A Study of Rate of Speech and Intelligibility of Speech in Hearing impaired Pupils of Baghcheban School of Zahedan, Iran[1]

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Abstract

Hearing loss results in disruption of coordination in muscles and structures engaged in speech timing tasks and consequently acquisition of speech sounds is affected. The purpose of this study is to investigate and compare the speed and intelligibility of speech in hearing impaired and normal hearing Persian speaking elementary school boys and girls. 33 hearing impaired students are randomly selected from three hearing impaired groups (profound, severe and moderately-severe) and compared with 60 normal hearing students. The speed of speech was measured according to reading Words Per Minute (WPM), and speech intelligibility was tested by a 5-rank scale method. As expected, the normal hearing had more speed and intelligibility of speech in contrast to the hearing impaired group. Also hearing impaired boys had a better speed and intelligibility of speech compared to hearing impaired girls but in normal hearing group, girls had better speed. The amount of P-value for moderately-severe and sever hearing impaired was 0.006 and this amount for profound and moderately-severe hearing impaired was 0.002, so p-value is <0.05 and significantly important. Profound hearing impaired group read the text more slowly and had lower speech intelligibility than other two hearing impaired groups.

Keywords: speed of speech; speech intelligibility; profound hearing impaired; severe hearing impaired; moderately-severe hearing impaired, Persian

Izvleček

Izguba sluha ima za posledico motnje v koordinaciji mišic in struktur, ki sodelujejo pri tempiranju govora, kar posledično vpliva na usvajanje glasov govora. Cilj te študije je raziskati in primerjati hitrost in razumljivost govora pri slušno prizadetih in pri normalnih osnovnošolskih otrokih, katerih materinščina je perzijščina. 33 slušno prizadetih učencev je bilo

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na slepo in izbranih izmed treh skupin slušno prizadetih (globoko prizadetih, hudo prizadetih in lažje do hudo prizadetih), da bi jih primerjali s 60 slušno normalnimi otroki. Hitrost govora se je merila s številom besed na minuto (WPM), razumljivost pa s petstopnejsko lestvico. V skladu s pričakovanji so normalni otroci v primerjavi s slušno prizadetimi dosegli večje hitrosti pri govoru ter so bili bolj razumljivi. Prav tako so slušno prizadeti dečki dosegali boljše rezultate pri hitrosti in razumljivosti govora kot pa slušno prizadete deklice. Nasprotno pa so deklice z normalnim sluhom dečke prekašale v obojem. Koeficient P za lažje do hudo slušno prizadete ter za hudo slušno prizadete je bil 0.006, za globoko in lažje do hudo prizadete, 0.002, v obeh primerih < 0.05, torej statistično signifikanten. Globoko slušno prizadeti so brali besedilo počasneje in so bili bolj nerazumljivi kot ostali dve skupini slušno prizadetih.

Ključne besede: hitrost govora; razumljivost govora; globoko slušno prizadeti; hudo slušno prizadeti; lažje do hudo slušno prizadeti, perzijščina

1. Introduction

Language learning is one of the skills that should be tackled from the very early years of life and in case of neglect, human beings are faced with a lot of irreparable damage. Some factors are involved in impeding language learning one of the most important of which is hearing impairment. In learning a language a special place should be reserved for hearing since it has (at least) temporal priority compared to other human senses. From the first day of life, a child reacts to the sounds of his/her environment and later s/he produces sounds known as cooing. Here we first review some of the studies that have been conducted in the field of hearing impairment. Then we explain the method of our research and the results. After that we have a discussion part in which we compare and contrast the findings of the present paper with the previous research.

