

Conference Paper

Theoretical Views on Mechanisms of Formation of Speech Act

Lidia Belyakova and Yulia Filatova

Moscow Pedagogical State University, Moscow, Russia

Abstract

The methodology of the modern logopaedic science becomes the expansion of knowledge through the study of the 'internal speech patterns' mechanisms and coming up to theoretical views on the role of some core transformations of speech system within the ontogenesis. The increase of understanding of formation process of speech act becomes possible through the use of interdisciplinary approach and system analysis. The article outlines issues related to the possibility of studying the hypothesis proposed by the authors: speech functional system (SFS) results into the action in the form of psychosensorimotor (PSM) speech stereotype. The parameters of PSM speech stereotype in native language are being formed by the age of 6–7. The functional system of speech act is considered in details: speech motivation, situational, auditory, kinesthetic, visual, and emotional afferentations, genetic and ontogenetic speech memory, afferent synthesis, etc. Special attention is paid to the speech fluency as an indicator of the rhythmic mechanisms formation of the brain. The definition of speech fluency and its development in ontogenesis is shown. Stepwise and nonlinear character of speech fluency development in ontogenesis is experimentally proved.

Keywords: speech functional system (SFS), speech act, psychosensorimotor (PSM) speech stereotype, rhythm, speech fluency, ontogenesis, system analysis

1. Introduction

Cognition of the speech mechanisms requires a philosophical comprehension of not only the meaning but also the sources of formation of this complex mental activity of human being (Vygotsky, 1934; [19, 24], etc.). In this context, it is worth mentioning the ideas of Vernadsky [31] concerning the biosphere which is connected with his concept of three-dimensionality and geohistorical idea of the 'space-time'. Biosphere, according to scientist, is not a static structure of 'life wrap'. It is a geobiohistorical process that started with the hypothetical Universe and stretching throughout to specific biogeochemical cycles and evolution of living systems on our planet. Vernadsky

Corresponding Author:

Yulia Filatova
 yofilatova@yandex.ru

Received: 25 July 2018

Accepted: 9 August 2018

Published: 1 November 2018

Publishing services provided by
 Knowledge E

© Lidia Belyakova and Yulia

Filatova. This article is
 distributed under the terms of

the [Creative Commons](#)

[Attribution License](#), which
 permits unrestricted use and
 redistribution provided that the
 original author and source are
 credited.

Selection and Peer-review
 under the responsibility of the
 Fifth International Luria
 Memorial Congress Conference
 Committee.

OPEN ACCESS

was one of the first scientists who rose to the understanding of human thought as a planetary phenomenon – the ‘noosphere’. Luria [22, 23] and his disciples used these achievements for finding general principles that bring tremendous complexity of multifarious phenomena of the brain nature to the grand simplicity.

The progress of these ideas as we believe refers directly to the language science and its disorders.

The methodology of the modern logopaedic science becomes not only and not so much the study of the externally observed picture of verbal phenomena, but also the expansion of knowledge through the study of the mechanisms of ‘internal speech patterns’ and coming up to theoretical views on the role of some core transformations of speech system within the ontogenesis. The increase of understanding of formation process of such complex nature’s phenomena as speech act becomes possible through the use of interdisciplinary approach and system analysis [2].

Emergence of new neural networks in the brain during the process of a child’s speech development and his/her learning, the phenomenon of plasticity of the CNS as a fundamental and most specific characteristic of central neurons, the neurons of mind – these and other neurophysiologic ideas of recent years have greatly supplemented and enriched our theoretical understanding of the speech production mechanisms and understanding of the result of speech functional system (SFS).

2. Methodology

We have reviewed theoretical ideas about psychosensorimotor (PSM) speech stereotype as a result of the SFS. The review shows the perspectives of this approach for the purpose of understanding some mechanisms of speech formation [8, 11, 15–18].

We assume that PSM speech stereotype integrates all afferentations, both external and internal, that have evolved in the process of formation of genetic and ontogenetic memory, being the basis for formation of the SFS.

The theory of functional systems created by Anokhin [1, 2] as the system of behavior act and meaningful to us as a functional system of speech act [7, 8, 11, 12, 15] is used in this context as the primary method of analysis (see Figure 1).

The main postulate of this theory is that the processes of response, behavior and training are aimed at achieving a certain goal, or the ‘action result’. The action result or future event, as it is known, is a central system-forming factor for different functional systems at all levels of their organizations (both lower and higher).

