Lehto L, Alku P, Bäckström T, Vilkman E, Voice symptoms of call-centre customer service advisors experienced during a work-day and effects of a short vocal training course, Logopedics Phoniatrics Vocology, 2005; 30 (1): 14-27.

Logopedics Phoniatrics Vocology. 2005; 30: 14–27

Taylor & Francis
Taylor & Francis Group

ORIGINAL ARTICLE

Voice symptoms of call-centre customer service advisers experienced during a work-day and effects of a short vocal training course

LAURA LEHTO[1,2], PAAVO ALKU[1], TOM BÄCKSTRÖM[1] & ERKKI VILKMAN[2]

[1]*Laboratory of Acoustics and Audio Signal Processing, Helsinki University of Technology, TKK, Finland, and* [2]*Phoniatric Department, ENT Clinic, Helsinki University Central Hospital, HUCH, Finland*

Abstract
Occupational voice users often suffer from voice symptoms to varying extents. The first goal of this study was to find out how telephone customer service advisers experience voice symptoms at different moments of the working day. The second goal was to investigate the effects of a short vocal training course arranged for telephone workers. The results indicate that although the subjects did not suffer from severe voice problems, the short vocal training course significantly reduced some of the vocal symptoms they had experienced. The results suggest that systematic consultation and training for occupational voice users in the field of occupational voice care would be advantageous.

Key words: *Occupational voice, Occupational safety and health, questionnaire study, voice symptoms, voice training*

Introduction

In modern society, there is an increasing demand for oral communication in many occupations. People who use their voice as a main tool in their work, occupational voice users, often suffer from voice symptoms to varying extents (1–13).

The definition of a voice problem is not at all straightforward. A voice problem is a multidimensional phenomenon that usually includes a self-perceived reduction in physical, social, emotional and/or professional well-being. The task of establishing a self-perceived voice problem may be challenging because it does not necessarily correlate with the degree of voice-quality impairment measured acoustically and/or identified perceptually (14). Therefore, a voice problem must be interpreted as a complex of self-reported symptoms and clinically observed signs (15). This definition is in line with The International Classification of Impairments, Disabilities and Handicaps (ICIDH) (16), which is regarded as an excellent framework for diagnostic assessments of problems in functional health (as distinct from pathology) (e.g., (17)). In the most recent version of ICIDH-2 (18), the extent of activity limitation is no longer strictly classified into the categories of impairment, disability and handicap. If a person reports sufficient concern and functional disruption in voice, his/her opinion should not be ignored.

Early identification and treatment of voice problems is likely to reduce their severity and the time needed for recovery (19). Proper treatment of voice plays a key role in restoring and preserving the individual's occupational capacity (20). However, the status of voice disorders as an occupational safety and health issue is not so well acknowledged as, for instance, the prevention and diagnostics of occupational hearing disorders (21,22).

The risk factors in voice professions include background noise, unsatisfactory room acoustics, long speaking distance, poor air quality (dryness, dust), unfavourable working posture and vocal loading per se by speaking or singing (21). Insufficient pre-professional voice training is also thought to contribute to the voice problems of occupational voice users (22,23). The educational programmes for voice users who are required to have a high quality of voice in their occupation (such as singers

Correspondence: Laura Lehto, MA, Laboratory of Acoustics and Audio Signal Processing, Helsinki University of Technology, PO Box 3000, FIN-02015 Hut, Finland. Fax: +358 9 460224. E-mail: laura.lehto@iki.fi

(Received 22 December 2003; accepted 13 April 2005)

ISSN 1401-5439 print/ISSN 1651-2022 online
DOI: 10.1080/14015430510006659

and actors) include voice training. However, persons exposed to high vocal loading (teachers, salespersons, military, clergy) are only provided training occasionally and usually at the worker's own initiative. According to the European occupational safety and health (OS&H) legislation, the employer is obliged to provide for 'the prevention of occupational risks, the protection of safety and health, the elimination of risks and accident factors, the informing, consultation . . . and training . . ., as well as general guidelines for the implementation of the said principles' (24). To meet this challenge, occupational voice users should be provided with basic knowledge of voice production and vocal care.

