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Research Article

AUDITORY PROCESSING DISORDERS AND GENDER DISCRIMINATION AT CHILDREN ATTENDING THE FIRST GRADES OF PRIMARY SCHOOLS

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ABSTRACT

The research presented in this paper was carried out with the aim to examine the auditory processing disorders and gender discrimination at the children attending the first grades of primary school. The sample consisted of 30 respondents who attended the first-year classes according to the nine-year plan and program. The research was carried out in two primary schools in the area of the town of Tesanj using the Baterie Tests for the examination of auditory processing disorders PSP-1. The results showed that we had one male respondent with the result -2SD, value χ^2=1,091 with DF=2 and P=0,580 at the TFR test. At the TGB we had two respondents, both male, with the results worse than -2SD, value χ^2=3,41 with DF=3 and P=0,492. Also at the DTR test we had one male respondent with the result -2SD, value χ^2=3,667 with DF=3 and P=0,300. At the DTRE test we had one male respondent with -2SD, value χ^2=3,343 with DF=3 and P=0,342. According to the test criterion one male respondent had result worse than -2SD at two subtests, and hat was considered the auditory processing disorder. According to the T-test results and its belonging P-value we concluded that there was no statistically significant difference between the average results achieved in the subtests of filtered words (TFR), speech in the noise (TGB), the dichotomy of the words (DTR), the dichotomy of the sentences (DTRE) and the total sum on the test since the value was P > 0,05. This was the expected result considering the sample size.
It is the fact that the early APD diagnosis is important for the optimal progress at the students, and hopefully the PSP1instrument will find its application in Bosnia and Herzegovina.

INTRODUCTION

Fluent speech is highly complex skill that demands precise and coordinated movements of articulatory, voicing and respiratory system (Chesters, Baghai-Ravary i Möttönen, 2015). Listening and speech are connected, because without preserved hearing the speach development is imposible. Hearing is one of the human senses that primarily serves to detect and percieve various sound characteristics. Hearing path starts with external and middle ear that enables mechanical energy of sound to be conveyed to the sensory station in snail where the mechanical energy is transformed to bio-electrical signal that is conveyed to cortical center in brain through hearing nerv (Brkić, 2005).

Electrical signals, after leaving mechanical processes in external, middle and internal ear, travel to the hearing center in brain through hearing nerv, and there it is transformed to what we recognize as a sound or communication (Musiek, Baran, 2007). Later, bio-electrical signal is processed by the central synthesis and is perceived according to hight, loudness and duration (Heđever i Bonetti, 2010). Hearing is a complex process that manages the hearing stimuli transmission from both ears to neural impulses, and covers transmission of these impulses by hearing nerves to the brain, perceptual registration and cognitive prcessing of acustic signals in brain, as a conscious sound perception (Bamiou i sur., 2001).

Hearing processing is a term that is used to describe brain ability to recognize a sound signal and turn it into the meaningful information (Whitaker, 2008). Hearing processing or hearing information processing is thus all that "what our brain does with what we hear" (Stecker, 1998), namely hearing

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processing is a concept that describes how brain recognize and interprets surrounding sounds (Heđever, Bonetti 2010). Namely, there are persons with intact hearing, but hardly understand speech sounds, especially in the presence of noise. These persons cannot process information in the appropriate way (Roeser i Downs, 2004).

Hearing processing disorder (APD) is a sensory disorder that mainly affects hearing, speech understanding and learning, thus creating difficulties in auditory information processing (ASHA, 2005). APD is not disorder of hearing, reception or reduce hearing senzibility, but disorder caused by difficulties in stimuli understanding namely acustic signal. APD can be connected with difficulties in hearing, speech understanding, language development and learning (Kantić, 2014). All APD definitions include four key facts: that hearing is intact, that there is a neurological base for disorder, that a child's hearing ability is damaged and that there is a disruption in reception, remembarance, understanding and use of information received by hearing (Lucker, 2011). It is characeristical that the children with PSP sometimes can behave as if they have hearing loss, often asking to repeat or clarify what is said. They achieve better results in tasks that are not primarily relied to hearing, and they easier perform the tasks when they know what is concretely expected from them (Sanja, at all 2012).

