

Possibilities for early diagnosis of auditory discrimination in preschool children with impaired communication ability

(scientific paper)

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Abstract: *This paper is a brief insight into research focused on auditory distinction in preschool aged children utilizing words with high and low spoken vowels and consonants, by whispered and loud speech, screening with an orientational hearing test and subsequent comparison with the results of auditory perception of high and low pitched tones using a portable audiological device.*

The issue of examining the weakening of auditory perception as a separate component in the development of children's speech is addressed through multidisciplinary cooperation between the Ministries of Health and Education. The examination of auditory perception in children with impaired communication abilities in Czech and foreign practices is an important part of the initial examination and in counseling centers.

The ability to hear, listen and understand listening is associated with the development of children's speech, and later with thinking, reading and writing. Currently, much attention is devoted to the development of children's language, especially vocabulary, its passive and active form of nonverbal, and verbal levels of speech. Studies by different authors, such as [Průcha, 2011], [Matson, 2005], [Mikulajová, 2003], [Katz, 2007] that point out the problems of listening to understand in preschool aged children, and the ability to capture the main idea of what they hear.

Keywords: *auditory perception; impaired communication abilities; impaired of the auditory perception; phonetic and phonological awareness; auditory distinction; a diagnostic tests; the orientation hearing test; screening of hearing*

1 Auditory perception

The term *auditory perception* is defined in several ways. For instance, Zelinková [2001] states that auditory perception is the ability to receive, interpret, and differentiate between the verbal and nonverbal quality of sounds of speech. Průcha [1995] indicates that auditory perception is the process of receiving and processing stimuli. The psychologist [Vágnerová, 2005] defines auditory perception as the ability of children to hear human speech based on experience.

O'Callaghan [2013] describes auditory perception as the perception of objects of sound — including the surrounding factors such as tone, tone of voice — and the perception of speech, which includes the perception of speech sounds-phonemes, words, or other syntactic categories. Listening comprehension is understood as grasping meaning. Watson and Miller [1993] estimate that auditory perception is dependant on three variables: *short and long term memory, and auditory phoneme segmentation*. Bradley and Bryant [1983]; Lechta [2002]; Mikulajová [2003], and Gillon [2004] estimate that phonological variables also subsequently influence reading and writing.

1.1 Phonetic awareness

Phonetic awareness is the process of distinguishing between phonemes and their ranks, or words. If this ability does not develop in a child, it is identified as impaired phonemic awareness [Lechta, 2005; Klenková et al., 2006]. Clark [2003] in [Průcha, 2011, p. 7] describes languages as complicated systems of sound apparatus, their structural elements and functions, which children have to learn in order to use the language.

Lechta [2005, p. 176] mentions two functions regarding the problem of phonemic awareness:

1. *Phonetic awareness* is a process of distinguishing phonemes and their series (words).
The differentiation of the words is formed by the perception of distinctions between phonemes (*kosa* — *koza*) and phoneme series (*lípa* — *píla*). In this process, if the word is not segmented into the pieces from which it is formed, the child doesn't understand the sound structure of the word. Phonemic awareness forms in early childhood.
2. *Phonemic analysis* is a function, which is formed later in the development of a child's speech, and according to Styczeková [Antušeková, 1989] in [Lechta, 2005], it is estimated that children recognize a word on the basis of differentiated phonemes and on the analysis of the sound structure of words.

Phonemic analysis assumes these mechanisms:

- the determination of the presence or absence of vowels in the word,
- the identification of the first or last syllable of a word,
- the determination of the number of sounds, and their order in a word and in relation to other to the sounds [Lechta, 2005, p. 177].

Byrney and Fieldind-Barnsley, in [Dvořák, 2001], state that:

“Phonemic awareness is the knowledge of phonemic identities, i.e., and the recognition of individual phonemes in spoken words in context.”

Adams [1990], in [Dvořák, 2003, p. 102], proposes five degrees of phonemic awareness with the following capabilities in the areas:

- the ability to hear rhyme and alliteration (determined by children’s rhymes),
- the performance of special operations (comparing and differentiating sounds in words),
- the compilation and decompilation of syllables,
- the performance of phonemic segmentation (for example, counting the phonemes in words)
- the performance of phoneme manipulation tasks (such as adding or omitting phonemes to create words from the parts).