Most studies on occupational voice problems have focused on teachers' voices (1,5,8,13,19,25–31). This is understandable because teachers make up an occupational group exposed to extensive long-term loading of voice combined with a preference of high-quality voice. In addition to teachers, salespersons constitute another large group of employees whose work performance depends on voice (13). Differently from teachers, extensive voice use is seldom required of salespersons, but long-term loading and the need for high-quality voice are familiar to them, too. Employees working in telephone marketing constitute an interesting subgroup of salespersons because their working ability depends exclusively on voice. On the telephone, the speaker must rely solely on his/her voice, without any support from body language or written communication.

To our knowledge, there are only three previous studies on occupational voice users which focus on employees working on the telephone (3,23,32). According to the study of Jones et al. (3), telemarketers have an increased prevalence of voice disorders compared with the general population. In addition, as reported by Ohlsson et al. (23), vocal symptoms and reports of major demand at work were more common among switchboard operators who worked on the telephone than among a control group represented by speech therapists. Both the study by Jones et al. (3) and Ohlsson et al. (23) focused on voice complaints of persons working on the telephone. Previously only the authors of the present study have investigated the effects of voice training on telephone workers (32). According to the results presented by Lehto et al. (32), vocal training was considered a positive support in persons working in a vocally loading occupation.

Goal of the study

Our study group consisted of customer service advisers (CSA). This project was initiated by the largest Finnish telecommunications operator Sonera (currently known as TeliaSonera Finland Oyj) in an effort to gather data about the voices of their call-centre personnel. The objective was to improve the working environment of CSAs and to minimize the incidence of voice failures leading to sick-leave. At Sonera, the call-centre personnel had more sick-leave than the other groups of employees, and the company therefore wished to find out the reasons for this.

The goals of this study were 1) to find out how telephone workers experience voice symptoms at different moments of the working day; 2) to investigate the effects of a short vocal training course arranged for telephone workers; and 3) to analyse the long-term effects of training by carrying out a questionnaire survey one-and-a-half years after the course.

Material and methods

Subjects

The subjects of this study consisted of 35 female and 10 male call-centre customer service advisers, whose work involves exclusively answering customer calls during the entire working day. The length of their working day is 7.5 hours including a 29-minute lunch break and two 10-minute coffee breaks. Some of them work partially in three shifts. All subjects work at the same call-centre located in Kuusamo, Finland. This call-centre was chosen by Sonera. All the employees of this particular call-centre participated in the experiment. A description of the subjects is given in Table I.

In this paper, the main data on voice symptoms were collected using questionnaires (see details section Data Collection). In addition, prior to the research, the CSAs were asked to fill in a secondary

Table I. Description of the background variables of the subjects.

		Age (years)		Working experience		
Gender	n	mean	range	mean	range	Smoking
Females	35	28	21–41	15 months	1 month–10 years	no 71%; yes 29%
Males	10	26	21–38	7 months	2 months–1 year	no 70%; yes 30%

questionnaire concerning certain background factors that might have an effect on voice (e.g., hobbies including intense voice use, smoking, hearing loss, GERD (gastro-esophageal disease), previous voice therapy). The subjects were also examined by a phoniatrician at the beginning of the study. This phoniatric examination included perceptual voice analysis and laryngeal examination with a mirror. Both the collection of the background factors and the phoniatric evaluation were performed in order to get a comprehensive view of the health status of the subjects.

Collection of background factors is a routine procedure in studies concerning voice complaints. In the present study, the effects of the background variables were not analysed, because our recent study on the same subjects showed that the background variables did not have a specific influence on subjective voice complaints (see (32), pp. 167–8).

Working environment

The subjects worked in an open-plan office, where individual working spaces are separated by movable partitions. According to a work-hygienic survey made by the local occupational health authority (Oulu Regional Institute of Occupational Health), the background noise level in the office during the working hours was 42 dB(A), which can be considered low. The room temperature was quite high (23 °C), which caused the air to be relatively dry; ambient humidity was only 19% instead of the recommended 25%–45%. Formaldehyde concentration (0.1–0.2 ppm) also exceeded the recommendations (<0.03 ppm). A probable reason for this could be the recent renovation of the office: new furniture often contains formaldehyde. A number of studies have indicated that drying has a negative effect on many aspects of vocal performance (33–36), and even a low concentration of formaldehyde is known to affect the mucous membrane of the respiratory tract (37).