According to Chermak and Musiek (1997), APD incidenceis in the range from 3 to 5% and is more common than hearing damage. Bamiou, Musiek i Luxon (2001 determined the incidence 5-7 %, ratio between boys and girls is 2:1, and APD is often accompanied by other difficulties such as: ADHD, dyslexia, language difficulties, autistic spectrum disorder, etc. In the anamnestic data of the children with APD very often chronical infections of the middle ear are reported (Kelly, 2004). Some studies show that 94% of children with PSP also have language difficulties as well as reading difficulties (Hoff, 2006; Sharma, Purdy i Kelly, 2009). In the Sharma i sur. (2006) study it was confirmed that children with reading difficulties have hearing processing difficulties. Also, recent studies point out the fact that autistic spectrum children have distinctive hearing deficits that are of a central origin (Gravel, Dunn, Lee, i Ellis, 2006), as well as that children with low birth weight and premature children more often have distinctive APD symptoms at the later age (Demanez *et al*, 2003; Demanez and Demanez, 2003).

Some researches (Bishop *et al*, 1999; Bailey and Snowling 2002; Bishop and McArthur 2005) point out the probability that PSP is a cause of language diciculties, while on the other hand some researches assume that ASD is one of several factors that joint together give a clinical picture of language difficulties (Turner, 2013; Rosen, 2003).

Although professionals of various profiles have researched this area during several decades there are still a lot of unknowns: about a cause, successfulness and types of therapy (Chermak 2001; McArthur, 2009).

MATERIALS AND METHODS

Sample of Respondents

The main statistical group out of which a sample for this research was selected, was made of the students attending the first-year classes according to the nine-year plan and program. The sample was made of 30 students of both genders. The research was carried out in wo primary schools in the area of the town of Tešanj during the period 09-23rd April 2018. The sample was random considering the selection of a school as well as in selection of students.

Sample of Variables

Variables in this research covered gender and the results achieved in four subtests from the Baterie Tests for the examination of auditory processing disorders PSP-1 that consisted of: test of the filtered words (TFR), test of the speech in the noise (TGB), test of the dichotomy of words (DTR), test of the dichotomy of the sentences (DTRE) and the total sum achieved on the test PSP-1 (Sum).

Implementation and Measuring Instruments

Examination was carried out using the Baterie Tests for the examination of auditory processing disorders PSP-1 (Heđever, 2015). The test served to examine auditory processing disorders at children age 5.5 and 11.5. It consisted of four subtests: test of the filtered words, test of the speech in the noise, test of the dichotomy of words and test of the dichotomy of the sentences (Heđever, 2015).

TEST - PSP-1 was designed according to the model of the revised test SCAN – C for examining auditory processing disorders at children (Keith, 2012). This test used similar tasks and acustic parameters in the sound processing (filtering, masking, etc), and the same types of tasks as in SCAN – C test. This group of subtests was based on a simple repetition of the given stimuli (words or sentences), and the respondents were not asked either for the semantic task understanding or their phonetic/phonological discrimination.

Test of the filtered words (TFR) is a mono-aural low-redundant speech test for examining the ability of recognition of word that are reduced in their understandability namely intelligibility. It enables us to evaluate a child's ability to understand distorted speech. Testing is carried out in the way that a respondent is presentd a series of filtered words (low-permeable filter with the border frequency at 1 kHz and choking gradient of 32 dB/okt) in one ear (mono-aural). The test is carried out for each ear separately.

Test of speech in the noise (TGB) is also in the chategory of mono-aural low-redundant speech tests. In this test the words-stimuli are presented without filtering but in the presence of background noise (*auditory figure-ground*). The noise here is used as a continuous human noise of a large group of people that has to be completely incomprehensible and of a constant uniform intensity that is for 8 dB lower from the level of a word-stimulus. It is presented mono-aural as the previous test.

