Comparison of Vocal Characteristics of Future Professionals in Three Different University Majors

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The voice is a primary vocational tool for people in many professions. According to statistics, almost one third of the total labor force requires professional use of voice as a primary labor instrument (Vilkman, 2000). Vocal problems are more commonly reported in professions that are considered vocally demanding. There is evidence of an increased incidence of voice problems in occupations such as preacher, social worker, aerobics instructor, lawyer, teacher, radio or television broadcaster, singer, and actor (Long, Williford, Olson & Wolfe, 1998; Pekkarinen, Himberg, & Pentti, 1992; Rantala, Haataja, & Vilkman, 1994; Russel, Oates, & Greenwood, 1998; Tepe et al., 2002; Timmermans et al., 2002; Verdolini & Ramig, 2001). Many of these vocations require consistent vocally abusive behaviors such as heavy telephone use, constant voice use, speaking over background noise, vocal performance, vocal performance in environmentally challenging locales, and vocal projection. These vocal behaviors may not be as problematic when they occur inconsistently, but when chronic vocal abuse or misuse occurs, voice problems often arise (Colton & Casper, 1996). Due to the increased use of their voice each day, along with poor vocal hygiene, these professionals have been found to be at a greater risk for developing voice problems than professionals who have less stringent vocal demands and can afford more vocal rest.

Vocal characteristics of a number of vocally demanding professions have been studied at length (Heylen, Wuyts, Mertens, De Bodt, & Van de Heyning, 2002; Kitch & Oates, 1994; Rothman, Brown, & LaFond, 2002; Rothman, Brown, Sapienza, & Morris, 2001; Smith, Lemke, Taylor, Kirchner, & Hoffman, 1998; Timmermans, De Bodt, Wuyts, & Van de Heyning, 2004). Professional voice users are defined as (a) those who depend on a consistent, special, or appealing voice quality as a primary tool of trade and (b) those who, if afflicted with dysphonia or aphonha, would generally be discouraged in their jobs and seek alternate employment (Titze, Lemke, & Montequin, 1997). Although it is known that singers and actors are included in this...
category of professionals, telemarketers, teachers, receptionists, emergency vehicle dispatchers, and broadcasters are also considered to be members of these professions. These people would find it virtually impossible to interact with their clients, students, or audiences without a well-functioning and enduring voice (Titze et al., 1997). In professions such as teaching, vocal stamina is of great importance. On the other hand, in professions such as television and radio broadcasting, and in occupations requiring artistic work, the emphasis is often placed on the quality aspects of voice (Vilkman, 2000).

Unfortunately, artistic voice users may be at particularly high risk for the development of vocal problems. Research suggests that artistic voice users “smoke far too much, they shout and talk too much, and they often eat late...they are a breed unto themselves” (Timmermans et al., 2002, p. 380). Other life-style choices can also affect a performer’s voice, thereby contributing to vocal troubles. Some of the activities that may jeopardize voice quality include smoking, performing in smoke-filled environments, excessive drinking, poor nutritional and eating habits (e.g., intake of too much caffeine), and insufficient sleep. These factors, in addition to the strain brought about by the demands of a vocal profession, are often the reasons for the high incidence of voice problems in the population of professional voice users (Timmermans et al., 2002; Titze et al., 1997; Vilkman, 2000).

Research reveals that people in professions at higher risk for vocal problems could benefit from education and training regarding vocal hygiene and early warning signs of functional vocal pathologies (Ziene & Walter, 2002). Knowledge of the vocal mechanism and training in strategies for improving and maintaining vocal function may serve to prevent vocal problems. This, in turn, may prevent professional vocal deviations and/or poor job performance because of severe or chronic vocal problems, which has been reported in select cases (Bailey & Bowman, 2003; Vilkman, 2000). Ziene and Walter surveyed 79 professional actors, 73 amateur actors, 124 acting students, and 69 individuals serving as controls regarding their interest and knowledge levels of vocal function and disfunction. In the study, the professional actors and amateur actors reported higher perceived knowledge levels than did students or the control group. However, very few of the professional voice performers claimed to have a thorough working knowledge of voice care and maintenance. Kitch and Oates (1994) recommended that information about the prevention of vocal problems be provided for future vocal performers while they are enrolled in university training programs.

