties (**Fig**. 4): The student was evaluated in the area of basic reading skills and more specifically in phonological awareness 16 semesters under the base line and in morphology-orthography 16 semesters under the base line (First Grade of Primary school - First Semester).

According to the Third phase of the TISIPfSENs a plan of divergent teaching was structured. The teacher used the direct teaching applying the teaching model of task analysis. The teaching goal for the student was to speak, to distinguish, to show and to remember the 24 letters of the greek alphabet. The application of the TISIPfSENs lasted 8 months. The student was being daily taught the basic linguistic decoding skills for 3 educational hours (45 minutes per hour).

Finally, according to the Forth phase of the TISIPfSENs the student was taught by panels with cards. Every panel included four columns (**Fig**. 1): In the first column there were 10 words. The ten words were into groups of those who begun with the letter and those that included the letter the student was taught (for example the first week he learned the letter «Α-α» the second week the letter «Β-β», «Ε-ε» etc.). The second column included images. The third column was empty. In this column the student was supposed to put the ten portable cards that depicted the same words. The fourth column of the panel included activities to decode words. The activities on the panel were as it follows: in the first column the teacher was reading the stable words and explained their meaning with the help of the images (second column). In the fourth column the student tried to pronounce and after that to depict the letters of this word with the help of rhythm (claps) emphasizing the letter he was taught every week. Afterwards in the third column the student was given the cards and tried to match them either by looking the image of each word or its' structure. Every week the images were fewer because our basic priority was for the student to match the words observing their structure/morphology.

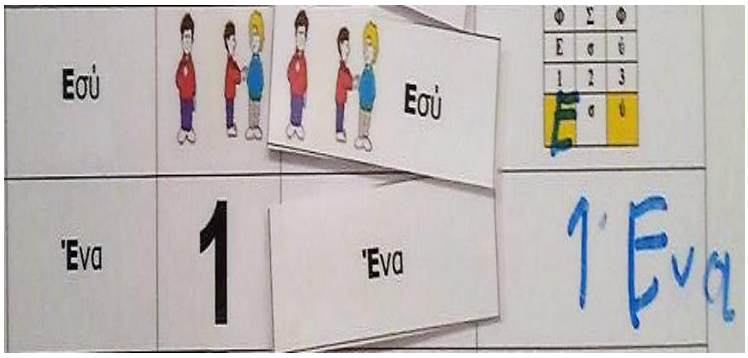


**Fig. 1.** The student decodes the words «Εσύ» (You) and «Ένα» (One) with phonological awareness activity.

The cards were also used in other activities like in the work envelop. By putting some of the cards the student already knew inside the envelop and by matching the letters and the sound he continued to decode words having as a goal to understand them phonologically, morphologically and also understand their meaning. The words the student was taught were 120. They were words with two or three syllables and they had the following structure: consonant-vowel-consonant or vowel-consonant-vowel (**Fig**. 2).

**Fig. 2**. The student corresponds to the sounds and the letters of the word «Βήμα» (Step) = consonant-vowel-consonant- vowel).

## 3 Results

The results came out during the fifth phase of the TISIPfSENs out of the final observation with the use of CBS and the records to the FTI. According to the final observation to the CBS table of «learning readiness» and more specifically in the areas of «Optical memory» and «Syllogism» there was a progress of 2 semesters comparing to the initial observation (Second Grade of Primary school - First Semester). In the table of CBS of «special educational needs» as the depict to the FCSE the student improved 2 semesters in the areas of «Reading» (Second Grade of Primary school - First Semester) and «Writing» (Second Grade of Primary school - First Semester) comparing to the initial observation (**Fig**. 3)

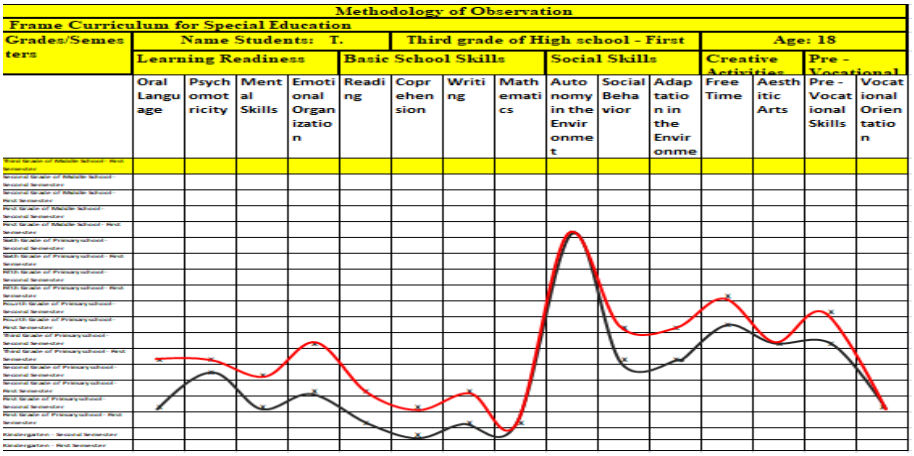


**Fig.3:** CBS of Informal pedagogical evaluation of the levels of the FCSE.

In the table of CBS of «general learning difficulties» the school performance of the student in the area of «Reading» was recorded to the Second Grade of Primary school - First Semester and in the area of «comprehension» he was evaluated in the First Grade of Primary school - Second Semester. Finally in the table of CBS of «Specific learning difficulties» (**Fig**. 4) the student was evaluated 3 semesters above the initial observation in the area of «phonological awareness» (Second Grade of Primary school - Second Semester) and in the area of «Morphology – Orthography» 2 semesters

above the initial observation (Second Grade of Primary school - First Semester).

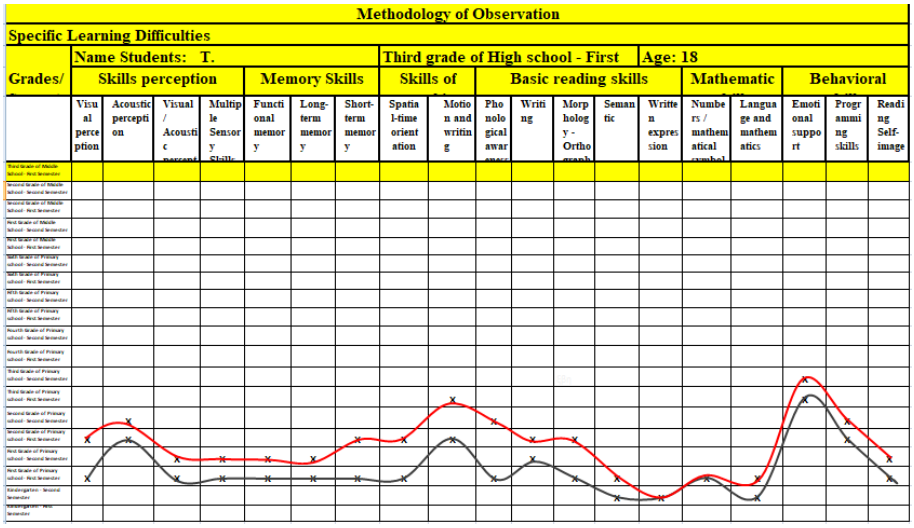


**Fig. 4:** CBS of Informal pedagogical evaluation of the levels of the specific learning difficulties**.**

The low reading overall of the student comparing to his age was recorded in the FTI. Initially he had difficulties to respond in the word decoding teaching because for many years he's been taught by sights words. However, the differential intervention with the teaching of phonological awareness using rhythm (claps) and the teaching of letter – sound correspondence using the work envelope helped the students' improvement. The student achieved to correctly decode the words according to the third column of the panel where he matched the stable and the portable cards.

## 4 Conclusion

The application of the TISIPfSENs for a long term focusing in reading skills for the student with ID was considered effective in general education because in the CBS tables there was an improvement of the student in learning and linguistic abilities of the student in the CBS tables. Researches of Drossinou et al. (2016) and Drossinou – Korea and Panopoulos (2017) indicated that the use of TISIPfSENs enforces the reading skills of students with ID. In this paper we proved the efficiency of the TISIPfSENs in reading skills of the student such as phonological awareness and letter – sound correspondence abilities , which the students are being taught. This is proved by the research of Allor et al., (2010) who studied the effectiveness or not of an interventional program for reading. The 28 students who participated had medium ID (IQ= 40-55). For them there were activities as clapping words in sentences, clapping syllables within a multisyllabic word, initial sound isolation, phoneme segmentation, phoneme blending, and phoneme discrimination etc. The results indicate that students with medium ID cav learn the basic reading skills through teaching instructions in reading for a long term. The most obvious and important outcome of this research was the effect of phonological awareness.

Furthermore, the teaching of reading which includes many skills and not only one is more effective in students with ID. This is also confirmed Afacan, Wilkerson and Ruppar (2017) who made a bibliographic review studying the effectiveness of multicomponent reading interventions (phonemic awareness, phonics, fluency, vocabulary, and comprehension) for junior school students with ID. The results showed that multicomponent reading interventions for a long term proved to be effective for the amelioration of the reading skills of students with ID that were studying in general schools.

Finally according Lemons et al., (2016) the ten requirements that a reading curiculum in students with ID (like TISIPfSENs) must have are the following: to set longterm goals, to set the students needs and set goals, to apply an explicit and systimatic reading instruction (e.g. when the students decode a word they must first say the voices of each letter and then to combine these voices to say the

word or the must be taught word decoding skills combined with images), to provide instruction with sufficient intensity, for the teachers to search additional education on what concerns reading teaching, for the teachers to remember that the linguistic skills are mandatory for reading skills, to enforce the memory skill of students with ID with the use of images, to use teaching steps, to use methods (tools) for the data collection of the students progress and to involve service providers and family members.

As a conclusion the students with ID can learn reading skills, so there is no point to highlight the teaching of reading for this population.

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# The importance of group work for socialization and communication in children with speech, language or behavioral disorders

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**Abstract.** This paper shows the results of the study titled obtained through a survey compiled for this research. The aim of this study was to analyze the impact of group work on socialization and communication in children with speech, language or behavioral disorders based on their parents' answers to questions in the survey. The results of this research have shown that children with speech, language and behavioral disorders socialize better as a result of group work, which leads to better communication (expressive and receptive speech), which has also been confirmed by comparative analysis of the answers provided by parents and therapists.
Keywords: group work, socialization, communication in children with speech, language or behavioral disorders.

## Introduction

The development of man as a bio-psychosocial being is the result of a complex interaction between biological and environmental factors. The importance of socialization is especially evident in children who grow up in conditions of social deprivation.

Socialization is a learning process which begins soon after birth. The period of early childhood is a period of the most intense and most important socialization. That is the period when language is acquired and when the basics of culture are learned. However, socialization continues throughout life (Nedovic, Odovic&Rapaic, 2010.).

In the area of education, group work becomes more and more important (Glanz, 1962.). In group work, the tasks of every group's team member are defined to accomplish the same goal. Every group can have the same or different goals, but in the end they can integrate in a common goal (Nikolic, 2003.).

Kamenov (1997) cites as an advantage of group work the possibility of individualization, giving older children independence in decision making about making a choice between activities, funds and materials, as well as big influence on the process of socialization in children, development of cooperative relations and forming a sense of satisfaction with regard to the group.

Speech and verbal communication are the main basic activities of a social being with which he interacts within narrow and wide living and working environments. Verbal communication includes a complex background of habits, information, relations, tendencies and knowledge which are related and which determine what we will say and how we will react to a certain message.

When child's abilities to understand speech or to speak is under the expected level for his/her mental age it is a delay in speech development. Delays of varying degrees can appear in understanding and in speaking, from misunderstanding simple speech orders to inability to understand complex grammatical constructions. However, ability to speak is delayed while in understanding speech there are no major obstacles (Golubovic 2012). In a group of peers during organised activities a child, with the help of an adult, spontaneously reveals potentials that are preserved, which represent the best base on which knowledge, abilities, self-confidence, independent and positive attitude towards himself and others are going to be further built. Finding in what the child is successfull is creating the conditions not only for adequate social but also for cognitive development within the limits of the child's possibilities. The aim of this study was to assess the significance of group work in the socialization and communication of children with speech, language and behavior disorders.

## Methodology

### Place and Time of Study

The study took place at the Institute for Experimental Phonetics and Speech Pathology „Đorđe Kostic“ in Belgrade from February to May 2017.

### Sample description

Sample included 21 parent whose children are included in audiolinguistic treatment and group daily stay at the Institute for Experimental Phonetics and Speech Pathology „Đorđe Kostic“.

### Instruments

The instrument used for assessment was a questionnaire constructed for the purposes of this research. The questionnaire consists of 16 closed type questions which are organized in two parts. First part involves speech and language and has 9 questions, for example “does your child use new words’’ and the second part involves socialization and has 7 questions, for example ‘’does your child like to play with other kids’’).

The scores range from 1 to 3, where 1 is the lowest degree of agreement and 3 is the biggest.

## Research results

**Table 1** The results of the part of the test related to speech and language

| | mean | Sd |
|---|---|---|
| Speech and language 1 | 13,52 | 2.24 |
| Speech and language 2 | 21,76 | 2.96 |
| | p<0,05 | |

Mean- arithmetic mean, Sd- standard deviation

Table 1 shows the results of the part of the test related to speech and language . The first test has an arithmetic mean of 13,52 with a standard deviation of 2,24, while the retest had an arithmetic mean of 21,76, with a standard deviation of 2,96. The results show that there is a statistically significant difference (p<0,05).

**Table 2** The results of the part of the test related to socialization

| | Mean | Sd |
|---|---|---|
| Socialization1 | 11,19 | 2,80 |
| Socialization 2 | 18,09 | 1,54 |
| | p<0,05 | |

Mean- arithmetic mean, Sd- standard deviation

Table 2 shows the results of the part of the test related to socialization. The first test resulted in an arithmetic mean of 11,19 and a standard deviation of 2,8. The retest resulted in an arithmetic mean of 18,09 with a standard deviation of 1,54. The results demonstrate a statistically significant difference (p<0,05).

**Table 3** The results of the summed results of scores on the first test and the retest

| | mean | Sd |
|---|---|---|
| Ukupno 1 | 24,23 | 4,84 |
| Ukupno 2 | 39,42 | 3,94 |
| | p<0,05 | |

Mean- arithmetic mean, Sd- standard deviation

Table 3 shows the results of the first testing with an arithmetic mean of 24,3 and a standard deviation of 4,84, while the retest has an arithmetic mean of 39,42 and a standard deviation of 3,94. The results show a statistically significant difference of ($p<0,05$).

## Discussion and conclusion

Group work is significant for the development of cognitive, social, emotional and working skills. Children with disorders of speech, language and behaviour most often have reduced capabilities to adopt the aforementioned skills.

