SPEECH RATES OF TURKISH PRELINGUALLY HEARING-IMPAIRED CHILDREN

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The aim of training children with hearing impairment in the auditory oral approach is to develop good speaking abilities. However, children with profound hearing-impairment show a wide range of spoken language abilities, some having highly intelligible speech while others have unintelligible speech. This is due to errors in speech production. While children with hearing-impairment speak, segmental and prosodic errors may occur, so the intelligibility of their speech is affected. Because of these segmental and prosodic errors, the speaking rate of hearing-impaired children can be slower than that of hearing children. The aim of the current study is to find out if there are differences between children with and without hearing-impairment in terms of speech and reading rates. Relationships between speech rate, intelligibility, hearing loss, and aided thresholds of children with hearing-impairment are investigated as well. Hearing impaired children's speech and reading rates along with their speech and reading intelligiblity scores are compared. The speech samples of 25 high school students' with profound hearing impairment pre-lingually were compared with those of 15 students without hearing impairment. Data on the rate of speech were collected by means of a laryngograph. Speech intelligibility was rated by a jury of naive listeners who were asked to write down what they heard after listening to recorded statements from the speech samples. Findings revealed a difference between speech and reading rates of hearing and hearing impaired children, and a relationship between speech rate and speech intelligibility. No relationship was found between hearing loss and speech rate, hearing loss and intelligibility, aided thresholds and speech rate, and aided thresholds and intelligibility. The diffference between hearing-impaired children's speech and reading rate was not statistically significant while the difference between their speech and reading intelligibility was significant. Implications for the education of children with hearing impairment are presented.

Introduction

Individuals' adaptation to society and their success are mostly empowered through fluent and efficient use of communication channels. The core of interpersonal communication is language and its verbal dimension, speaking (Konrot, 1991; Vardar, 1982). Speech is one of the most immensely and frequently applied communication modes in interpersonal communication. Children acquire their native language and its verbal channel, speech, through their hearing ability starting from birth. They start using language for communication in an efficient and fluent manner in a short span of time, i.e. three to four years. Hearing carries an important role in the acquisition of speaking skills (Rabin et al., 1999). However, hearing loss present before birth or during the first year of life, severely interferes with acquisition of the mother tongue and speech (Osberger & Mc-Garr, 1982). When this happens, the chance to acquire the culture of his/her society is reduced for the child with hearing impairment and an interruption in their intellectual development is likely to occur (Tüfekçioğlu, 1989). Such problems lead to defects in communication process (Sanders, 1971) of children with hearing impairment.

In order for speech production to occur, feedback from interconnected sensorial channels should be perceived sufficiently (Crandell, Smaldino, & Flexer, 2005). Through this feedback, speakers can control
their voice along with segmental and suprasegmental features of their speech, and correct their mistakes. In order to realize this function, a speaker primarly relies on the hearing channel (Rabin et al., 1999). Insufficiency or total lack of aural feedback stemming from sensory-neural hearing handicap

leads to defects in the ability to notice and correct their own speech deficiencies and mistakes. As a result, speech patterns of individuals with hearing impairment deviate from that of the non-hearing impaired. Studies revealed that segmental errors occur in the production of vowel and consonant phonemes (Hudings & Numbers, 1942; Markides, 1970; Osberger & Mc-Garr, 1982). Prosodic errors, on the other hand, stem from situations such as intonation deficiencies caused by poor control of fundamental frequency (i.e. monotonous speech), inappropriate breath control, slow speech rate, abnormal uses of pauses, and abnormal uses of rhythm and stress (Girgin, 1999; John & Howarrth, 1965; Leder et al., 1978; Markides, 1970).

Speech intelligibility is affected by several factors including the degree of hearing loss, age when hearing aid is introduced, proper selection and use of hearing aids, learning settings and instructional approaches. Speech intelligibility has a crucial role in verbal communication. Speech intelligibility can be defined as the accuracy to which individuals with hearing impairment deliver speech, and the intelligibility of this speech to a non-hearing impaired listener (Brannon, 1986; Gordan & Brannan, 1994; Osberger & Mcgarr, 1982; Tüfekçioğlu, 1989). It has been emphasized since the study of Hudgins and Numbers (1942) that, there is a significant relationship between pre-lingually hearing-impaired children's speech intelligibility and the degree of hearing loss. Studies scrutinizing speech rate, degree of hearing loss and aided thresholds have rarely been conducted for children with hearing impairment in a Turkish language environment, which necessitates new studies on these subject (Girgin, 1999). Thus, the current study examines Turkish-speaking children with hearing impairment in terms of these variables, and aims to answer the following research questions:

1- Do hearing children differ from hearing impaired children in terms of speech and reading rate?
2- Is there any difference between hearing impaired children's speech and reading rates?
3-Are there any relationships between speech intelligibility, speech rate, hearing loss and aided thresholds?
4-Is there any difference between speech and reading intelligibility?