The test of the dichotomy of words (DTR) is presented bi-aural two different words at the same time (bi-aural separation) where one word is heard on one ear and at the same time other word on the other ear. Respondant is first asked to repeat the word he/she heard on one (for example, right) ear, and then the word he/she heard on the other ear (although both words were presented at the same time). In the other part of the test respondents are asked to replace the order of answering (first to repeat the word from the left and then right ear)

Test of the dichotomy of the sentences (DTRA) is presented bi-aural two different sentences, and examination is carried out in the same way as in the previous test with words. This test is also called a test of competition of sentences namely test of bi-aural separation (Heđever, 2015).

The examination was carried out with the written approval given by parents and the primary school headmaster. The testing was carried out with each child individually in peace and quiet room, without distraction stimuli and without presence of other persons or children. During the examination each child sat opposite to an examiner, so that the examiner could properly see the child's face and hear the child' answer. Kit for examining auditory processing disorders contained a laptop with recorded examination tests, paper for writing answers, tables with standardized norms for the results' reading, the manual, as well as two pairs of headphones Behringer HPS3000 Studio Headphones (16 Hz – 20 kHz). Loudness was adjusted to the same level, namely to 60 dB SPL for all respondents. In the beginning each child got instructions about the examination procedure. First, a rehearsal was carried out for each subtest in order to check whether a child had understood a task, and then the testing was carried with the average duration of 30 minutes. All subtests were carried out without tasks' repetition and interruptions. The answers were recorded in the special form with the tasks from all four subtests.

Statistical data processing

Data was processed by the statistical program SPSS 22.0. Descriptive statistic was done.

RESULTS

Basic information on the research sample

For the purpose of determining auditory processing disorders and gender discrimination at students attending the first grades of a primary school, the following tables show data on number and structure of students who were covered by the research. The research covered 30 students, 15 male and 15 female. The same was carried out with 4 subtests from Baterie Tests for the examination of auditory processing disorders (PSP 1) as follows: test of filtered words (TFR), test of speech in the noise (TGB), test of the dichotomy of words (DTR) and test of the dichotomy of the sentences (DTRE).

The total result achieved in the test, according to the instructions of the author of the instrument, is standardized by calculating z value and it is a base for further definition of: the auditory processing disorder (negative deviation of the two standard deviations, -2 SD), border result (negative deviation of one standard deviation, -1 SD), average result (Zero SD) and above average result (positive value of one standard deviation +1 SD)

According to the test criterium, one male respondent had a result worse than -2 of SD at least at 2 subtests what was considered the auditory processing disorder. In such cases, according to the criteria, it is suggested to take a detailed audiological (OAE-oto-acustic emission) and psychological testing in order to determine whether it is about the auditory processing disorder or co-morbidity is in question, namely existence of a similar interfering disorder as ADHD, language difficulties, etc.

Test of the filtered words (TFR)

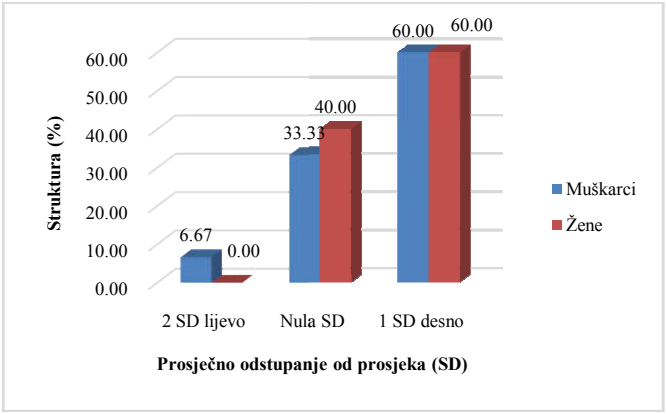
Table 1 Number and structure of the respondents by gender and deviations at TFR

Average deviation	Male		Female		Total	
	f	%	f	%	f	%
- 2 SD	1	6,67	0	0,00	1	3,33
Zero SD	5	33,33	6	40,00	11	36,67
- 1 SD	9	60,00	9	60,00	18	60,00
Total	15	100,00	15	100,00	30	100,00
χ^2=1,091; DF=2; P=0,580						

From the above table results it is visible that at TFR there are deviations -2 of the standard deviation (according to the test criterion it is a disorder), then without deviations (Zero SD) and with the deviation -1 of the standard deviation what is according to the test criterion a border result. Respondents of both genders with the deviation -1 are dominant, while the least represented are respondents with deviation of -2 of SD.