The results of our research show significant progress in the areas of speech, language and socialization based on the grades provided by parents during the retest versus the test. The first testing had a much lower scare versus the score after the retest, which was performed after 3 months and which resulted in a much higher score. On the basis of the results, we may conclude that group work has a significant impact on the betterment of the areas that were tested aside from individual audiolinguistic treatments.

Parents have rated the improvement in attention span and speech understanding with the highest mark. They rated the children's interest or their desire to ask questions with the lowest mark. There is a great impact of group work in children with disorders of speech, language and behavior are big. The children have the chance to learn from one another.

Children with development disorders demand special forms of care and protection on their growth path, socialization and social inclusion.

The first step on the path towards the complete and successful protection of these children is an adequate assessment of their needs, followed by planning the type of support.

The support children with developmental disorders get in every stage of their development and socialization needs to be socially valid and functionally based (Mitic, 2011.).

Group work helps children achieve better communication and socialization, spending time with other children, learning from one another, children enrich their capabilities and strengthen their personal motivation.

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## Značaj gupnog rada u socijalizaciji i komunikaciji kod dece sa poremećajem govora, jezika i ponašanja

U ovom radu prikazani su rezultati istraživanja, dobijenih pomocu upitnika sastavljenog za ovo istazivanje. Cilj ovog istrazivanja je ispitivanje uticaja grupnog rada na socijalizaciju i komunikaciju kod dece sa poremecajem govora, jezika i ponasanja, na osnovu odgovora roditelja dobijenih upitnikom. Rezultati ovog istrazivanja su pokazali da deca sa poremecajem govora, jezika i ponasanja pod uticajem grupnog rada, imaju bolju socijalizaciju i paznju sto direktno dovodi do poboljsanja komunikacije (ekspresivni i receptivni govor), sto je i potvrdjeno uporednom analizom dobijenih odgovora roditelja i terapeuta.
*Ključne reči*: grupni rad, socijalizacija, komunikacija dece sa poremecajem govora, jezika i ponasanja.

# Examining differences in parents' attitudes towards corporal punishment on preschool children with developmental disorders and their peers with typical development

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**Abstract.** The objectives of this study were to examine differences in parental attitudes towards corporal punishment on preschool children with developmental disorders and their peers with typical development. The study included parents of both genders, from Serbia, Montenegro and Bosnia and Herzegovina. Their children aged up to 7 years. One group was formed out of parents of children with typical development (PCTD), and the other one of parents of children with developmental disorders (PCDD). Children of parents from the second group were patients of The Institute for Experimental Phonetics and Speech Pathology in Belgrade. The participants filled out a questionnaire that included various issues related to socio-demographic and individually psychological factors and a questionnaire on Attitudes towards physical punishment. Certain differences in two groups of parents were examined.

## 1 Introduction

Physical punishment is an act that is carried out to inflict pain to the child, but not injury, for the purpose of correction or control (Straus & Paschall, 2009). Today, all forms of corporal punishment are banned in 51 states (Global Initiative to End All Corporal Punishment of Children, 2017). With ratifying the United Nations Convention, Serbia took a commitment to ban corporal punishment of children (Građanski zakonik Republike Srbije, 2015). When Serbian parents are asked directly if they consider physical punishment as an adequate method of disciplining, 93% parents find it unnecessary (Republički zavod za statistiku & UNICEF, 2014), while other studies point out that 55% of parents administer this form of disciplining (UNICEF, 2010).

Research shows that corporal punishment is associated with the younger age of children, and the most punished children are those younger than seven (Sesar, 2009). Factors associated to the use of corporal punishment are parents' sex (Straus & Fauchier, 2007), their age (Kimura & Yamazaki, 2015), educational level (Gracia & Herrero, 2008), marital status (Heilmann et al., 2015), material status (Heilmann et al., 2015), religiosity (Cox, 2013; Taylor et al., 2013), number of children in family (Heilmann et al., 2015), presence of stress (Knox et al., 2015), and parents' experiences in punishment during their own childhood (Deater-Deckard et al., 2003).

The most vulnerable children are those who are called "difficult" for upbringing: children with medical problems, cognitive impairments, externalizing or internalizing problems, problems with dieting or sleep, various developmental disorders, etc. (Kimura & Yamazaki, 2015; Woodward & Fergusson, 2002; Xing et al., 2011; Gershoff et al., 2012; Choe, et al., 2013). Comorbidity is also often present.

We found no previous research in our country which explored the differences in attitudes towards corporal punishment between parents of children with some type of developmental disorders (PCDD) and parents of children with typical development (PCTD). Thus, it is very important to explore this issue and determine whether the results of our study will be consistent with results in other countries. Also, it is important to explore which parental features affect those attitudes. At last, we need to examine whether the parents of our country are ready to a complete ban of physical punishment. These findings can help to understand whether children with some kind of difficulties are at a greater risk for the use of corporal punishment.

## 2 Methodology

Participants in this study were parents of both genders (N=100), 32 males (32%) and 68 females (68%) from Serbia, Montenegro and Bosnia and Herzegovina. Their children aged up to 7 years. Parents were divided in two groups. One group was formed out of PCTD, and the other one of PCDD. Children from the second group were patients of The Institute for Experimental Phonetics and Speech Pathology in Belgrade and they were receiving speech therapy due to the presence of some form of speech disorder.

The questionnaire included items regarding socio-demographical data (parental sex, age, education level, number of children, level of religiosity, marital status, material status, level of stress, experiences in corporal punishment during own childhood). Attitude towards corporal punishment was measured with a 10-item questionnaire which represents a translated and adapted version of Holden's questionnaire *Attitudes toward spanking* (Holden, 1995). Parents had to determine whether they "fully disagree" or "fully agree" on a scale from 1 to 5. Reliability of the questionnaire was satisfactory ($\alpha$=0,86). The last item was used to examine parents' belief about banning corporal punishment.

We used following statistical methods: descriptive methods for analysis and description of sample. Pearson correlation for exploring correlations between parents attitudes toward corporal punishment and parental age, level of education, marital status, religiosity, number of children, material status and experiences in corporal punishment during own childhood, and t-test for examining differences in attitudes between males and females and two groups of parents (PCTD and PCDD).

## 3 Results

### 3.1 Differences in attitudes towards physical punishment between parents of children with and without developmental disorders

Although the average score on the questionnaire Attitudes towards physical punishment is higher in the group of PCDD (M = 25.06) than in the group of PCTD (M = 22.39), these differences are not statistically significant (t= -1.641, p = 0.104).

### 3.2 The correlation of attitudes towards physical punishment and socio-demographic and individual psychological factors

**Table 1**. The correlation of attitudes towards physical punishment and socio-demographic and individual psychological factors and its significance

| | **r** | **p** |
|---|---|---|
| Parental age | -.327 | .022 |
| Number of children | -.045 | .760 |
| Level of education | -.264 | .067 |
| Socio-economic status | .157 | .282 |
| Religiosity | .245 | .090 |
| Level of stress | .044 | .763 |
| Experiences in corporal punishment during own childhood | .510 | .000 |

Note – r represents correlation while p represents the significance of that correlation;

Although the attitude towards physical punishment is somewhat more positive in males (M=25.45, SD=8.96) then in females (M=24.39, SD=5.55), these differences weren't statistically significant (t=0.454, p=0.652). As can be seen in the table, we found statistically significant negative correlations between

attitudes towards corporal punishment and parental age, and statistically significant positive correlation with experiences in corporal punishment during own childhood (Table 1). Other factors were not significantly correlated to the attitude towards corporal punishment. Even though we wanted to explore whether marital status is correlated with attitudes towards corporal punishment, we decided to exclude this variable from the study because there were not enough divorced parents, so we couldn't derive any conclusions.

### 3.3 Parental beliefs about the necessity of prohibiting physical punishment

Parental beliefs on this issue were completely divided. Namely, 15 parents (30,6%) considered that corporal punishment should not be banned, 17 parents (34,7%) were undecisive, and 17 parents (34,7%) considered that it is necessary to establish this form of prohibition.

## 4 Discussion and Conclusions

The aims of our study were to determine whether there are differences in attitudes towards physical punishment between PCTD and PCDD, and which socio-demographical and individually psychological factors of PCDD have an influence on this attitude. We also wanted to explore beliefs of PCDD about a complete ban of corporal punishment.

The results in our research did not confirm the findings of previous research (Kimura & Yamazaki, 2015; Woodward & Fergusson, 2002; Xing et al., 2011; Gershoff et al., 2012; Choe, et al., 2013) when it comes to the presence of differences in attitudes towards corporal punishment between PCTD and PCDD. These non-existent differences may be explained in terms of the type of developmental disorder. Namely, in our research, children with developmental disorders had some form of speech pathology, and maybe these differences exist in some other types of developmental disorders. Also, previous research mainly explored the use of physical punishment, but not the attitude itself, so we can assume that parents from two groups have similar attitudes, but differ in using this form of discipline.

Furthermore, our findings are consistent with previous studies concerning the age of parents, respectively, that the younger age is related to a more positive attitude towards physical punishment (Kimura & Yamazaki, 2015). Maybe younger parents lack patience or time, so they choose this easy and instant method to discipline their children. Also, our results confirmed previous research concerning the correlation between attitude and experiences in corporal punishment, meaning that parents who had been physically punished during their own childhood have more positive attitudes towards this form of punishing (Deater-Deckard, et al. 2003). Obviously, these findings indicate that there is presence of a trans generational behaviour pattern, respectively, the belief about the necessity of using this method of discipline is passed down from generation to generation.

Parental sex (Straus & Fauchier, 2007), level of education (Gracia & Herrero, 2008), material status (Heilmann et al., 2015), religiosity (Cox, 2013), number of children (Knox et al., 2015) and stress (Heilmann et al., 2015) were not linked to the attitude towards physical punishment in our research, which is contrary to previous research.

When it comes to banning physical punishment, parents are completely indecisive about this issue, which certainly leaves a space for the influence of experts who deal with children and their development.

The limitations of this study are a small number of participants, so we believe that a larger number of participants would give more precise results and perhaps a better explanation of the obtained data. Further researches about this issue are needed.

Since the results on this topic are inconsistent, we can conclude that the attitude towards physical punishment is under a significant influence of previous experience, respectively, that it is transferred from generation to generation, through upbringing and education, and that physical punishment is a topic that requires further and more detailed exploration.

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## Ispitivanje razlika u stavovima roditelja prema fizičkom kažnjavanju predškolske dece sa razvojnim poremećajima i njihovih vršnjaka sa tipičnim razvojem


Ciljevi ovog istraživanja su bili da se ispitaju razlike u stavovima roditelja prema fizičkom kažnjavanju dece predškolskog uzrasta sa razvojnim poremećajima I njihovih vršnjaka sa tipičnim razvojem. Istraživanje je uključivalo roditelje oba pola, iz Srbije, Bosne i Hercegovine i Crne Gore. Njihova deca su bila uzrasta do 7 godina. Jedna grupa je uključivala roditelje dece sa tipičnim razvojem, a druga roditelje dece sa razvojnim poremećajima. Deca roditelja iz druge grupe su bila pacijenti Instituta za Eksperimentalnu Fonetiku i Patologiju Govora u Beogradu. Ispitanici su popunjavali upitnik koji je uključivao različita pitanja koja se tiču sociodemografskih i individualno psiholoških činilaca, kao i upitnik Stava prema fizičkom kažnjavanju. Ispitivane su određene razlike među dve grupe roditelja.

# Dysphagia in patients with acute stroke: early screening

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**Abstract.** *Introduction/Objective.* Oropharyngeal dysphagia is a common consequence of acute (hemispheric) stroke and many patients remain dysphagic even one year after stroke had occured. Aspiration, pneumonia and malnutrition are most common complications of dysphagia, therfore many patients are being fed by nasogastric catheters or via endoscopic placed gastrostomes that require a long-term institutional care. Although dysphagia can be treated differently, there is no standardized clinical protocol for assessment and treatment of this disorder. Considering complexity of cerebral control of swallowing, it is hard to predict which patients may have swallowing disturbance based on neuroimaging methods only. This study's main purpose is to enable a clinical assessment of swallowing in the first 72 hours after stroke and to identify a correlation between severity of dysphagia and localization of the lesion.
*Methods.* Patients (with acute stroke) from the BSU (Brain Stroke Unit ) of the Department of Urgent Neurology were assessed in first 72 hours after stroke by *Screening test for dysphagia* and *Dysphagia Severity Degree Scale*. Those two instruments were structured for the purposes of this research. The lesion was localized based on MRI or CT scan.
*Results.* Presence and the degree of poststroke dysfagia were correlated with lesion localization based on MRI/CT scan. Patients diagnosed with poststroke dysphagia were included in structured training for restitution of the swallowing act with specifically defined nutrition methods and food modification in order to provide recovery of the swallowing act and to protect respiratory tract
*Conclusion.* Suggested protocol for evaluation of poststroke dysphagia severity degree correlated with neuroimaging scans can give a significant contribution to early detection and rehabilitation of swallowing disorders.
*Key words:* acute stroke, dysphagia, swallowing, screening, scale, detection, rehabilitation

## Introduction

Acute stroke is commonly complicated by oropharyngeal dysphagia in 50% of patients; of these, up to 40% remain dysphagic even one year after stroke [1]. According to some studies, the incidence of dysphagia after stroke is between 14% and 94% [2-8], depending on the different methodologies of research. Dysphagia is complicated by aspiration, pneumonia, and malnutrition and patients often need enteral feeding through a nasogastric tube or percutaneous endoscopically induced gastrostomic tube, which often requires long-term institutional care [1], and leads to social isolation and bad quality of life [9]. Pneumonia is the most important complication of dysphagia. It occurs in 10% of the cases and leads to higher rate of morbidity and mortality [10-13]. Given that 50% of these cases were attributable to aspiration, with the early detection of dysphagia this complication could be avoidable. Timely used, standardized diagnostic protocol for dysphagia at the units for brain stroke could contribute to early detection of dysphagic patients and consequently to an adequate modification of feeding and food consistencies and rehabilitation of the swallowing act [14-17].

Despite its serious consequences and the difference in recovery patterns, the neuromechanism of dysphagia is still unclear. Previously, swallowing was thought to be an automatic response/process, with its dominant areas at the brainstem level. However, later it was discovered that, the swallowing was a patterned response mediated by a complex neurophysiological response and that the cerebral cortex, such as frontal and cingulate gyrus, may play an important role in swallowing. With the increasing number of neuroimaging techniques, many studies have confirmed that injury of the swallowing motor areas or their connection to the brainstem might be the cause of swallowing dysfunction [9].

The process of swallowing involves a complex sequence of neuromuscular events that transport food from mouth to stomach whilst ensuring protection of the airway. Its neural control is commonly divided into three stages – an afferent system, consisting of cranial nerve fibres V, IX, and X, providing swallow sensory feedback; the brainstem swallowing centre, reflexly coordinating swallowing via the V, IX, X, XII motor nuclei; and higher centres, including the frontal cortex, which initiate and modulate volitional swallowing [18].