In ergonomics, it is known that computer work predicts a high risk for musculoskeletal symptoms in the shoulder, elbow, and lower-back regions. In order to determine how current these problems are at the Sonera call-centre, both the working posts and the working postures of the subjects were preliminary studied by Oulu Regional Institute of Occupational Health (informal report to Sonera). The report describes two harmful working postures that were common when working with computer at the Sonera call-centre. One is the position where the upper part of the back bends down while the shoulders are pushed forwards. In the other position, the head leans forward, which causes tension in the neck and throat. Half of the subjects reported having aching shoulders and/or tension in their neck muscles.

The data on ergonomical factors of the Sonera call-centre were in the possession of another research institute. Therefore, they could not be used in the present study.

Data collection

The subjects completed a questionnaire about how they experienced their voice at four different moments of the day: in the morning, before the lunch break, after the lunch break and at the end of the working day. The questionnaire was completed three times: before starting the voice training program, two weeks after the one-day speech communication seminar (five weeks after the two-day vocal health course) and one-and-a-half years after the course.

The questionnaire consisted of 12 questions on subjective vocal symptoms, as listed below. In this context, the word 'subjective' refers to the subjects' own judgement about the presence of the symptom. Hereafter, the term 'symptom' will be used to refer to these self-reported symptoms. The names of the symptoms given in parentheses are used in Figures 1–4 and Appendices A–D.

1. My voice is overstrained (strained)
2. My voice is hoarse or husky (hoarse)
3. I have a feeling of a lump in my throat (lump)
4. I feel like having a choker around my neck (choker)
5. I have a feeling of mucus in my throat and/or I need to clear my throat frequently (mucus)
6. My throat is dry and/or itchy (dry)
7. My voice is weak/my voice doesn't resonate (weak)
8. My voice is tense or I feel I must make an effort when speaking (effort)
9. My voice is creaky (creaky)
10. My voice often breaks when I speak (breaks)
11. I feel short of breath/I need to gasp for air (no air)
12. My voice gets worse during the day (worse)

Question no 12 was answered simply by yes or no, while the other 11 questions were answered using Visual Analogue Scale (VAS) (e.g., (38)) with the range 'no symptoms like this' to 'a lot of symptoms like this'. The Visual Analogue Scale is a commonly used instrument for assessing a subjective characteristic or attitude that is believed to range across a continuum of values and is not amenable to direct measurement. From the subject's perspective this

approach appears continuous—for example, self-experienced symptoms do not make discrete jumps, such as a categorization into 'none', 'mild', 'moderate' and 'severe' would suggest (39). In this study, the line was 7.5 cm long. All the four moments of the day were marked on the same VAS line each time the questionnaire was filled out. The subjects were not given an opportunity to refer to their former questionnaires.

Although the amount of call-centre personnel sick-leave in Sonera was the main reason for starting the study, the relation between voice problems and sick-leave was not specifically studied in the present study, because the data were not available for the authors. Moreover, the company's main motivation to support the research was to gain preliminary knowledge of the effects of voice training programmes.

Short voice training course

The subjects were given vocal training for two days by a speech- and language therapist. The training programme comprised both indirect and direct therapy methods (e.g., (40)).

The first day consisted of six hours divided into two sections. The first section consisted of lectures on the theory of voice production, resonance and articulation. The basics of vocal hygiene, balanced breathing patterns and the importance of good body posture were discussed as tools to reduce tension when speaking. The subjects were also provided with information about the kinds of foods and drinks that may have a negative effect on voice.

The later section of the first day and the entire second day of the training course were devoted to practice vocal exercises. The subjects were taught different vocal exercises: they were informed of how to produce voice more economically, and they learned exercises to warm up or cool down voice. The exercises that were taught are widely recognized and clinically used. These include, for example, relaxation of jaw and pharynx while producing nasal-, vowel- and humming sounds (e.g., (41) chapter 10).

Three weeks after the two-day vocal health course, the subjects participated in a speech communication seminar for one day. The following topics were discussed: principles of speech technique, special demands of telephone communication, mental impressions transmitted by voice and appropriate verbal expressions. The speech communication seminar was conducted by a speech instructor.