Venkatagiri (1999; also cited in Ahadi et al., 2009) examined the speed of speech in three tasks of reading a text, describing a text and conversation by 16 male and female college students between the ages of 19 to 31. The results were as follows:

- speed in reading a text: 174-186 words per minute, 249-251 syllables per minute
- speed in describing a text: 133-147 words per minute, 171-181 syllables per minute
- speed in conversation: 136-144 words per minute, 183-204 syllables per minute

Svirsky (2000) measured English language skills of children who had lost their hearing ability in pre-language period, before and after cochlear implantation and reached the conclusion that in the face of personal differences, people with the best scores had developed their oral language systems based on the *auditory data* received from cochlear implantation.

Another research by Oliveria, Ortiz, and Vieira (2004) was carried out on 11 people with speech paralysis aged from 18 to 69. In the control group, for every patient

there were 3 normal people with the same age and gender. The results showed that in both tasks of reading a text and two-minute conversation, the speech-paralyzed group had a significantly lower speed of speech compared to the control group.

According to Pena-Brooks and Hedge (2000) deaf children can not learn and imitate the mental activity of their parents and other hearing adolescents just because these children can't hear these people's talks. The process of development in spoken and written language is essentially slower in hearing impaired people than the normal and in the case of congenitally hearing impaired children. According to them, speech intelligibility is also a problem.

Finally it's useful to refer to a research conducted by Tye-Murrey and Woodworth (1989) on 28 deaf children with cochlear implantation to measure their speech intelligibility. The hearing of these children had begun to decrease when they were in their pre-linguistic period. The score for the speech intelligibility was obtained by analyzing the percentage of correct phonemes and words which they produced during both spontaneous and imitative speech. The results indicated low speech intelligibility for children who had used cochlear implantation for 3 years (i.e. 53 percent of phonemes and 22 percent of words were correct). This research also showed that children with cochlear implantation before 5 years of age were better in speech production skills compared to children who were cochlear-implanted after 5.

In line with the above studies, the present research combines two methods of Rank Scale and WPM to the aim of investigating the speed and intelligibility of speech in hearing impaired students in Baghcheban school and examine if the findings are approved here or not.

2. Research Method

The method of this research is a combination of descriptive study and fieldwork and it tries to investigate the effects of hearing on speed and intelligibility of speech. Our statistical population consisted of two groups: Hearing impaired children from a school for exceptional children named Baghcheban as our experimental group and normal hearing male and female children from Salman Farsi and Sama schools as our control group. The control group consisted of 60 male and female elementary school students with normal hearing (15 girls and 15 boys in the third grade, 9 years old; 15 girls and 15 boys in the fifth grade, 11 years old). Since we had no variability for age, the standard deviation, which is an index of dispersion, was zero. The number of hearing impaired students was 33 (17 boys, 16 girls) who were at the third, fifth, and complementary fifth grades. 7 girls were profound hearing impaired between the ages of 10-16, average 12, standard deviation 2.23; 4 girls, severe hearing impaired between 10-13, average 11, standard deviation 1.51; 5 girls, moderately severe hearing impaired between 10-15, average 12.5, standard deviation 2.19.

Among boys, 4 students were profound hearing impaired, between the ages of 10-16, average 12.5, standard deviation 2.51; 7 students, severe hearing impaired between 10-14, average 11.42, standard deviation 1.61; and 1 student was moderately-severe hearing impaired aged 13.

For calculating the students' speed of speech we requested them to read a selected text from their Farsi (Persian) course book. Then by counting the number of pronounced words, dividing it by the total time spent on reading and multiplying it by 60, we gained the speed of speech in terms of words per minute (WPM):

$$\text{WPM} = \frac{the\ number\ of\ pronounced\ words}{total\ talking\ time\ (TTT)} \times 60$$

(Richard E. Ham, 1999)

For evaluating the students' intelligibility of speech, we used the results of a research by Peng, Spencer, and Tomblin (2004) in which the intelligibility of speech of children with cochlear implantation had been evaluated. The children participated in this study had lost their ability of hearing before the pre-linguistic period. Peng and his colleagues presented these children's speech samples for non-professional adolescents with normal hearing. 3 Normal hearing students judged the speech of every child by a scale of 5 ranks. Rank 5 meant a completely intelligible speech and rank 1 meant a speech not intelligible at all. This method of calculating the intelligibility of speech is called "Rank Scale Method".