Recently, increasing number of functional neuroimaging techniques (such as fMRI and PET) have been used to study the functional changes of dysphagia and predict its clinical outcomes. Vascular lesions of different volume and localizations (brainstem, cerebral cortex (including insular and postcentral gyrus) and subcortical structures - basal ganglia (BG)) were correlated with dysphagia in patients with brain stroke. Some authors accentuate the importance of praecentral and cingulate gyri in the regulation of the swallowing act [9].

There is considerable evidence from functional imaging and lesion studies indicating that specific phases of swallowing may be differentially lateralized. Damage of the left hemisphere was found to be associated with oral phase dysfunction, while right hemispheric stroke caused pharyngeal phase impairment. Moreover, right hemispheric stroke location leads to a higher rate of dysphagia and more severe swallowing dysfunction and complications [19-23]. A study that was conducted by Daniels et al. showed that lingual discoordination during swallowing occurred commonly in patients with subcortical lesions with the periventricular white matter. The lesions of the periventricular white matter may disconnect anterior and posteriorbcortical regions that are critical to oral control and coordination in swallowing [24]. Lesions to the left periventricular white matter may be more disruptive to swallowing behavior than similar lesions to the right periventricular white matter [25]. These data also suggest that the neural mechanisms that mediate lingual coordination may at least in part be independent of the neural systems that mediate buccofacial, limb, and speech praxis functions [24]. Unlike the oral phase, the pharyngeal phase of swallowing is predominantly regulated by the right hemisphere.

Right hemispheric parietal-temporal regions related to aspiration, especially the supramarginal gyrus, as a sensorimotor integration area, as well as the superior temporal gyrus, Heschl's gyri and the temporopolar and orbitofrontal cortex were also significantly associated with impaired swallow response and oropharyngeal residue. Affliction of the parietal operculum, which constitutes a secondary somatosensory cortex, causes severe and long-lasting dysphagia. These results stress the importance of intact sensory afferents for the motor output network of swallowing [25].

It is known that vagal afferents are responsible for initiating the cough reflex, with centres in the lower brainstem. However, current knowledge about the supramedullary regulation of cough is poor. It has been hypothesized that the cerebral cortex modulates the sensitivity of brainstem reflex cough centre. The anterior part of the cingulate cortex is known to have direct connections with brainstem autonomic nuclei and it is involved in visceromotor control, especially the regulation of autonomic responses to external stimuli. In another functional imaging study, throat clearing resulted in activation of the cingulate area, frontal and pericentral cortex, and the superior and middle temporal gyri [29], which suggests the relevance of these regions for airway protection. Moreover, these results indicate that swallowing and cough response may underlie different supramedullary control [25].

Considering the importance of the early screening and the objective of this research, we structured the protocol for early screening for poststroke dysphagia. After the assessment of the swallowing act, the results were correlated to lesion localizations.

## Objectives

This study's purpose was to enable a clinical assessment of swallowing in the first 72 hours after stroke and to identify a correlation between severity of dysphagia and localization of the lesion. The main objective of the study was to determine if the basic neuroimaging methods (such as CT or MRI) could be used to predict which patients with acute stroke may have swallowing disorders.

## Methodology

This research was conducted from June, 2017 until October, 2017 at the Brain Stroke Unit (BSU) of the Department of Urgent Neurology (Clinical Centre of Serbia). The swallowing act of the patients with acute stroke from the BSU was assessed in the first 72 hours after stroke. The lesion was localized based on MRI or CT scan. After the initial diagnosis of CVI was confirmed, patients' act of swallowing was assessed. The swallowing assessment was consisted of the *Screening test for dysphagia* and – if its results indicated presence of dysphagia – the *Assessment of the severity of dysphagia*.

The swallowing act of 48 patients was assessed. Nine of them were excluded from survey: one patient was uncooperative and rejected further assessment after the Screening test for dysphagia was conducted; one patient was discharged from hospital before the Assessment of the severity of dysphagia was conducted; four patients had global aphasia and MMSE (Mini Mental State Examination) score lower than 10; three patients were initially diagnosed with CVI, but further examination showed that patients suffered from transient ischemic attack (TIA). The swallowing assessment wasn't conducted on the patients who were intubated with nasogastric catheter right after they had been admitted to hospital.

After collecting the basic information about the patient (including age, sex, lateralization, mother tongue, educational level and lesion localization based on CT/MR) and conducting the cognitive screening (MMSE – Mini Mental State Examination) [28], patients'act of swallowing was assessed. The swallowing assessment consisted of the *Screening test for dysphagia* and – if its results indicated presence of dysphagia – the *Assessment of the severity of dysphagia*..

Screening test for dysphagia was structured for this study's purpose. The Screening included the examination of the oral cavity and velopharyngeal mechanism, phonation ability, mobility and strenght of lips and tongue, volicious cough, dry swallow (with assessing the initiation of swallowing and elevation of the larynx), water swallowing by spoon, water swallowing – swallow by swallow, continuously swallowing (100ml of liquid). After swallowing the liquid, voice quality (phonation) and subjective impression of the patient were observed. Presence of dysphagia was confirmed if symptoms such as: choking, hypersalivation, lack of swallowing reflex, throat clearing, changes in voice quality, impaired control/manipulation of liquid bolus, reflex coughing, subjective discomfort etc. occured during any swallowing task. In that case, patients were further examined with *Assessment of the severity of dysphagia.*

The Assessment of the severity of dysphagia included examination of swallowing different consistencies (solids, mash, pudding, thickened and clear liquids). After the assessment was conducted, the severity of dysphagia was determined using the Dysphagia Outcome and Severity Scale (DOSS) (O'Neil et al, 1999), considering the level of independence during feeding, level of nutrition (per os/null per os) and diet level with diet modification (diet consistency restrictions) [27].

### Statistical Analysis

SPSS statistics software package was used for data analysis. Demographic and clinical characteristics are presented in tables and refer to examined population. Statistical analysis contained descriptive statistic measurements, Mann-Whitney U test for comparison of continuous variables between two groups and Kruskal-Wallis H test for comparison of continuous variables between three or more groups. $\chi^2$ test was used for examining relation between the expected and the observed frequencies. P value lower than 0.05 was considered statistically significant.

## Results

This study included 39 patients of whom 26 were males (66,7%) and 13 were females (33,3%). Average age of examined population was 56.10±12.62 years (Min 22 years, Max 79 years). Dysphagia was registered in 8 patients (20.5%). Dysphagia was confirmed in 7 males (87,5%) i 1 female patient (12,5%). Patients with dysphagia were younger than patients without dysphagia, but there wasn't statistically significant difference (54,38±9,98 vs 56,55±13,32, p=0.695).

Patients with dysphagia in 25.0% of cases had mild moderate dysphagia, in 50,0% of cases mild dysphagia, and in 25,0% of cases functional dysphagia while all other patients had preserved swallowing act (p<0,001) (Table 1).

**Table 1.** Frequence and severity of dysphagia

| Scale | Dysphagia | Other | p-value |
|---|---|---|---|
| **Mild moderate** | 2 (25.0) | 0 | <0.001 |
| **Mild** | 4 (50.0) | 0 | |
| **Functional dysphagia** | 2 (25.0) | 0 | |
| **Total** | 8 (100.0) | 31 (100.0) | |

All patients with dysphagia (100,0%) and 23 patients without dysphagia (74,2%) had pathological findings on CT scan. Frequence of pathological findings on CT scan doesn't differ statistically significant between tested groups (p=0.168).

Frequence of pathological findings on CT scan doesn't differ statistically significantly between tested groups considering dysphagia severity (Table 2).

**Table 2.** Dysphagia severity and lesion localization

| Scale | Lesion localization based on CT scan | | | | | | |
|---|---|---|---|---|---|---|---|
| | Cortical Left | Cortical Right | Subcortical Left | Subcortical Right | Subcor.-Cor. Left | Cerebellum | BG |
| **Mild moderate** | 0 | 0 | 2(50.0) | 1(33.3) | 0 | 0 | 1(33.3) |
| **Mild** | 1(50.0) | 0 | 2(50.0) | 2(66.7) | 1(100.0) | 1(50.0) | 2(66.7) |
| **Functional** | 1(50.0) | 0 | 0 | 0 | | 1(50.0) | 0 |
| **Preserved swallowing** | 0 | 0 | 0 | 0 | | 0 | 0 |
| **Total** | 2(100.0) | 0 | 4(100.0) | 3(100.0) | 1(100.0) | 2(100.0) | 3(100.0) |
| **p-value** | 0.422 | | 0.063 | 0.322 | 0.465 | 0.422 | 0.322 |

Disorder of oral stage is signifficantly more common in patients with lesion located in basal ganglia (50,0% vs 6,1%, p=0,022). Disorder of pharyngeal stage is also signifficantly more common in patients with lesion located in basal ganglia (42,9% vs 6,1%, p=0,045) (Table 3).

**Table 3.** Phase of dysphagia and lesion localization

| Lesion localization | Pharyingeal | | | Oral | | |
|---|---|---|---|---|---|---|
| | + | - | p-value | + | - | p-value |
| **Cortical left** | 2 (28.6) | 7 (21.9) | 1.000 | 0 | 9 (27.3) | 0.351 |
| **Cortical right** | 0 | 6 (18.8) | 0.505 | 0 | 6 (18.2) | 0.603 |
| **Subcor. left** | 4 (57.1) | 6 (18.8) | 0.103 | 3 (50.0) | 7 (21.2) | 0.328 |
| **Subcor. right** | 3 (42.9) | 6 (18.8) | 0.381 | 2 (33.3) | 7 (21.2) | 0.903 |
| **Cort-subcor. left** | 1 (14.3) | 2 (6.2) | 1.000 | 0 | 3 (9.1) | 1.000 |
| **Cort-subcor. right** | 0 | 2 (6.2) | 1.000 | 0 | 2 (6.1) | 1.000 |
| **Cerebellum** | 1 (14.3) | 8 (25.0) | 0.909 | 1 (16.7) | 8 (24.2) | 1.000 |
| **BG** | 3 (42.9) | 2 (6.2) | 0.045 | 3 (50.0) | 2 (6.1) | 0.022 |
| **Mesencephalon** | 0 | 0 | - | 0 | 0 | - |

## Discussion

Analysis of the results showed that there are no statistically significant correlation between poststroke dysphagia and lesion localization shown on CT.

Among patients with dysphagia, we found that disorder of the oral phase is in correlation with lesions located in basal ganglia (p=0,022). Also, correlation between pharyngeal phase and lesions localized in basal ganglia is statistically significant (p=0,045). Although there is no statistical significance, our results show that poststroke dysphagia is more often caused by bilateral lesions of subcortical structures (7/8 patients) and lesions of cerebellum (2/8).

These results confirm the previous findings [25] which correlated the act of swallowing to widespread neural network involving bilateral input from sensorimotor cortex via descending pathways through basal ganglia to brainstem and reflex centre of swallowing in the medulla. It is assumed that lesions of basal ganglia and capsula interna in poststroke patients result in impairment of cortico-subcortical circuits (cortex-brainstem). Swallowing disorders caused by these lesions emphasize the importance of cortical input to the brainstem swallowing centre in maintaining the systematic modulations of the swallowing act. Swallowing disturbance can occur as a consequence of delayed initiation of movements, discoordination, reduced muscular tone, speed and strength of movements necessary for normal physiology and neuropsychology of swallowing act. Although localization of the vascular lesion in cerebelum wasn't statistically significant, cerebelar dysphagia was registered in 2 out of 8 patients (oral and pharyngeal phase). Swallowing disorder was manifested as impairment of sequence, coordination, range, precision and temporal organization of movements of orofacial musculature during oral phase and velopharyngeal and laryngeal musculature during pharyngeal phase.

In spite of small survey sample (39) our research confirms the findings of several studies that computed tomography (CT) is less sensitive neuroimaging method than other highly sofisticated methods such as fMRI, PET, SPECT in visualizing vascular lesions and that the smaller responses from the supposedly "unaffected" hemisphere in dysphagic patients actually reflect undetected cortical or brainstem damage [26].

## Conclusion

Such structured protocol as this one for the swallowing assessment in patients with acute stroke represents highly sensitive method for detection of aspiration/penetration, as confirmed in previous research. Unlike some other techniques (such as videofluoroscopy), this protocol is less invasive, easier to perform and cheaper [10, 14]. Its greatest advantage is the fact that it is easy to perform in the emergency departments, with high sensitivity. Early detection of swallowing disorders enables a timely use/application of protective measures such as adequate way of feeding (per os/null per os), diet modification (by reduction of certain consistencies) and initial rehabilitation of the swallowing act.

In correlation with neuroimaging, suggested protocol for assessment of the severity of dysphagia represents an important predictor for patients in risk of aspirational pneumonia. The use of such structured diagnostic protocol, multidisciplinary approach and collaboration of different professionals (speech and language pathologists, physicians, nutritionists, medical technicians etc.) signifficantly contributes to a more rapid recovery and restoring the oral way of feeding which affects the independence and resocialization of the patients after stroke.