Salomonová states [in Škodová, Jedlička, 2003] a basic and a short overview of the development of the articulation of Czech sounds for children

Table 1: The age range of the development of the articulation of sounds [Salomonová in Škodová, Jedlička et al., 2003].

Age	The development of the articulation of sounds
1–2,5 years	B, P, M, A, O, U, I, E J, D, T, N, L
2,5–3,5 years	AU, OU, V, F, H, CH, K, G
3,5–4,5 years	Č, Š, Ž
4,5–5,5 years	C, S, Z, R, Ř, differentiation: Č, Š, Ž a C, S, Z

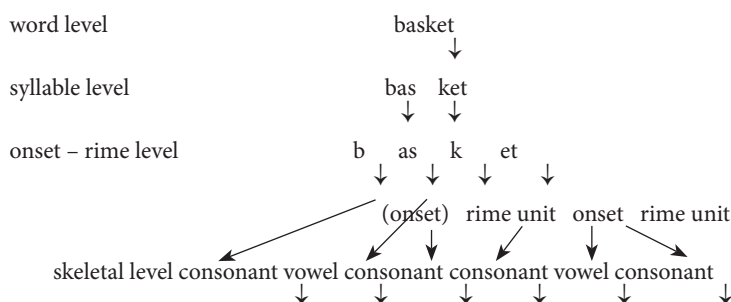
1.2 Phonological awareness

Phonological awareness is the ability to play with the language, the skill to rhyme, isolate the first or last sound in the word, to omit or add part of a word, and the ability to divide words into syllables [Zelinková, 2003, 2008].

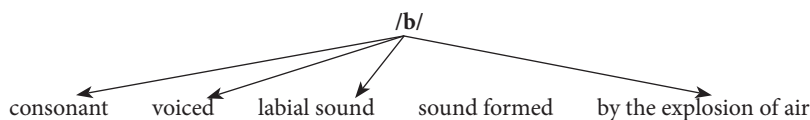
Gillon [2004] states that the term phonologic awareness is associated with the terms “metalinguistic skills, phonological and phonetic processes”, and that they have the following categories:

- syllable awareness,
- onset – rime awareness.

The author [Gillon, 2004, s. 4] illustrates of phonologic awareness on the word “basket” as such:



The segmental level is characteristic of each sound, for instance the sound:



Holopainen, Ahonen, and Lyytinen [2001] estimate that the information of phonologic awareness depends on visual backing if the child encounters it during phonological awareness.

They discuss the supporting role of visually analogous thinking in connection with the ability of phonological discrimination. Both processes have an effect on the ease of learning to read. The authors singled out categories of children who met the two processes in different time spans, and the groups are labeled with acronyms:

- Precocious decoders (PD); the group classified children who could read at school entry,
- Early decoders (ED); the children who learned to read in the first fourth months in school,

- Ordinary decoders (OD); children who have learned to read in nine months,
- Late decoders (LD); include children who have failed to adequately fulfill criteria in reading even after 18 months of reading training.

Lonigan [1998] talks about phonological sensitivity in children from the ages of two to five years. This ability can be strengthened by exercises in this area.

The author Gúthová [2009] refers to Yavas [1998], who divides phonological processes into the following sections:

- The process of changing the structure of syllables and words, weak syllable deletion,
- Epenthesis: the situation when a child does not omit, but adds sounds to words, because of a perceived word assimilates to a known word from her/his vocabulary Dvořák [2003] in [Gúthová, 2009].
- Metathesis: this phonological process is characterized by a change in the place of sounds in a word [Kráľ, Sabol, 1989 in [Gúthová, 2009].
- Inversion: [Kráľ and Sabol, 1998] in [Guthová, 2009] regarded inversion as the changing of the sounds, which are in contact.
- Coalescence, Reduplication, Consonant Cluster Reduction.
- Substitution processes: Gúthova [2009] includes stopping, fronting, velar fronting, palatal fronting, backing, affricating, deaffricating, liquid gliding, and vocalization.
- Assimilation process: the sound is amended so that it assimilates to other contiguous sound [Kráľ, 2005] in Gúthová [2009].