There is limited evidence that the onset of vocal deviations may occur before the beginning of a vocally demanding career. Vocal deviation may begin while students are enrolled in preprofessional training programs (Timmermans et al., 2002; Titze et al., 1997). University students studying for vocally demanding careers may be at higher risk for the development of vocal problems than those who are studying for nondemanding careers. Sapir (1993) conducted a survey of 74 female students enrolled in undergraduate and graduate voice programs within one university’s school of music. The students were identified as training for a career in professional voice use, specifically, singing. Results of this survey indicated that 26% of the student participants had one or two symptoms of vocal problems, and a higher percentage (61%) had three or more symptoms. The symptoms identified included hoarseness, reduced pitch range, vocal fatigue, sensation of tightness or pressure in the throat, discomfort in the throat, throat dryness, and pain in the throat. Some of the student participants (20%) reported that these problems had already affected their career goals. In the year before the investigation, they had quit performing, avoided auditioning or taking part in shows/productions/concerts, limited their performance repertoire, or quit singing altogether because of the voice problems they were experiencing.

Timmermans et al. (2002) conducted an investigation of 86 preprofessional voice students who were enrolled in the Department of the Erasmus Institute Brussels at the Royal Conservatory of Brussels and RITS, which is a specialized school for the study of audiovisual communication. Researchers used a multidimensional test battery to assess students’ voice quality in order to analyze acoustic, perceptual, aerodynamic, and stroboscopic information, as well as perceived psychosocial impact of the voice problem on their daily life. The dysphonia severity index (DSI; Wuys et al., 2000) was used to indicate the overall voice quality. DSI is based on the weighted combinations of a selected set of voice measurements, including the highest frequency, lowest intensity, maximum phonation time, and jitter ratios. The voice handicap index (VHI; Jacobson et al., 1997) was also used. Vocal characteristics of future occupational voice users were compared with those of members of a control group that was associated with no vocal pathology or vocal complaint and with perceived normal vocal quality. Timmermans et al. found that the VHI and DSI were significantly worse for the future occupational voice users than for the control group. In almost every parameter, future vocal performers had the poorest ratings outcomes and highest percentages of voice problems when compared with the control group.

Timmermans et al. described that this group of pre-professionals was a “breed unto themselves” and stated that “with their desire to communicate and experiment with sounds and words, they underestimate the risk to their voices” (p. 380). In addition, analysis of self-reported questionnaires suggested that future vocal performers and professional voice users took fewer precautions in the care of their voices. The vocal performers and vocal professionals indicated consistent vocal abuse (22% and 17%, respectively) and high rates of smoking (61% and 40%, respectively). The results support previous research findings that professional voice users have a high incidence of voice-related problems.

It is not known whether a predisposition to vocal deviations begins in the undergraduate preprofessional program or if problems occur as a result of the emotional stress and physical demands of professional voice users. It is important to know when the onset of vocal problems occurs so that educational programs might be instituted before the development of vocal problems that may limit
the careers of future vocal professionals. Students of speech-language pathology and audiology were chosen as a control group because they receive training in vocal hygiene and are exposed to information about the vocal mechanism through their undergraduate coursework, and, perhaps more importantly, because they have not been identified as a professional group with an increased risk of voice problems.

The purpose of the present study was to determine whether students in preprofessional programs that have been identified as having a high risk of voice problems actually experience these problems before beginning their careers. This information is needed to identify student populations who are at risk for development of voice problems. It is possible that this information could be used to develop education and training programs for future voice professionals in order to prevent unnecessary vocal problems.

METHOD

Participants

Sixty-seven individuals (49 females and 18 males) between 18 and 35 years of age participated in the present study. They were undergraduate students who were recruited from three preprofessional majors at Illinois State University: speech-language pathology and audiology (control group), broadcast communication, and theater (experimental groups). The students enrolled in the major of speech-language pathology and audiology were used as a control group for two reasons: (a) They had not been identified as a professional group that is at higher risk for the development of vocal problems, and (2) they had all received information about the vocal mechanism and vocal hygiene during their undergraduate training. Broadcast communication and theater majors were the experimental groups in the study. Purposive samples of two experimental groups were used because of the reported high incidence of voice problems in their subsequent careers.