According to the hi-square test results and its belonging P-value that is lower than 0,05 (5% significance level) we conclude that there is no interdependence between students gender and deviations at TFR.

Graphic representation of the structure of students by gender and deviations at TFR:



Graph 1 The structure of respondents by gender and deviations at TFR

Test of the speech in the noise (TGB)

Table 2 Number and structure of the respondents by gender and deviations at TGB

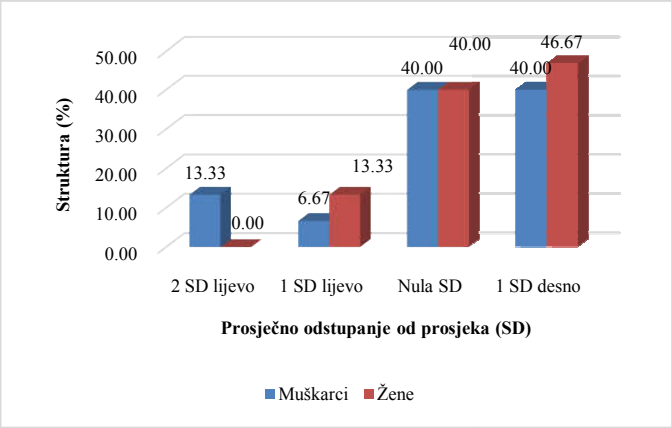
Average deviation	Male		Female		Total	
	f	%	f	%	f	%
- 2 SD	2	13,33	0	0,00	2	6,67
- 1 SD	1	6,67	2	13,33	3	10,00
Zero SD	6	40,00	6	40,00	12	40,00
+ 1 SD	6	40,00	7	46,67	13	43,33
Total	15	100,00	15	100,00	30	100,00
χ^2=3,41; DF=3; P=0,492						

From the above table results it is visible that at TGB there are deviations -2 of the standard deviation what is according to the test criterion a disorder, then the deviation -1 of the standard deviation what is according to the test criterion a border result, without deviations (Zero SD) and with deviation +1 of the standard deviation what is according to the test criterion an above average result.

Respondents of both genders without deviation are dominant, namely with the deviation -1 of SD. At the male respondents the least were represented respondents with deviation of -1 of SD, while at the female respondents the least were represented the respondents with deviation of -2 of SD.

According to the hi-square test results and its belonging P-value that is lower than 0,05 (5% significance level) we conclude that there is no interdependence between students gender and deviations at TGB.

Graphic representation of the structure of students by gender and deviations at TGB:



Graph 2 The structure of respondents by gender and deviations at TGB

Test of the dichotomy of words (DTR)

Results achieved at the test of dichotomy of words (DTR) are presented in the following table

Table 3 Number and structure of the respondents by gender and deviations at DTR

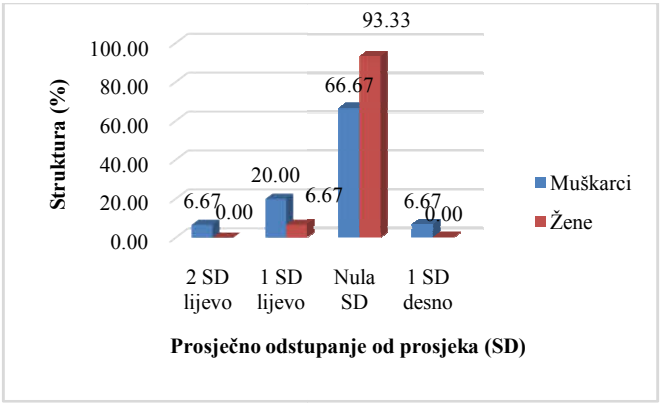
Average deviation	Male		Female		Total	
	f	%	f	%	f	%
- 2 SD	1	6,67	0	0,00	1	3,33
- 1 SD	3	20,00	1	6,67	4	13,33
Zero SD	10	66,67	14	93,33	24	80,00
+ 1 SD	1	6,67	0	0,00	1	3,33
Total	15	100,00	15	100,00	30	100,00
χ^2=3,667; DF=3; P=0,300						

From the above table results it is visible that at DTR there are deviations -2 of SD what is according to the test criterion defined as disorder, -1 of SD (border result), then without deviations (Zero SD) and with deviation +1 of SD what is according to the test criterion an above average result.