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## Disfagija kod pacijenata sa akutnim moždanim udarom: rana procena

*Uvod/cilj*. Akutni moždani udar je često praćen orofaringealnom disfagijom, a mnogi bolesnici ostaju disfagični i godinu dana nakon moždanog udara. Aspiracija, upala pluća i malnutricija, najčešće su komplikacije disfagije, te se bolesnici hrane putem nazogatrične sonde ili endoskopski plasirane gastrostome što često zahteva dugotrajnu institucionalnu negu. Iako disfagija može biti različito tretirana, ne postoji standardizovan klinički protokol za procenu i tretman. S obzirom na složenost cerebralne kontrole gutanja, na osnovu neuroimidžinga teško je predvideti koji bolesnici bi mogli imati poremećaj gutanja. Cilj ovog rada je da se akt gutanja klinički proceni u prva 72 sata nakon moždanog infarkta i da se težina disfagije koreliše sa lokalizacijom lezije.
*Metode*. Bolesnici koji su primljeni u JMU Odeljenja Urgentne neurologije sa kliničkom slikom akutnog moždanog udara procenjeni su u prva 72 sata *Skrining testom za disfagije* i *Skalom za procenu težine disfagije*. Kliničke skale su strukturisane za potrebe ovog istraživanja. Lezija je lokalizovana na osnovu CT/MR snimka.
*Rezultati*. Prisustvo i stepen postinfarktne disfagije su korelisani sa lokalizacijom lezije na osnovu CT/MR snimka. Bolesnici sa dijagnostikovanom postinfarktnom disfagijom uključeni su u program strukturisanog treninga restitucije akta gutanja sa posebno definisanim načinom ishrane i modifikacijom hrane u cilju oporavka akta gutanja i zaštite disajnih puteva.
*Zaključak*. Predloženi protokol za procenu težine postinfarktne disfagije u korelaciji sa neuroimidžingom može dati značajan doprinos ranoj detekciji i rehabilitaciji poremećaja gutanja.
*Ključne reči:* akutni moždani udar, disfagija, gutanje, skrining, skala, procena, rehabilitacija

# The importance of early screening of disgraphic remarks in the children of young school age

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**Abstrakt:** Writing is a very important communication link between the author and the one to whom the written text is intended. In order for the communication aspect to be satisfactory, the act of writing includes general health potentials and numerous individual psychological, neurological, emotional, physiological and other aspects. The manuscript of each person has its own development flows and phases. It is gradually formed over a period of 8-10 years, including components such as rhythmic, maturity, visual control, increased writing speed ... An analysis of the handwriting of children of the younger school age can serve as an indicator of good or bad coordination and functionality of the structure graphomotor couplings for the purpose of writing. Writing texts can be grouped into several groups, they are a wide diapason, and in that sense we can talk about different types of dysgraphia According to the definition of contemporaries, dysgraphia is a specific disturbance in the development, learning and acquisition of writing abilities, and in addition to the existence of normal intelligence, good vision, hearing, appropriate education and social conditions (Golubović, 2011). The more commonly known fact is that the diagnostic disturbances are very often correlated with dyslexic disorders, and these two entities can not be viewed separately. The intersection of dyslexia and dysgraphia is growing, and in addition to this, among other things, there is also data on an increasing number of publications on this subject in our country and in the world.
What is the significance of the early diagnosis of children of the younger school age, with which difficulties children with dysgraphia meet when adopting school material, what is the socio-emotional
status of a child with dysgraphia, what consequences dysgraphia may have on his socio-emotional maturation , how and in what way it is possible to help a child with a diagnostic disorder in overcoming the accompanying problems, the questions we will try to best answer in the best possible way.
*Key words***:**.important aspects of writing, writing as a communication link, dysgraphy, the influence of disgrace on the general socio-emotional status of the child in the early school age, support in helping a child with a disgraphic manuscript.

## 1 Introduction

As complex, multiple speech - language functions, reading and writing are an important communication aspect and are the basis of learning. Reading and writing are a reflection of complex brain activities that involve visual, auditory, speech, semantic, language, and thought processes. It can be said that the successful development of the ability to read and write, from a psychophysiological point of view, depends on the development of visual, auditory, speech - language, graphomotor abilities of the child. Research in the field of development of reading and writing abilities suggests that children easily and in a short time interval master these two computers if all of these conditions are met. However, in children with disabilities in the development of verbal communication, the development of these abilities can be compromised. In order for the communication aspect to be satisfied, the act of writing includes general health potentials and many individual psychological, neurological, emotional physiological, social and other aspects. The manuscript of each human has its own developmental currents and phases. It is gradually formed over a period of 8-10 years, including components such as rhythmic, maturity, visual control, and increased writing speed. An analysis of the handwriting of children of the younger school age can serve as an indicator of good or bad coordination and functionality of the structure of the graphomotor connection in order to write. Letter is a system of signs that record characters in a language. The letter as a means of verbal communication has its own history. It has gone its development path. In support of this, there are many historical monuments that testify to the benefit of the early beginnings of a written message that originates from the palaeolithic period. It is known that in the beginnings of interpersonal

communication there was no so-called. graphomotor series and that the communication of the message was transmitted through certain symbols and image expressions. It is believed that the first letter as a form of a graphomotor expression with the aim of transmitting the message appeared 2500 years before the new era. It is also known that the letter has taken different forms over the centuries and has improved over time in order to take on its final form, the way we are using it today. The modern letter is the result of a long-term upgrading of various graphic systems. The most recent letter is phonetic.

## Letter and language of mutual differences and connection

The letter plays a significant role in the life of a modern man, and literacy is a step towards human emancipation and improvement. The entire cultural heritage created by the human race became available to the modern man thanks to the letter. It has enabled the transmission of information from one end of the world to another. It preserves the values of the present and the past.On the one hand, we can freely say that the letter today is a very important and important aspect of education, it is used for the entertainment of generations of all ages in political life as well as in medicine and culture, contributes and records all scientific achievements. Therefore, it is present in all social segments. However, on the other hand, the development of this science and technology letter is anticipated to end because it is believed that the era of electronic writing and transmission of information occurred.

Writing is a very important communication link between the one who sends the written message and the one who receives and decodes the message. So, reading and writing are two inseparable entities, and as well as a reading and writing disorder should not be separated. It is known that the writing process is one of the most complex human ability and integrates many aspects of it physiologically, neurological, motoric, psychological, manipulative, kinesthetic, visual and auditory mechanisms, ability to reason , the ability to use linguistic and non-linguistic knowledge.Success in written expression depends on proper physical development as well as on the overall health status of an individual. and if today it is possible to talk about all the relevant elements that are necessary for the realization of the writing, it is still with sufficient precision that you can not answer what actually happens during the act of writing. However, previous research has found that the writing process takes place in stages. Writing begins with the planning phase in which thoughts are organized and the lexical-grammar drawing is prepared, followed by a stage that involves the inclusion of awareness of language and social conventions to which those who write write. At this level, the writer has in mind the system of letters that he uses, the legibility of manuscripts, the rules of graphic expression, spelling rules, and the use of punctuation characters. The next stage includes motoriness as well as certain motor maturity, then motor control and viso-space orientation. Written speech does not involve gestures and mimics, no intonation, pause, therefore written language must flow according to established grammatical rules in order to create the contents of a written speech that is understandable. In the language of the basic functional unit is the phoneme, so in the letter, the basic functional unit makes a graph that contains the visual and motor component. In order for the writing, which at the same time represents complex graphomotor activity, could be realized it is necessary that all linguistic, visual and graphomotor aspects are integrated.

Letter and speech are two different and equally important manifestation of one language. Through the history of language studies, there are very different attitudes about the relationship between scripture and speech. In the past several centuries in the study center there was a written language. It was considered, on the one hand, that the letter gives stability and authority to the language in relation to the speech itself. On the other hand over time, it has been pointed out that the speech is many thousands of years older than the letter, that children develop naturally, while the writing must be artificially taught, and that the writing systems are derived and mostly based on the voices of speech.Written speech develops at the latest and makes it a completely unique medium of speech expression. The language within this media gets a different dynamics and a completely unique shape. Attempts are being made to convey the speech, that is, verbally expressed in the exchange of information and the description of events and relationships, just as it is to the written expression. It is understandable that speech and language are opposed and regardless of their relationships through

history it has been established that in modern society both communication media are at the disposal of the perfect society and man. The relative durability of a written language makes it an ideal means for storing and transmitting information through space and verme. The letter is related to the space, it is static permanently, while the speech is time-bound, dynamic, transient and the result of mutual interaction of two visible satellites. There remains a question of how far the future way of transmitting coded messages will solve the overall problem of dysgraphy, because writing does not mean just the design letters and have a well-trained motor activity of the hand. Writing is the most complex human activity and the most complex form of expressing language abilities.

In order to successfully master the writing technique, it is necessary, among other things, to be satisfied and properly developed abilities such as fine motor mechanics, visual perception of eye coordination, voice analysis and synthesis. The overall motor development plays a very important role in acquiring writing skills. Graphic expression actually begins in the early development period of about 18 months and lasts until school starts when the child begins to master the writing technique.Ćordić and Bojanin state that by maturing the structures that perform the writing work just at the time when the training of writing was going on within the family, whether within the school and in the progress of writing in writing, the forms of letters, lines and manuscript as a whole will change their original appearance . A child at the age of about a year begins to take the pencil with interest, holding it with his whole fist and begin the first written manifestation in the form of stammering ie shaving and moving his hand forward- backward.In the period between two and two and a half years old, the child expresses a pen with a thumb, index finger and middle finger in the form of vertical, horizontal and circular lines. Between the third and fifth year, the child is absolutely sure to hold a three-finger pencil and the written act takes place with the movement of the whole hand. In the period between the fourth and fifth years he begins to hold the pen with the tips of his fingers, draw a square, print some letters and numbers. The correct holding of the pen, the fingertips between the thumb, forefinger and middle finger begins between the fifth and the sixth year. Then in this period is able to cross the triangle, can write his name, to print some printed letters, numbers. What is also important to emphasize is that the graphomotoric act also occurs at a certain level of orientation of emotional needs to reality. The manuscript matures in proportion to the emotional maturation and maturation of psychomotor organization.

By going to school, children intensively build their language by establishing grammatical, semantic rules and correct articulation of all the voices of the mother tongue. Developing written expression in younger grades of primary school has a communicative function that transfers thoughts, ideas and descriptions to the text in a clear and precise manner. The goal of developing the skill and habits of writing is that the student gradually becomes self-sufficient and creates written texts himself. Child literacy is an individual process that largely depends on the emotional status and on the motivation of the child himself. The question arises as to what a child should master at the end of the first grade when writing is concerned?According to the established norms it is considered that the child should know by the end of the first grade that he should be able to write in letters and letters in the letter of the mother tongue, to correctly format letters and connect them in words, separate words while writing, write simple, exhausting sentences, correctly use punctuation symbols, respect grammatical rules when it comes to writing capital letters at the beginning of the sentence, writing personal names and names of settlements, able to extract the title and passages, is able to sign the full name and surname, and write short texts based on their own experience and the world of imagination. Written vocabulary in children usually increases slowly. The reading dictionary outperforms speech and writing.

In some working dysgraphia it is explained as a problem in written expression and can not be characterized as childish laziness. For some children with dysgraphia, try to properly hold the pen and write it, actually, cramming into the line itself is a difficulty. Often, doctors and psychologists in the international determining of the definition of dysgraphs use the expression specific learning disorder or disorder in written expression. If you notice that the child has a reduced ability to express himself in writing, he will surely pay more attention to this. Learning about what is in such situations we should pay attention to it,we can be very proactive in providing help and support to a child with disabilities in writing It is also certain that there is no magic or medicine who will cure dysgraphia, but there is a strategy that will help the child deal with the problem in the best possible way and become functional within their capabilities. A large number of people with dysgraphia also have

dyslexia. However it is used or defined by the diagnostic and dyslexic disorders, it is important to emphasize that any child who slowly progresses in mastering reading and writing techniques and who has a problem with written expression should not be classified as a group of children who do not work hard enough. For children with dysgraphic disorders , the process of learning writing is inherently difficult and slow, so that without adequate help, education alone can represent a serious, difficult and strenuous process for him.

Developmental dysgraphia and dyslexia, implies a clinical picture that involves the whole personality. Children with dysgraphia and dyslexia usually have a bad attitude about the school and their social adjustment is more difficult.Symptoms depend on the age of the child. Real symptoms of disgraphia are actually occurring when a child starts to learn writing. It is known that to a large extent the disgrace and dyslexic disorders compromise the adoption of school material. The child provides resistance to learning, he does not like to read.Disgraphic and dyslexic disorders, in addition to compromising the adoption of school materials, have an impact on the ability to emotionally and socially adjust. Because of their inability to fully respond to the demands placed on them, and are related to reading and the different forms of written expression, children are frustrated. In children with disabilities in reading and writing, an increasing experience of failure causes a sense of less value, a feeling of self-confidence, a child can have a sense of insecurity, can have a feeling of being rejected and isolated, inferiority, reduced self-esteem. It can be, irritable, scattered, anxious, aggressive, not motivated for better achievements. Often, children are discouraged, with each attempt to read or write again, quickly give up and quickly stop trying again. It is not possible to exclude depressive behavior. The suffering of such children is associated with personal or school problems. The moment of correct and timely assessment of students and their abilities, as well as the perception of teachers in relation to a child with reading and writing impediments is also significant. This is explained by the theory of expectations (Expectancy theory) that emphasizes the importance of teachers' belief in children's abilities. She emphasizes that the child's self-perception is often determined by the perception of the teacher's feelings towards him. Teacher perceptions can be precise or inaccurate, flexible or fixed. An imprecise and fixed opinion about a child can hurt him. Since reading and writing of the skills that children are systematically learning is expected to have some educational problems in that process that lead to resistance to learning and school. As Harris & Sipay (1986), the school for such children becomes an unbroken series of fights and the struggle of periodically interrupted sentences, and the teacher-pupil relationship for such children rarely creates good learning conditions. As the process of adopting the skills of reading and writing is the most preoccupied teachers and parents, a child can feel hostility towards parents, teachers, or both towards one and the other. The same authors also say that children can be occupied by their own thoughts to the extent that they can devote only superficial attention to their surroundings, so they can not direct the necessary attention in reading, writing and learning. Harris (1961) also believes that the ability to acquire school skills, and above all the skills of reading and writing, largely depends on the social environment from which it came. In the opinion of this author, and based on the analysis of the conducted research, children who have expressed reading difficulties came from the lower or lower middle class. Also, many other researches speak in favor of the fact that the family environment, especially stimulating, significantly influences the development of speech and language and the success of children in mastering school skills. Children who come from disadvantaged families or families in which there is a lot of quarrels, with reason in such families feel unloved and insecure. Thus, poor socioeconomic conditions, multi-member families and many other factors may adversely affect the school's success in the dyslexic and disgraphic child. Some American authors report that persistent interruptions in reading and writing can lead to serious problems and disruptive behavior. They find that 75% of juvenile delinquents have experienced shift in reading and writing, and therefore consider it necessary to identify children with disabilities in reading and writing early because most of them will be able to overcome the difficulties with additional effort, proper approach and good cooperation between the teacher, the parents and the child himself.It is also important to understand the environment for the problem that the child is facing, as well as the positive attitude of the child towards his own problem.

