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Voice quality assessment before and after social and professional voice use

Análise da qualidade vocal antes e após o uso profissional e social da voz

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ABSTRACT

Purpose: To analyze the effects of social and professional voice use in the voice quality of women in a time frame of two hours and 30 minutes using auditory-perceptual evaluation. **Methods:** A case-control study with two groups: professional voice users, with 31 Belo Horizonte school teachers aged 28-59 years; social voice users, with 42 females aged 31-59 years with no occupational voice use. The data was collected at two time points, in the morning period, before starting the use of voice and after two hours and thirty minutes. The subjects were instructed to read sentences in their normal speaking voice. The same recording scheme was used for the group of social voice use, with normal use of the voice in the home of each participant. The voices were evaluated through an auditory-perceptual assessment by two experienced raters who compared the emissions before and after voice use and determined whether there was improvement, deterioration or similarity between time points. **Results:** Both groups had a higher frequency of similarity between the voices before and after the vocal loading according to the auditory-perceptual evaluation. In subjects with changes in their vocal patterns, roughness was the auditory-perceptual parameter that changed the most for both groups, albeit with a low degree of deviance. **Conclusion:** The social voice use and the professional voice use resulting from the teaching activity, both during two hours and thirty minutes, caused no changes in voice quality as evaluated by auditory-perceptual analysis.

Keywords: Voice disorders; Dysphonia; Faculty; Voice; Voice quality

RESUMO

Objetivo: Analisar, do ponto de vista perceptivo-auditivo, os efeitos do uso profissional e social da voz na qualidade vocal de mulheres, em um intervalo de tempo de duas horas e 30 minutos. **Métodos:** Pesquisa do tipo caso-controle, formada por dois grupos: grupo de uso profissional da voz, com 31 professoras, faixa etária de 28 a 59 anos e grupo de uso social da voz, com 42 mulheres, faixa etária de 31 a 59 anos, sem o uso profissional da voz e sem queixa vocal. A coleta foi realizada pela manhã, em dois momentos - antes da primeira aula e após duas horas e 30 minutos -, na própria escola em que as professoras lecionavam e consistiu em leitura de frases. O grupo de uso social seguiu os mesmos padrões de gravação, com uso da voz na residência de cada participante. As vozes foram avaliadas de forma perceptivo-auditiva por dois avaliadores experientes, comparando-se as emissões antes e após o uso e classificação de melhora, piora ou similaridade entre os momentos. **Resultados:** Os grupos não apresentaram diferenças entre as vozes, comparando-se os momentos antes e após o uso da voz. Nos casos em que houve modificação do padrão vocal, a rugosidade foi o parâmetro perceptivo-auditivo mais frequente nos dois grupos, porém com baixo grau de alteração. **Conclusão:** O uso social e o uso profissional da voz, decorrente da atividade letiva, no período de duas horas e 30 minutos, não causaram alterações na qualidade vocal, analisada de forma perceptivo-auditiva.

Descritores: Distúrbios da voz; Disfonia; Docentes; Voz; Qualidade da voz

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INTRODUCTION

Among professional voice users, teachers are particularly susceptible to dysphonia[1-3], as they are subject to heavy vocal loading[4,5] and, consequently, to inadequate vocal adaptations[6,7]. The health of teachers, including the voice-related aspects, is related to the physical environment and management profile of their school[8].

The influence of the working environment includes environmental and chemical risks such as noise (sound pressure level above 65 dB), extreme temperature changes, and vocal tract dryness caused by air conditioning, inadequate ventilation, vocal discomfort, and chalk dust[9]. Individual factors include, for example, insufficient hydration, allergies, and self-medication[6]. Further, there are risks linked to the organization of the work process, with heavy teaching loads and/or accumulated functions and an excessive number of students per class.

Those are factors that compromise the teachers' vocal health, and this may manifest as vocal fatigue, dry mouth, palpitations, heartburn, muscle strain, and headaches[9].

