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phonatory function analyzer, Lx speech studio, jitter, shimmer

SPSS (Statistical Package for the Social Science) independent t-test

95% confidence. []: 90% confidence (p < .001), 95% confidence (p = .025)

(p < .001). []: 90% confidence (p < .001), 95% confidence (p < .001)


1. Introduction

In this chapter, we will discuss the various factors that influence vocal efficiency. These factors include subglottic pressure, Bernoulli effect, glottal sound, resonance, and articulation. Van den Berg\(^3\) in 1956 and Carroll\(^4\) have contributed significantly to the understanding of these factors.
Vocal efficiency (VE)

\[
VE = \frac{Acoustic \ power, \ watts}{Aerodynamic \ power, \ watts \times \text{airflow rate} \times \text{subglottic pressure}}
\]

(\text{R} \ 0.3 \text{m}^2, \ 4 \times 3.14 \times R^2 \times \text{Sound intensity})
pressure, dB) \( \times \) (Fundamental frequency, Hz) \( \times \) (Fig 1).

Fig. 1. Phonatory function analyzer

(ultra speed cinematography), (Laryngeal stroboscopy), (Electroglottography)\( \times \) (impedance) \( \times \) (Fig 10).
(closed quotient, CQ, Qx), speed quotient (SQ), jitter, shimmer, HNR (Harmonic-Noise Ratio). Fig. 2. Lx Speech Studio (Laryngograph Ltd., London, UK).
II. 本节

1. 这里

<table>
<thead>
<tr>
<th>内容</th>
<th>10</th>
<th>30</th>
</tr>
</thead>
<tbody>
<tr>
<td>内容</td>
<td>10</td>
<td>内容</td>
</tr>
</tbody>
</table>
2. Electroglottography

Lx Speech Studio (Laryngograph Ltd., London, UK) SPEAD (Speech Pattern Element Acquisition and Display) ¼º¹®Æó¼âÀ²(Qx), Jitter, Shimmer À» ½Ç½Ã°£À¸·Î³ªÅ¸³¾¼öÀÖ´Ù.

Fig. 3. Lx Speech Studio ¸¦ÀÌ¿ëÇÑ À½¼ººÐ¼®°Ë»ç. SPEAD ¼º¹®Æó¼âÀ²(Qx), Jitter, Shimmer À» ½Ç½Ã°£À¸·Î³ªÅ¸³¾¼öÀÖ´Ù. Speech pattern element display, speech spectogram, fundamental frequency contours, Lx contact quotient contours À» analogue waveform À» ½Ç½Ã°£À¸·Î³ªÅ¸³¾¼öÀÖ´Ù.
Phonatory function analyzer (Nagashima Ltd., Model PS 77H, Tokyo, Japan) was used. The phonatory function of "¡±(±è¸»ºÀ½Ã, ±Ý¼öÇö°î)ÀÇù¼ÒÀýÀÎ" was evaluated (Fig 4).

Fig. 4 "¡± (±è¸»ºÀ½Ã, ±Ý¼öÇö°î)ÀÇù¼ÒÀýÀÎ" ³º±ó ¹øµµ·Ï ÇÑÈÄ ±â·ùÀ² (fundamental frequency), ±Ý¹Ú¹°¸°À½ÀÎ (subglottic pressure), À½ÀÇ°­µµ (mean flow rate), ±âº»Á֯ļö (intensity) (Fig. 5).
... maximal phonation time, MPT) is the time

during which a person can sustain a
constant pitch of the voice. "Fig. 3"

... Fig. 5. "..."
3. Results
   
   Through the SPSS analysis, the independent t-test was conducted to compare the two groups. The results showed that the difference was significant at the 95% confidence level.
III. III

28.7 (24-31), 24.7 (20-29), 23.1 (19-29), 21.1 (19-23)

6.1 (1-10), 3, 7, 4, 5, 5.9 (1-10), 5, 5, 5
1. _phrase

.  (Fundamental frequency)

phonatory function analyzer,  

Lx Speech Studio,  

(Table 1).