Speech Samples and Speech Recording

Speech samples used included (a) sustained phonation of vowels /a/, /i/, and /u/, and (b) the first paragraph of the “Rainbow Passage” (Fairbanks, 1960). The recording took place in a sound-treated booth of a voice laboratory. During the recording, the participants were instructed to read the “Rainbow Passage” once and to sustain the vowels three times for at least 5 s at a comfortable loudness level, pitch level, and speech rate. In order to obtain maximum phonation time information, the participants were also asked to sustain vowels /a/, /i/, and /u/ three times for as long as they could. The order at which the speech samples were produced was randomized so as to eliminate the order effect. A brief instruction was given to the participants before the actual recording. However, in order not to influence their production, the participants received no vocal demonstration from the experimenter. During the recording, the condenser microphone (Realistic, Model 33-109B) was placed approximately 8 in. from the participant’s mouth. Speech samples were stored on audiotapes via a high-quality audio recorder (Marantz, Model PDM 101).

Assessment of Voice Quality

Voice quality was assessed in three ways: (a) acoustic measurements, (b) perceptual assessment by a speech-language pathologist (SLP), and (c) a self-reported questionnaire of participants’ vocal characteristics.

Acoustic Measurements and Maximum Phonation Tests

Acoustic measurements included the percent jitter values, percent shimmer values, and harmonic-to-noise ratios for the 5-s vowel production samples and a connected speech sample, the “Rainbow Passage” (Fairbanks, 1960). Maximum phonation times (MPTs) were also recorded for the vowels /a/, /i/, and /u/ and were measured using a stopwatch. To confirm accuracy of MPTs, timings were recorded in real time; tape recordings of the samples were used to confirm accuracy of timing data. Recorded speech samples were digitized at 20,000 Hz using the Computerized Speech Lab (CSL; Model 4300B, Kay Elemetrics). Percent jitter values, percent shimmer values, and harmonic-to-noise ratios were calculated based on the digitized speech samples using the CSL.

Perceptual Assessment of Voice Quality by SLP

Randomized speech samples were presented to an SLP who had more than 10 years of experience in voice evaluation. The SLP rated the voice quality of the speech samples based on four areas: (a) roughness, (b) breathiness, (c) asthenia, and (d) strain. The ratings were categorized using a dichotomy of normal and abnormal. A rating of “0” indicated a normal production, and a rating of “1” indicated perception of abnormality. Because the ratings were later used for statistical analyses, no attempt was made to scale the severity of voice problem. A rating of “1” was given to an abnormal quality of any extent.

In order to test for reliability of the perceptual ratings, 20% of the speech samples were randomly selected and rated by a second SLP who was also experienced in perceptual voice evaluation. The results were used to determine the validity and reliability of the ratings provided by the first SLP.

Self-Reported Vocal Characteristics

Similar to the study reported by Timmermans et al. (2002), a questionnaire on vocal use and vocal problems was used to obtain self-reported vocal characteristics from the participants (see Appendix). Based on one’s daily habits on voice use, each participant completed a questionnaire that
included questions and risk factors regarding vocal problems, medication, and medical history pertinent to voice use. Participants also indicated the number of late meals per week, presence and amount of vocal abuse, and presence and amount of additional life-style factors of voice problems such as smoking and drinking. Individuals with current or chronic respiratory illnesses that were known to affect voice production (e.g., asthma, chronic bronchitis) were excluded from the study. The scoring of the self-reported vocal characteristics was as follows: a score of “1” was assigned to responses A, B, or C, and “0” to responses D, E, or F. Total scores were calculated and statistically tested.