Vocal fatigue is cited in the literature as one of the several symptoms of dysphonia[10], and defined as a negative compensation deriving from prolonged voice use[11], as is frequently the case of teachers[1,12]. Although consensus is lacking between studies regarding the definition, characteristics, and mechanisms of vocal fatigue, it can be analyzed through auditory-perceptual, acoustic, aerodynamic, or physiological assessments[13].

The literature highlights that a major factor in voice quality alterations caused by vocal fatigue is a rise in pitch. Other symptoms can be present, such as tiredness, pain, a burning sensation, dry throat, strain of the laryngeal, neck, jaw, and thoracic muscles, progressive hoarseness without vocal fold lesions, vocal effort when increasing or sustaining voice loudness, and body fatigue[14]. Therefore, vocal loading has a multi-faceted impact on voice quality, due to both anatomical and physiological factors and intensive voice use[13,15].

Despite the existence of numerous studies, the great majority of them focus on the analysis of the acoustic characteristics of the voice (fundamental frequency, vocal tremor, aerodynamic measures) using tasks of sustained vowel phonation[15,16], on the individuals' self-perception of the voice[17], or on physiological and laryngeal characteristics[18,19]. Little attention has been given to the study of the auditory-perceptual properties of the voice in situations of prolonged use.

Furthermore, there are few studies analyzing the changes in voice and speech in specific professional groups[16] in the presence of dysphonia[15] and in real-life ergonomic settings found in the voice professional's work environment[20].

In view of this, the purpose of our study was to examine, by auditory-perceptual evaluation, the effects of professional and social voice use on the quality of the voice of women within a time frame of two hours and thirty minutes. The results of this study could contribute to the creation of strategies and protocols to promote vocal health and prevent voice problems.

METHODS

The present case-control study included 73 participants: 31 women aged 28-65 years (mode = 59 years) working as teachers in the Belo Horizonte municipal school system (BHMSS), who comprised the group of professional voice users (G1), and 42 women aged 31-59 years (mode = 42 years) without voice complaints or self-reported voice disorders, with no occupational use of the voice, and elementary level education or higher, who constituted the social voice use group (G2). The professional occupations in G2 were: civil servants (11), homemakers (6), shopkeepers (7), business administrators (6), nurses (3), hairdressers (3), engineers (2), dietitian (1), student (1), clergyperson (1), and educationalist (1).

The professional voice use group (G1) comprised elementary school teachers with classroom experience ranging from 5 to 40 years (mode = 20 years) and a teaching load of 12-47 hours per week (mode = 22 hours). Of the teachers, 41.93% worked one shift; 51.61%, two shifts, and 6.45% worked three shifts.

Participants were included in G1 if they were female teachers without voice complaints. For G2, the inclusion criteria were female gender and age range matching that of G1. Individuals who were in speech-language therapy (G1) or presented with voice complaints (G2) were excluded from the study.

Professional use of the voice was defined as classroom teaching for a continuous period of two hours and thirty minutes; the teachers were instructed to perform their usual teaching activities, which included lectures and class work. Social use of the voice was considered the speaking activity of the women at home, in the family environment, continuously for two hours and thirty minutes.

Both the occupational and social use of the voice were assessed in typical settings. The type of voice use (professional or social) was not controlled in our study. All G1 and G2 participants were instructed to proceed with their activities as usual, both in teaching (G1) as in the home (G2). This instruction was necessary so that the voice assessment could reflect the typical situations of voice use in real-life settings.

All the participants provided their written informed consent, expressing their agreement to participate in the study and with the publication of the study and its results, according to Resolution 196/96. This study was approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais (UFMG) under Formal Opinion ETIC 0531/2011.

The present study was developed at four schools of the BHMSS with a convenience sample composed of teachers that voluntarily agreed to participate, who constituted G1. The informants in G2 were recruited from a variety of environments, provided that they met the sample inclusion and exclusion criteria.