<table>
<thead>
<tr>
<th></th>
<th>Fundamental frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Phonatory Function</td>
</tr>
<tr>
<td></td>
<td>Analyzer</td>
</tr>
<tr>
<td>Male NS</td>
<td>123.53± 6.12</td>
</tr>
<tr>
<td>S</td>
<td>136.83±14.93</td>
</tr>
<tr>
<td>Female NS</td>
<td>248.53±24.83</td>
</tr>
<tr>
<td>S</td>
<td>285.70±18.94</td>
</tr>
</tbody>
</table>

1.  Hz ±       .  

2. *:  Lx Speech Studio,  

\( p > .05 \)

NS: Non singers,  S: Singers.
Table 2. Intensity (Intensity, dB)

<table>
<thead>
<tr>
<th></th>
<th>Intensity</th>
<th>NS</th>
<th>S</th>
<th>NS</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td></td>
<td>75.00±2.78</td>
<td>77.90±4.43</td>
<td>74.36±2.78</td>
<td>84.93±3.03†</td>
</tr>
<tr>
<td>Female</td>
<td></td>
<td>68.86±2.50</td>
<td>75.66±4.03</td>
<td>71.00±3.63</td>
<td>79.66±3.80‡</td>
</tr>
</tbody>
</table>

1. dB: (Intensity, dB)

* : (/[]/) /* / [] / [] /[] /[], P < .001
† : (/[]/) / [] / [] / [] / [], P < .001
‡ : (/[]/) / [] / [] / [] / [], P = .035

NS: Non singers, S: Singers.
### Mean Flow Rate

<table>
<thead>
<tr>
<th></th>
<th>NS</th>
<th>S</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>225.46±74.15</td>
<td>230.60±72.51</td>
</tr>
<tr>
<td>Female</td>
<td>143.63±30.91</td>
<td>186.46±36.85</td>
</tr>
</tbody>
</table>

1. ml/sec / Table 3.

*MFR: Mean Flow Rate.*

NS: Non singers, S: Singers.
Subglottic pressure, Psub

Table 4. Subglottic pressure (mmH2O) differences between non-singers (NS) and singers (S).

<table>
<thead>
<tr>
<th></th>
<th>NS</th>
<th>S</th>
<th>Psub</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>78.10±23.89</td>
<td>69.10±24.09</td>
<td>111.60±31.60</td>
</tr>
<tr>
<td>Female</td>
<td>75.76±28.96</td>
<td>74.36±20.50</td>
<td>107.13±28.78</td>
</tr>
</tbody>
</table>

1. mmH2O: Millimeters of Mercury.

Psub: Subglottic pressure.

NS: Non singers, S: Singers.
表5. 最大发声时长 MPT

<table>
<thead>
<tr>
<th>性别</th>
<th>组别</th>
<th>MPT</th>
</tr>
</thead>
<tbody>
<tr>
<td>男</td>
<td>NS</td>
<td>21.59±2.05</td>
</tr>
<tr>
<td>男</td>
<td>S</td>
<td>33.27±10.41*</td>
</tr>
<tr>
<td>女</td>
<td>NS</td>
<td>15.71±2.57</td>
</tr>
<tr>
<td>女</td>
<td>S</td>
<td>25.90±6.25†</td>
</tr>
</tbody>
</table>

*：p = .003
†：p < .001

MPT: Maximal phonation time.
NS: Non singers, S: Singers.
2. cribing

2.2 (Fundamental Frequency)

The fundamental frequency (pitch pipe) of [Fundamental Frequency] (Table 6) was higher in [Fundamental Frequency] 6. Male and female voices were compared, and the results were [Fundamental Frequency]

**Table 6.**

<table>
<thead>
<tr>
<th></th>
<th>Fundamental frequency¹</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/Ø/</td>
<td>/Ø/</td>
</tr>
<tr>
<td>Male</td>
<td>NS</td>
<td>124.71±6.18</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>138.17±16.38*</td>
</tr>
<tr>
<td>Female</td>
<td>NS</td>
<td>257.10±41.68</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>286.84±19.35</td>
</tr>
</tbody>
</table>

1. [Fundamental Frequency] Hz ± [Fundamental Frequency] [Fundamental Frequency].

* : [Fundamental Frequency] /Ø/ [Fundamental Frequency] [Fundamental Frequency], \( P = 0.026 \)

† : [Fundamental Frequency] /Ø/ [Fundamental Frequency] [Fundamental Frequency], \( P = 0.025 \)

NS: Non singers, S: Singers.
3. Closed Quotient, Qx

<table>
<thead>
<tr>
<th></th>
<th>Closed Quotient (Qx)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/[] /</td>
<td>/[] /</td>
</tr>
<tr>
<td>Male</td>
<td>NS</td>
<td>51.31±4.28</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>52.28±6.72</td>
</tr>
<tr>
<td>Female</td>
<td>NS</td>
<td>46.01±6.27</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>42.48±9.41</td>
</tr>
</tbody>
</table>

1. ± 5% ∈ [ ] ± 10% ± 20% ± 30% ± 40% ± 50%.