RESULTS

Acoustic Measurements and Maximum Phonation Tests

Acoustic measurements included percent jitter values, percent shimmer values, and harmonic-to-noise ratios for the 5-s voice samples (see Figures 1, 2, and 3). Average MPT values were measured from the entire sustained vowel production (see Figure 4). Percent jitter values were obtained from the “Rainbow Passage” (Fairbanks, 1960).

Despite the variability in percent jitter measurements, students of the speech-language pathology and audiology and theater majors generally demonstrated a greater percent jitter value than did normal individuals (Horii, 1979, 1982). Students of the speech-language pathology and audiology major exhibited a mean percent jitter of 0.794%; broadcast communication, 0.642%; and theater, 0.879% (see Figure 1), compared with the normative percent jitter value of approximately 0.668%, as reported by Horii (1982). Average percent shimmer values were found to be 0.251 for students of speech-language pathology and audiology, 0.233 for those of broadcast communication, and 0.244 for those of theater (see Figure 2). With respect to harmonic-to-noise ratio, students of speech-language pathology and audiology exhibited 12.52 dB; broadcast communication, 10.89 dB; and theater, 10.85 dB (see Figure 3).

Results of two-way (3 majors × 3 vowels) analyses of variance (ANOVAs) indicated no significant interactions between different preprofessional voice programs and vowels with respect to percent jitter values, $F(4, 195) = 1.88, p = 0.116$; maximum phonation time values, $F(4, 195) = 0.15, p = 0.964$; percent shimmer values, $F(4, 195) = 0.17, p = 0.954$; and harmonic-to-noise ratio, $F(4, 195) = 0.39, p = 0.814$. No significant main effects for vowels were found for percent jitter values, $F(2, 195) = 10.43, p = 0.107$; maximum phonation time, $F(2, 195) = 1.026, p = 0.360$; and percent shimmer values, $F(2, 195) = 0.94, p = 0.392$. However, significant difference in harmonic-to-noise ratio was found between different vowels, $F(2, 195) = 8.67, p = 0.000$. A subsequent Scheffé post-hoc $t$ test indicated that the vowel /u/ was associated with significantly greater harmonic-to-noise ratio than both vowels /i/ and /a/.

With respect to preprofessional voice programs, no significant main effect was found for maximum phonation time, $F(2, 195) = 1.45, p = 0.236$; percent shimmer values, $F(2, 195) = 0.11, p = 0.897$; and harmonic-to-noise ratio, $F(2, 195) = 1.75, p = 0.177$. However, a significant difference was found in average percent jitter values between different majors, $F(2, 195) = 6.36, p = 0.009$. A Scheffé post-hoc test showed that students of the theater...
major exhibited significantly higher average percent jitter values than students of speech-language pathology and audiology and broadcast communication. In addition, a one-way ANOVA indicated no significant difference in average percent jitter values obtained from the “Rainbow Passage” among different majors, $F(2, 62) = 0.39$, $p = 0.681$.

**Perceptual Assessment of Voice Quality by SLP**

Perceptual ratings of participants’ voice quality provided by the SLP were obtained for vowels /a/, /i/, and /u/ based on four areas: roughness, breathiness, strain, and asthenia. Table 1 shows the average ratings for different majors for vowels /a/, /i/, and /u/, and the “Rainbow Passage” (see also Figures 5 and 6). Results of Pearson chi-square tests revealed significant correlations in (a) roughness quality in vowels /a/, $\chi^2(2, N = 67) = 14.48$, $p = 0.001$; /i/, $\chi^2(2, N = 67) = 11.77$, $p = 0.003$; /u/, $\chi^2(2, N = 67) = 15.89$, $p = 0.000$; and the “Rainbow Passage,” $\chi^2(2, N = 67) = 18.10$, $p = 0.000$; (b) breathiness quality in vowels /a/, $\chi^2(2, N = 67) = 10.24$, $p = 0.006$; /i/, $\chi^2(2, N = 67) = 13.54$, $p = 0.001$; /u/, $\chi^2(2, N = 67) = 13.82$, $p = 0.001$; and the “Rainbow Passage,” $\chi^2(2, N = 67) = 6.46$, $p = 0.040$; and (c) strain quality in vowels /a/, $\chi^2(2, N = 67) = 13.33$, $p = 0.001$; /i/, $\chi^2(2, N = 67) = 10.85$, $p = 0.004$; and /u/, $\chi^2(2, N = 67) = 11.02$, $p = 0.004$, only. All significant findings were found in participants with theater majors, but not in those of speech-language pathology and audiology and broadcast communication majors. For “Rainbow Passage,” strain quality rating was not significantly correlated with majors, $\chi^2(2, N = 67) = 5.29$, $p = 0.071$. Asthenia quality ratings of both vowels and “Rainbow Passage” were not significantly correlated with any of the three majors.