For G1, the voice samples were collected in the morning, in a quiet room selected by the investigators at the BHMSS schools where the teachers worked. The samples were recorded at two time points – before the beginning of the day's classes and after the last class – with a length of two hours and thirty minutes. The duration of each recorded sample was approximately 5-7 min. The G2 voice samples were also recorded at two time points and for the same length of time, in a quiet place in their homes.

The same recording equipment was used with both groups. For voice recording, the informants were asked to read the sentence "*A Lara guarda figuras de pássaros e as suas preferidas são a da arara, da patativa, da garça, do canário e do sabiá amarelo*"[21]. Subsequently, they were requested to produce a semi-spontaneous speech in response to ''Talk about the town where you were born."

The recordings took place with the individuals seated. A unidirectional Samson® model CO1 condenser microphone was positioned at an angle of 45 degrees and at a distance of 20 cm from the speaker. The microphone was plugged into a Roland UA55 Quad-Capture USB 2.0 Audio Interface–4X4 24 bit 192 kHz connected to an Intel Pentium Inside Dual Core® P6200. The speech samples were stored in "wav" files and processed with the aid of the SONAR LE software.

The voice samples were evaluated independently by four speech-language pathologists with more than 10 years' practice since graduation and experience in the field of voice. The evaluation was conducted by randomized comparison – the recordings were introduced in randomized pairs to prevent the raters from identifying whether the samples corresponded to the first or second recording. The evaluators should indicate whether the voice quality improved, declined, or was similar at the two time points. If any changes were detected, the raters should grade the deviance on a 10 cm visual analogic scale and mark a maximum of two of the five GRBASI scale parameters (roughness, breathiness, astheny, strain, instability) that in their perception most influenced the voice improvement or decline. The raters listened to the voice samples to perform the auditory-perceptual evaluations using a Coby® CV–3000 headphone, and were allowed to replay the samples as many times as needed. After completion, the ratings of two speech-language pathologists with the greatest inter-rater agreement (Spearman correlation=0.53) were selected to characterize the samples.

Descriptive statistical analysis was performed using percent values to calculate the frequency and degree of improvement, decline, or similarity in the voices as well as the frequency of auditory-perceptual parameters when comparing the two recording time points.

RESULTS

Voice quality was similar before and after two hours and thirty minutes of professional or social voice use. When voice quality declined after loading, this was more frequent in the group of professional voice use (G1) (Figure 1). Improvements were also more frequent in G1 compared to the group of social voice use (G2) (Figure 2).

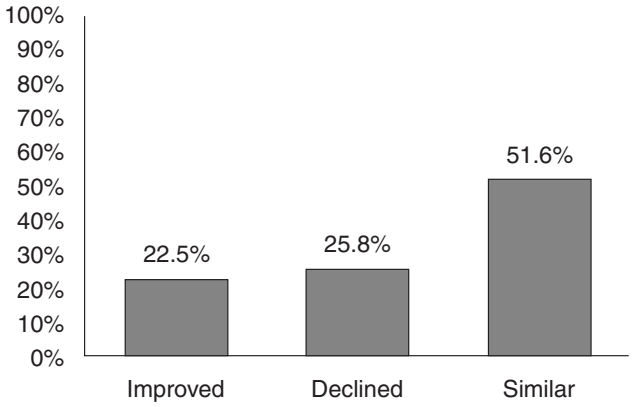

Figure 1. Comparison of the frequency of voice quality improvement, decline, or similarity after the professional use of the voice (G1)

