Voice Use Among Music Theory Teachers: A Voice Dosimetry and Self-Assessment Study

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Summary: Objectives. This study aimed (1) to investigate music theory teachers' professional and extra-professional vocal loading and background noise exposure, (2) to determine the correlation between vocal loading and background noise, and (3) to determine the correlation between vocal loading and self-evaluation data.

Methods. Using voice dosimetry, 13 music theory teachers were monitored for one workweek. The parameters analyzed were voice sound pressure level (SPL), fundamental frequency (F0), phonation time, vocal loading index (VLI), and noise SPL. Spearman correlation was used to correlate vocal loading parameters (voice SPL, F0, and phonation time) and noise SPL. Each day, the subjects self-assessed their voice using visual analog scales. VLI and self-evaluation data were correlated using Spearman correlation.

Results. Vocal loading parameters and noise SPL were significantly higher in the professional than in the extra-professional environment. Voice SPL, phonation time, and female subjects' F0 correlated positively with noise SPL. VLI correlated with self-assessed voice quality, vocal fatigue, and amount of singing and speaking voice produced.

Conclusions. Teaching music theory is a profession with high vocal demands. More background noise is associated with increased vocal loading and may indirectly increase the risk for voice disorders. Correlations between VLI and self-assessments suggest that these teachers are well aware of their vocal demands and feel their effect on voice quality and vocal fatigue. Visual analog scales seem to represent a useful tool for subjective vocal loading assessment and associated symptoms in these professional voice users.

Key Words: Vocal loading–Voice accumulation–Occupational voice–Background noise–Lombard effect.

INTRODUCTION

Teachers rely on their voice as a primary tool for work and are therefore recognized as professional voice users.[1] Like other professional voice users, such as singers or call center agents, teachers face an increased risk of encountering voice problems.[2,3] Roy et al[4] found that teachers develop voice disorders at almost twice the rate of the general population. Music and singing teachers are even more at risk.[5–7] Unlike classroom teachers, they not only use their voice to transmit the subject matter and manage the classroom but also use it as an instrument when singing with their students. In Belgium, certain music teachers are referred to as music theory teachers. Music theory teachers teach theoretical knowledge and practical musical skills such as reading and writing scores, as well as musical perception and production (pitch accuracy and singing in harmony), to groups of individuals who learn music during their free time. Employed at music schools, named *académies de musique* or *conservatoires de musique*, they often teach singing or playing an instrument. As they use both their speaking and singing voice at work, music theory teachers are assumed to experience extended voice use.

The increased risk for voice disorders among teachers in general, and among music or singing teachers in particular, has repeatedly been associated with the high vocal demands linked to their profession.[4,5,8–10] Vocal loading is a term that denotes the quantity of vocal demands placed on the phonatory system.[10] It is thought to be mostly determined by voice sound pressure level (SPL), fundamental frequency (F0), and phonation time.[11] Titze et al[12–14] introduced five vocal doses to determine the impact of repeated vocal fold vibrations on the exposed tissue over some selected durations of measurement: time dose (ie, total phonation time), cycle dose (ie, total vocal fold vibration cycle), distance dose (ie, total distance covered by the vocal folds), energy dissipation dose (ie, total amount of heat created by the vocal folds), and radiated energy dose (ie, total energy emitted by the mouth). Rantala and Vilkman[15] had previously described cycle dose as the vocal loading index (VLI); it depends crucially on phonation time and voice F0. Finally, background noise level may also influence vocal loading, as it automatically causes speakers to increase their voice SPL and F0 or modulate spectral aspects.[16,17] Studying all of these parameters is important in defining and interpreting the vocal profiles of teachers and other professional voice users. Large quantities of data, collected in ecological context, are needed to determine what constitutes a normal amount versus excess vocal loading.