Method

Subjects

15 hearing high-school teenagers who were reported to have no hearing, speaking or reading problems were randomly selected from a list of students for the control group. The experimental group consisted of all the 25 students with hearing impairment enrolled at the high-school of the Education and Research Center for Children with Hearing Impairment (İÇEM) at Anadolu University. When this group was formed, attention was paid to the following specific criteria; (i) they should have sensory-neural hearing handicap in both ears, (ii) they should be prelingually hearing impaired, and (iii) they should not have a second handicap beside hearing impairment. The mean degree of hearing loss calculated for the best hearing ears of all 25 students was 102 dB HL, ranging from 89dB HL to 120dB HL.

Stimuli

In order to investigate the research questions, a set of 30 pictures and 30 sentences written on cards were used. While selecting pictures, attention was paid to the contents of pictures ,they had to be familiar to the experiences of children with hearing impairment and their names had to be words easy to express. Sentences, on the other hand, were selected by classroom teachers based on the criterion that they were appropriate for their language proficiency.

Procedures

In a quite room, both hearing and hearing impaired children selected 15 sentences and 15 pictures out of 30 sentences and 30 pictures, and their speech rate was analyzed through recording the statements by means of a laryngograph, an instrument used to record the larynx movements in speech. Means of statements for both groups of children with hearing and with hearing impairment were calculated and the speech rate variable was found. Means were compared through conducting independent-samples t-tests.

Speech intelligibility of hearing children was considered as 100 %. In order to calculate speech intelligibility of children with hearing impairment, 15 picture and 15 read statements were listened to three times by four different naive listeners who were accustomed to the speech children with hearing impairment. Then, these listeners were asked to take down what they heard for each statement. To calculate the speech intelligibility proportion for each child with hearing impairment, the number of syllables that changed meaning was divided by the number of syllables understood correctly. Inter-rater

reliability coefficients among naive listeners were calculated. All reliability coefficients were above .80 with a corresponding significance value of .001 or below, which indicated that there was a consensus among raters. Averages of four listeners' scores were taken as the intelligibility score.
In order to answer research questions that focused on relationships between variables, Pearson Product Moment Correlation Coefficients were calculated since all variables used in the current study had a continuous nature.
To compare speech and reading rate and to compare speech and reading intelligibility of children with hearing impairment, paired-samples t-tests were conducted.

Results

Do hearing children differ from those with hearing impairment in terms of speech and reading rates?

In order to investigate whether children with hearing impairment differ from hearing children in terms of speech and reading rates, two independent-samples t-tests were conducted. Since two t-tests were conducted, the critical significance value was reduced to .025 in order to decrease the likelihood of conducting a Type I statistical error as suggested by Huck (2000). Summaries of the tests are provided in Table 1 below:

Table 1. Independent-samples t-tests comparing speech and reading rates of children with and without hearing impairment

	GROUP	N	Mean	Std. Dev.	df	t	Sig.
Speech rate	Hearing imp.	25	2,402	0,439	38	2,567	.014
	Hearing	15	1,985	0,585			
Reading rate	Hearing imp.	25	2,469	0,408	38	2,586	.013
	Hearing	15	2,061	0,589			

The means in the row named speech rate indicate the average of seconds spent for producing statements. That is, the less time spent for producing statements, lower means are observed, which means that a better speech rate is observed. In this respect, hearing children had a better speech rate than hearing impaired children. The result of the independent-samples t-test indicated that the difference between children with and without hearing impairment in terms of speech rate was statistically significant (t_{38}=2.567; p<.014). More specifically, hearing children produced statements in a significantly shorter time than those with hearing impairment.

The same analysis was repeated for the reading rates of children with and without hearing impairment. The means refer to the time spent for reading. Less time spent for reading indicates a better reading rate. A difference between the children with and without hearing impairment was observed and this difference was investigated through an independent-samples t-test to see whether the difference is statistically significant. The result indicated that hearing children had a significantly better reading rate than those with hearing impairment (t_{38}=2.586; p<.013). Meaning that hearing children produced statements in a significantly shorter time than those with hearing impairment.

Is there any difference between speech and reading rates of children with hearing impairment?

In order to understand whether there is a significant difference between speech speed and reading speed of children with hearing impairment, a paired-samples t-test was conducted. As also indicated in Table 2 below, reading speed (χ=2.469) was not statistically higher than speech speed (χ=2.336) (t_{24}=1.702; p<.102).

Table 2. Paired-samples t-test comparing reading and speech rates

N=25	Mean	SD	df	t	sig.
Reading rate	2,469	0,408	24	1.702	.102
Speech rate	2,336	0,543			

The researcher found a relationship between reading and speech rate of children with hearing impairment. A Pearson correlation cofficient of .697 with a corresponding significance of .001 indicated that the rates were significantly related for Turkish children with hearing impairment.

Are there any relationships between speech intelligibility, speech rate, hearing loss and aided thresholds?