In our research, recorded samples of students' speech which had been read from a 100-word text were played for 3 non-professional adolescent normal hearing listeners. They were requested to give a rank from 1 to 5 to the intelligibility of speech of students without consulting each other. Among the ranks given by the listeners, the rank which was agreed on by two of the listeners was considered as the correct rank. Most of the time, ranks given by the listeners were the same or similar. For comparing the statistical rank of male and female students' intelligibility of speech with hearing impairment, we used Levin Test. For comparing the statistical rank of male and female students' intelligibility of speech with hearing impairment according to their hearing status, we used ANOVA.

For analyzing the relationship between the speed of speech and intelligibility of speech in male and female students with hearing-impairment, we used Spearman Test and for analyzing the same relationship according to the students' hearing status, we used Kruskal-Wallis Test.

3. Results

Dispersion and central indices of speed of speech in male and female students with hearing-impairment in elementary school according to their hearing impairments are as follows:

The average of speed of speech in male students with profound hearing-impairment was 38.77, severe hearing impairment 51.66 and moderately-severe hearing impairment, 51.91. The average of speed of speech for female students with profound hearing impairment was 35.18, severe hearing impairment 43.5 and moderately-severe hearing impairment, 45.25. In students with hearing impairment the speed of speech of boys was higher than girls but in control group girls perform better in this task.

For intelligibility of speech, none of the hearing impaired boys obtained rank 5. Totally, 52.9 percent of them obtained rank 1, 17.6 percent of them rank 2 and 3 and finally 11.8 percent rank 4. Hearing impaired girls could not obtain rank 4 and 5. Totally, 75 percent of them got rank 1, 18.8 percent rank 2 and 6.3 percent rank 3.

According to Table 1 below, 85.71 percent of all students with profound hearing impairment obtained rank 1. This means that the speech of most of them was not intelligible. In severe hearing impaired group, 37.5 had unintelligible speech, 50 percent of them obtained rank 2 which means 20 percent intelligible speech and 50 percent rank 4 which means 80 percent intelligible speech. According to the same table, 100 percent of hearing impaired girls had completely unintelligible speech. In severe hearing impaired group too, 100 percent of their speech was unintelligible. Finally, in moderately-severe group, 60 percent obtained rank 2 meaning that 20 percent of their speech was intelligible.

Table 1: Intelligibility of speech (in reading a text) for students with hearing impairment in elementary school according to hearing status and gender

Gender	Rank Scale for Speech Intelligibility	Profound Freq./%	Severe	Moderately-severe	Total
Boys	Rank 1	6 85.71%	3 37.5%	0 0%	9 52.95 %
	Rank 2	1 14.29%	1 12.5%	1 50 %	3 17.65 %
	Rank 3	0 0%	3 37.5%	0 0%	3 17.65 %
	Rank 4	0 0%	1 12.5	1 50 %	2 11.75 %
	Rank 5	0 0%	0 0%	0 0%	0 0%

Gender	Rank Scale for Speech Intelligibility	Profound Freq./%	Severe	Moderately-severe	Total
Girls	Rank 1	7 100 %	4 100 %	1 20 %	12 75 %
	Rank 2	0 0%	0 0%	3 60 %	3 18.75 %
	Rank 3	0 0%	0 0%	1 20 %	1 6.25 %
	Rank 4	0 0%	0 0%	0 0%	0 0%

According to table 2 (Tukey test), there is a meaningful difference between severe and moderately severe group and also between profound and moderately-severe group but there is no meaningful difference between profound and severe group.

