

Teachers' Voice Use in Teaching Environments: A Field Study Using Ambulatory Phonation Monitor

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Summary: Objectives. This case-control designed field study examines the vocal behavior in teachers with self-estimated voice problems (VP) and their age- and school-matched voice healthy (VH) colleagues. It was hypothesized that teachers with and teachers without VP use their voices differently regarding fundamental frequency, sound pressure level (SPL), and in relation to the background noise.

Methods. Teachers with self-estimated VP ($n = 14$; two males and 12 females) were age and gender matched to VH school colleagues ($n = 14$; two males and 12 females). The subjects, recruited from an earlier study, had been examined in laryngeal, vocal, hearing, and psychosocial aspects. The fundamental frequency, SPL, and phonation time were recorded with an Ambulatory Phonation Monitor during one representative workday. The teachers reported their activities in a structured diary. The SPL (including teachers' and students' activity and ambient noise) was recorded with a sound level meter; the room temperature and air quality were measured simultaneously. The acoustic properties of the empty classrooms were measured.

Results. Teachers with VP behaved vocally different from their VH peers, in particular during teaching sessions. The phonation time was significantly higher in the group with VP, and the number of vibratory cycles differed between the female teachers. The F0 pattern, related to the vocal SPL and room acoustics, differed between the groups.

Conclusion. The results suggest a different vocal behavior in subjects with subjective VP and a higher vocal load with fewer possibilities for vocal recovery.

Key Words: Occupational voice—Classroom acoustics—APM—Voice accumulation—Field measurement—Teacher voice.

INTRODUCTION

This article examines teachers' voice use in their work environment, exploring the vocal behavior in a group of teachers with self-assessed voice problems (VP; nonpatients), comparing them with a group of teachers with self-assessed voice health. This is a follow-up study to Lyberg Åhlander et al.¹ and Lyberg Åhlander et al.²

One of the most important aspects of teaching is for the teacher to make herself or himself heard. The demands on a teacher's voice are varied. The voice is needed to communicate, instruct, and clarify. The teaching tasks at elementary and middle school levels can vary from soft facilitating talk during morning assembly to singing, reading loud, lecturing, and teaching in the sports hall. It is thus important for a teacher's voice to be flexible. However, with high levels of background noise and unfavorable room acoustics, this can be an effortful task that may be detrimental to the voice. Recently published data suggest that very few teachers in Swedish schools have undergone any voice training and that voice amplification is rare, even in the schools' sports halls.¹ As pointed out by many authors, teachers are at risk of developing VP, and there is a high prevalence of voice disorders in teaching staff also

compared with other occupations with vocal demands.³⁻⁶ Teachers' vocal load is also indicated by self-reported sick leave because of VP. In a group of teachers who assess themselves as suffering from VP, 35% compared with 9% in a group of voice healthy (VH) teachers reported recurring sick leave because of VP.¹ According to Sapir et al.,⁷ none in a group with no occupational vocal demands reported sick leave for this reason.

Recent results from comparisons between a group of 31 teachers with self-assessed VP and their 31 VH colleagues indicated that there were no differences between the groups in vocal, laryngeal, hearing, or psychosocial aspects. The differences were found in the time needed to recover from VP, occurrence of VP without a concurrent upper airway infection, and subjective assessment of voice symptoms.² This leads us to hypothesize that the differences between teachers with and without VP might be found in their daily voice use, possibly related to the teaching environment. The differences in teaching environment, other than classroom acoustics, can be in the activity noise produced and in the ability of the teacher to manage and vocally cope with classroom noise. A teacher with VP might manage classroom noise less well than a VH teacher.

During the last decades, a number of research groups have tried to understand teachers' voice use, based on the hypothesis that this behavior might differ from what can be seen in laboratory or clinical settings.⁸⁻¹³ Parameters that have been studied are fundamental frequency (F0), sound pressure level (SPL), and phonation (or speaking) time.

Södersten et al.¹² studied the vocal behavior of subjects at their workplace and concluded that the levels of F0 and SPL differed from the levels measured in quiet environment. Hunter and Titze¹⁴ also studied nonoccupational time and found that the SPL and phonation time of the occupational voice differed from the measurements of the nonoccupational voice. Changes

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in “fundamental frequency” during a workday have been identified as a sign of voice load. Laukkanen et al¹⁵ described the rise of F0 as a result of an increase in muscular activity, most likely an adaptation to vocal loading during a day at work. In addition, they described that the voice changes during vocal loading include an increase of the SPL and a decrease of jitter and shimmer. Also, Jonsdottir et al¹⁶ suggest that an F0 increase is a healthy reaction to voice load that promotes effective voice function. However, there seems to be a deviant pattern of the increase of F0 in individuals with VP. Rantala et al¹⁰ studied teachers’ vocal behavior during a workday and found a tendency for teachers with many voice complaints to show a smaller increase of their F0 level than their colleagues with fewer complaints, and Jonsdottir et al¹⁶ found a smaller F0 and SPL increase in teachers with voice complaints when they did not use voice amplification compared with when they did.