Early detection of children with reading and writing disabilities is of great importance because it allows the same to be alleviated or eliminated. Clinical trials have shown that children with developmental dysphasia and lagging in speech - language development are more at risk than dyslexia

and dysgraphia. Therefore, preventive work should first be directed in this direction. Early screening and detection of children with speech - linguistic problems, as well as the timely inclusion of such children in speech therapy contribute to the prevention of more serious and severe consequences. First of all, the thought of preventing the work of a speech therapist should first be directed at the youngest attendants in kindergartens, then in pre-school groups and then in elementary schools. Support and cooperation of the chosen pediatrician in health care homes is also important in the early detection of speech-language reactions. In solving this problem, the team work of a psychologist, a pediatrician, a pedagogue and a speech therapist is required, as well as experts from other profiles. The advocacy work of a speech therapist is an important part of the educational process for children to be diagnosed and dyslexic and is directed towards the child as well as on parents and teaching staff. It is not appropriate to focus solely on basic assistance, but also to build a positive attitude towards education and curricula, focus on providing assistance and support to the child with reading and writing disabilities to understand his or her disability in a better way and at least accept it. Motivation plays a significant role in this. In working with dyslexic and disgraceful children, it is necessary to strive to form a positive attitude of parents, of the whole family towards the child, as the attitude of the school, teacher and the departmental collective. If, despite a sufficient number of speech therapies, parents do not pay sufficient attention or are not interested in the child, they compare it with other children and have no realistic expectations, it can have an impact on the therapeutic process and the end result. It's not unusual for parents to blame the teacher most often from ignorance or wrong preference for school excellence for the failure of a disgraced and dyslexic child. Parents need to be educated on how and how they can help their child, because careful attention and reward for every little progress can have a very motivating effect on the child. It is important to give him emotional support, encourage the child not to give up easily, understand him, and be patient.Punishment and repressive methods are certainly not popular and should not be applied as a form of educational methods. It is possible that teachers who have not undergone adequate training are most often ill or not informed about the causes of the child's lagging with dysgraphia, thinking that the child is lazy, restless, with lack of attention and concentration, which entails a series of other consequences related to the child's behavior on this attitude of the teacher. Also, in this sense, training of teaching staff is necessary, which, among other things, would be aimed at providing incentive assistance to the student with dyslexia and dysgraphia, in order to establish in the best interest of the child the best possible relationship between the teacher and the pupil. Also, cooperation on the parent-teacher relationship is very important in the process of education of a dyslexic / digraphic child. The system of reward and praise here is also significant and stimulating. The peer group attitude in the department is in most cases negative in relation to the child with dyslexia and dysgraphia. Likewise, a child with dyslexia and dysgraphia can manifest jealousy in relation to students who do not have such a problem by expressing direct hostility toward them. Teachers and parents are those who must build a positive attitude towards the child with disabilities in reading and writing .Working with the child requires a conceptual approach in strengthening the child's self-esteem. It is also important to enlighten parents, health, education and social workers as well as work with the entire community.

## Conclusion

Problems encountered by children with dysgraphic and dyslexic disorders suggest a stimulating search for an adequate solution, they are in fact looking for timely screening for the purpose of early detection, early diagnosis of the diagnosis and dyslexic disturbances of children of the younger school age is necessary, for the early initiation of stimulative treatment. Only by this approach can the child be provided with comprehensive support and assistance in easier learning of the school's reading and writing skills.

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## Značaj ranog skrininga disgrafičnih smetnji kod dece mlađeg školskog uzrasta

Pisanje predstavlja veoma važnu komunikacijsku sponu između autora i onoga kome je pisani tekst namenjen.Da bi komunikacijski aspekat bio zadovoljen sam čin pisanja uključuje opšte zdravstvene potencijale i mnogobrojne pojedinačne psihološke,neurološke,emocionaln,fiziološke i druge aspekte.Rukopis svakog čoveka ima svoje razvojne tokove i faze.On se postepeno formira u periodu od 8-10 godine obuhvatajući komponente kao što su ritmičnost,zrelost,kontrolu vida , povećanje brzine pisanja…Analiza rukopisa dece mlađeg školskog uzrasta može da posluži kao indikator dobre ili loše usklaćenosti i funkcionalnosti strukture grafomotorne sprege u cilju pisanja.Smetnje pri pisanju mogu da se svrstaju u više grupa,one su širokog dijapazona ,te u tom smislu možemo govoriti o različitim tipovima disgrafija. Prema definiciji savremenika disgrafija (dysgraphia)je specifična smetnja u razvoju,učenju i sticanju sposobnosti pisanja i pored postojanja normalne inteligencije,dobrog vida,sluha,odgovarajuće edukacije i socijalnih uslova(Golubović,2011).Opše je poznata činjenica da disgrafične smetnje vrlo često koreliraju sa disleksičnim smetnjama te se ta dva entiteta ne mogu odvojeno posmatrati.Interesovanje za disleksiju i disgrafiju je sve veće ,a u prilog tome, između ostalog, govore i podaci o sve većem broju publikacija na tu temu kako kod nas tako i u svetu.

# Developmental level of graphomotor skills in children with specific learning disorders

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**Abstract.** In this paper we presented results obtained during graphomotor skills research in children with specific learning disorders, as well as correlations of this skills with other developmental abilities (perceptual and speech and language abilities). The sample consisted of 30 children with specific learning disorders, aged 7 years and 4 months to 11 years and 10 months (19 males and 11 females). As relevant measuring instrument Acadia test of developmental abilities was used. It showed that among children with specific learning disorders 40% of them had results in accordance with their age on subtests Shape drawing, and 30% on subtest Drawing. Subtest Shape drawing showed that 23, 4% had one SD (standard deviation) underage, and 36% had two or more SD underage. On drawing subtest 30% had one SD below standard, while 40% had two or more SD under expected norms. Ability of drawing shapes among children with specific learning disorders is a little bit better then acheavements in free drawing. There are no statistical differences between males and females with specific learning disorders with regards to graphomotor skills development. Subtest Shape drawing is not in correlation with subtests: visuomothor coordination and possibility of following, audio- visual association, auditive memory and free drawing. Low correlation existc at subtests: visual memory, following and encoding, possibility of concept creation, automathic language treasure and visual association. High and very high corelations were not noticed. Subtest Drawing had only one low correlation with subtest visual discrimination, while other correlations were not tracked.

## Introduction

Development of graphomotor abilities starts relatively early, from the age of 18. months, child starts to scribble and this period lasts till school begins and a child is ready to perform finest graphomotor activity- writing. During scribble period child most frequently moves the arm back and forth and makes wavy scribbles. Later on, wide arm moves enable better forearm control and at the end finger movements become wiling and precise. First children scribbles consists from egg like shapes, and later from circle spirals. In this period visual perception, that precede graphomotor activity, starts to develop. It means that child will be able to perceive circle and circle shapes before it will be able to draw them at the age of 3 years; at the age of 4 child will be able to draw square, but it will be able to have it's visual perception much earlier, perceptoon and drawing of circle and square are followed by triangle (5 years) and at the end rhomb (6 years). Development of graphomotor abilities can be devided into three phases: graphomotor development from 18$^{th}$ month till third year; graphomothor development from third to fifth year and graphomotor development from fifth to eight year when child is ready to get into phase of beginner writing that lasts from 6$^{th}$ till 8$^{th}$ year, called calligraphic phase (Mitić, Golubović, 2008).

## Writing disorders in children with specific learning disorders

Writing is scholastic skill developed during whole schooling. Literacy of students, their ability for writen communication, enables mastering of all school subjects and inclusion in independent learning. In other words, students should acquire functional literacy that represent basis of their further schooling. For acquiring writting skill, that represent complex psicholinguistic and neurolinguistic ability, as well as form of writteen language, integration of sensor processes is important (auditive, visual and mothor). Different writing types have different difficulty level, determined with engagement of person during exsecution of given task. Depending on letter type, difficulty level

growes in following order: transcript ( within this cathegory three types of transcripts distinguish: identical transcription by given model; transcription from block to cursive and from cursive to block and transcription from one leter type to another, ie.from cyrilic to latin letter and vice versa), dictation, picture description, writing after somebodies talk, event describing, writing to given topic and independent theme (creation of written composition) (Mitić, 2004).

According to WHO (world helth organization) classification ICD 10 specific development disorders of scholactis skills include disorders that manifest with specific and significant damage of scholastic skills. This disorders are not direct concequences of other disorders like cognitive deficiency, hudge neurological deficit, non corrected visual or hearing disorders or emotional disorders. According to DSM- IV, this disorders are diagnosed at younger school age or during adolescent age and contain reading, calculating and writing disorders. This disorders usualy become visible during schooling start when they start to influence school work mastering, but final diagnose of specific learning disorders does not set before the age of eight. Deffinitions from DSM-IV and ICD-10 manuals are usualy used in describing writing disorders, that is also present during determination of other specific learning disorders. In DSM-IV manual dysgraphia is deffined as specific writting disorder. It represtnts disability of a child to express by writting (according to spelling rules of particular language) characterised by numerous permanent and specific misstakes. Important characteristics of dysgraphia are: writting skill measured individualy by suitable standardized tests (or functional writting skill assesment) is noitecably under expected level for hronological age, intelectual level and educational level (criterion A); difficulties from criterion A significantly influence level of school achievement or to everyday activities that require composition of written texts (ie. Writting of correct sentences or chapter organization- criterion B) and if sensor deficiency exist writting disorders and more noteicable from the ones that usualy occure among that kind of defficit (criterion C). Frequency of reading and writting disorders among school children is 1,3% to 10%. In languages with non transparent orthography dificulties in writting appear in 8- 15% of school children, and procent vary from assesment and characteristic criteria of alphabet (Prior, 1996). In anglo- saxon language area percentage of dysgraphic children is from 20- 40% in population of school children (Mitić, 1999). According to Lion at least 10% of children in schools have writing disorders, and other authors state that major writing problems can be found in 6- 22% of school aged children (Hooper, Montgomery, 1993). Studies show that the writing disorders are 2-3 times more often within boys than girls (Hooper, Montgomery 1993). Developmental dysgraphia is divided into: visual, auditory, language and graphomotor. The division of dysgraphia on these subtypes is most common in domestic and foreign literature. According to the degree of severity, dysgraphia may be: Easy dysgraphia; expressed dysgraphia and agraphia (complete inability to write, usually transient condition which after the first to the second year of schooling becomes stable dysgraphia, accompanied with severe specific learning difficulties in the initial(Mitic, Golubović, 2008).

## The aim of the research

The aim of this study was to determine development level of graphomotor abilities in children with specific learning disabilities, as well as the correlation of these abilities with other developmental abilities (perceptive and speech language).

## Research methodology

The sample consisted of 30 children with specific learning disabilities aged 7 years and 4 months to 11 years and 10 months (19 boys and 11 girls). The research was conducted at the Institute for Experimental Phonetics and Speech Pathology "Djordje Kostic" in Belgrade. As the relevant measuring instrument Acadia test of development abilities is used. To assess the skills of drawing, subtests Drawing shapes and Drawing ACADIA were used to test of developmental abilities (Atkinson, Johnston, Lindsay, 1972), translated and adapted in 1985 (Novosel, Cavor, 1985). The test is further adapted to specifics Serbian language, but there was also a scaling results based on the attainment of younger school children of our population (Gligorović et al., 2005). It can be applied individually or in groups. It is not a speed type, so it gives ability to adapt to the rhythm of each child. Drawing Shapes (Subtest IV) contains 20 models of increasing complexity that the child should draw as it is shown. For each correct answer gets one point. Drawing (Subtest XIII) require the child to draw a man standing under a tree near the house. It is estimated on the basis of recognition, accuracy proportions, the rich of details and the relationship between the given elements. The maximum score is 20 points. Statistical analysis was performed in the statistical package SAS. We used the following parameters: range, the central rate, tendency, measures of variability, parametric and nonparametric analysis of variance, F-test and Pearson's correlation coefficient.

## Research results with discussion

In table 1 results of graphomotor skills evaluation in children with specific learning disabilities are shown. They have been analyzed from the angle of deviation from standard norms at subtests Shape drawing and drawing. Results of this subtests are ranged in three categories: achievements that match the age- range 3, achievements that does not match for two or more SD from average achievements- range 2, and achievements that doesn't not match for one SD- range 1. Results that are lower then one SD from expected point to elements of disorders, and deviation from 2 or more SD show existence of specific disorders in evaluated domains.

**Tabele 1.** Range of achievements at subtests Shape drawing and drawing among children at younger school age

| Range | Shape drawing | | Drawing | |
|---|---|---|---|---|
| | Number | % | Number | % |
| 1 | 7 | 23.4 | 9 | 30 |
| 2 | 11 | 36.6 | 12 | 40 |
| 3 | 12 | 40 | 9 | 30 |

Qualitative analyses of the results showed that in children with specific learning disorders 40% of results was in accordance with age at subtests Shape drawing and 30% at subtest drawing. At subtest shape drawing 23.4% of results had one SD below age, and 36% of results had two or more SD under the age. At subtest drawing 30% of results had one D under the standard norms, while 40% had two or more SD from defined standard norms. Representation of results that significantly deviate from standard norms for age is big, but is expected having in mind that sample is consisted from children diagnosed with specific learning disorders that includes writing disorders whose cause is in undeveloped grophomotor ability.

Analysis of drawing upon model assessment results and representational dimension of drawing is shown in table 2.

**Table 2.** Results of drawing assessment in children with specific learning disorders

| Variable | N | Mean | Std Dev | Sum | Min | Max | F test according to sex |
|---|---|---|---|---|---|---|---|
| Shape drawing | 30 | 44.4 | 13.76 | 1332 | 20 | 70 | 0.92; $p > 0.05$ |
| Drawing | 30 | 41.66 | 11.64 | 1260 | 14 | 61 | 0.54; $p > 0.05$ |

Achievements in area of drawing seen from the angle of range and medium values of the results in children with specific learning disorders is a bit better then achievements accomplished at drawing

task. We explain this result by the fact that in this task positioning objects in area of paper, reproduction of three dimensions and mutual object relation are required, and this consider to be complex task (Bremner i dr., 2000), while subtest shape drawing requires drawing two dimensional object by model, starting from less to more complex. Major prerequisite for successful competition of drawing by model tasks is recognizing spatial layout of lines . It is easier to follow the pattern of elements that are well known (Toomela, 2002). F test show that there are no statistically important differences between boys and girls with specific learning disorders with regards to development of graphomotor skills. Research of this skills, concluded with general population, showed that girls had much better results from boys in graphic representation (Gligorovic i dr., 2005), however this data are not consistent because most of this research aim to show male sax as superior (Halpern, 2000; Kimura, 1999; Newcombe, Mathason, Terlecki, 2002). According to results of some studies, in early developmental period and during early school age, girls are a bit better in visual special tasks, but this changes during time in boys favour (Watson i dr., 2003).

Table no. 3 shows correlation of the assay Drawing Shapes (T4) and Drawing (T13) with other subtests ACADIA test of developmental skills: auditory discrimination (T1), visual-motor coordination and ability to herring (T2), visual discrimination (T3), visual memory ( T5), audio-visual Association (T6), herring and encryption (T7), auditory memory (T8), skills to create concepts (T9), acquired linguistic goods (T10), automatic linguistic goods (T11) and visual associations (T12) . Values from 0.00 to 0.20 show a slight correlation, and correlation does not exist. Values of 0.20 to 00:40 indicate a low correlation or little cohesion; from 0.40 to 0.70 is a moderate correlation, or substantial connection; from 0.70 to 0.90 is a high correlation, or extreme connection; and from 0.90 to 1.00 is a very high correlation.