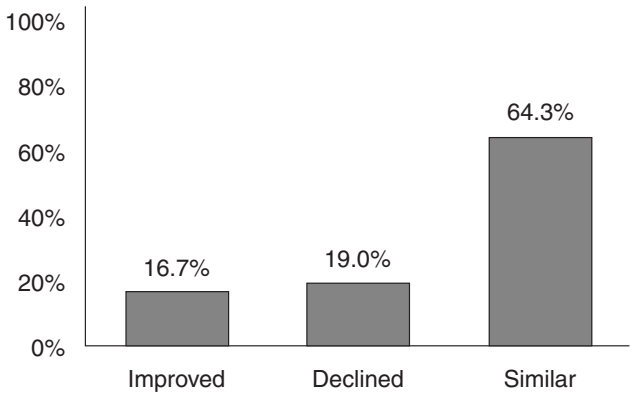

Figure 2. Comparison of the frequency of voice quality improvement, decline, or similarity after the social use of the voice (G2)

The GRBASI scale attributes were distributed according to voice improvement or decline following the vocal loading period. Roughness was the auditory-perceptual parameter with the strongest influence on voice quality - both in the cases of decline and improvement - for the two groups (Tables 1 and 2).

Table 1. Comparison between the auditory-perceptual parameters in the control group

Parameters	Improvement (%)	Decline (%)
R	87.5	88.8
B	0	11.2
A	12.5	0
S	0	0
I	0	0

Note: R = roughness; B = breathiness; A = astheny; S = strain; I = instability

The other auditory-perceptual parameters that showed improvement were astheny in G2 and breathiness in G1. The auditory-perceptual attributes that had an impact on voice

Table 2. Comparison between the auditory-perceptual parameters in the experimental group

Parameters	Improvement (%)	Decline (%)
R	77.7	72.7
B	22.3	0
A	0	0
S	0	0
I	0	27.3

Note: R = roughness; B = breathiness; A = astheny; S = strain; I = instability

Table 3. Degree of improvement and decline in the control and experimental groups

Group	Improvement (%)	Decline (%)
Control	10.4	10.6
Experimental	9	11

quality decline were breathiness in G2 and instability in G1 (Table 3).

DISCUSSION

Auditory-perceptual evaluation is routine in the clinical practice of speech-language pathology and audiology. Despite its subjectivity, it is the gold standard assessment, as it allows for inferences about pathophysiological correlates and psychosocial aspects of the voice[22,23].

Teachers represent a professional category at high occupational risk for voice disorders, since the voice plays a key role in this profession[3]. The present study was prompted by the need to investigate whether the occupational use of the voice in real-life working conditions at BHMSS schools - in a time frame of two hours and thirty minutes of continuous teaching - can generate voice problems that will eventually affect the teaching activity[24]. In addition, we sought to determine whether a difference exists between professional voice use (i.e., more prolonged and intensive) and social voice use (i.e., less vocally demanding) during these two hours and thirty minutes.

A study[24] involving five BHMSS teachers readapted for dysphonia identified their behavior regarding strategies of hyperfunction and voice protection. The study results showed that the working conditions can generate heavy vocal loading in the tasks developed by the teachers. Another study[3], which aimed to describe voice changes during work, found that some voices were abnormal at the end of the working day. The changes differed between subgroups, including the fundamental frequency (F0), which was found to be increased. When interpreting the changes, those authors considered that the deviance could be a consequence of vocal loading, which initially leads to voice warm-up and later to vocal fatigue[3].

Another factor to be taken into account with regard to vocal loading in teaching is the time for the development of some chronic lesions and behavioral dysphonias. An observational epidemiological study[25] correlating age, gender, profession, relevant pathological history, voice behavior, and the form of onset and duration of dysphonia, conducted during a period of five years with 65 patients diagnosed with functional dysphonia, revealed that the mean age for developing a voice disorder as a result of inadequate voice use was 34 years; 87.7% of the cases were women whose occupation involved great vocal demands. Most patients had gradually progressive dysphonia and the mean time of disease from the initial symptoms to the first appointment with a specialist was less than four years. Additionally, it was noted that when the voice quality alterations were greater in professional voice users, the time of progression since the onset of the voice problem was shorter.

