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Perception of Voice Use and Problems in Female Singers and Broadcasters: An Impairment, Activity Limitation and Participation Restriction Perspective

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Perception of Voice Use and Problems in Female Singers and Broadcasters: An Impairment, Activity Limitation and Participation Restriction Perspective

Abstract

Broadcasters and singing students are in a profession that requires frequent voice use for presentation and performance. They are at high risk of having voice disorder. In this study, the degree of voice impairment and the impact on quality of life in eight female singing students and six broadcasters was investigated and compared with those in eight female speech pathology students. The degree of voice impairment was measured by perceptual and acoustic measures while the impact on quality of life represented by voice activity limitation and participation restriction was measured by the Voice Activity and Participation Profile. Results showed no significant differences in voice impairment among the three groups. The broadcasters and singing students perceived their voice problems having greater impact on quality of life than the speech pathology students. In comparing with the speech pathology students, the singing students perceived greater effect on job and emotional areas ($p<0.01$), while the broadcasters perceived greater effect on job and communication areas ($p<0.05$). The data also showed that the degree of impact in the level of voice activity limitation and participation restriction did not correlate with the impairment level in these two groups ($p>0.05$). The findings highlight the importance of managing the impact of voice problems among professional users with different types of phonatory demands and identify the specific needs in singing students and broadcasters.

Key Words: voice impairment, activity limitation, participation restriction, quality of life

Introduction

Voice problems are common in life due to reasons such as prolonged voice use or under stress. To many people, the change may be temporary and does not cause any significant impact on their life. However, to the professional voice users who rely on their voices to perform job-related tasks, their situation may be different. Professional voice users are individuals who require various phonatory abilities and demands in their job (Harvey, 1997). According to the continuum of phonatory demands in professional voice (Fried, 1996), as shown in Figure 1, three types of voice use demands across the continuum were identified. They progress from the least demanding voice use in *conversation* and *presentation* to the most difficult *performance* type. Professionals voice users requiring conversation include professionals such as speech therapists, telephone operators and receptionists. They mainly use normal speaking voice in their job-related tasks. Professionals such as teachers, preachers and broadcasters require presentation in their voice use, in which intensive, loud and clear voice would be expected from them. Singers and actors are professionals that require the highest type of voice use demands: *performance*, needing finer vocal and air-stream control to attain a certain note with a particular vocal intensive to express the emotion conveyed by the voice.

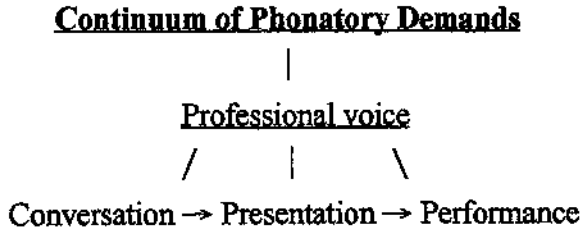

Figure 1. Phonatory demands of professional voice use

Voice problems are frequently reported in professional voice users who require different types of voice demands (e.g. Smith, Verdolini, Gray, Nichols et al. 1996; Smith, Lemke, Taylor, Kirchner & Hoffman, 1998). Singers have a high propensity in developing voice problems (e.g. Phyland, Oates, & Greenwood, 1999, Sapir, Mathers-Schmidt, & Larson, 1996; Sataloff, 1984,

1987). It is also found that voice problems are common among singing students (over 50%) (Galloway & Barry, 1981; Sapir, 1993), and so were the broadcasters (84%) (Benninger, 1995). However, the perception of their voice problems and the respective impacts to their life were not well documented. And it would not be surprising that voice problems would be experienced in different domains for different type of professional voice use.

Apart from the abnormality detected structurally (anatomical or physiological) in the larynx and auditory in voice quality, the impact of voice problems can affect various aspects of life, which include social functioning, psychological functioning and daily communication. Using the International Classification Impairments, Disabilities and Handicaps (ICIDH-) framework (Word Health Organization [WHO], 1980, 1997), voice problems could be viewed from three levels of experiences; impairment with a laryngeal dysfunction, limitations in performing vocal activities, and participation restriction in occupational, social and economic areas. For a vocal student with voice problem, one may experience limitation in singing high notes or certain difficult songs that require a precise laryngeal control. As a consequence, this prevents the student to perform in a concert. For a broadcaster, one may experience limitation in producing clear loud voice in the studio or broadcasting a continuous long program.

Therefore, three levels of experiences of voice problem can be affected independently according to different contextual factors (WHO, 1997). The contextual factors include environmental factors such as physical, social and attitudinal environment in which people live and conduct their lives and personal factors that concerns the individual background of an individual's life and living. The level of professional voice demands could be one of the factors. For vocal students, they constantly have vocal training and practice, but at the same time they may have a higher tendency to worry about their voice function since they require higher quality of vocal control in performance. This may in turn result in voice problems easily (Sapir, 1993). At the same time, they may be more sensitive to their voice problems and its impact may be

perceived more significantly compared to non-vocal students (Phyland et al., 1999). On the other hand, broadcasters may have little vocal training for intensive voice use in presentation and thus may result in voice problems due to inappropriate voice use. Yet, they may perceive their voice problem to have a lesser degree of impact because the demand of voice use (presentation) in their profession does not require fine vocal control like singers.