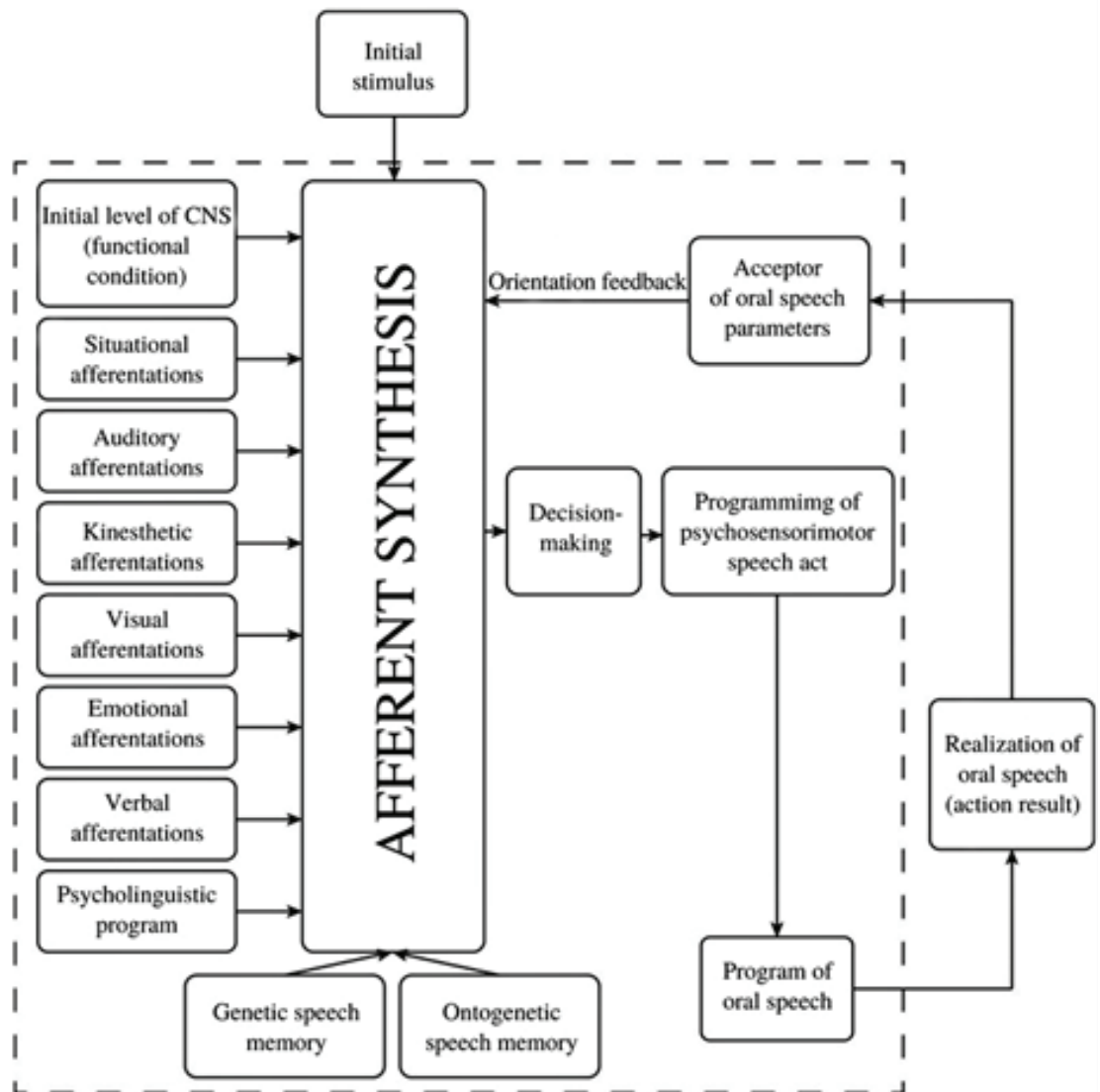


Figure 1: Functional system of speech act [11, 15].

We have studied forming in ontogenesis such components of PSM speech stereotype as: speech motivation, situational, auditory, kinesthetic, visual, and emotional afferentations, genetic and ontogenetic speech memory being parts of afferent synthesis. As we believe, the afferent synthesis serves as basis for integrated semantic and motor program of speech. PSM result of action performed under pre-formed program is considered as the result of efferent synthesis.

