대한음성언어의학회지
제 7 권 제 1 호 1996

Jitter and Shimmer of the Deaf Voice

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= Abstract =

The present study analyed jitter and shimmer of the deaf in 4 different voicing conditions. Thirty-two male subjects and 27 female subjects participated in the study on a voluntary basis. The age ranged from 6 to 18 for male and 8 to 21 for female subjects. The subjects were either congenitally or prelingually deaf. The four different voicing conditions included /a/ prolongation, counting, reading, and conversation. The experiment utilized CSL Visi-Pitch Model 6095(Kay Elemetrics Corp.) to sample and analyze the data. Both jitter and shimmer means were higher than the threshold values(normative data) reported. In addition, this investigation performed two separate 2-factor ANOVAs in order to determine if jitter and shimmer change as a function of gender and voicing condition. The results showed the following. First of all there was the gender effect on shimmer but not on jitter, in that male subjects' shimmer was higher than females'. secondly, there was the voicing condition effect both on jitter and shimmer. /a/ prolongation and reading produced lower jitter than counting and conversation. /a/ prolongation produced lower shimmer than the remaining conditions. Finally, no interaction between gender and voicing condition existed.

In recent years, improved understanding of the anatomy and physiology of phonation and modern technology have resulted in substantial advances in the diagnosis and treatment of voice disorders. Acoustic analysis of one's voice has provided a convenient way to investigate the differences in speech production that can be used in comparisons between normal and pathological condition. Computers have allowed the detection of minute interperiod variations in the acoustic waveform. Jitter and shimmer are two acoustic measures which are associated with frequency variation and amplitude variation, respectively.

Many methodologies for calculating and describing jitter and shimmer have been described and applied by voice scientists. Jitter is an estimation of cycle-to-cycle variation in period duration, whereas shimmer is an estimation of cycle-to-cycle variation in intensity. These interperiodic variations may be useful in predicting and perhaps differentiating vocal pathologies (Davis, 1979)[1].

Deaf speakers' voice disorders may be manifested in 3 phenomina, that are increased pitch, increased intensity, and faulty resonance (usually hypernasality)(정옥란, 1996)[2]. Their voice disorders are due to a lack of, if not no, auditory feedback. Jitter and shimmer of the deaf voice, however, were less studied. Furthermore, jitter and shimmer values of Korean deaf speakers have not been reported yet. Thus, the need for objective assessment and quantification of jitter and shimmer has become absolutely clear. The purposes of the present study, therefore, were ① to determine jitter and shimmer of the deaf voice, ② to investigate the gender effect on jitter and shimmer of the deaf voice, and ③ to explore the voicing con-

dition effect on jitter and shimmer of the deaf voice.

Method

1. Subjects

Thirty-two males and twenty-seven females were recruited from Meari School for the Deaf located in Ulsan, KOREA to serve as subjects. With respect to chronological age, male subjects ranged from 6 to 18, and female subjects ranged from 8 to 21. Originally thirty-seven male subjects and 31 female subjects participated in the study. However, in the course of collecting acoustic data, 5 male and 4 female subjects were excluded because they were unable to perform some of the phonation tasks. The subjects were either congenitally or prelingually deaf. They appeared to be in good health. All subjects were examined by an otolaryngologist.

2. Apparatus

The Computerized Speech Lab(CSL) Visi-Pitch Model 6095 was used to obtain and analyze the voice signal from all subjects.

3. Voice samples

Voice samples were gathered from each subject in four different conditions. The four voicing conditions included /a/ prolongation, counting, reading, and conversation.

4. Procedures

Prior to the actual experiment, a written instruction and verbal explanation about the tasks were given in order to ascertain the subject have a clear understanding of the tasks. In addition, to make the subject comfortable with the tasks, a trial session was attempted. Each subject was seated in a noise-controlled room and positioned at a mouth-to-microphone distance of 10cm.

Frist 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.

Thirdly, the subject read the "Sahnchek(go-for-a-walk) Passage." 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 speech output was controlled in such a way that only name itself (i.e., without any carrier phrase such as "My name is _____."), only age (i.e., without any other explanation such as "I am _____." or "My age is _____."), and only address (i.e., without any phrase such as "My address is _____.") were produced. In other words, the subject produced spontaneous conversation like the following : "Jeong Ok-ran, 50 seh (yrs old), Taegu-shi(city) Nam-Ku Daemyung-dong 2288."

5. Analyses

To compare jitter and shimmer values of the deaf voice with normative threshold data provided by CSL Visi-Pitch, jitter mean and shimmer mean were calculated.

In order to find if the gender and voicing condition affect jitter and shimmer of the deaf voice, two separate 2-factor Anlaysis of Variance(ANOVA) were performed. One was for jitter and the other was for shimmer.

Results

1. Jitter Mean

The jitter mean values were 1.17% on /a/ prolongation, 2.11% in counting, 1.13% in reading, and 1.87% in conversation. The jitter threshold in CSL is defined as 1.04%.

2. Shimmer Mean

The shimmer mean values were 0.37dB on /a/ prolongation, 0.68dB in counting, 0.63dB in reading, and 0.66dB in conversation. The shimmer threshold in CSL is defined as 0.35dB. Table 1 shows both jitter and shimmer mean values and their SDs.