Influenced by the ICIDH model (WHO, 1997), several voice evaluation methods apart from the instrumental and auditory perceptual analysis were thereafter developed (e.g. Enderby & John, 1997; Jacobson, Johnson, Grywalski, Silbergleit et al., 1997; Koschkee, 1993 and Smith et al., 1996). They aim to assess the impact of the patient's quality of life. For example, Jacobson et al. (1997) developed the Voice Handicap Index (VHI) consisted of 30 questions groups to the physical, functional and emotional domains. The VHI has been used by Rosen and Murry (2000) to investigate the degree of handicap expressed by singers with voice complaints. The singers' perception of disability due to a voice disorder in the three areas was measured. However, the limitation that a person may find with an activity and the willingness of that person to participate in that activity as a result of the disorder was unclear, as the VHI does not assess these two levels of experience separately. Also, the finding was limited to singers and it is not clear whether the voice problems reported by professionals at different level of professional voice use demands are restricted to the impairment level or a particular domains of impact on life including occupational, communication, social and emotional areas.

To fill the gap of these unknown, therefore, the purpose of this study was to find out the voice problems of professionals who require conversation, presentation or performance voice demands and their perception of the problems related to their life in different domains and in the three levels of experience. Professional voice users with higher voice demands including singing students and broadcasters were chosen to compare with speech pathology students who only required the lower voice demands to investigate their voice problem and perception of it. Only

females were recruited because they were more frequent to report suffer in work and communication effects (Smith et al., 1998).

To measure the impact of the disorder on the limitation of voice activities and restriction in participation, the Voice Activity and Participation Profile (VAPP) (Ma & Yiu, 2001) designed to investigate self-perceived voice problem on life was employed. VAPP was chosen among other self-assessing tools (e.g. Enderby, 1997; Hogikan & Sethuraman, 1999; Jocobson et al., 1997; Koschekee, 1993; Smith et al., 1996) because it assesses the degree of activity limitation and participation restriction separately. It explores an individual's limitation of activities and their reduced participation in the domains of job, daily communication and social communication due to voice impairment. The severity of self-perceived voice problems and the effect on emotion disturbance are also included. Besides, the severity of voice impairment will be measured by auditory-perceptual and acoustic evaluations (details will be discussed in the Methodology section).

Three hypothesis were tested: (1) Singing students and broadcasters had more voice symptoms and perceived the symptoms as having greater impact on quality of life than speech pathology students. (2) The degree of impact in the level of voice activity limitation and participation restriction does not correlate with the impairment level in singing students and broadcasters. (3) Singing students and broadcasters experience different domains of impact in the quality of life in experiencing voice problem.

The findings in this research will be crucial for predicting and for a better understanding of voice problems and its relationship with different types of professional voice use demands among singing students and broadcasters. Furthermore, the importance of subjective perception rather than solely the degree of voice impairment may be highlighted in future prevention and management efforts of voice problems.

Method

Subjects

The subjects consisted of three groups, singing students, broadcasters and speech pathology students. A total of 45 subjects were recruited for this experiment: 20 singing students, 15 speech students and 10 broadcasters. Subjects were recruited personally by the experimenter on a voluntary basis. The singing students were full-time students recruited from the Hong Kong Academy for Performance Arts (APA), the speech pathology students were undergraduates from the University of Hong Kong, and the broadcasters were from the Metro Broadcast Corporation Ltd. The selection criteria for all groups include (1) no report of any illness including upper respiratory infection, influenza, cold or allergic reaction in the last two weeks, and (2) for the last 12 months, engage in either full time study and, in the case of singing students, have at least been trained in singing classical music for one year; or full time employment in the case of broadcasters.

Materials

To measure the degree of voice impairment, connected speech samples based on the sentence /ba ba da bɔ/ (The father is hitting the ball) was recorded for each subject. This connected speech was considered as representative and reliable for vocal behaviors (De Krom, 1994). Bruel & Kjær O Type microphone was used for recording. For the singing students and broadcasters, the speech signal were recorded first in a DAT tape due to practical difficulty in inviting these subjects to the voice clinic for recording. The speech signals of the speech students were recorded directly in the Kay's Multi-Dimensional Voice Program (MDVP: Kay Elemetrics Corp., model 4300B). To measure the perception of voice use and problems on quality of life, Voice Activity and Participation Profile (VAPP) (Ma & Yiu, 2001) using an 11-equal-appearing interval (EAI) scales was employed, with the left end of the scale represents 'not affected' and the right end represents 'always affected'. It was made up of five sections that explore

individuals' limitation of activities and their reduced participation in the domains of job, daily communication and social communication due to voice impairment. Each area is assessed by a number of paired-questions. The first question of each pair addresses the extent of limitation that a person may encounter in particular voice-related activities. The second question addresses the extent of participation restriction perceived by the respondents in that corresponding voice-related activity. Besides, the severity of self-perceived voice problems and the effect on emotional disturbance were also asked. Personal information such as age, gender, medical history, self-reported vocal symptoms, register and genre of singing for singing students, general speaking and singing voice use pattern was obtained through a questionnaire.

Procedures

Subjects were recorded individually in a sound-proofed cubicle. They were required to read a written instruction that explains the purpose of the project with a confidential statement and what they have to do before participating the research study. All were given the Voice Activity and Participation Profile (VAPP) and the additional questionnaire to complete. Besides, they are required to produce the Cantonese sentence /ba ba da bɔ/ (The father is hitting the ball) for three times at a comfortable loudness and pitch for recording from the microphone held at 10 cm away from the center of each subject's mouth. Subjects were allowed to practice the sentence a few times before the actual recording. During the recording, a sound level meter was used to monitor background noise below 40 dB SLP.

Acoustic analysis of voice samples. The voice samples recorded on DAT tape were extracted and output through the analogue channel to the Kay Elemetric's Computerized Speech Lab (CSL) Model 4300B. They were low-pass filtered at 5 kHz and then digitized at a sampling rate of 50kHz. Connected speech (/ba ba da bɔ/) was chosen for the acoustic analysis because it is found to be more representative of functional voice use than isolated speech sounds (Askenfelt & Hammarberb, 1986; Hammarberg, Fritzell, Gauffin, Sundberg, & Wedin, 1980; Laver, Hiller, &

Beck, 1992). The Kay's Multi-Dimensional Voice Program (MDVP) was used for the analysis since it was tolerant to the variation of acoustic properties in connected speech samples (Yiu, Worrall, Longland & Mitchell, 2000).