From a developmental perspective, these processes can diverge in early development into those which disappear into the third year of life or later, and those which persist even after the third year of life [Gúthová, 2009, p 69].

[Gúthová, 2009, p 26] further indicates that most words gradually arrive at various changes that are affected by phonological processes, and the development of articulation usually ends with their elimination. In development we see the opposite case, when a phonetic (rare, but physiologically) development precedes phonological development. An example of this asynchrony, which Smith labeled [1973] in [Dvořák, 2003] with the term the “puzzle phenomenon”, the children’s pronunciation of the English consonants (s) and (z) as (θ), and sounds like words with (θ) are pronounced with (f) instead the resonance sound (θ) [Gúthová – [2009].

Gúthová [2009] further cites [Marwa, Rash, Mona and Pakinam, 2007], who characterize phonological development as a dynamic process, which works on three levels: universal development, specific development of a specific language and specific development of a particular child.

Crystal [1986], in [Průcha, 2011], found that at one year some children understand about 20 words, others up to 60 words. Children can understand the meanings of words a few months before they say their first words. Speech comprehension precedes the production of speech [Průcha, 2011].

The age limit of phonological distinction of language when the child learns to differentiate between all the sounds of the mother tongue, or the standard age to reach this benchmark, is 6.5 years to 7–8 years at the outer limit, according to [Lechta, 1990]. Other authors shifted this benchmark to 7–8 year of life. They argue that by this time there is the possibility of spontaneous reeducation, and the possibility of self – correction of impaired pronunciation.

1.3 Results of research

Research which has focused on phonetic – phonological language levels can contribute to the analysis of the developmental level of phonetic – phonological awareness, which is one aspect of the development of language skills in preschool aged children.

The following information will familiarize the reader with the surveys and their first results using the orientation hearing tests by loud and whispered speech to measure the auditory differentiation of low and high spoken vowels and consonants in words. During field research, two groups of children were examined. The first group consisted of children with speech impairments, and the second group was made up of intact children. Both groups were children of preschool age (3.0 to 6.0 years) in preschool institutions. To investigate auditory distinction, two tests were used: the orientation hearing test and hearing screening by using a portable audiological device. The research investigations were conducted from November 2011 to March 2012, and a second round continuing from January to the end of June 2014. The following information is an account of the first phase of research results comparing auditory distinction in terms of selected diagnoses among the first group of children with speech impairment.

1.3.1 The orientation hearing test

The battery of words used during testing was based on practical experience, and was created along the design of the orientation hearing test for examination under the auspices of the Special Education Centre. The battery includes 40 words for each ear and contains low and high spoken vowels and consonants words administered by whispered and loud speech. The battery does not omit of the consonants R and Ř – specific sounds in the Czech language – because children do not have these consonants fixed and automated in speech. The aim is to evaluate the status of the

auditory distinction for low and high spoken vowels and consonants in the words by whispered and loud speech in preschool aged children (ages 3.0 to 6.0). The battery is also used as an evaluation key.

1.3.2 The portable audiometer

The portable audiometry device produces a quick and clinically valid audiogram for children over three years old. The child interacts with the device by touching images — a symbol of animals on the screen that starts an acoustic stimulus. This symbol serves as a visual amplifier, and this further strengthens the child's cooperation during the investigation of his or her hearing. If a child hears a sound, she touches a smiling animal, which appears as a symbol on the screen. The test time is short. The test for one ear is, on average, less than two minutes. After a short demonstration, the child continues to self-implement the test, while feedback is controlled by the device. After selecting the last of the animal symbols, the device immediately determines the measurements and generates an audiogram. The advantage here is that the hearing examination is not dependent on the level of communication skills of the child [Odstrčilíková, 2011].

1.3.3 The MAGIC Test

The method of the *MAGIC test* ("The Multiple-Choice Auditory Graphical Interactive Check") has an easy approach.