Six months after the training, a refresher course (lasting for one day) was organized by the speech- and language therapist. Five group leaders of the customer service participated. The aim of the day was to refresh their knowledge of the basics of vocal care so that they could support their group members to do regular vocal exercise. The program consisted of a revision of both the theory of voice production and vocal practices. However, the aim of the refresher course was not achieved because the group leaders felt incompetent to coordinate vocal activities in their respective groups, not being professionals of vocal care. Therefore, the responsibility for vocal care became an individual concern for each person. For the purpose of the present study, this was not considered a problem, because the aim was not to investigate how often the subjects did vocal exercises but to investigate the effects of the training course in general.

Data analyses

The assessments of each subject at the four moments of the day were pooled together for a given symptom, to represent the severity of each symptom. This value is called the sum variable. When reporting the symptoms before and after the training, both the different moments of the day and the sum variable will be discussed. However, when discussing the long-term effects of the training program, only the sum variable will be considered. The results obtained are presented as means, ranges and standard deviations.

Statistical analyses were computed with the Statistical Package for the Social Sciences—software (SPSS 11.5 for Windows). For females ($N = 35$), the t-test (paired samples) and the Pearson's Chi-Square-test (cross-tabs) were used. Due to the small number of male subjects ($N = 10$) nonparametric tests (Wilcoxon signed ranks test) were used in statistical analyses of males.

Unfortunately, some of the subjects who participated in the data collection before the training were not available after the training and in the follow-up study. This was due to the fact that some subjects had left the company, changed their work tasks or that they were not reached, for example because of maternity leave. The number of females participating at the first, second and third data collection was 35, 32 and 27, respectively. For male subjects, the corresponding numbers were 10, 8 and 7.

Results

In the present study, the females and males are analysed separately due to a considerably smaller number of males, and due to the fact that females are known to have many more voice problems in general (42). In this section, the first three sections describe

the results of the female voices. The results of males are presented in the last section. Due to the small number of males, their results are given in the Appendices but not in the Figures.

The reported voice symptoms and their frequency at the four different moments of the working day in both subject groups before the training course, five weeks after the course and 1.5 years after the course are shown in the Appendices A, B and C, respectively. Also the sum variables before, five weeks after and 1.5 years after the training course are shown in Appendix D. As an example, vocal strain and hoarseness in females are presented in Figures 1 and 2, respectively. The changes in the sum variables in females are shown in Figure 3 and the answers to question 12 in Figure 4.

Voice symptoms during the working day (females)

On an average, there was a linear increase in all subjective voice symptoms of female CSAs during the working day (Appendix A). According to the sum variable, the most frequent symptoms of women are hoarseness, a feeling of vocal strain and a feeling of mucus in the throat. Of these, the feeling of vocal strain was the only symptom that invariably increased throughout the day ($p \leq 0.009$). Hoarseness increased both during the lunch break ($p = 0.001$) and in the afternoon ($p = 0.001$). The only increase in the amount of mucus took place during the lunch break ($p = 0.002$).

Before lunch, only 2 of the 11 symptoms increased (strain, dryness, $p = 0.000$, $p = 0.003$, respectively). Altogether 9 out of 11 symptoms increased after the lunch break (with the exception of dryness and creakiness). In the afternoon, there was also an increase in 9 symptoms (with the exception of mucus and a feeling of a loss of air). In many cases, the increase in reported symptoms was small.

Based on their responses to the question 'My voice gets worse during the day', 50% of the female subjects felt that their voice got worse during the working day.

Voice symptoms after the training (females)

Five weeks after the vocal training ($N = 30$), there was still an increase in all subjective voice complaints during the working day in females (Appendix B). When the situation after the training was compared to that preceding the training, there were fewer symptoms that increased after the lunch break and during the afternoon. However, even after the training, seven symptoms continued to show an increase during the first part of the working day.

There were only a few significant differences between the symptoms occurring at the same moment of the day before and after the training. The two-day voice training had diminished the amount of vocal strain before the lunch break ($p = 0.003$) and at the end of the working day ($p = 0.026$). The levels of reported hoarseness after the lunch break ($p = 0.031$) and at the end of the working day ($p = 0.019$) were lower.

The comparisons of the sum variable before and after the voice training in females also showed a decrease of certain symptoms. The reported degree of vocal strain and hoarseness decreased ($p = 0.001$ and $p = 0.010$, respectively). A significant part ($p = 0.002$) of those who reported vocal fatigue before the training no longer experienced such fatigue after the training.