Due to constraints on time and resources, only the second of the three recordings were analyzed. Each sentence was segmented to include the onset of phonation of the first word (/ba/) and the offset of the last word (/bɔ/). Three measurements: relative average frequency perturbation, amplitude shimmer in percent and noise-to-harmonic ratio were obtained from each segment. They are shown to correlate with common perceptual roughness and breathiness (Martin, Fitch, & Wolfe, 1995; Millet & Dejonckere, 1998; Wolfe & Steinfatt, 1987).

Reliability in segmenting signals for acoustic analysis. In order to evaluate the reliability in segmenting the voice samples for acoustic analysis, six randomly selected samples (25% of all the samples) were re-segmented by the author and another fourth-year speech pathology student. The three measurements obtained from these signals were used to calculate the inter- and intra-judge reliability in segmenting the signal using Pearson's correlation coefficient.

Perceptual analysis of voice samples. Three final-year female speech pathology students were invited as judges for the perceptual evaluation as they received similar amount of training on voice perceptual analysis to form a 'homogeneous group' (De Krom, 1994). Breathiness and roughness are used as perceptual parameters as they are found to be reliable in perceptual evaluation (Dejonckere, Obbens, de Moor & Wieneke, 1993). A training program developed by Chan (2000) was employed for the perceptual evaluation to increase the intra- and inter-reliability of the judges prior to the actual evaluation. The training program provides the definitions of roughness and breathiness adopted from the Clinical Voice Evaluation Profile (Yiu, 1996) and consists of a series of 26 female synthesized voice samples with different degrees of roughness and breathiness. Judges were asked to judge the severity of breathiness and roughness on the 11-point EAI scale independently. The left end of the scale represented 'normal' and the

right end indicated 'severe disruption'. Suggested answers were provided after the practice. The whole training session lasted for approximately 20 minutes.

Inter-and intra-judge reliability in perceptual analysis. To further assess the reliability in the perceptual evaluation process, all the voice samples (i.e. 22 samples) were duplicated and included in the stimulus set. Each judge took about 30 minutes to complete the evaluation.

Measurement on quality of life. Impacts on quality of life are measured by (1) the VAPP total scores (sum of five section scores) and (2) section scores (including self-perceived voice problem, job, daily communication, social communication and emotional scores), (3) total activity limitation score (ALS), and (4) total participation restriction scores (PRS). The mean scores of each subject group on each of the above parts were compared. The correlation (Pearson's *r*) of acoustic and perceptual measurements and the various VAPP scores (five section scores, total ALS and PRS scores) were taken. Pearson's r was used because the variables are measured by means of interval scales. This would be useful to answer whether the level of voice impairment would be dissociated with the degree of activity limitation and participation restriction in different domains, and whether the degree of self-perceived problem will closely correlate with the impairment level among different subject groups. Furthermore, the ALS & PRS scores of job, daily communication and social communication sections in each group will be compared by using two-tailed Wilcoxon sign rank tests since the data are paired and of ordinal type. This is to see if there is any difference in ALS and PRS scores for each section and if the degree of activity limitation and participation restriction is affected differently in each section.

Results

Of the 45 subjects recruited, 12 of the 20 singers (60%), seven of the 15 speech students (47.8%) and four of the 10 broadcasters (40%) reported recent illness (within the last 2 weeks) that had affected their voice (e.g. upper respiratory infection, influenza, cold, allergic reaction). Thus, they were excluded from further analysis. That phenomenon of having a large number of

subjects reporting recent illness may be related to the time of recruitment for this study, since the subjects were evaluated in winter, during the outbreak of winter upper respiratory infection season. As a result, only of 22 subjects were analyzed; eight singing students, eight speech pathology students and six broadcasters. All of them are females, single and nonsmokers. Table 1 lists the mean age, standard deviation and range of age for each group. Significant difference in age between broadcasters and speech pathology students (U = 1.00, p = 0.003) and between broadcasters and singing students (U=3.00, p=0.006) was found, but not between singing students and speech pathology students (U=30.50, p = 0.87).

Table 1. Mean age of subject groups

Age	Singing Students Group	Speech Pathology Student Group	Broadcasters Group
Mean	21.25	21.38	27.16
Standard Deviation	3.01	2.26	2.79
Range	17-26	19-25	25-32

Voice use patterns of singing students, broadcasters and speech pathology students

All the singing students sing classical opera. There were seven sopranos and one mezzo-soprano. The average number of years of singing training was 3.2 (1.5 *s.d.*), ranging from 1.25 to 5.25 years. The average number of hours for singing practice per week was 4.7 (1.7*s.d.*) ranging from 2 to 7 hours and their average warm up time before singing was 14.1 minutes (7.7 *s.d.*). The performance time per month was 2.1 (1.4 *s.d.*) ranging from 1 to 4.5 hours. For the speech pathology students and broadcasters, the average number of hours for professional voice use per week was 4.8 (1.7 *s.d.*), ranging from 2 to 7 hours and 6.8 (3 *s.d.*), ranging from 4 to 11 hours respectively. The time of broadcasting for each time ranges from 10 to 30 minutes. Broadcasters had an average 1.58 years (0.6 *s.d.*) working in broadcasting profession. In comparing the three groups, there was no significant difference with regard to the number of hours of professional voice use per week (Kruskal-Wallis Test: χ^2=1.61, p=.45).

Reliability in segmenting signals for acoustic analysis

The values of the acoustics measurements from the re-segmented signals were analyzed in order to determine the reliability in segmenting the signal. The inter- and intra-judge correlation coefficients were 0.93 (p=0.001) and 0.98 (p=0.001).