**Table 3.** Correlation of drawing shapes and drawing with the other subtests ACADIA test

| | Pearson's correlation coefficient | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | T1 | T2 | T3 | T4 | T5 | T6 | T7 | T8 | T9 | T10 | T11 | T12 | T13 |
| T4 | 0.24 | 0.13 | 0.39 | 1.00 | 0.53 | 0.05 | 0.48 | 0.18 | 0.50 | 0.37 | 0.52 | 0.55 | 0.00 |
| T13 | 0.10 | 0.05 | 0.26 | 0.00 | 0.17 | 0.13 | 0.00 | 0.05 | 0.07 | 0.11 | 0.08 | 0.02 | 1.00 |

The results showed that Subtest shape drawing has no correlation between subtests: visual-monitor coordination and the possibility of herring (T2), audio visual associations (T6), auditory memory (T8) and drawing (T13). There is a low correlation with the subtests: auditory discrimination (T1), visual discrimination (T3) and acquired linguistic goods (T10). There is a moderate correlation with the subtests: visual memory (T5), herring and encryption (T7), skills to create concepts (T9), automatic linguistic goods (T11) and Visual Association (T12). There was not high and very high correlations.

Drawing subtest had only one low correlation with subtest visual discrimination, while other correlation was not present.

## Conclusion

School achievements depend on elementary activities such as: speaking, reading, writing and arithmetic. These capabilities are the foundation of acquiring and developing knowledge and advancement of individuals and society as a whole. Unfortunately, for a particular group of children, these abilities rather than tools, are a major constraint for learning.

Children with specific learning disabilities have deficits in the development of graphomotor capabilities. On a drawing form subtest, 23.4% of results had one SD below the ages, a result 36% had two or more SD below the age. Drawing on the subtest 30% of results had one SD below the norm, while 40% had two or more of the defined SD standards. Representation of results that differ substantially from the norm for the age is big, but it is expected bearing in mind that these are children who have a diagnosis of specific learning disabilities which implies writing disorder whose cause and located in undeveloped graphomotor capabilities. Between boys and girls with specific learning disabilities there is no statistically significant differences in the level of development graphomotor capabilities. Children with specific learning disabilities are better at shape drawing than drawing self. Drawing shapes is not correlated with: visuomotor coordination and sequencing capability, audio

visual association, auditory memory, and drawing. Low correlation exists with: auditory discrimination, visual discrimination, and acquired linguistic treasure. Moderate correlation exists with: visual memory, order and code, the art of creating concepts, automatic linguistic treasure, and Visual Association. There was not high and very high correlations. Drawing subtest had only one low correlation with subtest visual discrimination, while other correlation was not present.

In recent years, an increase in speech and language disorders and therefore the number of "risk children" for the development of specific learning disorders is increasing. Early symptoms of dyslexia and dysgraphia and dyscalculia are identified by the child start of speak, so that there remains sufficient time to implement the next rehabilitation and stimulating treatment. If the symptoms of dyslexia, dysgraphia and dyscalculia are detected at an early stage, treatment will be successfully completed by the start of school. If symptoms are detected at a late stage, when the child has already started school, it will be necessary that the treatment is done "fast" so a child wouldn't have a deeper learning disabilities. Assessment of children with specific learning disabilities involves testing at all levels of verbal linguistic development necessary for the development of reading, writing and numeracy, as well as determining the level at which the child is located. Based on such assessments, individual plans and programs are made of therapy. Speech therapy is undergoing rehabilitation certain abilities, while others are subjected to stimulation, so that after some time of therapy leads to spontaneous development (Mitić et al., 2008). Speech therapy work with children who have disorders in reading, writing and arithmetic is carried out according to individual plans and work programs for each child. The cooperation of teachers, psychologists and speech therapists, and other associates is necessary in order to reach the best possible work program.

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## Nivo razvijenosti grafomotornih sposobnosti kod dece sa specifičnim smetnjama u učenju

U radu su prikazani rezultati istraživanja dobijeni ispitivanjem grafomotornih sposobnosti dece sa specifičnim smetnjama u učenju, kao i korelacija ove sposobnosti sa ostalim razvojnim sposobnostima (perceptivnim i govorno jezičkim). Uzorak ispitanika je činilo 30 dece sa specifičnim smetnjama u učenju uzrasta 7 godina i 4 meseca do 11 godina i 10 meseci (19 dečaka i 11 devojčica). Kao relevantan merni instrument korišćen je Akadia test razvojnih sposobnosti. Utvrđeno je da je kod dece sa specifičnim smetnjama u učenju 40% rezultata u skladu sa uzrastom na subtestu Crtanje oblika, i 30% na subtestu Crtanje. Na subtestu Crtanje oblika 23.4% rezultata je imalo jednu SD ispod uzrasta, a 36% rezultata je imalo dve ili više SD ispod uzrasta. Na subtestu Crtanje 30% rezultata je imalo jednu SD ispod normi, dok je 40% rezultata imalo dve ili više SD ispod očekivanog od definisanih normi. Sposobnost crtanja oblika kod dece sa specifičnim smetnjama u učenju je nešto bolja od postignuća na zadatku samostalnog crtanja. Utvrđeno je da nema statistički značajnih razlika između dečaka i devojčica sa specifičnim smetnjama u učenju u odnosu na razvijenost grafomotornih sposobnosti. Subtest Crtanje oblika nije u korelaciji sa subtestovima: vizuomotorna koordinacija i mogućnost sleda, audio vizuelna asocijacija, auditivno pamćenje i samostalno crtanje. Niska korelacija postoji sa subtestovima: auditivna diskriminacija, vizuelna diskriminacij, i stečeno jezičko blago. Umerena korelacija postoji sa subtestovima: vizuelno pamćenje , sled i šifriranje, veština stvaranja pojmova, automatsko jezičko blago, i Vizuelna asocijacija. Visokih i veoma visokih korelacija nije bilo. Subtest Crtanje je imao samo jednu nisku korelaciju sa subtestom vizuelna diskriminacija, dok ostalih korelacija nije bilo.
Ključne reči: specifične smetnje u učenju, grafomotorni razvoj, Acadia test razvojnih sposobnosti

# The level of adoption of physics teaching content in students with the hearing impairment

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**Abstract.** A large number of factors that determine the success of hearing impairedchildren in regular school. Mention a few of these factors: the level of hearing loss, time of occurrence of damage, pre-treatment and its continuity, then adequate amplification, the degree of speech-language development, the degree of cognitive development, the degree of emotional growth of the child, family relations.The problem in the subject teaching is due to the volume and content that are much more complex (for hearing impaired students), and the teachers are not scarce enough to help students compensate for the effects of hearing loss through various methods, models and methods of work. In this paper, attention is focused on the school success of physics teaching in students with hearing impairments, as well as on the relationship between school achievement in physical education and grades from general school achievement in children with severe hearing impairment. The sample consisted of 7 students with severe hearing impairment and 7 students of the control group with regular hearing (VI, VII and VIII grade). Adequate statistical analysis of the obtained results indicate a discrepancy between the estimates of the test and the assessment expressed by the general teacher mark in the test object. On the test of knowledge in physics, the pupils were more successful than the deaf. The results show that, according to Blum's taxonomy, there is an equal number of deaf students who have reached only the level of memory, understanding and application, and the number of those students who reach the level of analysis, synthesis and evaluation.
Key words: school success, physics test, severe hearing loss.

## 1 Introduction

School success is related to the level of student's knowledge acquisition, intellectual and practical skills, cognitive strategies envisioned by programs of different school disciplines. Success, which is most often expressed in quantitative terms, is only one of the indicators of the acquired knowledge, the perception of student's personality and the factor of further educational promotion, social behavior and the overall behavior of the child (Gadžić, Milivojević, 2009).

Roksandić (2016) points out that school success is a significant indicator of the degree of student's adaptation to the school environment. That is why school success also appears as a significant diagnostic instrument for assessing the degree of integration in the group of students and the adoption of certain social values in accordance with the age. Thus, school achievement is a result of the school success, but also a failure. The mutual influence of various indicators in collaboration with the consequences of primary damage to deaf and hard-of-hearing students makes the school achievement issue particularly complex. In literature, there is a three-group classification of factors that affect school efficiency of deaf and hard-of-hearing learners (Powers, 2003). Characteristics of students such as hearing impairment (Wood et.al 1986), causes of hearing loss (Conrad 1979), damage time (Allen, 1986), use of hearing aids and intelligence (Conrad, 1979; Lewis, 1996), additional difficulties (Allen, 1986, Conrad, 1979), the personality traits (Conrad, 1979) and the use of the sign language (Bodner-Johnson, 1986) make the first group. The listening status of parents (Brasel & Quigley, 1977), social class (Conrad, 1979), ethnical group (Allen, 1986; Schildroth & Hotto, 1995) and parents' knowledge, skills and competences (Bodner-Johnson, 1986) belong to the second group of family factors. The type of educational context-inclusive or special education (Kluwin, 1992), linguistic and communicational approach, and early intervention (Brasel & Quigley, 1977; Lewis, 1996) make up the third group of factors.

Often, failure in schoolwork is associated with changes in physical, emotional, social and intellectual development (Pavković, 2013). The most common cause of the school problems of

students with hearing impairment are basically difficulties in learning and mastering the content of teaching subjects, emotional difficulties, and behavioral problems. The problem in the subject teaching of deaf and hard-of-hearing students is due to the volume and content that is much more complex (for hearing impaired students), and teachers who are not educated enough to help students compensate for the effects of hearing loss through various methods and models of work.

The aim of the research was to determine the school achievement of deaf students who are involved in the regular education system, assess the performance on the physics test, and determine the success of deaf students on the physics test in relation to the initial grade in the subject.

The sample consisted of 7 pupils with hearing impairment over 91 dB (very serious hearing impairment according to the World Health Organization classification) and a control group of 7 pupils with regular hearing (VI, VII and VIII grade).

## 2 Methodology

For the research needs, a physics knowledge test taken from the Institute for Pedagogical Research in Belgrade was used. It contained seventeen tasks set in open-ended and closed-ended form. The open-form group of tasks contained questions with adding or recognition tasks, while the group of task-related forms contained alternative questions, assignments with comparing and organising, sequence assignments in which students were required to set up a logical or chronological order i.e. to enumerate the elements by recognising the logical or chronological order as well as and multi-choice questions.

## 3 Research results

The obtained results of the assessment of knowledge from the physics education course show that the number of (seven) successful and (seven) unsuccessful deaf students on the physics test is equal (Chart 1). The results show that the number of deaf students who reached only the level of memory, comprehension, and application and the number of those students who reached the level of analysis, synthesis, and evaluation on the Blum scale is equal.

The results of the examination of the achieved success of the deaf students on the physics test in relation to their initial grade show that out of four students who used to have mark 2 in physics, two were unsuccessful and two successful in solving the test of physics. Out of the three students who had grade 3, all three students were unsuccessful in the test of knowledge. Out of the three students who used to have mark 4, the two failed the test and one performed successfully. All four students who had a grade 5 successfully completed a physics knowledge test (Chart 2).

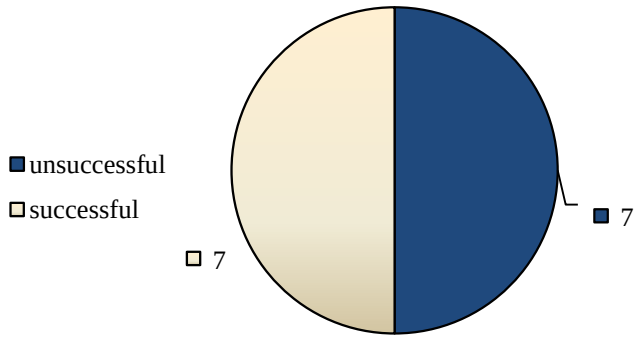


**Chart 1**. Results of deaf students on the knowledge test in physics (VI, VII, VIII grade)

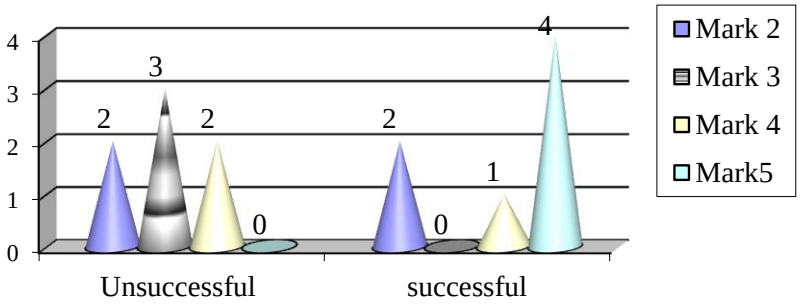


**Chart 2.** The success of deaf students on the knowledge test in physics compared to their initial grade

Comparison of the initial grades in physics and the results of deaf students on the physics knowledge test (Chart 2) shows that out of 4 students who initially had grade 2 in physics, two were unsuccessful and two were successful. Out of the three students who had grade 3, all three students were unsuccessful in the test of knowledge. Out of the three students who had mark 4, the two failed the test and one performed it successfully. All four students who had grade 5 successfully completed a knowledge test in physics.

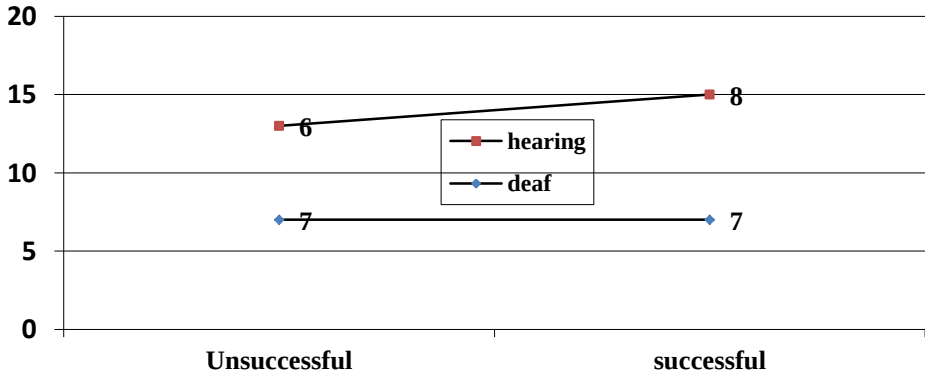


**Chart 3.** The success of the students of the experimental and control group on the knowledge test in physics

An analysis of the results of the students of the experimental and control group on the physics knowledge test (Chart 3) shows that on test seven deaf students were successful, and the same number of deaf students was unsuccessful. The hearing students achieved better results, eight students were successful, and six students failed on a physics test. Hearing pupils have better mastered the material than the deaf students.

## 4 Conclusion

The efficiency and quality of the realization of the teaching process and the educational outcomes are conditioned by teachers' competencies to harmonize the relationships between different value systems and in providing social, pedagogical and emotional support to students.