In order to understand whether there were relationships between speech intelligibility, speech rate, hearing loss and aided thresholds, Pearson Product Moment Correlation Coefficients among these continuous variables were calculated. A coefficient of -.415 was found with a corresponding significance level of .008 indicating that there was a significant negative correlation between speech rate and speech intelligibility. The result suggests that as the time spent for producing statements decreases, intelligibility increases. On the other hand, the relationship between hearing loss and speech rate (r=.057; p=787), the relationship between hearing loss and speech intelligibility (r=-.348; p=.088), the relationship between aided thresholds and speech rate (r=-.125; p=.561), and the relationship between aided thresholds and intelligibility (r=-.077; p=.720) were not statistically significant. Summary of investigated relationships is provided in Table 3 below:

Table 3. Summary of relationships among variables

	Speech intelligibility	Speech rate	Hearing loss	Ear Aided threshold
Speech intelligibility	-	**-,415****	-,348	-,077
Speech rate		-	-,057	-,125
Hearing loss			-	-,049

* Correlation is significant at the p-level of .01

Is there any difference between speech and reading intelligibilty?

Previous analysis revealed that there was no statistically significant difference between speech and reading rates. To analyze the data further, reading and speech intelligibility were compared through a paired-samples t-test. As also indicated in Table 4, hearing impaired children's reading intelligibility was significantly better than their speech intelligibility (t_{24}=3.205, p<.004) even though their speach speed and reading speed did not differ.

Table 4. Paired-samples t-test comparing reading and speech intelligibility

N=25	Mean	SD	df	t	sig.
Reading intelligibility	88.519	9.876	24	3.205	.004
Speech intelligibility	83.320	13.783			

Discussion

As indicated in Table 1, speech and reading rates (i.e. duration) of children with hearing impairment were significantly slower than those of hearing children. In other words, their speech and reading duration were longer in comparison to hearing children. Findings related to speech rate were in line with previous research (John & Howarth 1965; Nickerson, 1975). A similar finding was found for the reading rate in the current study as well. Slowness in their production worsens the quality of their speech and reading patterns, and leads to labored and monotonous production. Slowness observed in hearing impaired children's production generally stems from difficulty in controlling organs used in speech production, their abnormal use of pauses (i.e. unnecessary or longer pauses) which is caused by problems in adjusting breath, and longer time is spent for producing phonemes. The best way to minimize hearing impaired children's problems in terms of their production rate is to use their existing but meager listening ability efficiently to improve their production.

Table 2 shows that reading and speech rates of children with hearing impairment did not differ significantly. Besides, a high correlation was found between the reading and speech rate. This might be caused by the fact that Turkish is a phonemic language, that is, the language is spoken as it is written. While reading children with hearing impairment may produce speech segments more easily while speaking.

As indicated in Table 3, there is a significant relationship between speech rate and speech intelligibility. More specifically, as the speech speed increases, children control their organs used in speech production better, control their breath more efficiently and use shorter pauses, which can have a positive influence on their speech intelligibility. Nonetheless, the analyses did not reveal any relationship between hearing loss and speech rate, hearing loss and intelligibility, aided thresholds and

speech rate, and aided thresholds and intelligibility. Particularly, the finding which revealed no relationship between intelligibility and hearing loss contradicted the findings of a previous study (Markides, 1985; Musselman, 1990). This finding might have been influenced by the profile of the participants who had either severe or profound hearing loss rather than partial hearing loss. Besides, the fact that these students were taught their mother tongue in a setting which provided instruction through an auditory oral approach might have caused a relatively different speech intelligibility pattern (Intelligibility; maximum: 99.23, minimum: 68.19, mean: 85.92). The finding that indicated no relationship between speech rate and hearing loss and between speech rate and aided thresholds might have been caused by these students' being given the hearing aid at an early age and by being exposed to efficient listening strategies.

The last significant finding of the study indicated a statistically significant difference between speech and reading intelligibility of Turkish children with hearing impairment, reading intelligibility being significantly better. This finding is not in line with the literature on English speaking children with hearing-impairment. Conrad (1979), Davis and Silverman (1978), and Markides (1983) claimed that speech intelligibility of English speaking children with hearing-impairment is better than their reading intelligibility. However, a completely opposite finding is revealed in Turkish children with hearing-impairment. This might be due to the fact that Turkish is read as it is written (i.e. phonemic language). Turkish children with hearing-impairment whose morphologic decoding skills and phonetic awareness are sufficiently developed have an inclination to produce segments properly in reading whereas they cannot produce the same segments during speech.

Children with hearing impairment should be equipped with state of the art hearing devices so that they can improve their listening, speaking and language abilities starting from an early age and both the children with hearing impairment and their families should be supported in instructional settings. This need should lead to the development of appropriate programs so that they can use their residual hearing abilities in an efficient way (Cheng-Ju & Brown, 2004). While developing such programs, positive attitudes of families and teachers towards hearing impaired children, the cooperation between teachers and families, and having high expectations carry utmost importance (Clark, 1986; Tüfekçioğlu, 1998).

The ultimate aim of the auditory oral approaches is to equip children with hearing impairment with both intelligible speech skills (i.e. production) and listening comprehension (i.e. reception) (Girgin, 2003). Aural approaches based on intensive auditory and oral practices facilitate hearing impaired children's lives in the hearing society. Besides, these approaches help children with hearing impairment speak intelligibly and fluently and reduce the problems they face in hearing society (Moeller, 2000). The children with hearing impairment who participated in the current study have been exposed to such an approach starting from an early age in the Education and Research Center for Children with Hearing Impairment (İÇEM).

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