Jitter and Shimmer of the Deaf Voice

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Abstract

The present study analyzed 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). Deaf speakers' voice disorders may be manifested in 3 phenomena, that are increased pitch, increased intensity, and faulty resonance (usually hypernasality, 육관, 1996). 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 Mean School for the Deaf located in Ul-

san, 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 part-

icipated 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 ot-

tolaryngologist.

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-con-

trolled 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 loud-

ness 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 sch

(ys 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 Analysis 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/ pro-

longation, 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/ pro-

longation, 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

<table>
<thead>
<tr>
<th>Voicing Condition</th>
<th>Jitter(%)</th>
<th>Shimmer(dB)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>(SD)</td>
</tr>
<tr>
<td>/a/</td>
<td>1.17</td>
<td>(1.27)</td>
</tr>
<tr>
<td>Counting</td>
<td>2.11</td>
<td>(1.08)</td>
</tr>
<tr>
<td>Reading</td>
<td>1.13</td>
<td>(2.50)</td>
</tr>
<tr>
<td>Conversation</td>
<td>1.87</td>
<td>(2.22)</td>
</tr>
<tr>
<td>Mean</td>
<td>1.57</td>
<td>(1.91)</td>
</tr>
</tbody>
</table>

Table 2. 2-factor ANOVA on Jitter

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Square</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Model</td>
<td>7</td>
<td>58.08675328</td>
<td>8.29810761</td>
<td>2.35</td>
<td>0.0246</td>
</tr>
<tr>
<td>Error</td>
<td>228</td>
<td>805.18856875</td>
<td>3.53152881</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Correct Total</td>
<td>235</td>
<td>863.27532203</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

R-Square 0.067286  C.V. 119.8259  Root MSE 1.879236  Jitter Mean 1.568305

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Square</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENDER</td>
<td>1</td>
<td>6.24298997</td>
<td>6.24298997</td>
<td>1.77</td>
<td>0.1850</td>
</tr>
<tr>
<td>VC</td>
<td>3</td>
<td>42.95565085</td>
<td>14.31855028</td>
<td>4.05</td>
<td>0.0078</td>
</tr>
<tr>
<td>GENDER*VC</td>
<td>3</td>
<td>8.88811246</td>
<td>2.96270415</td>
<td>0.84</td>
<td>0.4738</td>
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</table>

Table 3. 2-factor ANOVA on Shimmer

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Square</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr&gt;F</th>
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<tbody>
<tr>
<td>Model</td>
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<td>4.47228698</td>
<td>0.63889814</td>
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<tr>
<td>Error</td>
<td>228</td>
<td>14.35187743</td>
<td>0.06294683</td>
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<td></td>
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<tr>
<td>Correct Total</td>
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<td>18.82416441</td>
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<td></td>
<td></td>
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</tbody>
</table>

R-Square 0.237582  C.V. 43.08727  Root MSE 0.250892  Jitter Mean 0.582288

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Square</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Pr&gt;F</th>
</tr>
</thead>
<tbody>
<tr>
<td>GENDER</td>
<td>1</td>
<td>0.65562861</td>
<td>0.65562861</td>
<td>10.42</td>
<td>0.0014</td>
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<tr>
<td>VC</td>
<td>3</td>
<td>3.74191695</td>
<td>1.24730565</td>
<td>19.82</td>
<td>0.0001</td>
</tr>
<tr>
<td>GENDER*VC</td>
<td>3</td>
<td>0.07474141</td>
<td>0.02491380</td>
<td>0.40</td>
<td>0.7562</td>
</tr>
</tbody>
</table>

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 relevant 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


2) 정옥란 : 음성과 음성치료. 서울: 도서출판 원미사 (2판), 1996

=한 글 요 약=

농자 음성의 주파수 변동율 및 진폭 변동율

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대구대학교 의과대학 언어치료학과

본 연구는 농자의 음성의 주파수 변동율(jitter) 진폭 변동율(shimmer)을 4가지 발성 상황에서 분석하였다. 32명의 남자 학생과 27명의 여학생이 참여하였다. 남자 학생의 연령 범위는 6세~18세, 여학생의 연령 범위는 8세~21세였다. 학생들은 선천적인 농이거나 연어발달 이전에 농자가 될 뻤했다. 4가지의 발성 상황인 /a/를 연장발성 하는 것, 수락 1에서 10까지 해 아리는 것, '산책이라는 문장을 납득하는 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 변화하는지 연구하기 위하여, 2가지의 2원 변량분석(2-factor ANOVA)을 실시하였다.

결과는 다음과 같다. 첫째, 성별은 주파수 변동율에는 영향을 미치지 않았지만 진폭 변동율에는 영향을 미쳤다. 남자 학생의 진폭 변동율이 여학생의 진폭 변동율에 비해 높았다. 둘째, 발성상황은 주파수 변동율과 진폭 변동율 모두에 영향을 주었다. /a/ 연장발성과 납득에서는 수어아리기와 대화상황에서보다 주파수 변동율이 낮았다. /a/ 연장발성에서는 나머지 상황에 비해 진폭 변동율이 낮았다. 마지막으로, 성별과 발성상황간의 상호작용(interaction)은 발견되지 않았다.