Long-term effects on voice symptoms (females)

Altogether 26 female subjects participated in the follow-up study, which was carried out one-and-a-half years after the short vocal health programme. The subjects filled in exactly the same questionnaire as on the first occasion. In line with the previous findings, there was again an increase in all symptoms during the working day. The numerical results are presented in Appendix C.

When the long-term effects are compared to the situation before the training, two sum variables appear to have decreased: the feeling of vocal strain ($p = 0.001$) and hoarseness ($p = 0.010$). In addition, there were fewer CSAs who reported impairment of their voice during the working day ($p = 0.031$).

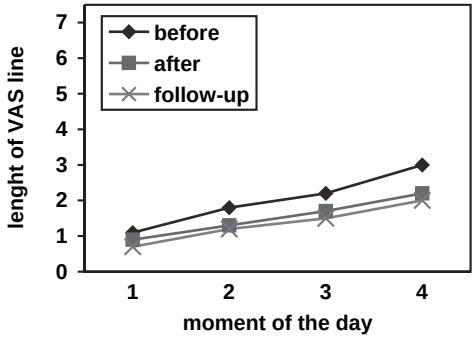

Figure 1. Vocal strain of females. Subjective symptoms at four different moments of the day: in the morning (1), before lunch (2), after lunch (3) and at the end of the working day (4) before the training (before), five weeks after the training (after) and 1.5 years after the training (follow-up). The maximum score for each moment of the day is 7.5, measured with Visual Analogue Scale (VAS).

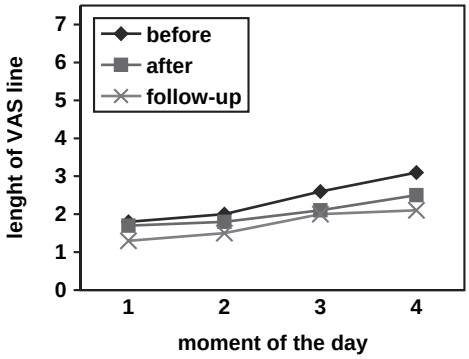

Figure 2. Hoarseness of females. Subjective symptoms at four different moments of the day: in the morning (1), before lunch (2), after lunch (3) and in the end of the working day (4) before the training (before), five weeks after the training (after) and 1.5 years after the training (follow-up). The maximum score for each moment of the day is 7.5, measured with Visual Analogue Scale (VAS).

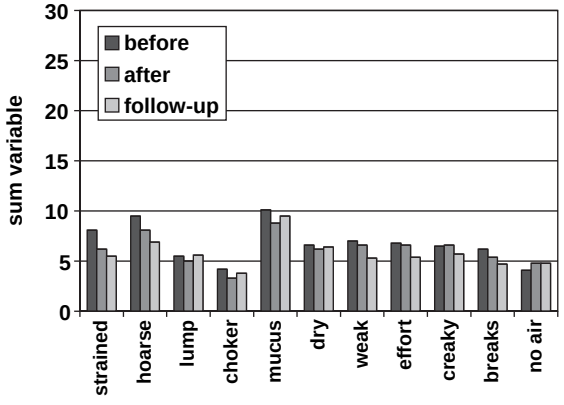

Figure 3. The sum variable of females for all the symptoms before the training (before), five weeks after the training (after) and 1.5 years after the training (follow-up). The maximum score for the sum variable is 30.

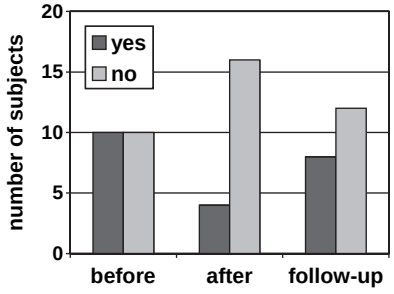

Figure 4. Answers to question 12: 'My voice gets worse during the working day'. Only includes answers from those 20 female subjects who answered the question before the training (before), five weeks after the training (after) and 1.5 years after the training (follow-up).

Voice symptoms during the working day, voice symptoms after the training and long-term effects on voice symptoms (males)

There was some increase in most of the subjective voice symptoms of male CSAs during the working day before the training, five weeks after the training and in the follow-up study 1.5 years after the training (Appendices A, B and C). The sum variable (Appendix D) showed the feeling of mucus in the throat and the dryness of the throat to be the most frequent symptoms males experienced. However, neither of these showed a statistically significant change throughout the day. Only hoarseness increased statistically significantly in the afternoon before the training ($p = 0.012$). Five weeks after the training, the feeling of vocal strain and hoarseness increased in the afternoon ($p = 0.033$ and $p = 0.024$, respectively) compared with the previous moment of the working day.