Inter- and intra-judge reliability in perceptual voice evaluation

Table 2 shows the inter- and intra-judge correlation coefficients and percentages of agreement within 1-point on the EAI on the breathiness and roughness. The inter- and intra-reliability coefficient (Pearson's r) were above 0.4 and 0.6 respectively (p=0.01).

Table 2. Inter- and intra-judge reliability and agreement in perceptual voice evaluation

		Pearson's *r*	% of agreement (within 1 point on the EAI)
Inter-judge	**Judge 1 – Judge 2**	0.47**	88.6%
	Judge 1 – Judge 3	0.44**	88.6%
	Judge 2 – Judge 3	0.42**	100%
Intra-judge	**Judge 1**	0.68**	97.7%
	Judge 2	0.77**	97.7%
	Judge 3	0.83**	100%

** Correlation is significant at 0.01 level (2-tailed)

Self-reported vocal symptoms

Fourteen symptoms were surveyed: short of breath, roughness, week voice, dysphonia, phonation break, in the throat, pitch break, frequent throat clearing, sensation of tightness, pain, discomfort or dryness in the throat, voice fatigue, unable to speak loud and unable to speak soft. These symptoms represent some of the characteristics of vocal attrition (e.g. Koufman & Blalock, 1988; Teachey, Kahane & Beckford, 1991). The subjects were asked to indicate if they experienced each of these symptoms, but not to include times when the voice problems were associated with illness. The findings were shown in Table 3.

Table 3. Number of symptoms reported among the three groups

No. of symptoms/ Group	Singing students		Speech Pathology students		Broadcasters	
	N	(%)	N	(%)	N	(%)
Free of symptoms	2	25%	3	37.5%	1	16.7%
One or two symptoms	4	50%	5	62.5%	5	83.3%
Three or more symptoms	2	25%	0	0%	0	0%

For the symptomatic singing students, dryness in the throat was most prevalent (66.7%), followed by vocal fatigue (50%). For the symptomatic speech pathology students, complain included rough voice (40%). For the symptomatic broadcasters, weak voice was most common (60%), followed by short of breath and vocal fatigue (40%). There was no significant difference of the number of vocal symptoms among the three groups (χ^2=2.49, P > 0.05).

Difference between the singing students, speech pathology students and broadcasters

To compare the difference between the data of three groups, Kruskal-Wallis tests were used. Non-parametric test was used because none of the acoustic data set (relative average frequency perturbation, amplitude shimmer in percent and noise-to-harmonic ratio) showed a normal distribution. Besides, the number of subjects in each group was small and may not be normal distributed. The mean perceptual ratings, acoustic measurements, the VAPP Section and Total Scores of the three groups of subjects and the results of Kruskal-Wallis tests were presented in Table 4.

Perceptual Measurements

In table 4, we can see that the three groups did not have significantly higher mean perceptual ratings on breathiness (p=0.136) and roughness (p=0.885). The average perceptual rating on breathiness and roughness among the three groups were shown Figure 2. From the figure, we can see that the ranges of the average ratings were low, which were between 0 to 1.33 on breathiness and between 0.33 to 1.67 on roughness for the three groups.

Table 4. Mean scores of the perceptual ratings, acoustic measurements, Voice Activity and Participation Profile (VAPP) Scores of the singing students, speech pathology students and broadcasters

	Singing student group		Speech pathology student group		Broadcasters group		*Kruskal-Wallis* χ^2	*P* values
	Mean	SD	Mean	SD	Mean	SD		
Perceptual ratings								
Breathiness	0.33	0.62	0.62	0.38	0.33	0.42	3.99	0.136
Roughness	0.92	0.59	0.88	0.59	1 .06	0.33	0.24	0.885
Acoustic measurements								
RAP (%)	1.14	0.54	1.21	0.38	1.07	0.48	0.56	0.754
Shimmer (%)	8.17	2.20	6.16	0.86	7.28	0.23	5.90	0.053
Noise-to-Harmonic ratio	0.26	6.64	0.22	0.07	0.23	0.06	2.10	0.350
VAPP Total Score	56.88	35.92	9.50	16.21	35.33	31.19	5.50	0.009**
VAPP Section Scores								
Self-perceived voice problem Section	2.13	1.64	0.75	0.89	1.67	1.21	3.78	0.151
Job Section	11.00	9.71	1.75	4.20	8.50	8.55	9.65	0.008 **
Daily Communication Section	18.75	13.86	5.75	9.92	17.00	13.46	5.01	0.082
Social Communication Section	3.25	4.53	0.50	1.41	3.83	7.11	2.91	0.233
Emotion Section	21.75	21.80	0.75	1.49	3.67	6.15	9.91	0.007**
Total ALS Score	19.38	11.46	5.13	8.85	19.33	13.49	8.13	0.017*
Total PRS Score	13.63	13.68	2.88	5.49	10.00	11.21	5.12	0.077

** Significant at 0.01 level (2-tailed)
* Significant at 0.05 level (2-tailed)
RAP Relative average frequency perturbation
SD Standard deviation