Respondents of both genders without deviation (Zero SD) are dominant, namely with the deviation -1 of SD, while the least were represented respondents of both genders with deviation of -2 of SD, and +1 of SD.

According to the hi-square test results and its belonging P-value that is lower than 0,05 (5% significance level) we conclude that there is no interdependence between students gender and deviations at DTR.

Graphic representation of the structure of students by gender and deviations at DTR:



Graph 3 The structure of respondents by gender and deviations at DTR

Test of dichotomy of the sentences (DTRE)

Table 4 Number and structure of the respondents by gender and deviations at DTRE

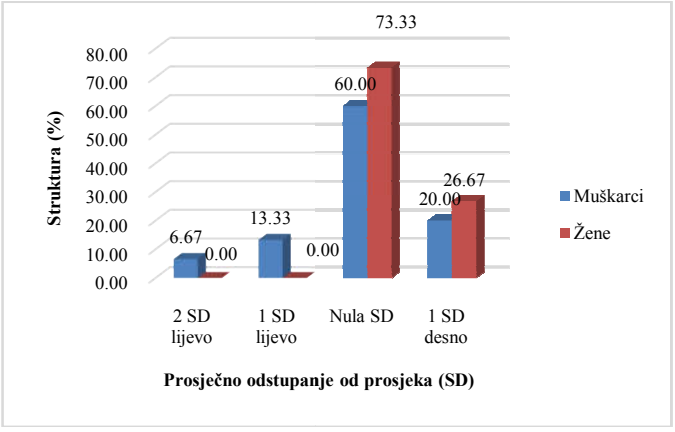
Average deviation	Male		Female		Total	
	f	%	f	%	f	%
- 2 SD	1	6,67	0	0,00	1	3,33
- 1 SD	2	13,33	0	0,00	2	6,67
Zero SD	9	60,00	11	73,33	20	66,67
+ 1 SD	3	20,00	4	26,67	7	23,33
Total	15	100,00	15	100,00	30	100,00
χ^2=3,343; DF=3; P=0,342						

As in the case of the DTR test there are deviations at DETRE test of -2 of SD what is according to the test criterion a disorder, -1 of SD (border result), then without deviations (Zero SD) and with deviation +1 of the standard deviation what present above average result.

Respondents of both genders without deviation are dominant, namely with the deviation +1 of SD..

According to the hi-square test results and its belonging P-value that is lower than 0,05 (5% significance level) we conclude that there is no interdependence between students gender and deviations at DTRE.

Graphic representation of the structure of students by gender and deviations at DTRE:



Graph 4 The structure of respondents by gender and deviations at DTRE

Determination of differences at PSP 1 test among students considering the gender

The following table shows Kolmogorov Smirnov test results on normality of the analized marks distribution, namely results from the subtests and the test in general

Table 5 Rezults of Kolmogorov-Smirnov test

		TFR	TGB	DTR	DTRE	SUMA
Greatest Differences	Apsolute	0,133	0,200	0,267	0,333	0,333
	Positive	0,133	0,200	0,200	0,333	0,333
	Negative	-0,067	-0,067	-0,267	0,000	-0,133
Kolmogorov-Smirnov Z test		0,365	0,548	0,730	0,913	0,913
P-value		0,999	0,925	0,660	0,375	0,375

From the above table results we conclude that the results from all four subtests and the test in general follow the normal distribution since P > 0,05.