Any functional system has specific features that are dependent on the quantity and quality of afferent impulses, and permanent connection with the peripheral organs. Each of afferentations represents a complex structural-functional formation and can

be considered either as a subsystem of functional system of speech act or as a self-sufficient functional system as well, for each of afferentations has its own action result, its own action program, central and peripheral mechanisms.

Genetic speech memory and ontogenetic speech memory are one of the base components of afferent synthesis in functional system of speech act. By the 'genetic speech memory' we understand the innate preverbal articulation, and intonation, which are implemented in the infant's cry, vocal babbling and the first stages of canonical babbling. This stage of speech development of congenital speech mechanisms is supported by kinetic, kinesthetic and auditory afferentations. It begins with a cry immediately after the birth of a child.

The quality of initial cry signalize about the normal condition of the CNS. Sonority and voice duration indicate sufficient maturity and integrity of the medulla oblongata which ensures normal muscle tone, good filling of lungs with air and sufficient subglottic pressure of vocal folds ([3, 29], etc.). Vocal babbling period shows the onset of more complex genetically inherent underlying mechanisms of speech providing for further specific way of communication between humans – verbal contacts. At a later stage of canonical babbling (7–8 months) sound production characteristics of the native language, its prosodic are formed, that is, the speech ontogenesis and formation of ontogenetic speech memory 'launches' [11, 12]. Complex acoustic characteristics of oral speech in the native language are gradually formed in the process of speech ontogenesis and their characteristics become stable and individual by adolescence.

Speech motivation pointed in afferent indicators is not equivalent to the initial stimulus. It constantly exists as an internal condition of developing speech contacts. This can explain the high speech activity of preschool children, their constant desire to verbalize their actions, surrounding objects, etc. [11].

Visual afferentations that seemingly do not relate directly to the development of speech act nonetheless play role from the first months of a child's life. An infant begins to fix the look while communicating with adults not on the face and eyes (as adolescents and adults do) but on lips and tongue of a speaking person, mechanically repeating these movements and sounds.

Emotions are the necessary factor that maintains the optimal level of wakefulness of the higher parts of the brain and contribute to the development of higher mental functions. This factor relates to biologically caused increased mood of toddlers, their use of facial expressions and expressive body movements, changing the tone and volume of voice. The main contribution of the emotional part is in the regulation of

tonic activity of the brain necessary for the realization of speech and mental activity in general ([20, 28], etc.).

The stage of afferent synthesis is the most important point in forming any system of any behavioral act, which includes speech. At this stage brain structures analyze either background or specific internal/external afferentations, which will be further considered while making the action program. This very phase of afferent synthesis is of particular importance for the formation of PSM speech stereotype.

3. Results

3.1. Role of rhythmical processes in development of speech functional system

Central mechanisms of SFS have not only a complex architecture, but also complex rhythmic interaction and coaction. All internal and external components of the system are analyzed and synthesized in a certain rhythmic coherence during the preparation of motor program of oral speech [12, 17, 18]. The overall rhythmic impulsion is formed in the process of afferent synthesis, such impulsion further enters the central efferent, that is, executive level of action program of PSM speech stereotype, due to which there are possibility to pronounce a connected statement.

Experimental studies and theoretical considerations lead to the idea that rhythmic activity is the psychobiological process basing on which complex and various relationships of an organism with external and internal environment factors are formed and implemented (Bekhtereva, 1988; [21], etc.).

Modern science intensively discusses the importance of the pacemaker mechanism in the brain activity in the context of the analysis of rhythmic processes influence on SFS formation [4, 5]. It is known that the cellular elements of the CNS have a special kind of rhythmic activity of the endogenous origin. This innate rhythmic activity makes each neuron an excitation generator, that is, pacemaker or rhythm-driver. Spatial synchronization of brain rhythms is interpreted by researchers as a manifestation of identical pacemaker traits of spatially separated neurons ([14], etc.). According to Bekhtereva [5], pacemaker is obligingly involved in any interaction of certain parts of the brain, but it is not attached to any single or several structures.

We assume that special role of the pacemaker mechanism is revealed at co-rhythmization of neuronal activity of different brain structures involved in certain activities, for example, during particular speech-motor program ([25], etc.). The activity

of pacemaker is flexible because due to its dynamism the control, organization and reorganization of any activity are performed. Repetition of the same activity facilitates the formation of pacemaker, and in this case, according to Bekhtereva, a rhythmically organized 'relevant matrix in long-term memory' is created and constantly innervated ([4], p. 93).