* : /[] / [] [] [] [], \( p = .025 \)
† : /[] / [] [] [] [], \( p = .048 \)

N-S: Non singers, S: Singers.
Table 8. Jitter/Shimmer

<table>
<thead>
<tr>
<th></th>
<th>Jitter</th>
<th>Shimmer</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>/[]/</td>
<td>/[]/</td>
</tr>
<tr>
<td>Male</td>
<td>NS 0.314±12</td>
<td>0.283±12</td>
</tr>
<tr>
<td></td>
<td>S 0.852±0.49</td>
<td>0.409±0.24</td>
</tr>
<tr>
<td>Female</td>
<td>NS 0.285±0.10</td>
<td>0.796±0.57</td>
</tr>
<tr>
<td></td>
<td>S 0.581±0.40</td>
<td>0.706±0.72</td>
</tr>
</tbody>
</table>

1. %: Jitter/Shimmer ± Nonsingers, *: p < 0.05

NS: Nonsingers, S: Singers.
3. Vocal efficiency

Vocal efficiency (VE)  
= Acoustic power, watts  =  4 × 3.14 × R² × Sound intensity  
Aerodynamic power, watts  airflow rate × subglottic pressure  
(R = 0.3 m,  p < 0.001)

Table 9. Vocal efficiency ¹

<table>
<thead>
<tr>
<th></th>
<th>Vocal efficiency</th>
<th>/S/</th>
<th>/N/</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>NS</td>
<td>2.63±1.17</td>
<td>3.96±3.17</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>3.05±1.40</td>
<td>16.1±4.82*</td>
</tr>
<tr>
<td>Female</td>
<td>NS</td>
<td>1.30±1.26</td>
<td>6.07±1.26</td>
</tr>
<tr>
<td></td>
<td>S</td>
<td>1.53±1.10</td>
<td>6.41±5.64</td>
</tr>
</tbody>
</table>

¹: 10⁻³ m

* : /S/ /N/ 10⁻³ m,  p < .001

N-S: Non singers, S: Singers.
IV.  

144Hz, 288Hz (Fig. 6).
75.00±2.78dB, 77.90±4.43dB] \[ P = .046 \).

\[ 74.36±2.78dB, 84.93±3.03dB] \[ P < .001 \).
Howard (1995) 20, 21 stated that vocal boundaries are affected by these factors, and Howard's data is useful for understanding the relationship between vocal registers. However, vocal registers are often subjective and can vary greatly from person to person. Therefore, it is important to consider the individual's vocal characteristics when determining the appropriate register for a particular voice part.

In conclusion, vocal registers are a complex and important aspect of vocal performance. Understanding the various vocal registers and their associated characteristics can help singers to improve their vocal technique and overall performance. However, it is important to remember that vocal registers are not static, and they can change depending on a variety of factors. Therefore, it is important to continue to study and explore the relationship between vocal registers and vocal performance.
register), head register), falsetto register]
(middle register)

'(voice transition, register break points)"...

passaggio (vocal register transition)"

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ÀÇ Á¶°Ç"

ÀÇ Á¶°Ç"
jitter, vF0 (fundamental frequency variation), shimmer, vAm (peak amplitude variation). 

15. 16 17.
V.  " "

10

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' ' 

10

10
IV. References


23 ¹®¿µÀÏ.À½¼º°ú; 1994
Abstract

Comparitive evaluation of electroglottography and aerodynamic study in trained singers and untrained controls under different two pitch

Sung Yoon Ahn
Department of Medicine
The Graduate School, Yonsei university

(Directed by professor Hong-Shik Choi)

Background and Objectives: Aerodynamic study is valuable information about the vocal efficiency in translating airflow to acoustic signal. The purpose of this study was to investigate the differences between trained singers and untrained controls under different two pitch by simultaneous using the airway interruption method and electroglottography(EGG).

Materials and Methods: Under singing a Korean lied ‘Gene’, 20(male 10, female 10) trained singers were studied on two one-octave different tone. Mean flow rate(MFR), subglottic pressure(Psub) and intensity were measured with aerodynamic test using the Phonatory function analyzer. Closed quotients(Qx), jitter and shimmer were also investigated by EGG using Lx speech studio. These data were compared with that of normal controls.

Results: MFR and Psub were increased on high pitch tone in all subject groups. Statistically significant increasing of Qx and intensity were observed in male trained singers on high pitch tone(p < .05). Beacause of increasing of Qx and intensity, vocal efficiency was also significantly increased in male singers(p < .001).
Conclusion: The trained singers’ phonation was more efficient than untrained singers. The result means that the trained singers can increase the loudness with little changing of mean flow rate, subglottic pressure but more increasing of glottic closed quotients.

Key words: trained singers, EGG aerodynamic study, frequency, intensity, MFR, subglottic pressure, closed quotients