**Interrater Reliability of Perceptual Ratings**

To test the reliability of perceptual ratings given by the SLP, 20% of the speech samples were randomly selected and were re-rated by another SLP who was also experienced in perceptual voice evaluation. The results from the 2 SLPs were compared and a correlation coefficient was 0.000; and the “Rainbow Passage,” $\chi^2(2, N = 67) = 18.10$, $p = 0.000$; (b) breathiness quality in vowels /a/, $\chi^2(2, N = 67) = 10.24$, $p = 0.006$; /i/, $\chi^2(2, N = 67) = 13.54$, $p = 0.001$; /u/, $\chi^2(2, N = 67) = 13.82$, $p = 0.001$; and the “Rainbow Passage,” $\chi^2(2, N = 67) = 6.46$, $p = 0.040$; and (c) strain quality in vowels /a/, $\chi^2(2, N = 67) = 13.33$, $p = 0.001$; /i/, $\chi^2(2, N = 67) = 10.85$, $p = 0.004$; and /u/, $\chi^2(2, N = 67) = 11.02$, $p = 0.004$, only. All significant findings were found in participants with theater majors, but not in those of speech-language pathology and audiology and broadcast communication majors. For “Rainbow Passage,” strain quality rating was not significantly correlated with majors, $\chi^2(2, N = 67) = 5.29$, $p = 0.071$. Asthenia quality ratings of both vowels and “Rainbow Passage” were not significantly correlated with any of the three majors.

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**Table 1. Average perceptual ratings for different speech samples for different majors.**

<table>
<thead>
<tr>
<th>Major</th>
<th>Roughness</th>
<th>Breathiness</th>
<th>Asthenia</th>
<th>Strain</th>
</tr>
</thead>
<tbody>
<tr>
<td>Speech-language pathology</td>
<td>0.280</td>
<td>0.103</td>
<td>0.000</td>
<td>0.069</td>
</tr>
<tr>
<td>/a/</td>
<td>0.200</td>
<td>0.000</td>
<td>0.000</td>
<td>0.100</td>
</tr>
<tr>
<td>/i/</td>
<td>0.210</td>
<td>0.000</td>
<td>0.000</td>
<td>0.000</td>
</tr>
<tr>
<td>/u/</td>
<td>0.280</td>
<td>0.103</td>
<td>0.000</td>
<td>0.030</td>
</tr>
<tr>
<td>Rainbow Passage</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Communication</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/a/</td>
<td>0.680</td>
<td>0.316</td>
<td>0.000</td>
<td>0.211</td>
</tr>
<tr>
<td>/i/</td>
<td>0.500</td>
<td>0.400</td>
<td>0.100</td>
<td>0.200</td>
</tr>
<tr>
<td>/u/</td>
<td>0.420</td>
<td>0.300</td>
<td>0.000</td>
<td>0.200</td>
</tr>
<tr>
<td>Rainbow Passage</td>
<td>0.740</td>
<td>0.421</td>
<td>0.000</td>
<td>0.160</td>
</tr>
<tr>
<td>Theater</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>/a/</td>
<td>0.790</td>
<td>0.526</td>
<td>0.000</td>
<td>0.526</td>
</tr>
<tr>
<td>/i/</td>
<td>0.700</td>
<td>0.500</td>
<td>0.000</td>
<td>0.500</td>
</tr>
<tr>
<td>/u/</td>
<td>0.790</td>
<td>0.400</td>
<td>0.000</td>
<td>0.400</td>
</tr>
<tr>
<td>Rainbow Passage</td>
<td>0.840</td>
<td>0.263</td>
<td>0.000</td>
<td>0.260</td>
</tr>
</tbody>
</table>
calculated. The value was used to indicate the reliability of the perceptual ratings provided by the SLP. A correlation coefficient of 0.95394 was found, indicating that the perceptual ratings provided by the SLP participating in the present study were less than 5% different from the ratings provided by another individual, which was considered a reliable rating.