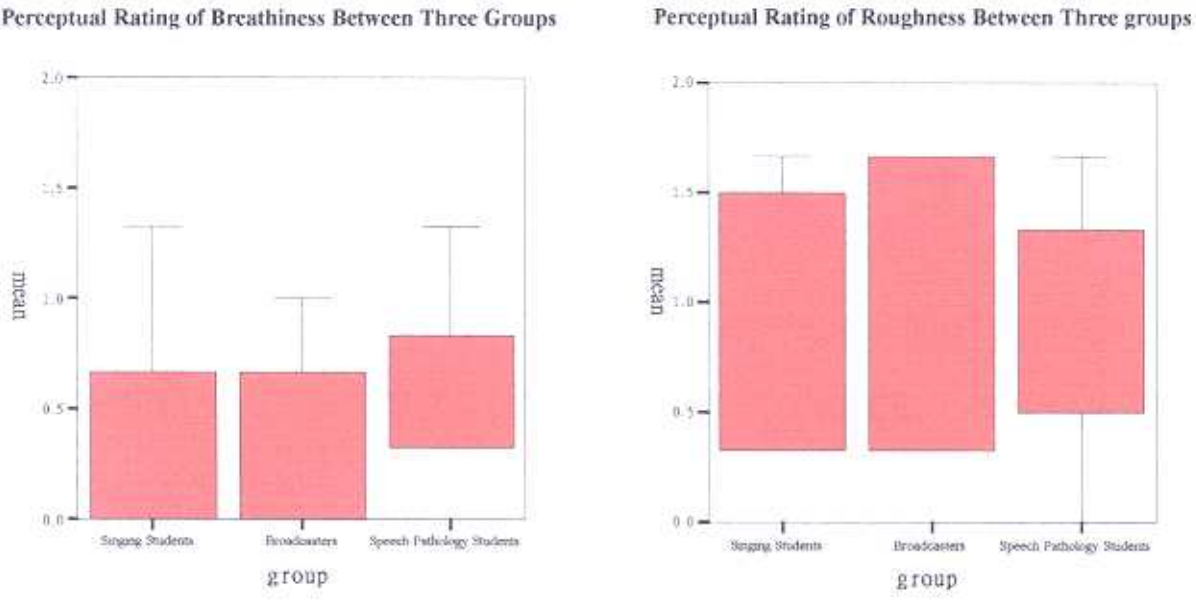

Figure 2. Mean perceptual rating on a) breathiness and b) roughness among the three groups.

Acoustic measurements

When comparing the acoustic measurements of the voice signal, no significant differences were found among the three groups of subjects (relative average frequency perturbation: p=0.75; amplitude shimmer in percent: p =0.05; noise-to-harmonic ratio: p=0.35).

VAPP Ratings

The mean Total VAPP Scores of the singing students was more than five times of that of the speech pathology students (χ^2 =9.40, p=0.009). Post-hoc Mann Whiney-U tests were performed. Significantly higher scores were found in singing students (U=5.50, p=0.005) and broadcasters (U=8.00, p=0.038) when comparing with speech pathology students.

In the subsection scores, there was no significant difference between the three groups under the self-perceived voice problem section (χ^2=3.78, p=0.15), communication section (χ^2=5.01, p=0.8) and social communication section (χ^2=2.91, p=2.3). However, a closer examination of the scores of broadcasters group under the communication section (mean=18.75) showed that they were significantly higher than the speech pathology students (U=9, p=0.05). For the Job Section Scores, the singing students (mean=11) and the broadcasters (mean=3.67) were statistically higher than speech pathology students (U= 5.50, p=0.004), (U=6.00, p=0.02) respectively. Under the Emotion Section, singing students (mean = 21.75) were significantly higher than the speech pathology students (U= 5.50, p=0.004) and the broadcasters (U=8.50, p=0.04). A comparison of the subscores reveals that the singing students had higher average subscores for each component of the VAPP.

For the total ALS, singing students (mean=19.38) and broadcasters (mean=19.33) were significantly higher (U=7.40, p=0.009; U=7.00, p=0.03 respectively) than the speech pathology students (mean=5.13) (see Table 4). The three group were significantly different (χ^2=10.94, p=0.004) on the ALS under the Job Section. When the post-hoc test Mann Whiney-U test was performed on the ALS under the Job Section, singing students (mean=7.50) were significantly

higher than the speech pathology students (U=5.50, p=0.003) and the broadcasters (U=8.00, p=0.04). Broadcasters (mean=3.67) was significantly higher than the speech pathology students (U=8.50, p=0.04) on this score. For the ALS under the Daily Communication Section, broadcasters (mean = 13.50) were significantly higher than the speech pathology students (U=6.00, p=0.02). The three groups did not differ statistically on the ALS under Social Communication Section, so did the PRS on all the three sections (see table 5).

Difference in between Activity Limitation Scores (ALS) and Participation Restriction Scores (PRS) of the three groups.

The mean Total ALS and PRS obtained by the singing students subjects were 19.38 and 13.63 respectively and they were not significantly different from each other (Wilcoxon Signed Ranks Test: Z=-1.54, 2-tailed p=0.12) (See table 6).

Table 5. Mean and (standard deviation) scores of activity limitation and participation restriction scores among the three groups

	Singing student group		Speech pathology student group		Broadcasters group		*Kruskal -Wallis* χ^2	*P* Values
	Mean	SD	Mean	SD	Mean	SD		
Activity Limitation Score								
Job Section	7.50	5.37	1.13	2.47	3.67	5.09	10.94	0.004**
Daily Communication Section	9.25	6.69	3.75	6.20	13.50	7.82	6.18	0.040*
Social Communication Section	2.63	4.37	0.25	0.71	2.17	3.92	2.27	0.322
Participation Restriction Score								
Job Section	3.50	5.42	0.63	1.77	4.83	4.58	3.83	0.147
Daily Communication Section	9.50	8.45	2.00	3.74	3.50	6.66	5.32	0.070
Social Communication Section	2.63	0.63	0.25	0.71	1.67	3.20	1.30	0.522

* Significant at 0.05 level (2-tailed) ** Significant at 0.01 level (2-tailed)

Table 6. Mean and (standard deviation) scores of the activity limitation and participation restriction scores of the three groups

