Acoustic Characteristics of Korean Deaf Speakers

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ABSTRACT

This study was attempted to analyze the acoustic characteristics of profoundly deaf students. The 59 profoundly hearing-impaired and 36 normal subjects were divided into 3 age groups: 6-10 yrs group, 11-15 yrs group, and 16-20 yrs group. The voice was sampled in /a/ prolongation, counting, reading, and conversation using the Computerized Speech Lab (CSL). The vocal pitch of the deaf subjects was significantly higher than the normal subjects. The younger in age was tended to be higher in pitch and jitter values of the deaf subjects. The three age groups of the deaf subjects did not show any difference in loudness and shimmer, excepted to minimum loudness. The pitch mean of males was significantly lower than that for females.

Keywords: acoustic characteristics, Korean deaf, jitter, shimmer, pitch, loudness

Introduction

Speech is a multidimensional stimulus varying in a complex way in both frequency and time. Although the speech wave can be described in terms of amplitude and time, this is perceived and processed psychoacoustically at different level of the auditory system (Clark & Yallop, 1995; Baken, 1987).

A severe to profound hearing impairment may have a devastating effect on the development of language and communicative competence. It may be manifested in increased pitch, increased loudness and faulty resonance due to a lack of auditory feedback this, compared to normal voice. Therefore, evaluation of abuse and misuse patterns in the hearing impaired individuals is necessary in order to assess the degree of their voice disorders and to determine appropriate voice therapy goals. In recent years, modern

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technology has provided great contribution to evaluate the precise acoustic differences between the normal and abnormal voice. Nevertheless, review of literature revealed a paucity of information on the acoustic analysis in profound hearing loss, especially in non-English speaking population (Monsen, 1979). The purpose of the present study, therefore, was to analyze the acoustic characteristics of the deaf speakers selected from a Korean deaf school, which were compared to the normal speakers.

Materials and Methods

Subjects

Thirty-two males and twenty-seven females were recruited from a deaf school in Korea to serve as subjects. Their age ranged from 6 to 18 years for male and from 8 to 20 years for female. Thirty-six normal subjects who were matched in age served as control group. The subjects were divided into 3 age groups: 6-10 yrs group, 11-15 yrs group, and 16-20 yrs group. The hearing-impaired subjects were either congenitally or prelingually deaf. They appeared to be in good health and did not keep hearing aid. All subjects were examined by an otolarynologist. Their hearing threshold was over 95 dB without hearing aids.

Apparatus

The computerized speech lab (CSL) Visi-Picth model 4331 was used to obtain and analyze the voice signal. The voice samples were gathered from each subject in four voicing conditions including /a/ prolongation, counting, reading, and conversation.

Procedures

A written instruction and verbal explanation about the tasks were given in order to ascertain the subject have a clear understanding of the tasks. Each subject was seated in a noise-controlled room and positioned comfortably at a mouth to microphone distance of 3-4cm. A trial session took place prior to the actual experiment.

First of all, the subject sustained the vowel /a/ at least for 5 seconds at a comfortable pitch and loudness level. Secondly, the subject counted 1 to 10 and /ga/ to /sa/ among Korean characters. Thirdly, the subject read "Sahnchek(go-for a walk) passage" (Jeoung, O.-R., 1994). The portion used for analysis was from the beginning of the passage for at least 5 seconds. Finally, the subject produced a spontaneous conversation about his/her name, age, and address. The pitch, loudness, jitter, and shimmer measurements were taken.

Analysis

Student t-test, 1-way ANOVA, and 2-way ANOVA were performed.

Results

Table 1 and Table 2 showed the 1-way ANOVA results on normal and deaf subjects, respectively.

Table 1. 1-way ANOVA analysis of normal groups (* $p<0.05$, ** $p<0.005$).

	age groups	pitch(Hz) mean(SD)	loud(dB) mean(SD)	jitter(%) mean(SD)	shimmer(dB) mean(SD)
total	6-10 yrs	259.18(10.96)*	73.82(2.49)	0.73(0.15)*	0.51(0.27)
	11-15 yrs	225.16(39.79)	74.05(1.85)	0.43(0.44)	0.63(0.69)
	16-20 yrs	184.35(55.63)*	74.23(1.91)	0.27(0.29)*	0.29(0.08)
males	6-10 yrs	257.41(12.68)**	73.58(1.84)	0.43(0.16)	0.45(0.3)
	11-15 yrs	200.48(44.49)**	73.46(1.83)	0.73(0.47)**	0.89(0.92)
	16-20 yrs	132.42(15.68)**	72.87(1.48)	0.27(0.17)**	0.29(0.09)
females	6-10 yrs	260.95(9.78)**	74.06(3.18)	0.48(0.14)	0.56(0.25)
	11-15 yrs	249.84(6.38)**	74.65(1.81)	0.51(0.43)	0.36(0.15)
	16-20 yrs	236.28(9.46)**	75.58(1.18)	0.62(0.29)	0.28(0.07)

In normal subjects, there was a significant difference between the 6-10 years group and 16-20 years group in terms of pitch and jitter. That is, the younger subjects showed higher pitch and jitter than older subjects. Figure 1 showed the difference.