**Self-Reported Vocal Characteristics**

The average ratings on the 10 self-reported vocal characteristics are depicted in Table 2. Pearson chi-square correlation tests were performed on the self-reported voice characteristics. Results indicated that only self-reported morning hoarseness and strained or tired voice were significantly correlated with university major: $\chi^2(2, N = 62) = 7.20, p = 0.027$ for morning hoarseness; and $\chi^2(2, N = 62) = 9.00, p = 0.011$ for strained or tired voice. Students of theater majors were significantly correlated with self-reported morning hoarseness and strained voice.

Other aspects of self-reported voice characteristics, including low or hoarse voice, $\chi^2(2, N = 62) = 9.00, p = 0.011$; voice breaks, $\chi^2(2, N = 62) = 7.20, p = 0.027$; voice loss, $\chi^2(2, N = 62) = 4.82, p = 0.090$; throat clearing and coughing, $\chi^2(2, N = 62) = 3.15, p = 0.207$; pain in the throat, $\chi^2(2, N = 62) = 1.21, p = 0.546$; lump in the throat, $\chi^2(2, N = 62) = 0.384$; voice breaks, $\chi^2(2, N = 62) = 1.21, p = 0.546$; lump in the throat, $\chi^2(2, N = 62) = 0.384$; strain, $\chi^2(2, N = 62) = 1.28, p = 0.526$; and difficulty being heard, $\chi^2(2, N = 62) = 0.426, p = 0.808$, were not statistically correlated with any major.

**DISCUSSION**

Voice problems have been reported to be more common among professional voice users than among nonprofessional voice users. Such prevalence of vocal problems was believed to be closely related to their professions, requiring heavy and prolonged use of the vocal mechanism. The present study attempted to determine if such prevalence already exists during students’ preprofessional training programs.

*Table 2. Average ratings of self-reported vocal characteristics for different majors.*

<table>
<thead>
<tr>
<th>Voice Characteristic</th>
<th>SLP</th>
<th>Communication</th>
<th>Theater</th>
</tr>
</thead>
<tbody>
<tr>
<td>Morning hoarseness</td>
<td>0.1724</td>
<td>0.3889</td>
<td>0.5790</td>
</tr>
<tr>
<td>Strain</td>
<td>0.2414</td>
<td>0.4444</td>
<td>0.4211</td>
</tr>
<tr>
<td>Low or hoarse voice</td>
<td>0.2414</td>
<td>0.2222</td>
<td>0.2631</td>
</tr>
<tr>
<td>Voice breaks</td>
<td>0.1724</td>
<td>0.2778</td>
<td>0.1579</td>
</tr>
<tr>
<td>Loss of voice</td>
<td>0.1724</td>
<td>0.1100</td>
<td>0.1579</td>
</tr>
<tr>
<td>Difficulty to be heard</td>
<td>0.2759</td>
<td>0.1667</td>
<td>0.1579</td>
</tr>
<tr>
<td>Frequent throat clearing</td>
<td>0.3793</td>
<td>0.5000</td>
<td>0.2632</td>
</tr>
<tr>
<td>Pain in the throat</td>
<td>0.1724</td>
<td>0.1111</td>
<td>0.1579</td>
</tr>
<tr>
<td>Feeling of lump in throat</td>
<td>0.1724</td>
<td>0.1667</td>
<td>0.1579</td>
</tr>
<tr>
<td>Tension</td>
<td>0.2759</td>
<td>0.2222</td>
<td>0.3158</td>
</tr>
</tbody>
</table>