	Maximum score	Activity Limitation Score Mean	Participation Restriction Score Mean	*Wilcoxon sign rank tests Z*	*P* values
Singing Students					
Job Section	20	7.50 (5.37)	3.50 (5.42)	-2.11	0.035*
Daily Communication Section	60	9.25 (6.69)	9.50 (8.45)	-0.25	0.799
Social Communication Section	20	2.63 (4.37)	0.63 (0.92)	-1.07	0.285
Total	100	19.38 (11.46)	13.63 (13.68)	-1.54	0.123
Speech Pathology Students					
Job Section	20	1.13 (2.47)	0.63 (1.77)	-1.41	0.157
Daily Communication Section	60	3.75 (6.20)	2.00 (3.74)	-1.83	0.068
Social Communication Section	20	0.25 (0.71)	0.25 (0.71)	0.00	1.000
Total	100	5.13 (8.85)	2.88 (5.49)	-1.83	0.068
Broadcasters					
Job Section	20	3.67 (5.09)	4.83 (4.58)	-0.42	0.674
Daily Communication Section	60	13.50 (7.82)	3.50 (6.66)	-2.20	0.028*
Social Communication Section	20	2.17 (3.92)	1.67 (3.20)	-1.34	0.180
Total	100	19.33 (13.49)	10.00 (11.21)	-2.00	0.046*

* Significant at 0.05 level (2-tailed)

For the broadcasters, the mean Total ALS and PRS were 19.33 and 10.00 respectively and significant difference was found (Wilcoxon Signed Ranks Test: Z=-2.00, 2-tailed, p=0.046). A close examination of the scores of broadcasters showed that the ALS under the Daily Communication Section (mean=13.50) was significantly higher (Wilcoxon Signed Ranks Test: Z=-2.20, 2-tailed p=0.03) than the PRS (mean=3.50). On the other hand, the ALS scores of singing students under the Job Section (mean=7.50) was significantly higher (Wilcoxon Signed Ranks Test: Z=-2.11, 2-tailed p=0.04) than the PRS (mean=3.50).

Correlation between voice impairment severity, the self-perception of voice problem and the impact of the voice problems in singing students and broadcasters groups

There was no significant correlation between the severity of voice impairment (as measured by perceptual and acoustic analysis) and the Total or Section Scores of the VAPP (see Table 7) in the group of singing students and broadcasters. Besides, the perception of voice problem by the two subject groups did not demonstrate any significant correlation with the Job, Daily Communication and Social Communication Section Scores.

Table 7.1. Correlation (Pearson's *r*) between voice impairment (perceptual ratings and acoustic measurements) and the VAPP scores of the singing student group

Voice Impairment Measures	Total VAPP Scores	Self-perceived voice problem Score	Job Section Score	Comm-unication Section Score	Social Section Score	Emotion Section Score	Total Disability Score	Total Handicap Score
Breathiness	0.12	0.44	-0.06	0.60	-0.23	-0.19	0.28	0.32
Roughness	0.19	0.46	0.19	0.67	-0.16	-0. 19	0.35	0.46
RAP (%)	-0.22	0.07	-0.38	-0.17	-0.33	-0.12	-0.28	-0.33
Shimmer (%)	0.64	0.43	-0.08	0.21	-0.07	0.11	-0.10	0.31
NHR	-0.35	-0.23	-0.26	-0.46	-0.31	-0.10	-0.52	-0.31

None of the values were significant at 0.05 level (2-tailed)

RAP Relative average frequency perturbation

NHR Noise-to-harmonic ratio

Table 7.2. Correlation (Pearson's *r*) between voice impairment (perceptual ratings and acoustic measurements) and the VAPP scores of the broadcasters group

Voice Impairment Measures	Total VAPP Scores	Self-perceived voice problem Score	Job Section Score	Comm-unication Section Score	Social Section Score	Emotion Section Score	Total Disability Score	Total Handicap Score
Breathiness	-0.38	0.61	-0.29	-0.25	-0.46	-0.23	-0.31	-0.44
Roughness	-0.55	0.05	0.64	-0.44	-0.57	-0. 22	-0.53	-0.74
RAP (%)	-0.12	0.63	-0.20	-0.12	-0.21	-0.06	-0.12	-0.29
Shimmer (%)	-0.09	0.65	-0.22	-0.06	-0.37	0.21	-0.15	-0.30
NHR	-0.02	-0.35	0.11	-0.11	-0.12	-0.05	-0.10	-0.01

None of the values were significant at 0.05 level (2-tailed)

RAP Relative average frequency perturbation

NHR Noise-to- harmonic ratio

Discussion

In this study, the degree of voice impairment, voice activity limitation and participation restriction in singing students and broadcasters who required performance and presentation voice demands respectively in their professions were compared with speech pathology students who used conversational voice. This is to find out the difference of voice use patterns and voice problems experienced in the three levels between different types of professional voice use.

Voice impairment severity among the three groups

The level of impairment measured by perceptual and acoustic analysis was not significantly different ($p>0.05$) among the singing students and broadcasters when comparing with speech pathology students, and multiple voice complaints were not frequently reported among them (only 25% in singing students and 16.7% in broadcasters). This indicated that the singing students and broadcasters did not have significant vocal impairment due to their professional voice use. However, the absence of significant vocal impairment among these two groups in this study can also be accounted by other factors. They included the small sample size and the phenomenon that people who had significant voice problem tended to be screened out since they were likely to coincide with those suffering from URI at that point of time (e.g. Benninger, 1995).