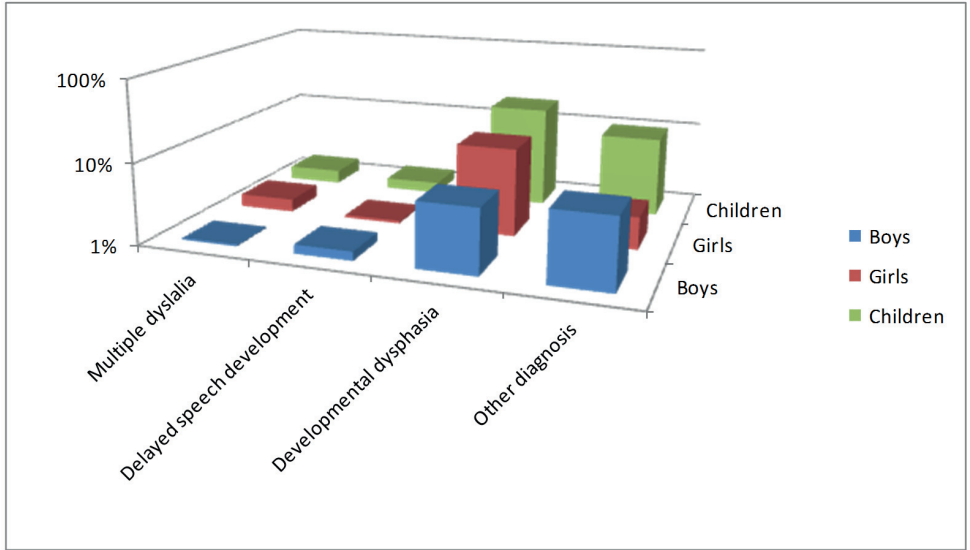
The goal of screening and testing for the auditory distinction of high and low pitched tones in preschool aged children is the possibility to detect hearing loss in preschool aged children (aged three to six years old), to enable the identification of children who may have minor hearing loss which could influence their communication, speech development and, subsequently, auditory perception at a school. This portable audiological device was selected for comparison with the orientation hearing test. The results of the hearing screening will also be the subject of statistical evaluation of the research results.

1.4 Auditory distinction in terms of selected diagnoses

Preschool age children with speech impairments are referred to speech therapy classes in nursery schools based on the recommendations of the Special Education Centre (SPC), which base their recommendations on expert reports about the child. All documents are saved in the SPC regarding this particular field. In the first stage of research, an orientation hearing test was conducted. In total 216 children were

examined, of whom 132 were diagnosed with dyslalia multiplex, 45 children had a diagnosis of delayed speech development, 22 subjects were diagnosed with developmental dysphasia and the remaining 17 composed a group of “other diagnosis”. Subsequently, these children were examined with the hearing screening – portable audiological device with a test of the Magic – on the auditory distinctions of high and low pitched tones, and then the results were compared.

On the basis of the results, as measured by the orientation hearing test, the results are evaluated in the following graphs:



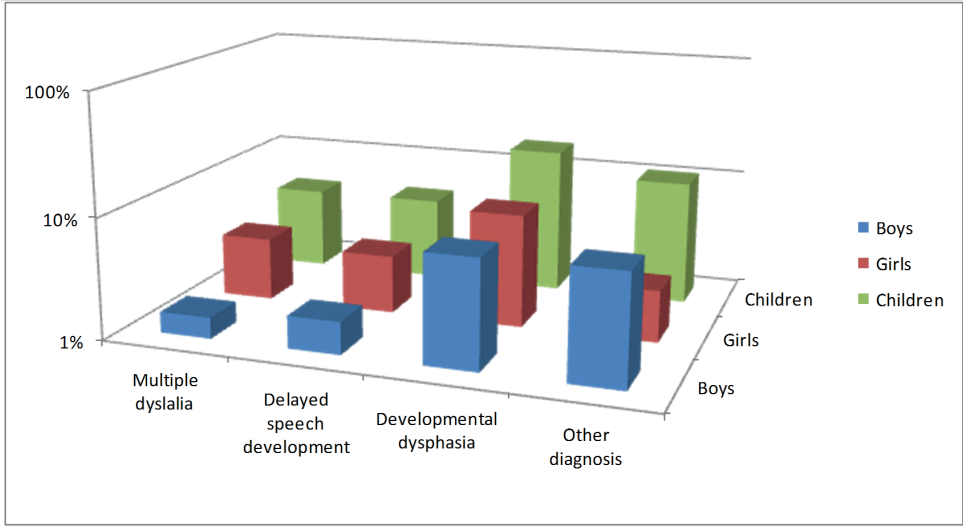
Graph 1: Comparison of diagnosis – HSVC/Vm