Among male subjects, the pitch significantly decreased as their age increased and a significant difference was found in jitter between the 10-15 years group and 16-20 years group. The pitch also decreased as their age increased in female subjects as in male subjects. However, there was no significant difference in any other vocal parameters in normal female subjects(Table 1).

Table 2. 1-way ANOVA analysis of deaf groups (* $p<0.05$).

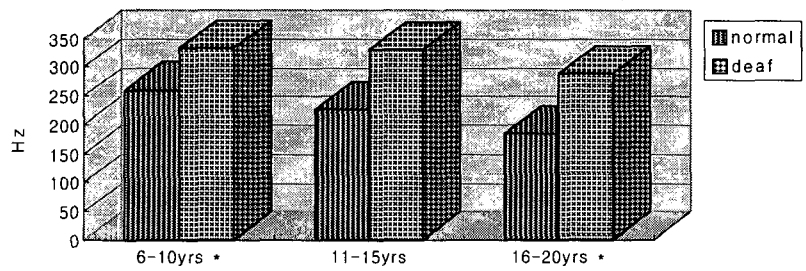
	age groups	pitch(Hz) mean	loud(dB) mean	jitter(%) mean	shimmer(dB) mean
males	6-10 yrs	310.64*	75.69*	1.52	0.49
	11-15 yrs	273.37	74.81	0.81	0.37
	16-20 yrs	225.21*	75.1*	0.73	0.46
females	6-10 yrs	359.1	73.75	3.3	0.5
	11-15 yrs	365.37	75.15	1.13	0.39
	16-20 yrs	377.75	75.51	0.66	0.25

In deaf subjects, there was a significant difference in jitter showing higher jitter in the younger deaf subjects. In addition, the male deaf subjects showed lower pitch than female deaf subjects, as in normal subjects. There was significantly change revealing higher pitch and louder intensity in the younger male subjects, but not in female subjects(Table 2).

Table 3. t-test results of normal and deaf groups (* $p<0.05$, ** $p<0.005$).

	age groups	pitch(Hz) mean	loud(dB) mean	jitter(%) mean	shimmer(dB) mean
normal	6-10 yrs	259.18(10.96)**	73.82(2.49)	0.46(0.15)	0.51(0.27)
	11-15 yrs	225.16(39.79)**	74.05(1.85)	0.62(0.44)	0.63(0.69)
	16-20 yrs	184.35(55.63)**	74.23(1.91)	0.45(0.29)	0.29(0.08)
deaf	6-10 yrs	332.7(63.65)**	75.28(2.57)	2.81(4.92)	0.44(0.26)
	11-15 yrs	335.77(142.83)**	75.03(2.61)	0.98(0.73)	0.36(0.17)
	16-20 yrs	294.83(152.17)**	75.42(3.2)	0.62(0.41)	0.36(0.26)

Figure 1. Comparison of the pitch mean between normal and deaf subjects



When the normal subjects compared to deaf subjects, Only pitch element was significantly different between normal and deaf groups(Table 3). As Figure 1 illustrates the

higher pitch was observed in the deaf group across the three age groups. Therefore, the voice of deaf children tended to produce high pitch, and unclear sound as in a highly irregular voice perturbation (Monsen, 1979).

Conclusion

The acoustic characteristic of profound hearing-impaired students was analyzed and compared with that of normal hearers. The 6-10 yrs group showed higher pitch and jitter than 16-20 yrs group in the normal groups. That is, the normal subjects showed increased pitch as their age decreased. The vocal pitch of the deaf subjects was significantly higher than the normal subjects. The deaf subjects younger in age tended to be higher in pitch and jitter values. The increased of the vocal pitch tended to related with that of jitter in deaf subjects. The three age groups did not show any difference in loudness and shimmer, except to minimum loudness. The pitch mean of males was significantly lower than that of females. These findings seem to be explained due to lack of auditory feedback. It will be more clearly defined if the acoustic change of deaf voice is evaluated under various voice conditions with several parameters.

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