Based on their responses to the question 'My voice gets worse during the day', only one of ten male subjects felt that his voice got worse during the working day. Five weeks after the training, the same subject reported still worsening of the voice, while the seven other subjects participating did not.

The comparisons of the sum variable before and after the voice training showed an interesting trend in males. While females experience mainly decreasing voice symptoms, the situation was vice versa in males: all symptoms increased after the training and still in the follow-up study.

Discussion

Speaking is hard work for the vibratory structures of the body: during each vibration, the vocal fold mucosa surfaces collide. For a female teacher this may amount to as much as 1,000,000 vocal fold vibrations during the daily working hours (43). Subjective voice complaints have been found to correlate positively with the total number of vocal fold vibrations during vocal loading (44).

Concerning persons using mainly telephone at work and the duration of their voice use, it is important to know whether the conversation is closer to monologue than dialogue. The speech data of the present study consisted mostly of counselling conversations, and the subjects therefore usually had a chance for short-term recovery during the calls. Even a very short break might help to preserve undisturbed voice function, as shown in a recent study by Yiu and Chan (45). They studied amateur karaoke singers and found that the subjects who had a one-minute break and drank 100 ml of water after singing each song were able to sing significantly

longer than those who did not take any water or rest. Titze (46) remarks that athletes need recovery from strenuous physical activity. Similarly, recovery is needed also by voice users after speaking extensively because they can be considered to have undergone physical activity in their larynx.

The first goal of this study was to find out how telephone workers experience voice symptoms at different moments of the working day. Before the short vocal training course, there was an increase in all the subjective voice symptoms experienced by call-centre operators during the working day. According to the sum variable, the most frequent symptoms of the female subjects were hoarseness, a feeling of vocal strain and a feeling of mucus in the throat. This finding is in line with previous studies on the most common problems experienced in connection with a voice disorder (2,6–9,11,12,47,48). For male subjects the most common symptoms were mucus in the throat and dryness of the throat.

The second goal of the current study was to investigate the effects of a short vocal training course. In a recent article (32), the present authors investigated subjects' responses concerning a short vocal training course and its effects on working ability. The subjects' general opinions about the vocal training course were very positive. They felt they had gained useful and important knowledge concerning their work, and had attained new knowledge about voice production (32). To the best of our knowledge, only Broaddus-Lawrence et al. (49) have previously studied the effects of a short vocal hygiene course. However, their subjects were all singers. Therefore, the authors wished to continue studying the possible effects of a short training programme, arranged for healthy occupational speakers with no education in singing or acting. The combination is new, because most of the previous studies on the effects of voice training have either focused on therapy programmes lasting for months with weekly sessions (e.g., (31,50–53)), or involved singers and actors (e.g., (49)).

In the present study, there was a persistent increase in subjective symptoms throughout the working day even after the short training programme. However, the sum variable in females showed a decrease in most symptoms after the training (Figure 3), and in two symptoms (vocal strain, hoarseness) this decrease was significant. This finding is important, because these symptoms are widely considered to reflect working ability (or its impairment) (4,8,9,28,48). However, in males the sum variable interestingly increased after the training and also in the follow-up study. It is possible that this different behaviour of females and males reflects the findings reported by Herrington-Hall et al. (54), according to which women in general appear to be more interested in health, more likely to recognize bodily changes as symptoms of illness, and more willing to seek medical care than males. The indication might be that when females get 'permission' to feel some symptoms and are taught to learn to control these symptoms in some way, they experience it as positive feedback about their self-control. Conversely, when males learn to observe their voice more carefully, it is not always a relief (6).

Various studies have shown that a group receiving therapy always achieves better results compared to control groups (e.g. (8,50,53,55,56)). However, the efficacy of different treatment methods continues to be a topic of intensive debate (20,50,55,57). Given that the definition of a voice problem is far from straightforward, the topic of subjective symptoms and their change remains challenging. Questionnaires are inevitably subjective. In addition, it is difficult to determine the extent to which subjects' reports of the effects of voice treatment are influenced by the way they have experienced the training procedure (58). For example, the voice training programme of the present study offered basic knowledge not only of voice production, but also on the effects of good body posture and some environmental factors, such as the importance of air humidity. In future studies on voice training, it would be informative also to analyse how general knowledge of related issues affects the results.