Voice dosimetry or voice accumulation allows researchers to establish such corpora of voice use data. Voice dosimeters are portable devices that can be used to monitor a person's vocal behavior in real-life situations and over extended periods of time, for example, during the course of a normal workday. This method of collecting data allows one to present an authentic picture of both professional and extra-professional vocal demands. Voice accumulation research on teachers' voices has led to three important findings, which provide the background for this study: (1) Vocal loading is higher in teachers than in the general population[18]; (2) teachers' vocal loading is higher at work than during their free time[11,19–21]; and (3) certain subgroups of teachers

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TABLE 1.
Personal Information on Each Subject

Subjects	Age (years)	Teaching experience (years)	Teaching time per week (hours)	Total duration of voice monitoring (hours)	Duration of voice monitoring at work (hours)	Duration of voice monitoring off-work (hours)
F1	29	8	18	74	26	48
F2	38	10	20	53	26	27
F3	58	36	24	99	24	75
F4	49	23	21	77	13	64
F5	39	16	24	39	15	24
F6	26	3	20	51	17	34
F7	46	22	12	74	21	53
F8	47	23	17	44	19	25
F9	50	26	18	63	26	37
M1	52	26	24	72	17	55
M2	29	5	24	68	26	42
M3	49	30	11	62	29	33
M4	27	2	11	82	24	58

Note: Female subjects are labeled with the letter F (ie, F1-F9) and male subjects with M (ie, M1-M4).

show different vocal loading patterns.[10,11] Music teachers, in particular, must cope with much higher vocal loading than regular schoolteachers.[10] To date, the specific population of music theory teachers has not been investigated.

Although objectivity is one of the decisive advantages of voice accumulation, the consultation of subjective data as well may be important to interpret vocal loading measurements. Rantala and Vilkman[15] found that objective values for teachers' vocal loading are reflected in how these teachers self-assess their voice. In their study, 12 female teachers were instructed to answer a questionnaire about subjective voice complaints and recordings were made of their professional voice use. The voice recordings were then used to calculate the VLI. A higher VLI was associated with a higher number of subjective voice complaints. A more recent study on 28 teachers' vocal loading supports this finding: Measured cycle dose (ie, VLI) was significantly higher in female teachers with self-reported voice complaints than in those without voice complaints.[22] Comparing VLI measures with self-assessment measures may therefore help us understand the relationship between phonatory behavior and the development of voice disorders.

The present paper describes vocal loading parameters and background noise levels experienced by 13 music theory teachers as measured with voice dosimetry. Our aims were (1) to describe music theory teachers' vocal loading and their exposure to background noise as a function of context (professional versus extra-professional); (2) to determine the relationship between background noise level and the three vocal loading parameters: voice SPL, voice F0, and phonation time; and (3) to examine whether the VLI is reflected in subjects' self-perception of their voice.

METHODS

Subjects

Thirteen music theory teachers (9 females and 4 males) from the French-speaking part of Belgium agreed to wear a voice dosimeter for one 6-day workweek (from Monday to Saturday). Table 1 provides individual information on each subject. The subjects' age ranged from 26 to 58 years, with a mean of 41 (standard deviation [SD] = 11). On average, subjects worked 19 hours per week (SD = 5) and had 18 years of teaching experience (SD = 11).

Voice dosimetry

A VoxLog voice dosimeter (Sonvox, Umeå, Sweden) was used to measure the subjects' vocal loading over the course of the week. VoxLog voice dosimeters contain a neck collar with an integrated accelerometer and a microphone. The former measures the speaker's F0 (Hz) and phonation time (%), while the latter detects voice SPL (dB) and background noise SPL (dB). Like other voice dosimeters, the VoxLog records voice data without recording the actual speech signal and thereby protects the speaker's confidentiality.

The subjects were instructed to wear the VoxLog each day from the early morning until late evening, resulting in a mean of 44 hours (SD = 16) of data recording per subject. Regarding the VoxLog settings, the time window was set to 5 seconds, meaning that data were averaged every 5 seconds. No A-weighting was applied. The feedback function was not activated. During the week of monitoring, the examiner met twice with the subjects to download and save their voice dosimetry data. VoxLog Discovery software was used to analyze phonation time, F0, voice SPL, VLI (calculated by VoxLog Discovery), and noise SPL over the recording days based on the context. The professional context included all work activities such as teaching, lesson preparation, rehearsals, and concerts. The extra-professional context included nonwork-related activities, such as leisure and family time.

Questionnaire

Each monitoring day, subjects answered a two-part questionnaire. The first part consisted of a timetable in which subjects