The teacher does not act alone in the classroom. Results from an earlier study showed that 92% of the teachers found the activity noise from the students to be disturbing.¹ Thus, it is important to consider the effect of the activity noise on the teacher’s voice. The Lombard effect¹⁷ describes the influence of surrounding noise on the voice. The speaker automatically raises the SPL and changes the spectral contents of the voice signal as the noise level increases. The background noise level (BNL) in classrooms is usually high, also during instruction.^{18–20} There are a number of studies exploring the effects of noise on vocal behavior, most performed in a laboratory setting: Södersten et al²¹ investigated the rise of F0 and SPL because of background noise in healthy subjects. They showed that the speaker increases the SPL and F0 and prolongs the phonation time when exposed to noise, especially continuous noise. In that study, female speakers also reported less success in making themselves heard and greater effort to do so.²¹ Ternström et al²² measured the ratio of energy in the frequency bands of 2–6 and 0.1–1 kHz and found it to be less negative as a function of increasing BNL and voice SPL. Moreover, Lindström et al¹³ showed that there is a large variation in vocal behavior because of noise exposure. Thus, it is important to study voice use outside the laboratory to further understand the vocal behavior and detect possible individual differences in voice use and in the management of vocal load.

Dry air is often mentioned by patients at voice clinics to affect their voices. The dryness of air has been proven to affect vocal prerequisites in laboratory settings.²³ However, only one field study seems to have been made where the effects of air quality and temperature on VP have been examined. Rantala et al²⁴ concluded that poor ambient air quality affected the occurrence of laryngitis in teachers.

One of the factors often mentioned, but seldom studied in relation to the development of voice disorders, is the influence of the room acoustics on the teacher’s voice. Pekkarinen and Viljanen¹⁸ concluded that many Finnish classrooms were too reverberant with a resulting reduced intelligibility, which may cause the speaker to use more effort when speaking. Kob et al²⁵ studied teachers with different voice status acting in different rooms and concluded that teachers with VP were more affected by the acoustic properties of the room than their

VH colleagues. Lacking a measure describing the speaker’s perception of the room acoustics, earlier investigations have used measures that focus on the listeners’ perspective, such as the reverberation time (RT) or the speech transmission index (STI). Brunskog et al²⁶ and Pelegrín García²⁷ introduced a measure of “voice support (STv),” linked to vocal intensity variations experienced by an individual talking under different room acoustic conditions. It is a measure based on the two properties of the impulse response defining the airborne acoustic path between the mouth and the ears. These are the direct sound from the mouth to the ears and the indirect sound from the reflection at the boundaries of the room. Thus, the STv is the ratio between the energy of the reflected sound (E_r) and the energy of the direct sound (E_d) (Equation 1).

$$\text{STv} = 10 \log \frac{E_r}{E_d} . \quad (1)$$

This study is a field study with case-control design. The article presents the results of the measurements of the teachers’ voices exploring the vocal behavior in a group of teachers with self-assessed VP and comparing them with a group of teachers with self-assessed voice health. This article further presents the room acoustics, background noise, and ambient air quality in the two groups’ teaching environment. Detailed results on the link between the STv and the vocal behavior are presented in the study by Pelegrin-Garcia et al.²⁸

METHODS

Subjects and schools

The subject group of 28 teachers was recruited among participants who had been followed in two previous studies: Lyberg Åhlander et al¹ (a cross-sectional study) and Lyberg Åhlander et al² (a case-control design). In the study by Lyberg Åhlander et al,¹ teachers at 23 randomly selected schools rated their voices and prevailing VP, together with aspects of their teaching environment in a questionnaire. All teachers present at prescheduled collegial meetings responded to the questionnaire ($n = 487$). The grouping of teachers with and without VP was based on the statement “I have problems with my voice.” The division to the two groups was further validated by the answers to the questions on voice symptoms from a Swedish validated version of the VHI-T (Voice Handicap Index-Throat).²⁹ The group with self-assessed VP consisted of individuals most of whom without previous contact with any clinical voice care. In the study by Lyberg Åhlander et al,² 31 individuals among the teachers with self-assessed VP were matched to 31 VH colleagues, for gender, school, and as close as possible for age. For the present study, among the 31 pairs, 14 pairs from the schools with the highest frequency of matched pairs were asked to participate. The pairs included 24 women and four men. The demographics of the teachers in the present study are shown in Table 1. As emerges from Table 1, there were no differences between the groups for age or time in occupation, respectively, as shown by a t test: $t(223) = 0.579$ and $t(223) = 0.510$, with $P > 0.05$ in both cases. Teaching subject varied between individuals as emerges from Table 2.

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