By utilizing the neurobiological aspect of understanding such complicated processes we can theoretically imagine how the result of afferent synthesis 'comes' to a neuron of operating (executive) mechanisms in the form of electrical innervations of a cell membrane, which is then transformed into a biochemical process of efferent synthesis of neuronal activity with the final result. Thus, it's obvious that **action effect in the form of PSM speech stereotype is a vehicle for self-organization of the SFS.**

3.2. Ontogenesis of speech act

Knowing how to change the program of action, and, consequently, the quality of the oral speech as the action result at the stage of afferent synthesis with the insertion of new afferentations can allow to analyze speech ontogenesis and the stages of its development.

The language acquisition implies the accurate differentiation of all elements of a heard, spoken or read speech, and this analysis is inevitably associated with the pronunciation of words aloud, in a whisper or silently. It is reasonably assumed that right in the preschool age children due to permanent kinesthetic and aural evaluation of speech sort out according to of Anokhin, 'all degrees of freedom' and retain only those that facilitate the standard of native language, which is shown experimentally in the works of Beltyukov [6], Ushakova [30], etc.

Theoretical ideas about the SFS help identify the specific consistencies of development of some subsystems of speech production (speech breathing, sound production, etc.), the complex of which can be defined as a norm. In this regard, there is an opportunity to differentiate their quality from disorders.

For example, in 1926 Vygotsky referred the breath to speech movements considering that without it the oral speech is unthinkable [32]. Later researches show that a least electrical activity arising in speech muscles that accompany the inner speech affect the EMG of speech muscles [26]. According to Luria [23], the kinetic component of movements is performed in the form of kinetic and melodic schemes. In relation to the speech, this factor provides for a smooth switching from sound to sound in the process of word pronouncing and moving from word to word, which comprises the

fluency of speech. The articulatory muscle and speech breathing acquire fairly stable characteristics by 5 years that later become stereotyped [10].

The formation of the sound system of language in ontogenesis also has its consistencies. From the very beginning of the speech development a child while communicating with others is actively using global sound structures, which are gradually divided by the dichotomy principle and produce sounds that later reflect the national language [6]. This principle can be traced at higher levels of language development of children. Prior to pronouncing new words a child is anticipating it by the sounds or syllables of a generalized speech structure [30].

According to recent studies, one of the physical parameters of speech is the '**speech fluency**'. This term includes temporal and rhythmic characteristics of the speech exhalation during the speech utterance. Researchers identified and characterized some indicators of speech disfluency and their dynamics depending on a child's age and his/her rate of speech development ([9, 13, 15, 27, 35], etc.).

Internal processes of rhythmic organization of speech being of immense complexity are approachable for external observation and evaluation through the analysis of speech fluency. Speech fluency develops during preschool period of a child development. However, in the school age as well (especially primary) the rhythm of speech, temporal characteristics of speech and speech breathing are not sufficiently stable. Either children or adults as well accelerate the rate of speech in conditions of emotional tension, iterations, unfinished words and sentences and even the semantic incoherence of speech may quite often occur. In accordance with this, the speech fluency is changed [10, 18].

We have experimentally proved that within the characteristics of speech rhythm as an essential quality ensuring the speech fluency there is a clear dynamics of speech rhythm maturation in different hierarchical levels, from the syllable and word levels speech rhythm of preschoolers to sentence rhythm of speech of primary school children, all this relates to children with normal speech. This is the evidence of a **gradual and nonlinear nature of formation of various components of the SFS in process of PSM speech stereotype formation** [16, 18].

Age peculiarities of oral speech that indicate the instability of the SFS in the preschool years make clear the roots of its selective 'fragility' under the influence of various external and internal factors. All the indicators of a developing oral speech are closely interrelated. As to the concept of the SFS one can say that the change of any afferentation transforms the action program of SFS and therefore the action result.

4. Conclusions

According to the Vygotsky's theory, speech and language activity is a part of the holistic psyche of a child, as it was originally included in the formation of a world image, and either perceived or utilized linguistic means begin to identify what they are formed for. In this regard considering PSM speech stereotype one can say that it accumulates all levels of mental and psychomotor activities. Such external indicator as speech fluency is formed by temporary combination of programs of selection of lexical and grammatical expression means, choice of motor realization of speech (speech breathing, voice, and articulatory program) and realization of the general speech program.