*Note. SLP = speech-language pathology.*

Four acoustic parameters representing the objective physical measurement of voice quality were used. Harmonic-to-noise ratio has been used to represent the relative amount of noise that is present in a speech sample. It is believed that the more aperiodic vocal fold vibration is, the lower the harmonic-to-noise ratio is. Yamoto, Sasaki, and Okamura (1984) found that harmonic-to-noise ratios were highly correlated with the amount of perceived hoarseness. In the present study, average harmonic-to-noise ratio values for students of speech-language pathology and audiology, broadcast communication, and theater majors were found to be within the normal range as compared with data reported by Yamoto, Gould, and Baer (1982). According to Yamoto et al. (1982), normal speaking individuals exhibited a mean harmonic-to-noise ratio of 11.9 dB, standard deviation of 2.32 dB, and range of 7.0 dB to 17.0 dB.

Of the four parameters, only average percent jitter values obtained from vowels were found to be significantly different among majors, but not average percent shimmer values, harmonic-to-noise ratios, or MPT (see Figures 1–4). In their vowel productions, students of the theater major demonstrated significantly higher percent jitter values than did speech-language pathology and audiology and broadcast communication majors. However, several of the self-reported vocal characteristics and perceptual ratings provided by the SLP indicated that the voice quality of students of the theater major were significantly worse than the others. Perceptual ratings given by both the SLP and the participants themselves indicated more vocal deviations in the speech sample produced by students of the theater major.

Vocal fold vibration of a hoarse voice, in theory, is associated with greater aperiodicity and thus should result in greater noise. Accordingly, shimmer and jitter should be increased and harmonic-to-noise ratio should be reduced. However, in the present study, both average percent shimmer values and harmonic-to-noise ratio were not found to be indicative of the voice problems. Such discrepancy between acoustic measurements and perceptual ratings from the SLP and the participants may imply that acoustic measurements are not as accurate and responsive toward vocal deviation as perceptual ratings, particularly when vocal deviation is not apparent. Perceptual judgment from both the SLP and the participants themselves appears to be more sensitive toward subtle deterioration of vocal quality. Despite the use of the SLP’s audition and judgment, faithful and reliable ratings of voice quality can still be obtainable.

In the analyses of perceptual ratings, significant correlations were found between majors and strained voice quality for vowels /a/, /i/, and /u/, but not in reading the “Rainbow Passage.” Vocal quality was generally perceived as more normal in reading the “Rainbow Passage” than in sustained vowel productions. This indicates that the use of continuous speech instead of sustained vowels tended to yield perceptual voice quality ratings that indicate less deviation. The addition of semantic and contextual information in the speech samples appears to have reduced the threshold for the judgment of disordered voice quality. Listeners tended to be more demanding when judging sustained vowels than...
Acoustic measurements and perceptual ratings from both sources indicated that students who were enrolled in a theater major were associated with a higher incidence of voice deviations when compared with students who were enrolled in speech-language pathology and audiology and broadcast communication majors. This may be explained by the nature of this unique field of study. Training in a theater major (including those with a specialization in acting) often requires students to perform in a group setting and in an open area (such as in the auditorium) without any amplification. To excel at performance, students are encouraged to practice their performances repeatedly with minimum rest. As a result, voice is used heavily and repeatedly, often without adequate rest. Moreover, the environment in which these artistic presentations take place is usually open and not devoid of noise. Students often must practice their performances over loud background noise. Such repeated and prolonged hyperfunctional use of voice in these students apparently increases the likelihood of developing vocal problems.

In addition, according to the current curriculum of theater majors, not all of the students are required to take courses on professional voice use. Of the four undergraduate major programs in theater (i.e., acting, design/production, theater education, arts technology), just one (acting) required coursework in the area of voice. The majority of the theater major participants generally lacked formal training in vocal hygiene and the knowledge of prevention of vocal problems. Also, the students enrolled in the theater major by nature tended to be more performance oriented and possessed a more outgoing personality than others. In fact, data from the self-report questionnaires indicated that students in the theater major were more likely to have a smoking habit and to lack sleep than students of the speech-language pathology and audiology and broadcast communication majors. This observation is consistent with the findings reported by Timmermans et al. (2002). It may explain why students in the theater major tend to have poorer voice quality and higher incidence of vocal deviations.