3. Gender Effect

There was no gender effect on jitter, whereas there

Table 1. Jitter and Shimmer of the Deaf Voice in 4 Voicing Conditions

Voicing Condition	Jitter(%)			Shimmer(dB)		
	Mean	(SD)	Threshold	Mean	(SD)	Threshold
/a/	1.17	(1.27)		0.37	(0.22)	
Counting	2.11	(1.08)		0.68	(0.28)	
Reading	1.13	(2.50)		0.63	(0.24)	
Conversation	1.87	(2.22)		0.66	(0.28)	
Mean	1.57	(1.91)	1.04	0.58	(0.28)	0.35

Table 2. 2-factor ANOVA on Jitter

ANOVA Procedure					
Dependent Variable : Jitter					
Source	DF	Sum of Square	Mean Square	F Value	Pr>F
Model	7	58.08675328	8.29810761	2.35	0.0246
Error	228	805.18856875	3.53152881		
Correct Total	235	863.27532203			
	R-Square	C.V.	Root MSE	Jitter Mean	
	0.067286	119.8259	1.879236	1.568305	
Source	DF	Anova SS	Mean Square	F Value	Pr>F
GENDER	1	6.24298997	6.24298997	1.77	0.1850
VC	3	42.95565085	14.31855028	4.05	0.0078
GENDER*VC	3	8.88811246	2.96270415	0.84	0.4738

Table 3. 2-factor ANOVA on Shimmer

ANOVA Procedure					
Dependent Variable : Jitter					
Source	DF	Sum of Square	Mean Square	F Value	Pr>F
Model	7	4.47228698	0.63889814	10.15	0.0001
Error	228	14.35187743	0.06294683		
Correct Total	235	18.82416441			
	R-Square	C.V.	Root MSE	Jitter Mean	
	0.237582	43.08727	0.250892	0.582288	
Source	DF	Anova SS	Mean square	F Value	Pr>F
GENDER	1	0.65562861	0.65562861	10.42	0.0014
VC	3	3.74191695	1.24730565	19.82	0.0001
GENDER*VC	3	0.07474141	0.02491380	0.40	0.7562

was gender effect on shimmer. Male subjects produced higher shimmer than female subjects.

4. Voicing Condition Effect

There was voicing condition effect both on jitter and shimmer. /a/ prolongation and reading produced lower jitter than counting and conversation. /a/ prolongation produced lower shimmer than the remaining conditions. Table 2 and table 3 shows two separate 2-way Analysis of Variance(ANOVA) results.

5. Gender X Voicing Condition Effect

As was shown in Table 2 and Table 3, no interaction between gender and voicing condition effect existed.

Discussion

This study presented jitter and shimmer data of 59

deaf speakers. Their mean values were higher than thresholds provided by Kay Elemetrics even though the differences were not extensive. This may be indication of a lack of glottal irregularity of deaf speakers.

Gender factor influences shimmer, but not jitter in that male deaf speaker produces higher shimmer than female deaf speaker. This may imply that shimmer is a more sensitive and relavant parameter to describe male and female vocal disorders(symptoms) of deaf speakers, compared to jitter.

Voicing condition factor affects both jitter and shimmer. In shimmer, /a/ prolongation produced lower value than the remaining conditions. In jitter, /a/ prolongation and reading produced lower values than counting and conversation. This may imply that representative voice sampling should include more than just vowel prolongation which has often been used in research paradigm.

References

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=한 글 요 약=

농자 음성의 주파수 변동율 및 진폭 변동율

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본 연구는 농자의 음성의 주파수 변동율(jitter) 진폭 변동율(shimmer)을 4가지 발성 상황에서 분석하였다. 32명의 남자 피험자와 27명의 여자 피험자가 자진하여 실험에 참여하였다. 남자 피험자의 연령 범위는 6세~18세, 여자 피험자의 연령 범위는 8세~21세였다. 피험자들은 선천적인 농이거나 언어발달 이전에 농자가 되었다. 4가지의 발성 상황이란 /a/를 연장발성 하는 것, 수를 1에서 10까지 헤아리는 것, '산책'이라는 문단을 낭독하는 것, 대화시 발성 등을 말한다. 실험에 사용된 기구는 CSL Visi-Pitch Model 6095(Kay Elemetrics Corp.)이었다. 주파수 변동율 평균치와 진폭 변동율 평균치 모두 보고된 역치(표준 자료)보다 높았다. 또한 본 연구는 주파수 변동율과 진폭 변동율이 성별과 발성상황에 따라 변하는지 규정하기 위하여, 2가지의 2원 변량분석(2-factor ANOVA)을 실시하였다. 결과는 다음과 같다. 첫째, 성별은 주파수 변동율에는 영향을 미치지 않지만 진폭 변동율에는 영향을 미쳤다. 남자 피험자의 진폭 변동율이 여자 피험자의 진폭 변동율에 비해 높았다. 둘째, 발성상황은 주파수 변동율과 진폭 변동율 모두에 영향을 주었다. /a/ 연장발성과 낭독에서는 수헤아리기와 대화상황에서보다 주파수 변동율이 낮았다. /a/ 연장발성에서는 나머지 상황에 비하여 진폭 변동율이 낮았다. 마지막으로, 성별과 발성상황간의 상호작용(interaction)은 발견되지 않았다.