At preschool age two sides of speech and language activity are intensively formed: mental and speech. The ontogenesis of speech begins with motor mechanisms – cry, voice babbling, and canonical babbling – and is, as previously stated, the demonstration of genetic speech memory. Then, during the speech ontogenesis the specific psychomotor stereotypes – speech articulation of the native language – start to develop. The mental component is also associated with the development of vocabulary, grammatical structure and intonation of speech. Normally, mental and motor aspects of speech develop quite synchronously and harmoniously. Gradually the motor component of speech is becoming a more distinct symbolic character.

The aforementioned discussion allow to say that the material component of speech is the highest form of consciousness evolution and it is one of the concepts of the noosphere. There is no doubt that the SFS as a complex information process of nature in the near future will become the subject of study of bioinformatics and molecular biology. That will allow to reveal more clearly the relationship and interdependence of the phenomena of the material world.

References

- [1] Anokhin, P. K. (1968). Funktsional'naya sistema [Functional system]. *Annual of BME*, vol. 1, pp. 1300–1322.
- [2] Anokhin, P. K. (1980). *Uzlovye voprosy teorii funktsional'noy sistemy* [Key questions of the functional system theory]. Moscow.
- [3] Bazghina, T. V. (2008). *Rannie kriki detej: segodnya i chetvert' veka nazad* [Early child's cry: today and a quarter of a century ago], in T. N. Ushakova (ed.) *Child's Speech: Problems and Solutions*, pp. 115–129. Moscow: Institute of Psychology RAS.

- [4] Bekhtereva, N. P. (1977). Slovo v nejronnyh ansamblyah [The word in neural ensembles]. *Science and Life*, vol. 10, pp. 90–94.
- [5] Bekhtereva, N. P. (2010). *Zdorovyj i bol'noj mozg cheloveka* [Healthy and diseased human brain]. Moscow.
- [6] Beltyukov, V. I. (2003). *Sistemnyj process samorazvitiya zhivoj prirody* [The system process of self-development of nature]. M: SPb.
- [7] Belyakova, L. I. (1976). Narushenie funkcional'noj sistemy rechi pri zaikanii [Stuttering: Impairment of speech functional system]. *Neuroscience and Behavioral Physiology*, vol. 10, pp. 1555–1558.
- [8] Belyakova, L. I. (1981). *Kliniko-fiziologicheskij analiz central'nyh patogeneticheskikh mekhanizmov zaikaniya* [Clinical and physiological analysis of the central pathogenic mechanisms of stuttering]. Leningrad.
- [9] Belyakova, L. I. (2003). Rechevoj ontogenez i znachenie gipersenzitivnyh periodov [Speech ontogenesis and the value of hypersensitive periods], in Yu. F. Garkusha (ed.), *Child. Early Discovery of Deviations in Speech Development*, pp. 8–16. Moscow: Voronezh: MPSI.
- [10] Belyakova, L. I. (2005). Ontogenez rechevoj deyatel'nosti kak prioritethoe napravlenie nauchnoj shkoly kafedry logopedii MPGU [Ontogenesis of speech as a priority of the scientific school of the MPSU speech therapy department], in L. I. Belyakova (ed.) *Ontogenesis of Speech and Language: Norm and Pathology*, pp. 18–24. Moscow: Prometey MPSU.
- [11] Belyakova, L. I. and Filatova, Yu. O. (2008). Mekhanizm rechedvigatel'nogo akta v svete logopedicheskogo analiza [Mechanism of speech act in the field of logopaedic analysis], in T. N. Ushakova (ed.), *Child's Speech: Problems and Solutions*, pp. 40–54. Moscow: Institute of Psychology RAS.
- [12] Belyakova, L. I. and Filatova, Yu. O. (2016). Psihofiziologicheskij instrumentarij v prostranstve izucheniya rechi rebenka [Psychophysiological tools in child's speech study]. *Journal of Psycholinguistics*, vol. 4, no. 30, pp. 31–39.
- [13] Bernstein, N. E. (1981). Are there constraints on childhood disfluency? *Journal of Fluency Disorders*, vol. 6, pp. 341–350.
- [14] Danilova, N. N. (2009). Neinvazivnoe otobrazhenie aktivnosti lokal'nyh nejronnyh setej u cheloveka po dannym mnogokanal'noj registracii EHEHG [Non-invasive mapping of local activity of the neural networks in humans according to the EEG multichannel recording]. *Psychology Journal of Higher School of Economics*, vol. 1, pp. 114–132.