Table 2: Resultates: Comparison of diagnosis – HSVC/Vm

HSCV/Vm	Boys	Girls	Children
Multiple dyslalia	1,04 %	1,44 %	1,48 %
Delayed speech development	1,29 %	1,07 %	1,36 %
Developmental dysphasia	6,16 %	12,14 %	18,3 %
Other diagnosis	7,22 %	2,5 %	9,72 %

Auditory distinction between the groups depends on the diagnosis of words with HSVC/Vm, which achieves the following results:

The predominant diagnostic group is held in the first position by a group of girls with **Developmental dysphasia** (12, 14 %), meaning that the children had more mistakes in this area. That group is followed a group of boys with **Other diagnosis** (7, 22 %). Children with **Delayed speech development** and **Multiple dyslalia** had relatively good results.



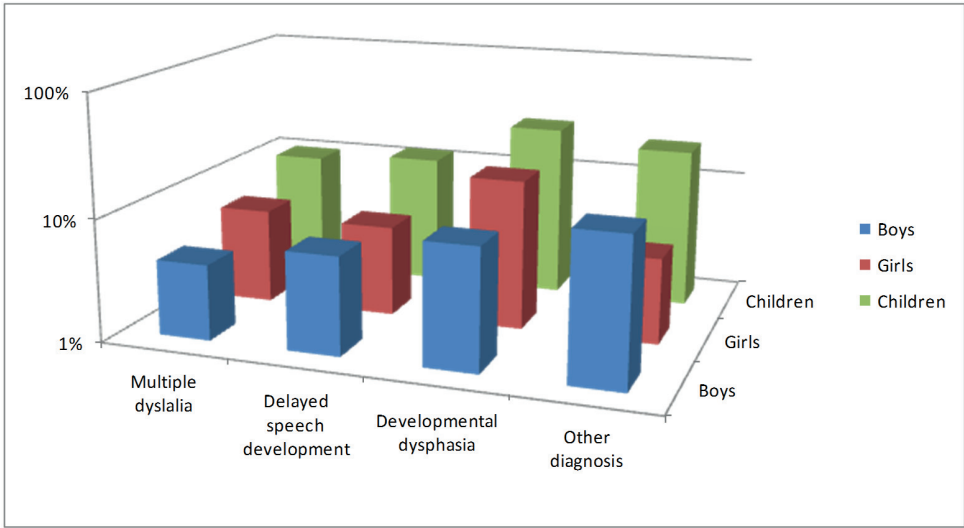
Graph 2: Comparison of diagnosis – LSCV/Vm

Table 3: Resultates: Comparison of diagnosis – LSCV/Vm

LSCV/Vm	Boys	Girls	Children
Multiple dyslalia	1,49 %	3,33 %	4,82 %
Delayed speech development	1,85 %	3,03 %	4,88 %
Developmental dysphasia	7,83 %	8,57 %	16,4 %
Other diagnosis	8,05 %	2,66 %	10,71 %

Auditory distinction among the groups depended on the diagnosis in the area of the words with LSVC/Vm achieves the following results:

The first position is again held by a group of girls with **Developmental dysphasia** (8, 57 %) – meaning that the children had more mistakes in this area. That group is followed a group of boys with **Other diagnosis** (8, 05%). Children with **Delayed speech development** and **Multiple dyslalia** had relatively good results.