Quality of life due to voice problems in singing students and broadcasters

To a person with voice problems, the quality of life will deteriorate with increased activity limitation and participation restriction at different domains: economical, social and psychological functioning. (Ma, 1999). The higher VAPP scores represent higher disruption in the quality of life. Results revealed that the singing students group and broadcasters group scored significantly higher ($p<0.01$ and $p<0.05$ respectively) than the speech pathology students group, indicating that singing students and broadcasters' quality of life was affected more by their voice problems. This finding reflects that these two groups of people perceive more impact on their quality of life in the aspects of jobs, communication, social and psychological than the speech

pathology students group despite equally insignificant degree of voice impairment within the three groups. However, despite the difference on VAPP scores among the three groups, ranges of measurement scores were large for the singing students (ranging from 7 to 116) and broadcasters groups (ranging from 7 to 93), causing overlaps in scores between the groups. This means that even in cases where two groups display a significant difference on a particular measure, scores for individual subjects may not always reflect the group-based difference.

Findings of the present study support the hypothesis that singing students and broadcasters perceive greater impact on quality of life than speech pathology students. Though the job area received significantly higher scores for both the two groups, the higher scores on emotional state for singing students and on daily communication for broadcasters compared with speech pathology students suggested that to some degrees these two groups of subjects experience different domains of impact. Besides, the degree of impact in the level of voice limitation and participation restriction did not correlate with the impairment level in these two subject groups (see Table 7). Singing students and broadcasters scored higher total ALS (see Table 4), reflecting they had more activity limitation among the total three domains (job, daily communication and social communication). When comparing between the Activity Limitation Scores (ALS) and Participation Scores (PRS), the singing students had higher activity limitation in the job domain while the broadcasters had higher activity limitation in their daily communication. This confirms the notion that the three levels of experiences of voice problems can be affected independently in professionals voice users.

Predicable factors on the difference of impact on quality of life between singing students and broadcasters

The reason behind the higher impact on broadcasters and singing students was unlikely related to the number of hours of professional voice use and degree of vocal impairment, since they were not significantly higher in singing students and broadcasters (p=0.45). Instead, the

types of voice use demands in their professions would be the main factor. Different domains of impact experienced by singing and broadcasters are closely related to the different contextual factors in the two professions. For the singing students, they require singing voice at performance level. Since all of them sing opera, which has specified pitch and rhythmic elements for a particular emotion expression, they would require greater vocal flexibility, fine pitch and vocal intensity control and endurance (Harvey, 1997). These demands on larynx and coordination between the larynx and the human ear exceed the demands in speaking voice (Gregg, 1997). Moreover, to maintain their monthly performance standard, they would strive to perform with maximal vocal efficiency or musical skill. Therefore, a minimal noticeable voice quality change even like little variation of vocal control, pitch, quality caused by premenstrual symptoms can result in diminished performance ability to them. Their perceived limitation do not only come from themselves but can also be projected by the others who have high expectation on them (e.g. singing teachers, audience). All these demands are critical in this competitive profession, especially for the singing students who are at the beginning of their careers. Any little deviant voice quality can interfere their career opportunities. Though they are students and do not solely rely on singing for a living, their voice can have impact on their future economic well-being. As a result, they perceive greater effect and pressure on their job.

This work-related functioning and voice demands did not only affect job opportunities but also psychological status. Singing students are also found to be most emotionally disturbed among the three groups (p=0.007). A detailed examination on the questions in this part found that they tend to feel upset, embarrassed, worried and dissatisfied because of their voice problems. In view of the high demands of voice use at performance level, they would be more likely to attach great importance to their singing voices in their profession (Phyland et al., 1999). Any variation in vocal status such as vocal fatigue and dryness as reported among them in this study may cause great fluctuation in their emotion. Besides, in their early stage of the career, without fully learned

the potential of their voice, they would be prone to worry that any voice problem may somehow diminish their musical talent (Harvey, 1997). Moreover, regular monthly performance (an average of 2.1 hours per month), intensive curriculum and competitive nature in this professional can also intensified their emotional disturbance.

For the broadcasters, they perceive greater impact on job (p=0.02) and communication domain (p=0.05) when compared with speech pathology students. To broadcasters, their voices are highly opened to public through the radio waves. Millions of people could be listening to their on-line show at the same time. Since they are radio broadcasters and depend only on voice during broadcasting without exposing physical appearance to mask their voice, minor changes in voice would therefore be easily noticeable (Benninger, 1995). This particular demand of voice use may increase the pressure created by voice change on their job and thus they perceive greater impact on job areas compared with speech pathology students, though age difference between the two groups of subjects may be a confounding variable.

Despite the impact on their job, broadcasters' emotional state was statistically less affected compared with singing students (p=0.044). To explain the difference, two factors were suggested. The importance they attached to the presentation voice may not be as high as that of the singing voice for singing students, because the consequence of a little diminished vocal ability would less likely to induce instant irreversible impact. For broadcasters, they speak to a microphone instead of to the public face to face, and thus the adjustment of amplification and advertising time can compensate or alleviate some of their voice problems. However, for singers, they perform in a concert hall in which amplification of vocal loudness is not always provided. Sometimes, they even have to sing over an orchestra. A little change in a singer's voice, therefore, can result in limited musical expression that falls below the acceptable performance standard and disappoints her audience. To a singing student, this can greatly affect her performing opportunity in this profession. Consequently, singing students are more stressed and worried about their voice and

perceive greater impact on their emotional state. Second, we should not eliminate a possibility of the age-related factor since singing students are young adults in their early twenties when comparing with broadcasters (p=0.006) and may experience more instability and emotional changes (Spiegel, Sataloff, & Emerich, 1997).

Broadcasters had reported more impact on communication domains (p=0.05) when comparing with speech pathology students. All the six broadcasters more frequently perceived that voice problems affect their communication in noisy environment (p=0.013). The reason behind can be related to their working environment. Since all of them are radio broadcasters and they work in the studio which is sound proofed and with amplification, they may be adapted to speak in quiet place and thus perceive greater difficulties when speaking in noisy environment. This is evidenced by the common complain of weak voice among the broadcasters (50%). Their perception of this difficulty could be explained by the Lombard effect as the vocal intensity and pitch may increase in the presence of background noise. Different from general people who are used to speak in places with certain degree of background noise, this effect perhaps is more easily noticeable to them.