- [15] Filatova, Yu. O. (2012). *Ritm rechi i dvizhenij u detej: teoreticheskie i prikladnye problemy logopedii: Monografiya* [Rhythm of child's speech and movement: theoretical and applied problems of logopaedics: Monograph]. Moscow: MPSU.
- [16] Filatova, Yu. O. (2012). Ontogenez i dizontogenez ritmicheskoj organizacii rechi [Ontogenesis and Dysontogenesis of Speech Rhythmical Organization]. *Journal of Special Education "Defectology"*, vol. 3, pp. 28–36.
- [17] Filatova, Yu. O. (2013). Transdisciplinarnyj podhod v sovremennoj logopedii [Transdisciplinary approach in modern speech and language therapy]. *Journal of Special Education "Defectology"*, vol. 4, pp. 19–28.
- [18] Filatova, Yu. O. (2014). *Rechevye i motornye ritmicheskie processy i model' ih razvitiya u detej s narusheniyami rechi* [Speech and motor rhythmical processes and the model of their development in children with speech and language disorders]. Moscow.
- [19] Zhinkin, N. I. (1982). *Rech' kak provodnik informacii* [Speech as an information transmitter]. Moscow.
- [20] Lebedinsky, V. V., Nikolskaya, O. S, Baenskaya, E. R., et al. (1990). *Emocional'nye narusheniya v detskom vozraste i ih korrekciya* [Emotional disorders and their correction in childhood]. Moscow: MSU.
- [21] Livanov, M. N. (1989). *Izbrannye trudy. Prostranstvenno-vremennaya organizaciya potencialov i sistemnaya deyatel'nost' golovnogo mozga* [Selected works. Spatio-temporal organization of potentials and systemic activity of the brain]. Moscow: Science.
- [22] Luria, A. R. (1962). *Vysshie korkovye funkcii cheloveka i ih narusheniya pri lokal'nyh porazheniyah mozga* [Higher cortical functions of human and their disturbances in local brain lesions]. Moscow: MSU Publ.
- [23] Luria, A. R. (1973). *Osnovy nejropsihologii* [Fundamentals of Neuropsychology]. Moscow: MSU Publ.
- [24] Luria, A. R. (1979). *Yazyk i soznanie* [Language and Mind]. Moscow: MSU Publ.
- [25] Medvedev, S. V. (2010). Mekhanizmy deyatel'nosti mozga [Brain activity mechanisms]. *Science in Russia*, vol. 4, pp. 19–24.
- [26] Sokolov, A. N. (1967). *Vnutrennyaya rech' i myshlenie* [Inner Speech and Thinking]. Moscow: Prosvescheniye.
- [27] Starkweather, C. W. (2002). *The Development of Fluency in Normal Children*. USA, SFA.
- [28] Sudakov, K. V. (2012). *Izbrannye trudy. T. 3. Emocii i ehemocional'nyj stress* [Selected works. T. 3. Emotions and emotional stress]. Moscow.

- [29] Tonkova-Yampolskaya, R. V. (1974). *Fiziologicheskie mekhanizmy formirovaniya vtoroj signal'noj sistemy u detej* [Physiological mechanisms of second signal system formation in children]. Moscow.
- [30] Ushakova, T. N. (2008). Uzlovye problemy rannego rechevykovogo razvitiya rebenka [Key problems of early child speech-language development], in T. N. Ushakova (ed.) *Child's Speech: Problems and Solutions*, pp. 13–39. Moscow: Institute of Psychology RAS.
- [31] Vernadsky, V. I. (1975). *Razmyshleniya naturalista. Kn. 1. Prostranstvo i vremya v nezhyvoj i zhivoj prirode* [Thoughts of the naturalist. Book. 1. Space and time in the animate and inanimate nature]. Moscow.
- [32] Vygotsky, L. S. (1926). O vliyaniy rechevogo ritma na dyhanie [About the influence of speech rhythm on breathing], in K. N. Kornilov (ed.) *Problems of Modern Psychology*, pp. 169–173. Leningrad.
- [33] Vygotsky, L. S. (1984). *Orudie i znak v razvitii rebenka* [Tool and sign in child development], in M. G. Yaroshevsky (ed.) *Collected Works. Tom 6. Scientific Heritage*, pp. 5–90. Moscow: Pedagogics.
- [34] Vygotsky, L. S. (2012). *Thought and language*. Cambridge, MA: MIT Press. (Original work published 1934.)
- [35] Yairi, E. (1981). Disfluencies of normally speaking two-year-old children. *Journal of Speech and Hearing Research*, vol. 24, pp. 490–495.