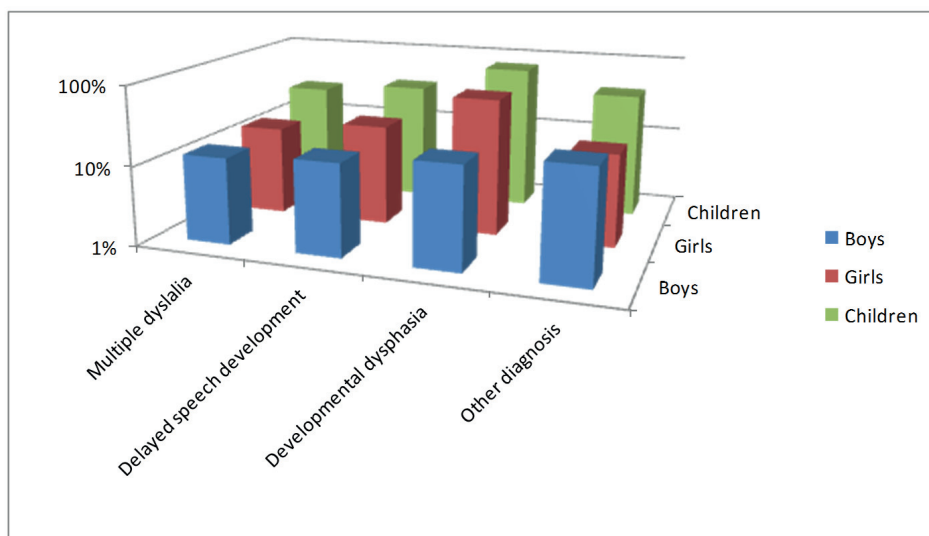
Graph 3: Comparison of diagnosis – HSCV/Vs

Table 4: Resultates: Comparison of diagnosis – HSCV/Vs

HSCV/Vs	Boys	Girls	Children
Multiple dyslalia	4,17 %	6,06 %	10,23 %
Delayed speech development	6,37 %	5,53 %	11,9 %
Developmental dysphasia	9,83 %	16,79 %	26,62 %
Other diagnosis	15,55 %	5,0 %	20,55 %

Auditory distinction between groups depends on diagnosis in the area of the words with HSVc/Vs achieves the following results:

The first position is still held by a group of girls with **Developmental dysphasia** (16, 79 %) — meaning that the children had more mistakes in this area. That group is followed a group of boys with **Other diagnosis** (15, 55 %). Children with **Delayed speech development** and **Multiple dyslalia** had better results.



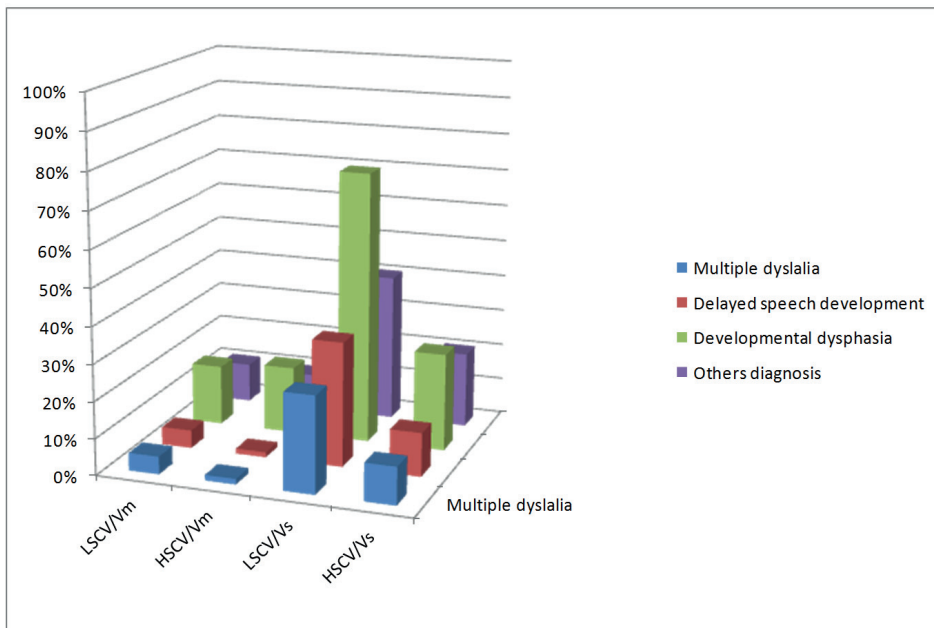
Graph 4: Comparison of diagnosis – LSCV/Vs