Table 2: Comparison of the statistics of speech intelligibility in male and female students with different hearing status using Tukey test

Hearing Group (I) Hearing Group (J)	Mean Difference (I-J)	Standard Deviation	P-Value
Profound/ Severe Moderately-severe	0 -1	24% 23%	1 0.002
Severe/Profound Moderately severe	0 -1	24% 23%	1 0.006

4. Discussion

Our research investigates three factors of speed of speech, intelligibility of speech and gender in students with hearing impairment. In this section we compare our studies with some of the previous researches.

In the field of speed of speech, our observations confirm the findings by Nickerson (1975), Pissoni (2000) and Geers (2002) in which there is a relationship between the degree of hearing impairment and speed of speech: With increasing the degree of hearing impairment, speed of speech decreases. Our research doesn't confirm the findings of Venkatigiri (1999) which was mentioned in the introduction. The reason may come from the fact that in our test the unit of measurement was "word" and the test was carried out on children while in Venkatagiri, the unit was "syllable" and the research was carried out on adolescents.

Another slightly different research was Zellner (1998). It shows that the difference between the threshold of hearing between two groups of profound hearing impaired

and moderately-severe hearing impaired children causes a meaningful difference in the speed of speech between these two groups. In general, this is done through two mechanisms, i.e., of "pause" and "extending the length of speech units". In our research the only mechanism used by examinees to decrease the speed of speech was "pause".

Regarding the intelligibility of speech, our findings confirm studies such as Munson, Edwards and Beckman (2005), Rob and Peng (1992) and Seifpanahi (2006) which point to the existence of a relationship between intelligibility of speech and degree of hearing impairment.

We didn't use hearing aid or cochlear implantation for our students. Therefore, we couldn't make any comparison with other researches in this field. However, other studies including Chin, Finnegan and Chung (2001) and Tobey, Geers, Brenner, Altuna, and Gabbert (2003) were in line with the present research. These studies also emphasize better intelligibility of speech in normal hearing people compared to the hearing impaired. They showed that there is a direct relationship between the progress of hearing impairment and decline in intelligibility of speech. Groups with moderately-severe, severe and profound hearing impairment in this order gained the highest statistical scores in intelligibility of speech.

Another research which is different from the present study in terms of ranking hearing impairment is Smith (1975). As we said earlier he believes that the speech of profound hearing impaired people is 20 percent intelligible, which equals rank 2 in the present research. Looking at our results we observe that most of the people with profound hearing impairment are put in rank 1 (completely unintelligible) and therefore different from the study by Smith. The reason can be attributed to the fact that Smith has used spontaneous speech by examinees for his test but we have used a guided method of reading a 100-word text.

As for the relationship between speed of speech and intelligibility of speech in hearing impaired people, an interesting finding is reported in Seifpanahi (2006). He contends that the speed of speech in examinees with rank 5 is higher than examinees with other 4 ranks but there isn't any meaningful difference among those 4 ranks. This shows that in completely intelligible speech, speed of speech is higher but even if 20 percent of speech is unintelligible (for example in rank 4), the rate of speech intelligibility can not have any positive meaningful effect on children's speed of speech. This finding was confirmed in our study and we observed that in hearing impairment higher than moderately-severe, the intelligibility of speech does not make any meaningful difference in the speed of speech.

In the previous studies, speed of speech and intelligibility of speech were measured according to the status of hearing-impairment but the present research adds up the factor of "gender". Here we found that speed of speech in reading words and intelligibility of speech are different for hearing impaired boys and girls. Boys had a

higher speed and more intelligible speech than girls while in normal hearing boys and girls, girls had a better performance.

5. Conclusion

According to the finding of this research, children with hearing-impairment have a lower speed and intelligibility of speech than normal hearing children. In the hearing impaired group, moderately-severe, severe, and profound hearing impaired children in this order had higher speed and intelligibility of speech. In general, there is a direct relationship between the status or rate of hearing impairment and the speed and intelligibility of speech: with increasing hearing impairment, the speed and intelligibility of speech declines. In terms of gender, boys have a better performance than girls in tasks of speed and intelligibility of speech.

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