Although there is vast literature concerning the subjective evaluations of a single time point of voice sampling, few studies describe auditory-perceptual correlates deriving from the professional use of the voice before and after teaching activities and in real working conditions compared with individuals who use their voices socially. A study[26] investigating vocal loading in 21 women (mean age, 22 years) who were not voice professionals showed through auditory-perceptual evaluation that prolonged voice use leads to a reduction in roughness and breathiness, and an increase in pitch, loudness, stability, and sound projection. Self-perception assessment also indicated increased voice effort following vocal loading. These findings suggest that voice quality improves in up to one hour of loading, which represents the limit of laryngeal efficiency for voice production. Another study[27], which compared the voices of 32 dysphonic subjects and 31 subjects with healthy voices before, immediately after, and one hour after vocal loading revealed that the individuals with dysphonia had more voice changes than the group with normal voice, although the frequency of occurrence was small.

The present study indicates similarity in voice quality before and after a teaching period for the group of professional voice users (Figure 1) as well as before and after the social use of the voice (Figure 2). Regarding G1, this finding could be related to the time interval of two hours and thirty minutes between recordings, which may not have been sufficient to cause voice quality alterations, even in settings of heavier vocal demands. This observation is in line with the findings of other studies[13,28] that, despite using different methods from those of our study, found no significant data with respect to the auditory-perceptual evaluation before and after a vocal loading task.

The occurrence of voice quality improvements and declines after the professional (Figure 1) and social (Figure 2) voice use was similar, and the frequency of such events was small. This complicated the interpretation of the results, which could have been influenced by multiple factors, such as the subjectivity of the auditory-perceptual analysis.

Regarding the five auditory-perceptual parameters (Tables 1 and 2) assessed using the GRBASI scale in the cases of voice

decline or improvement, the roughness parameter, which encompasses hoarseness, vocal fry, bitonality, and roughness was prominent, indicating irregular vocal fold vibration[22]. For both groups, roughness was the auditory-perceptual parameter that changed the most in the cases of voice improvement; however, this was more frequent in G2. This fact could be due to the voice warm-up[20] that occurred in the period between time points, considering that the voices were recorded in the morning. Roughness was also the most prominent attribute in the cases of voice decline in both groups, and was more frequent in G1. In this case, multiple factors (e.g., individual, environmental, and work-related) could have influenced the occurrence of voice problems and resulting vibratory irregularity.

By indicating the degree of voice deviance (Table 3), the auditory-perceptual assessment showed that the extent of the voice change was comparable and small for G1 and G2, both in cases of decline and improvement. This result suggests that the time frame of two hours and thirty minutes was likely not long enough to substantially affect the degree of voice quality deviation in the auditory-perceptual attributes analyzed.

A study[29] concerning the acoustic effects caused by attributes of vocal fatigue, conducted with seven volunteers aged between 20 and 50 years (five males, two females) correlated electromyographic findings to acoustic measures, and confirmed that the changes seen in muscle fatigue were associated with voice tremor and indicated that further effects could arise with the increase in the duration of the test. Further, another study[30] sought to identify signs of vocal fatigue in 51 teachers by assessing sustained phonation before and after vocal loading. The voice acoustic analysis indicated changes in jitter and pitch perturbation quotient; however, these alterations were not sufficient to cause marked voice changes.

Although those studies employed distinct methods from those in our study with regard to data collection and time of exposure, they demonstrate that acoustic analysis contributes to the evaluation of vocal loading, providing objective and punctual information on parameters that might show some alteration.

Arguably, a longer teaching period could more effectively demonstrate the effects of loading on the voice of teachers. We suggest that further studies developed to investigate the effects of vocal loading on teachers after work should include pre-defined days of the week for data collection and a longer time frame between the recording moments. They should also include control for the presence or absence of dysphonia in the study group, the nature of the vocal activity during the teaching period, the work environment and organization status, and establish a correlation between different modalities of evaluation, such as acoustic analysis.

CONCLUSION

The present study shows that the social use of the voice and the professional use in teaching activities, both during two hours and thirty minutes, did not lead to changes in voice quality according to auditory-perceptual evaluation.

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