Table 5: Resultates: Comparison of diagnosis – LSCV/Vs

LSCV/Vs	Boys	Girls	Children
Multiple dyslalia	12,5 %	13,79 %	26,29 %
Delayed speech development	14,76 %	19,11 %	33,87 %
Developmental dysphasia	19,33 %	54,64 %	73,97 %
Other diagnosis	25,28 %	15 %	40,28 %

Auditory distinction between groups depends on diagnosis in the area of the words with LSCV/Vs achieves the following results:

The first position is occupied by a group of girls with **Developmental dysphasia** (54, 64 %) – meaning that the children had more mistakes in this area. That group is followed a group of boys with **Other diagnosis** (25, 28 %). Children with **Delayed speech development** and **Multiple dyslalia** had better results also in this area.



Graph 5: Comparison LSCV and HSCV in the words by whispered and loud speech by children depending on the selected diagnoses

Table 6: Resultates: Comparison LSCV and HSCV in the words by whispered and loud speech by children depending on the selected diagnoses

	Multiple dyslalia	Delayed speech development	Developmental dysphasia	Other diagnosis
LSCV/Vm	4,82 %	4,88 %	16,40 %	10,71 %
HSCV/Vm	1,48 %	1,36 %	18,30 %	9,72 %
LSCV/Vs	26,29 %	33,87 %	73,97 %	40,28 %
HSCV/Vs	10,23 %	11,90 %	26,62 %	20,55 %

Of all the children tested for the aforementioned diagnoses, the most problematic was the auditory distinction of words with low spoken vowels and consonants by whispered speech (**LSCV/Vs**), followed by words with high spoken vowels and consonants by whispered speech (**HSCV/Vs**). The areas of the words with low and high spoken vowels and consonants by loud speech (**LSCV/Vm**, **HSCV/Vm**) demonstrated significantly better results.

In an analysis of the criteria of negative responses, errors in the auditory distinction of preschool aged children with impaired communicative ability are the main indicator of work and research. The preliminary results, which served as the basis of the above information and charts, reflect the most frequently occurring errors, mistakes in the auditory distinction between low and high sounds in words — the orientation hearing test of words with low and high spoken vowels and consonants by loud and whispered speech was evaluated according to the following criteria:

- 1) When children did not hear the word at all:
 - For reasons indistinguishable speech codes,
 - Due to poor concentration,
 - Due to the weakening of auditory discrimination in the low and high spoken vowels and consonants by whispering and loud speech.
- 2) Children auditory pattern switched to a different or similar sounding (for example pattern: **vem** – ven – fén, pattern: **mistička** – písnička – hvězdička, etc):
 - Along this criterion the issue of phonological density (the density of phonological area) can be considered [Goswami, 2010], which is determined by the number of words in a given language reminiscent of another word (or rhyming with another word).
- 3) The child repeated the word incorrectly or incompletely, or used the phoneme, the syllable in the word:
 - This can be considered on the level of phonetic – phonological awareness of every individual in the selected target research group, as the phonological structure of words in a particular language influences the development of technical awareness, and syllabic structure affects the construction of syllables in a particular language. Syllabic structure means the plurality of sound elements that shape in the each language a syllable [Volín, 2010; Seidlová – Malková, 2012].

Conclusion

The goal of screening for hearing loss in preschoolers (ages three to six) is to identify children who suffer possible hearing loss which may affect communication, development, health or future school performance [1].

Recent epidemiological studies confirm a significant increase of hearing impairment in school-aged children. Late identification may compound problems in communication, language acquisition and affect other areas of development. Contrary to newborn hearing screening, preschool hearing screening tests should provide more frequency-specific and quantitative information about the hearing loss.

The specification of the conclusions from this research can be helpful and beneficial for the practice of special education in the field of auditory distinction of high and low spoken vowels and consonants in words. Testing with both of the examinations — the orientation hearing test and then using auditory screening test, via the portable audiological device — also contributed to the detection of five children with significant hearing problems.

Auditory perception is the ability to perceive and understand sounds. Phonetic and phonological awareness are an important part of the process of speech development. The proper development of these processes is becoming a cornerstone for the successful development of the child in the areas of reading and writing in school.

Research focused on the phonetic and phonological awareness in every language in children of various age groups is necessary and an important part of pedagogical practice.

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