Though voice impairment was not significant among the three groups in the present study, there were greater limitations of activities in the job and communication domains as shown by the singing students and broadcaster respectively. On top of that, it was found that they were even significantly higher than the participation restriction in the corresponding areas (Wilcoxon Signed Ranks Test: Z=-2.11, 2-tailed, p=0.04; Wilcoxon Signed Ranks Test: Z=-2.20, 2-tailed, p=0.03) (See Table 6). Three factors were speculated. First, for both groups, it may be because the degree of limitation was not high enough to prevent them from participating in the voice related activities. Besides, for broadcasters, this may also be related to their personality and lifestyle as they are very likely the people who are more expressive and communicative to participate in daily communication. On the other hand, for singing students, their passion and

devotion in their profession may also lessen the likelihood of changing their jobs due to some limitation of activities. Instead, they would be more determined to overcome their limitations and maintain participation in the task.

Implication of the findings

The perception of the impact of impairment on quality of life to singing students and broadcasters were not solely influenced by the degree of impairment but also related to the voice demands in their profession. In assessing and managing professional voice users who require high demands of voice use such as presentation and performance, clinician should explore and care for their specific voice demands and their individual and contextual variables, which could be considered as maintenance factors to their perception on voice-induced quality of life deterioration.

The higher impact on the emotional domain for singing students can also place them at risk in voice impairment. Therefore, in managing this group of professional voice users, more support, career guidance and counseling should be provided to them. Speech clinicians should work more with the students' singing teachers and school to identify the possible source of the prevalent emotion disturbance (e.g. expectation from the teachers, compress school programs or attitude toward their voice). If a student overweighs her voice quality in performance and creates unnecessary stress, counseling should aim to desensitize her improper perception. For example, we shall help the singing students to realize that the voice of a singer is like the timbre of a musical instrument. For an ordinary musical instrument could bring out extraordinary music when played by a superb instrumentalist, to a singer, singing is not solely relied on the voice quality. Instead, to move the audience, the skills of efficiency, coordination, respiratory control and strong emotional involvement are equally important (Scherer, 1995).

On the other hand, broadcasters' perception of impact in daily communication may suggest they are more sensitive to their speaking voices. Therefore, investigation should be made to their

attitude towards their speaking voice and informative counseling on explaining the difference in perception between presentation voice during the job and daily conversational use of voice may be required.

In this study, the sampling size was small and limited to females. Eight singing students and six broadcasters were not large enough to detect the prevalence of voice problems among them. Besides, the findings could be explained by gender difference as females have greater tendency to report adverse emotional reactions (Cohen & Wills, 1985) and thus the findings may only be applicable to females. Another limitation is the selection bias. Recruitment efforts among singers in the school and broadcasters station were by volunteer basis. Therefore, it was unavoidably that those who had voice impairment were reticent to participate in the research and thus participants were mainly with healthy voice. Third, the measuring methods on the voice impairment level only relied on acoustic and perceptual analysis. Instrumentation measurement including laryngeal stroboscopy and aerodynamic measures of air-flow rate were not employed. Therefore, minor change in the aerodynamic and biomechanical properties of the voice production might not be easily detected.

The results of this study suggest further examination of the relationship between the demands and values of voice use among professional voice users. More groups of professional voice users for each type of professional voice use demands could be included so that generalization could be made across different groups. Besides, there may also be some variation of impact on the quality of life for different professionals using the same type of professional voice use. For example, at the presentation level, a teacher may experience a voice disorder and its impact on aspects of life different from a broadcaster. The environmental condition, their attitudes towards their voice and the employment of amplification in presentation are the factors that may account for the difference. Therefore, a homogenous and explicit survey on the vocal demands across professionals would be useful to provide insight on different professionals'

needs on voice demands. Moreover, efforts should be paid to investigate how to improve the external factors (e.g. reverberation in a concert hall, effect of the sound feedback system in a studio) in order to satisfy the voice demands and facilitate good vocal behaviors such as using optimal pitch and loudness in each profession. On the other hand, since only speaking voice was analyzed in this study, the voice impairment in singing voice could not be captured. To explore more specifically about the voice problem singers may encounter in singing voice, the singing power ratio (SPR) is suggested to evaluate the singing voice quality in future study. This is because SPR was found to be useful in capturing the voice impairment that may only be noticeably in singing voice (Omori, Kacker, Carool, Riley & Blaugrund, 1996).

Conclusion

Professional voice users are always at risk of voice disorder. Results from this study confirm: (1) Singing students and broadcasters requiring voice in performance and presentation respectively perceive greater impact on their quality of life than speech pathology students who only require conversation in their professions. However, contrary to our expectation, they did not differ significantly in voice complaints and level of voice impairment. (2) The degree of impact in the level of voice limitation and participation restriction does not correlate with the impairment level in singing students and broadcasters. (3) Singing students and broadcasters experience different domains of impact in the quality of life in experiencing voice problem: singers had more impact on job and emotion areas while broadcasters were more affected on job and daily communication. The possible factors of these findings were suggested and discussed.

Results from this study also demonstrated that VAPP is sensitive to assess the perception of impact on quality of life among professional voice users. However, more comprehensive instrumental evaluations on voice may be needed to detect minor voice quality change among singers. The findings also provide information about the singing students' and broadcasters' perception of voice problem in different domains of quality of life. With such information, it

helps clinicians to adapt our care to professional voice users according to their different types of voice demands and specific needs for each profession. We should design appropriate prevention workshop, collect relevant information during the assessment and manage their problems according to their needs. This serves to improve health care of voice among professional voice users, not only at the level of voice impairment but also concerning their quality of life.

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