The parameter tests are a selection when the analyzed markings follow the normal distribution. The parameter test T-test, namely its belonging P-value is used for the purpose of determining the existing difference in the average results among male and female students at subtests TFR, TGB, DTR , DTRE and the test in general (SUM)

The following table shows the test results on the existing difference among male and female students in the achieved average results at the subtests and the test in general

Table 6 Test results on the existing difference in the achieved average results among the students

	MALE	FEMALE	P
	$\mu \pm \sigma$	$\mu \pm \sigma$	
Test of the filtred words	21,00 ± 4,19	22,13 ± 4,06	0,459
Test of the speech in noise	19,20 ± 4,93	20,46 ± 4,13	0,452
Test of the dichotomy of words	36,73 ± 10,32	37,20 ± 4,34	0,873
Test of the dichotomy of sentencs	14,13 ± 4,91	16,40 ± 2,72	0,129
TOTAL SUM	91,20 ± 16,17	96,20 ± 7,72	0,289

According to the T-test results and its belonging P-value we conclude that there is no statistically significant difference in the achieved average results at the subtests of the filteres words (TFR), the speech in noise (TGB), the dichotomy of words (DTR), the dichotomy of sentences) (DTRE), as well as the total sum at the test, since the value is P > 0,05.

DISCUSSION

The main aim of this research was to determine the existence of the auditory processing disorders at children in the firs grades of the primary school and gender discrimination. Auditory processing disorders have insufficiently been explored in a daily speech therapists' practice in Bosnia and Herzegovina. One of the reasons lies in the fact that there has not been adequate standardized test for auditory processing disorders evaluation in our area.

Based on the results, it was determined that one male respondent had a result under -2 of SD at the least two subtests, what was, according to te test criterion, auditory processing disorder and required further audiological and psychological testing either to confirm APD or to determine the existence of a similar interfering disorder (such as ADHD). When we looked at the percentages, only one male respondent (3.33%) had a score of -2 of SD at TFR test and that was, according to the test conditions defined as a disorder. Two male respondents (6.67%) had scored -2 of SD at the TGB test what was considered a disorder. Test PSP1 included both the test of the filtered words and the test of the speech in noise that represented mono-aural low-redundant subtests and that could significantly improve sensitivity of the baterie tests for determining APD (Dawes i Bishop, 2009), what was connected with the fact that primary school children were specially sensitive to the noise (Shield i Dockrell, 2003).

At the following DTR test, again one male respondent (3.33%) had scored -2 of SD, and at the last DTRE test, as well as at the previous one, we had one male respondent (3.33%) who had scored -2of SD that was considered a disorder. Subtests the dichotomy of words and the dichotomy of sentences showed to be the most discriminative subtests that could evaluate the functions of neurological connections in the auditory system. Poorer results at these subtests could point out to the late development and maturation of the central neural system as well as neurological disturbances (Blaži, 2015).

From the previous it is obvious that in the chategory of all four subtests there are respondents with the score of -2 SD that is considered a disorder, and in all cases the respondents are male. On the basis of the results we can conclude that male respondents achieve poorer results in all tests. Karlin states that it is the fact that the mielinization process is faster at girls than at boys, and that girls earlier mature in language-speech and articulation development so it is understandable that they are more successful than boys in auditory processing ability. Percentagewise girls achieve better results at all subtests comparing to boys. This is in accordance with our expectations, as well as with other authors researches (Karlin, 1984; prema Guitar, 2014; Musiek i Chermak, 2014). However, analizing the tests results it can be seen that there is no significant difference between male and female gender. The reason might be in the fact that it is about relatively small sample in the research. APD prevalence is about 5-7%, and in this sample there is only one respondent with the results of at least two tests under -2 of SD, what is, according to the criterion, considered an auditory processing disorder. That is too small number for T-test to be able to show statistically significant difference. Since it is about a problem that is becoming the subject of attention of a number of scientists (Dawes i Bishop, 2009) we think that the problem of auditory processing disorder diagnostics should be worked out in the bigger sample that could be representative for our country.

CONCLUSIONS

Auditory processing disorder is a scientific topic that is getting its significance during last years. Broad spectrum of symptoms of the disorder reflects on a student's attention, language and speech development and achievement in school in general. Auditory processing disorders are insufficiently explored in the speech therapists practice in Bosnia and Herzegovina. The main reason is lack of adequate standardized test for the language processing disorder evaluation. Since the early diagnosis is important for the optimal progress of students with APD, we hope that PSP 1 instrument will find in application in Bosnia and Herzegovina as an instrument for differential diagnostics of APD.

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