On the basis of the findings from the present study, it is suggested that some formal training on the vocal mechanism, correct vocal use, and vocal hygiene be provided to students with majors leading to vocally demanding careers. In fact, this suggestion is in line with the recommendation put forth by Kitch and Oates (1994) and Timmermans et al. (2004).

CONCLUSION

Professional voice users have been reported to have a higher incidence of vocal deviations due to the unique usage patterns of their voices. However, results from the present study reveal that future professionals with high vocal demands may have experienced voice problems earlier during their undergraduate education and training programs. On the basis of the data from acoustic measurements, perceptual ratings by an SLP, and a self-reported voice characteristics questionnaire, students of the theater major demonstrated higher incidence of voice problems than did students of speech-language pathology and audiology and broadcast communication majors. The prevalence of vocal deviations is believed to be due to the nature of the discipline. It is suggested that in order to minimize vocal misuse and subsequent voice problem, formal voice education and training should be provided to students of the theater major. This may also prove to be true of students who are enrolled in other majors leading to a vocally demanding career such as teaching or social work.

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REFERENCES


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APPENDIX. SELF-REPORTED VOCAL CHARACTERISTICS QUESTIONNAIRE

Name: __________________________ Age: _______ Sex: _______

Classification

- __ elite vocal performer  Explain: __________
- __ professional voice user  Explain: __________
- __ nonvocal professional  Explain: __________
- __ nonvocal nonprofessional  Explain: __________

Risk Factors

Please complete the list below and indicate the number of units of consumption of the listed products per day and/or week when indicated.

**Risk Factors: units a day**

<table>
<thead>
<tr>
<th>Product</th>
<th>Units per day</th>
<th>(estimate ounces per drink)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alcohol</td>
<td>_____</td>
<td>(estimate ounces per drink)</td>
</tr>
<tr>
<td>Coffee</td>
<td>_____ cups per day</td>
<td>_____ decaffeinated</td>
</tr>
<tr>
<td>Soft drinks</td>
<td>_____ per day</td>
<td>_____ decaffeinated</td>
</tr>
<tr>
<td>Peppermint</td>
<td>_____ per day</td>
<td></td>
</tr>
<tr>
<td>Late meals</td>
<td>_____ days per week</td>
<td></td>
</tr>
</tbody>
</table>

**Risk Factors: voice use**

Vocal abuse: _____ yes _____ no  Explain:

Smoker: _____ yes _____ no  Estimate # cigarettes per day __________

Medication

Please write down the amount and kind of medication you take (e.g., sleeping pills, asthma medications, medications for the stomach including antacids).

Medical History

Please mention surgical treatments for the stomach or throat.

Have you had the following vocal symptoms during the past year? For each of the following symptoms, please indicate if and how often you experience the problems using these letters:

A. Daily or most days  B. Weekly or most weeks  C. Monthly or most months  D. Less often than above  E. Periodic symptoms (very infrequent)  F. No symptoms

<table>
<thead>
<tr>
<th>Symptom Description</th>
<th>Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>morning hoarseness</td>
<td>_____</td>
</tr>
<tr>
<td>strained or tired voice</td>
<td>_____</td>
</tr>
<tr>
<td>voice gets low or hoarse while talking</td>
<td>_____</td>
</tr>
<tr>
<td>voice breaks while talking</td>
<td>_____</td>
</tr>
<tr>
<td>lose voice for a few minutes while talking</td>
<td>_____</td>
</tr>
<tr>
<td>difficulty being heard</td>
<td>_____</td>
</tr>
<tr>
<td>throat clearing or coughing while talking</td>
<td>_____</td>
</tr>
<tr>
<td>feel pain in the throat while talking</td>
<td>_____</td>
</tr>
<tr>
<td>feel lump in the throat while talking</td>
<td>_____</td>
</tr>
<tr>
<td>feel tension in the throat while talking</td>
<td>_____</td>
</tr>
</tbody>
</table>