Out of the total number of deaf students tested in physics, 50% of deaf students in the sixth, the seventh and the eighth grade was successful, and 50% failed. The results show that the number of deaf students who reached only the level of memory, comprehension, and application and the number of those students who reach the level of analysis, synthesis, and evaluation on the Blum scale was equal. Comparison of achievements of deaf students from the sixth, seventh and eighth grade on the physics

test and assessment score in this subject, indicates that there is a difference between test results and initial grades, with the exception of pupils rated by grade 3. Hearing students mastered the material better than deaf students.
A holistic approach is needed for each student. A quality teaching requires teachers' awareness of the specific needs of the children, as well as the competence for pedagogical and developmental stimulus.

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## Nivo usvojenosti nastavnih sadržaja iz fizike kod učenika oštećenog sluha


Veliki je broja faktora od kojih zavisi uspeh gluve dece u redovnoj školi. Nabrojaćemo neke od tih faktora: stepen oštećenja sluha, vreme nastanka oštećenja, predškolski tretman i njegov kontinuitet, zatim adekvatna amplifikacija, stepen govorno-jezičke razvijenosti, stepen konitivnog razvoja, stepen emocionalne zrelosti deteta, porodični odnosi. Problem u predmetnoj nastavi nastaje zbog obima i sadržaja koji su znatno složeniji (za slušno oštećene učenike), a nastavnici nedovoljno ostručeni da putem različitih metoda, modela i načina rada pomognu učenicima da kompenzuju posledice oštećenja sluha. U ovom radu pažnja je usmerena na školski uspeh iz nastavnog predmeta fizika kod učenika oštećenog sluha kao i na odnos školskog uspeha iz nastavnog predmeta fizike i ocene iz opšteg školskog uspeha kod dece sa teškim oštećenjem sluha. Uzorak je činilo 7 učenika sa teškim oštećenjem sluha i 7 učenika kontrolne grupe sa urednim sluhom (VI, VII i VIII razred). Adekvatnim statističkim analizama dobijeni su rezultati koji ukazuju na nesklad između ocene na testu znanja i procene nastavnika iskazane opštom ocenom iz testiranog predmeta. Na testu znanja iz fizike, čujući učenici su bili uspešniji u odnosu na gluve. Rezultati takođe pokazuju da je pojednak broj gluvih učenika koji je dostigao samo nivo pamćenja, shvatanja i primene i broj onih učenika koji dosežu nivo analize, sinteze i evaluacije na Blumovoj lestvici.


*Ključne reči*: školski uspeh, uspeh na testu iz fizike, teško oštećenje sluha.

# The level of adoption of educational content in chemistry for pupils with the hearing impairment

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**Abstract**.The school achievement of pupils with hearing impairment is seen as relatively successful. The poor achievement is mainly due to the poor ability of pupils to understand school materials, not because of their low intellectual abilities ... In this paper, attention is focused on the school success of chemistry teaching in pupils with hearing impairments, as well as on the relation of school success in chemistry and grades from general school achievement in children with severe hearing impairment. The sample consisted of 7 students with severe hearing impairment and a control group of 7 pupils with regular hearing (VII and VIII grade). Adequate statistical analysis yielded results that indicate the discrepancy between the assessment on the test of knowledge and the teacher's estimates expressed by the general grade from the tested subject. The results also show that there is no significant difference between hearing and hearing impairment students. These results also suggest that hearing and hearing impairment students, according to Blum's taxonomy, reach the cognitive level of analysis.
Key words: school success, chemistry test, severe hearing loss.

## 1 Introduction

School is the institution where the educational process is being realized. It has the task to form successful individuals, and thus contribute to the success of the society, according to Anđelković et al. (2011). The achievement of school success in learning depends mostly on the involvement of students, teachers, and parents in the educational process. Along with the social changes that are inevitable, the attitude towards performance is also changing. Performance then gets the dimension of dynamism and variability depending on the elements of evaluation, as well as the way in which success is estimated.

Zorman (1966) is one of the first authors to research success and student's failure. He made a correlation between family and school success. The term failure is most often associated with certain disorders in mental or general development, and the failure as lagging behind in comparison to a particular age group in school work. The author further states that there is a difference between slow learning, which is due to inadequate teaching methods and lagging behind, which is the result of the discrepancy between the intelligence and educational achievements. Markovac (1973) says that the failure is the degree of realization of material, functional and educational tasks of teaching which is not acceptable and does not meet the criteria necessary for the realization of teaching tasks from the social and scientific point of view. A little later, Markovac (1978) sets a new concept that interprets failure as an inability to adopt the contents prescribed by the curriculum for a particular class and gives a definition of school failure which implies unsatisfactory degree in the realization of material, functional and educational tasks set by the curriculum and program.

Đorđević (1990) defines failure as a consequence of disorders related to the decline in learning achievement and the decline in a certain level of knowledge, which is explained by intellectual abilities, student development, and the environmental influence. The author considers that not only pupils are responsible for failing in school, but also a number of external factors.

Nikolic (1998) points out that student failure means a low level of acceptance of content and requirements planned by the mandatory curriculum for certain grades and subjects, expressed by a school mark based on teachers' opinions. Krneta (2003) gives a more comprehensive definition of failure compared to the previous definitions. The author points out that the definition of failure refers not only to the curriculum but also to the realization of all activities in the school. The author thinks

that the failure is the part of the achievement of educational goals and tasks predicted for a certain age which does not correspond to the set and expected results. This makes it difficult for the student to successfully follow the classes in the next grade.

A significant number of factors which contribute to success, as well as to a failure in school, are pointed out by pedagogues. Factors that influence the achievement can, in the same way, lead to failure.

Roberts, (2004) emphasizes that only a student who is capable of achieving certain personal goals and at the same time fulfilling his / her parents and teachers' expectations is a successful student. Roksandić (2016) also states that a student who acquired certain knowledge acquired skills and habits, achieved emotional stability, built adequate social skills and adopted the appropriate forms of behavior needed for further learning is a successful student.

The success, or failure of deaf children in the regular school, depends on a large number of factors. Some of these factors are the degree of hearing impairment, time of damage, preschool treatment, and its continuity, adequate amplification, level of speech-language development, the degree of cognitive development, the degree of emotional maturity, family relations ... (Pavković, 2016)

Success, which is most often expressed in quantitative terms, is only one of the indicators of the acquired knowledge, the perception of one's own personality and the factor of further educational promotion, social behavior and overall behavior of the child (Gadžić, Milivojević, 2009, Roksandić, 2016).

In recent years, in our society, school failure is seen as a personal choice of students, which from his perspective is more meaningful than the remaining opportunities.

The aim of the research was to determine the school achievement of deaf students who are involved in the regular education system, assess the chemistry test, and determine the success of the deaf students on the chemistry test compared to the initial grade in the subject.

The sample consisted of 7 pupils with hearing impairment over 91 dB (very serious hearing impairment according to the World Health Organization classification) and a control group of 7 pupils with regular hearing (VI, VII and VIII grade).

## 2 Methodology

For the research needs, a physics knowledge test taken from the Institute for Pedagogical Research in Belgrade was used. It contained seventeen tasks set in open-ended and closed-ended form. The open-form group of tasks contained questions with adding or recognition tasks, while the group of task-related forms contained alternative questions, assignments with comparing and organising, sequence assignments in which students were required to set up a logical or chronological order i.e. to enumerate the elements by recognising the logical or chronological order as well as and multi-choice questions.

## 3 Research results

Results of deaf students of grades VII and VIII in chemistry tests: on a chemistry test, four deaf students successfully passed the test, and three students were unsuccessful. This result shows that three deaf students reached only the level of memory, comprehension, and application, while four deaf students reached the level of analysis, synthesis, and evaluation on the Blum scale (Chart 1).

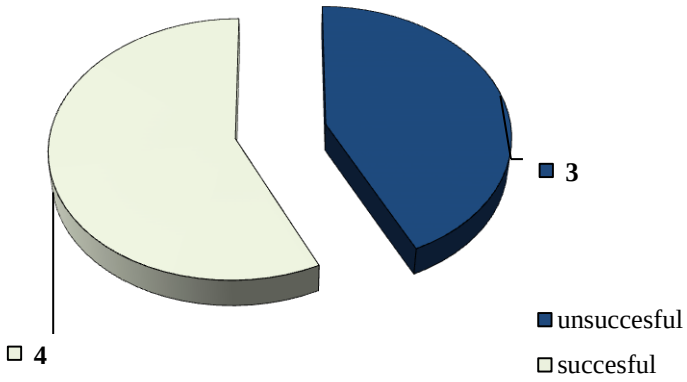


**Chart 1** The success of the deaf students in the chemistry test (VII and VIII grade)

The obtained results about the success on the test compared to the initial grade, show that out of the four students who had the grade 3, one failed the chemistry test and three did it successfully. One student who had a grade 4 failed the test of knowledge. Out of the two students who had grade 5, one was unsuccessful, and one successfully passed the test of knowledge (Chart 2).

The results also show that deaf students with grade 3 were the most successful in the chemistry test. Deaf students who were not successful in the test during the testing, most often commented that "they forgot" or "cannot remember the answer". The test failure of students rated by a high grade is the result of inadequate repetition of the material, which is the basis of learning.

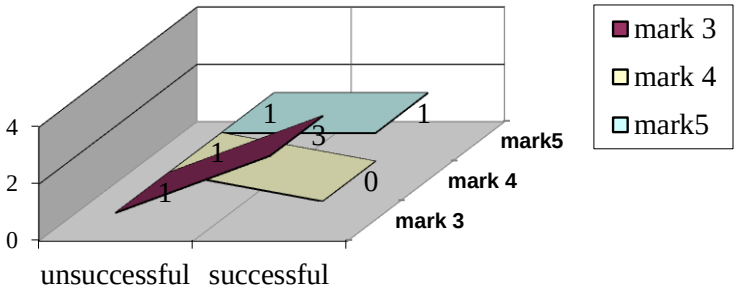


**Chart 2.** The success of deaf students in the chemistry test in relation to the initial grade

By analyzing the results of the students of the experimental and control group on the chemistry test (Chart 3), we realize that from the group of deaf students, four were successful in the chemistry test, and the three students were unsuccessful. In the group of the hearing pupils, four were unsuccessful, while the three were successful. There were no very successful pupils on this test. This dispersion of the results can be explained by the fact that the chemistry material for the seventh grade has many definitions, symbols, and tasks.

The results indicate that students have poor results in solving chemistry problems. In support to this, there are the results of the research carried out in Nigeria. The Samuel and Offiah Survey (2012) linked success in the adoption of chemistry materials with previously accepted mathematical knowledge. The results of hearing students indicate the shift of the Gaussian curve to the left side of the field of failure, while the results of deaf students indicate the shift of Gaussian curve toward the field of success, in this case to the right side of the curve. These results show that hearing and deaf students reach the cognitive level of Blum analysis.

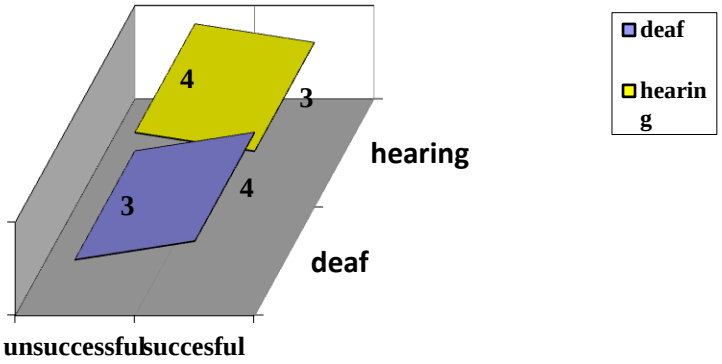


**Chart 3**. The success of the students of the experimental and control group on the chemistry test

## Conclusion

The conclusion that comes from the results is that 57% of deaf students in the seventh and eighth grades on the chemistry test was "successful" and 43% "unsuccessful". Comparison of the achievements of deaf learners from the seventh and the eighth grades in the chemistry test and their mark in this subject indicates that there is a difference between test results of deaf students and their initial grades from the chemistry subject, i.e. deaf students showed a lower level of knowledge on the test in comparison to the grade in the subject. The results of the achievements of deaf and hearing students on the chemistry test also show that there is no significant difference between hearing and deaf students.

The school environment is a context that provides students with the opportunity to form social relationships and positive behavior during learning, extracurricular and other activities. The positive dimension of the interaction among teachers and students, as well as among students, influences reaching better school achievement.

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## Nivo usvojenosti nastavnih sadržaja iz hemije kod učenika oštećenog sluha

Školsko postignuće učenika sa oštećenjem sluha je viđeno kao relativno uspešno. Loše dostignuće je uglavnom zbog loše sposobnosti učenika da razumeju školsko gradivo, a ne zbog njihove niske intelektualne sposobnosti...U ovom radu pažnja je usmerena na školski uspeh iz nastavnog predmeta hemija kod učenika oštećenog sluha kao i na odnos školskog uspeha iz nastavnog predmeta hemije i ocene iz opšteg školskog uspeha kod dece sa teškim oštećenjem sluha. Uzorak je činilo 7 učenika sa teškim oštećenjem sluha i kontrolne grupe od 7 učenika sa urednim sluhom (VII i VIII razred). Adekvatnim statističkim analizama dobijeni su rezultati koji ukazuju na nesklad između ocene na testu znanja i procene nastavnika iskazane opštom ocenom iz testiranog predmeta. Rezultati takođe pokazuju da nema bitne razlike između čujućih i gluvih učenika. Navedeni rezultati takođe ukazuju da čujući i gluvi učenici dostižu kognitivni nivo analize po Blumovoj taksonomiji.
*Ključne reči:* školski uspeh, uspeh na testu iz hemije, teško oštećenje sluha

# Foreign Language Teaching and Children with Disabilities - Hearing Impairment

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**Abstract.** Hearing impairment causes numerous difficulties on the development of oral communication skills. Usually, rehabilitation is based either on spoken language or sign language. Foreign language learning among HI is no longer an exception but a frequent educational challenge, especially when HI learners are part of the inclusion process. Learners are faced not only with difficulties in speech perception but also insufficient L1 knowledge and together with their teachers with lack of proper teaching material, environmental support etc. In order to address this issue so that necessary advancement of the teaching process can be made, both qualitative and quantitative studies should be conducted. The qualitative study reported in this paper included focus group and in-depth interviews with teachers who had experienced teaching hearing impaired children. The topics included previous experience with learners in inclusion, benefits of inclusion, types of impairment and specific difficulties during teaching, satisfaction with support provided by institution and additional education aimed at teaching impaired learners. The analysis revealed that teachers find inclusion beneficial, but stronger support to the teaching process is required. Support should include not only materials, education, but also information about impairment which are often missing. The teachers also emphasize that their teaching competence and skills are mostly based on in-service experience, whereas the specific knowledge about a disability and evidence-based approach to teaching is missing. Based on the analysis, a questionnaire for quantitative study was prepared. It consists of one section regarding diagnosis and impairment typology, followed by practical suggestions for classroom activities, curricular adaptation, teaching strategies, teachers' education and language teaching challenges.

## 1 Introduction

In order to address the complex issue of foreign language teaching to children with any type of disability or disorder the simplest way is to address the preconditions of the learning process or simply the elements of the impairment that are influencing the learning process. In the case of hearing impairment (HI) those are: characteristics of the impairment, types of rehabilitation, preferred communication modality, use of hearing aid and environmental factors.

Hearing impairment can be defined as a partial or complete inability to hear i.e. to detect and perceive sound. In order to classify the types of hearing impairment Elberling and Worsoe (2006) list five dimensions of hearing which can be affected by the impairment thus determining its type and the degree. Those are: sensitivity to sound intensity or level, dynamic range, frequency resolution, temporal resolution and binaural hearing. HI causes difficulties in oral communication due to the reduced or filtered input information, which is why HI individuals rely strongly on the visual communication. Therefore, HI individuals can either use only visual-manual modality (sign language) for communication or use the combination of visual and auditory information in variety of rehabilitation approaches (cued speech, lip reading) or attempt to develop sufficient oral communication which is promoted by some rehabilitation approaches (Auditory-Verbal Therapy, Verbotonal method etc.). What often remains unsaid in the debate between rehabilitation approaches is that language delays among HI individuals are not necessarily caused by the communicative modality but by the incomplete access to ANY language model. This means that when visual-manual modality is employed, adults do not provide complete and consistent model, since sign language is usually their foreign language, but express certain spoken elements (emotions) verbally. HI causes speech and language difficulties in L1 and this conclusion is the only one that can be considered definite from the huge body of research on HI speech and language development (Spencer & Marschark, 2010) while the rehabilitation methods and communication modalities fostering success remain disputed. Hearing aids, both traditional and implants, aid speech perception and foster oral

communication but they do not 'cure' the impairment and the successful use of HA depends on rehabilitation. Finally, successful development of communication among HI individuals is the result of strong environmental (family and community) support.

Another important question is about HI prevalence, since it is often mentioned in the research papers that the number of HI individuals is low which causes heterogeneity in the study samples and limited results showing only tendencies. The number of individuals who will benefit from the advancement of foreign language teaching of the individuals with disabilities is not insignificant. Today, there are 360 million HI individuals in the world (WHO) who have hearing loss greater than 40 dB in the better hearing ear, 32 million of these are children and slightly less than one fifth are deaf individuals (70 million, World Federation of the Deaf).

Contemporary educational policies promote inclusion as a dominant approach in education of individuals with disabilities (Vican & Karamatić Brčić, 2013) because it is based on the right of all students to participate equally in the education process in order to develop their full potential. Teachers' attitudes towards inclusion have generated a large body of research (Avramidis & Norwich, 2002) showing that teachers have positive attitude towards inclusion, but are clearly aware of the difficulties in the process. The term inclusion means that a mainstream educational setting is adapted to the needs of children with disabilities creating a community of all learners regardless of their ability or disability. Therefore, successful inclusion is a result of involvement and collaboration between teachers, other educational professionals and parents who support the learner during the learning process.

Finally, the importance of foreign language learning needs to be addressed. Unquestionably, foreign language learning is the 'educational necessity of the 21st century' for both hearing and hearing impaired individuals, and English language is definitely the most frequently learned foreign language. In order to help HI individuals to use the technology and other benefits of globalization, foreign language teaching (FLT) should be adapted to their special needs. This question is being raised among FL teachers in several European countries in which English is taught as L2; in Poland, Czech Republic, Hungary, Italy, France, Serbia, Norway and UK providing information about policies, teacher attitudes or teaching practice (see (Domagała-Zyśk, 2013) and (Domagała-Zyśk & Kontra, 2016) for an overview).

Croatia has a long and successful tradition in rehabilitation of hearing impairment implementing oral/verbotonal method by Petar Guberina (Guberina, 2010). Following that tradition, we also have great success with cochlear implantation and postoperative rehabilitation (Paškvalin, 2005). In Croatia, there is a possibility of either inclusive education or education in specialized educational institution (Polyclinic SUVAG, Slava Raškaj center) for the hearing impaired. Polyclinic SUVAG offers pre-school and primary education and Slava Raškaj center primary and secondary education. Both institutions offer individual rehabilitation sessions. Inclusion of a HI child also means that a team of experts monitors and supports child's progress depending on the individual needs. Despite the professional support provided by the expert team in school, teachers often question their competencies when it comes to teaching children with disabilities, feel unsecure, unsatisfied or even frustrated with their teaching performance.

## 2 Material and method

This study is a part of a larger project employing both qualitative and quantitative methodology in the study of attitudes on inclusive education. The aim of this study was to examine attitudes of foreign language teachers in Croatia about teaching children with disabilities in general. In the first phase, qualitative study design was used to gain deeper insight in the various issues that the teachers involved in the inclusive educational setting are facing, but also to examine the range of teaching strategies the teachers develop in practice. The insights from the first phase are used for the construction of a questionnaire used for the national quantitative study in the second phase.

During the first phase a focus group and two semi-structured interviews were conducted. The language teachers were recruited in a primary school in Zagreb. That school has a long inclusion tradition of children with hearing impairment and language difficulties and is a positive example of an

inclusive educational setting, thus a great starting point for qualitative insights. The number of participants in the focus group was nine, three more than planned, due to the greater interest among the teachers. Semi-structured interviews were conducted after the focus group to deepen certain findings.

The topics used for focus group and interviews were (Westwood & Graham, 2003):
(1) Number of students and types of disabilities in inclusion classes,
(2) Benefits of inclusion for typically developing students,
(3) Types of difficulties that teachers find the most challenging,
(4) Satisfaction with the available support (both material and professional),
(5) Teachers' education necessary for teaching children with disabilities (both before employment and during).

## 3 Results and Discussion

Focus group was opened with the following comments:
*I think that I do not give enough attention to my disabled learner.*
*Definitely, definitely, I always wonder whether he got enough, that is whether I can give him more. But, we have to achieve something, something average.*
*I wonder whether I will have enough time for that learner.*
The quotes from three different teachers show the current state, but also show teachers' motivation to give more, to adjust to learners' needs and teach better.

### 3.1 Diagnosis

Participants emphasised several problems regarding detection of the disability or disorder. If a child has hearing impairment it is, in most cases, detected during early childhood. The hearing impairment diagnosis is followed by rehabilitation and the diagnosis itself is the basis for organization of educational setting. On the other hand, certain language difficulties (i.e. dyslexia, dysgraphia etc.) become evident only after the child begins with formal education. Teachers often note that a child has difficulties with understanding and inform both the parents and educational experts in school. The expert team assesses the child and directs the parents to specialized institutions for precise diagnosis in case it is necessary. The diagnostic process is often lengthy and sometimes the precise diagnosis is set several years later. Therefore, the teachers stress that their education is neither systematic nor does it cover variety of difficulties so they feel uncertain whether a child shows certain developmental delay or disability.
Once the diagnosis is set, educational experts decide about program adaptations. Regardless of the program adaptations (regular or reduced program) student receives certain amount of help. The teachers are often puzzled by the amount of help needed by individual student. They want to provide help, but also foster autonomy.

### 3.2 Program adjustments

According to the Regulations of primary and secondary education of students with developmental difficulties (cro. Pravilnik o osnovnoškolskom i srednjoškolskom odgoju i obrazovanju učenika s teškoćama u razvoju), students can be educated by regular curriculum with individual adjustments or by adapted curriculum and individualized adjustments or by special curriculum. The participants say that most students in their school follow curriculum with individual adjustments while only small number is educated by adapted curriculum.

The participants agreed that their work is influenced by number of children with disabilities in their class because they have to offer various types of individualized program (materials, classroom management etc.). Furthermore, the boundary between individualized and adapted curriculum is unclear. This causes difficulties with preparations of lesson plans and materials. In most cases they adapt materials based on their personal judgements.

### 3.3 Parental and professional support

Parents can have both positive and negative influence on the teachers, since the teacher-parent cooperation is essential. Participants all agree that parents' attitude towards disability has great influence on child's success. If the parents accept the difficulty, if they are willing to pursue various diagnostic procedures in order to get precise and timely diagnosis and follow the recommendations given by the team of educational experts, the child begins to show progress. However, if the parents do not encourage their child, the results are slow or none. Regarding the teacher-parent relation, participants mentioned several examples of great cooperation with parents, sharing findings from educational process or successful methods. On the other hand, the examples of poor cooperation are often based on parents' attitude toward disability (non-acceptance) and/or attitude that program adjustments are not required.

Team of experts supports teaching process in all stages, and teachers feel that sometimes there is too much 'monitoring' and the child often feels pressured. Regarding materials, no explicit comments were given, except that they generate materials, even published textbooks for some subjects (Croatian language). It has to be noted that materials are tailored to suit individual needs and type of educational program, teaching materials are shared among colleagues.

### 3.4 Benefits of inclusion for typically developing students

When asked about inclusion benefits for typically developing students, teachers emphasized that the entire class benefits from the adjustments of the teaching process. For an example, slower exposition is a good example of the whole class benefit, accompanied by frequent repetitions and more question time.

Participants agreed that children with disabilities are insecure without real reason, leaving the impression of being unprepared. However, it is not the lack of knowledge that causes this impression, but fear of mistakes. Focus group participants put strong emphasis on this, saying that integration of children with disabilities in mainstream classrooms has benefits for all participants of the learning process. Similarly to Westwood and Graham (2003) the classrooms become encouraging settings fostering cooperation and tolerance. All the teachers want to create atmosphere in which comments and corrections, but also help is provided with no hesitation raising awareness that learning abilities among peers may differ.

### 3.5 Types of difficulties that teachers find the most challenging and teaching strategies

During the discussion about particular difficulties faced by language teachers, the participants mentioned: scarce L1 vocabulary and generally low metalinguistic awareness, difficulties with phonology and semantics. The students with small vocabularies in L1 will certainly have difficulties with L2 vocabulary because they cannot use L1 to explain new word or a concept. The teachers described their strategy; in such cases they use foreign language to learn new concepts in L1. Since L2 is learned explicitly with higher level of metalinguistic awareness, learning L2 indirectly influences L1. One of the examples is the notion of homesick in English which is translated as a desire for home in Croatian, but the problem arises when the student is not familiar with the notion of desire. If the English word is contextualized its meaning is learned but also applied to Croatian. Furthermore, students with disabilities often have problems in word order tasks. In this case the task adjustment is to make the task linear so that clauses are already inserted making the task easier.

Additional problem faced by HI students are speech sounds and their role in a language. Surely, if there are problems with phonology, there will be problems with semantics and this is particularly evident in L2, since semantics in L1 is less important, while in L2 the focus is on grammatical forms. Due to the differences in approach, certain phenomena being explained in detail in L2 it may sometimes seem that students have less difficulties with L2 phonology and semantics.

Participants stress that they do not approach the language as a study object but as a means of communication. This strategy encourages students to understand the context without details and to simplify the structures. The examples are: shortening of texts, simplification of sentence structure and

emphasizing important information in the text. More examples for wide variety of subjects are available in a book *Can you hear the difference?* (Bakota, 2015)

Lesson planning must include students with disabilities, consequently teachers develop certain teaching strategies. Participants listed the following strategies labelling them as their core ones: extremely detailed lesson plan, quantitative adjustment of teaching material and speed and development of "micro approach" depending on the difficulty. Detailed lesson plan means that the teacher has general (mainstream) lesson plan but also special assignments or procedures for the students with disabilities. That is why in some classes in which there are more children with disabilities this will mean preparation of several procedures for a single assignment. The procedure may include reduction of the teaching material which is another basic teaching strategy used for both individualized or adapted program. Another problem faced by teachers is assessment. Every subject teacher must take into account student's ability and possible limitations. Participants explain that teachers follow achievement and encourage progress resulting in a grade which is more an indicator of effort and progress than real achievement.

### 3.6 Teachers' education necessary for teaching children with disabilities

Teachers' education is neither systematic nor does it include wide spectrum of disorders, therefore the teachers are unable to make a difference between disability/disorder or developmental delay. They agree that educations are useful and can be applied for lesson planning. However, the educations are rare and sometimes give general information. In other words, the educators refer to children with disabilities in general terms, perceiving them as a compact group although education, lecture or a workshop, addressing particular impairment would be of greater use. Considering the fact that most participants have 20 years of experience in teaching children with disabilities, they pointed that the received no additional education and training at the beginning of their professional life.

## 4 Conclusion

The conclusion consists of two parts: final remarks on the qualitative study and the description of the questionnaire for the quantitative study constructed from the findings from the first part.

Study results show that participants often feel incompetent and unready to teach children with disability. This is caused by insufficient information about the type and degree of the child's disability or lack of specific education about a particular disability. Teaching skills for hearing impairment and other disabilities are gained in practice, and with the support from the team of experts they gain crucial insights for FLT to HI children. Both material and non-material support plays important part in the process of forming teaching strategy. Despite all the challenges that teaching children with disabilities brings, all participants agreed that inclusion is positive not only for children with disabilities, but also for those typically developing because they raise awareness about differences, but the process of inclusion must be administered systematically. Regarding FLT, participants are aware that we need to upgrade teaching process in order to make FLL useful for students with disabilities.

The questionnaire which will be used in the quantitative part of the study has six sections and demographics. The demographics include questions about age, gender, experience and type of school. The first section addresses diagnoses with the following questions:

1. Have you been informed about student's diagnosis?
2. Have you ever received any type of instruction on teaching student with a particular disorder?
3. If you were informed about the diagnosis and/or received instruction when has this occurred?
4. Who provides instruction regarding teaching children with disabilities?
5. Did you recommend diagnostic procedures for some students but they never completed them?
6. Are there students who completed diagnostic procedures and were given instructions which parents do not follow?

The second section examines teaching instructions and recommendations. Whether they were written or oral, general or particular, and who issued instructions or recommendations. The third section

aimed at the difference between adjusted program or curriculum and individualized program, former having reduced amount of information. The questions examined authorship of the program and its supervision. Section four is about teaching strategies. General strategies like preparation of monthly or yearly planning for the adjusted or individualized program. Questions regarding particular teaching strategies included: material reduction, teaching speed, task complexity, activity adaptation, usage of special didactic toys or materials adequate for hearing impaired children. Section five examined education of the HI teachers. The questions were about the disability they are or were educated the least, about education before and during teacher's degree, education after the degree and about the providers of additional education. Final section examines the challenges in FLT (low vocabulary level, low level of metalinguistic awareness, semantic or phonological difficulties, problems with understanding, slow learning and fear of mistakes).

Further research will bring results from the quantitative study, but also open more discussion on various aspects of various impairments and foreign language teaching.

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