In the present study, the questionnaire was based on the Visual Analogue Scale (VAS). On the day of the examination, all four moments of the day were marked on the same VAS line each time the questionnaire was completed. One might ask if the result would have been different if the subjects had filled out a blank questionnaire every time they estimated their subjective symptoms. It is possible that people have a tendency to 'build up' a logical sequence with their responses. However, by using the same form the authors wanted to give the subjects a possibility to assess comparatively the subjective symptoms they experienced at the different moments of the day. It appeared that the subjects considered thoroughly the use of the scale. It should also be noted that the subjects were not asked to directly evaluate the effect of the training in the present study. This was done by the authors. As the authors wanted all the three research events (before the training, 5 weeks after the training and 1.5 years after the training) to act as their own subjective units, the subjects were not given an opportunity to refer to their earlier questionnaires.

The current study addresses the effects of preventive voice care. Early identification and treatment

of voice problems are thought to reduce their severity and the time needed to recover from them. As mentioned before, the European OS&H legislation obliges the employer to provide for, for example, the prevention of occupational risks by consultation, training and general guidelines (24). However, this obligation is not always fulfilled. According to Jones et al. (3), some firms even declined to participate in the research because they wished to avoid raising employee awareness of voice problems. A previous study by Morton and Watson (6) showed that some employees regarded their vocal symptoms as inherent to their occupation and did not necessarily take appropriate countermeasures. In the light of many studies based on subjective judgements, persons with voice problems may benefit from voice training (20,49–51,55,56), and preventive voice care should therefore be emphasized as a tool to sustain occupational capacity.

A comparison of the sum variables of the symptoms before and after the two-day training programme showed in females that vocal strain and hoarseness had diminished significantly. One-and-a-half years after the training, there were no significant changes compared to the situation five weeks after the training. Therefore, it can be concluded that the female subjects gained long-term benefits from the training. The small number of male subjects, unfortunately, does not allow strong conclusions to be made on the effects of training on male voice users. However, the limited data available tentatively indicates that males might not benefit from vocal training as much as females.

The finding of long-term benefits for females is in line with the recent study by the authors, which is the only previous study measuring the effects of a short vocal training programme for 'ordinary' voice professionals (32). Concerning a similar short course on vocal hygiene arranged for untrained singers, Broaddus-Lawrence et al. (49) reported a high degree of benefit and learning, although there was minimal change in the subjects' vocal hygiene behaviour and their perceptual voice characteristics.

Although the present subjects did not suffer from severe voice problems, the short vocal training course significantly reduced some of the vocal symptoms the female subjects had experienced. However, it can be observed that, although the overall level of the voice symptoms was lower after the training (including both short-term and long-term effects), there was also increase in some of the symptoms in the follow-up study (Figure 3). Therefore, it might be justified to suggest that regular consultation and training in the field of occupational voice care should be provided for voice users in order to sustain positive effects of voice training.

Conclusions

The goal of the two-day voice training programme was to give the participating call-centre operators knowledge of how to preserve their voices. This study investigated both the short- and the long-term effects of the short training course by measuring the subjects' symptoms throughout the working day. It turned out that even a short vocal training course seems to have a positive effect on the experienced symptoms of persons, particularly in females, working in vocally demanding occupations.

Acknowledgements

The authors wish to thank Arja Kotomäki, Terttu Luoma-Aho and all the participants at Sonera for cooperation. The authors also wish to thank Hanna Oksanen (PhD) for her expert help with the statistical analyses and Ms Sirkka-Liisa Leinonen (Lic. Phil.) for the linguistic revision of this manuscript. The research was supported by Sonera Corporation, the Finnish Foundation of Occupational Health, the Finnish Ear Research Foundation and the Academy of Finland (project number 201018). The primary author also wants to thank for support the department of Speech, Music and Hearing at the Royal Institute of Technology in Stockholm, Sweden, where she had an opportunity to work as a Marie Curie trainee in summer 2003.

References

1. Fritzell B. Voice disorders and occupations. Log Phon Vocol. 1996;21:7–12.
2. Jónsdóttir V. Cordless amplifying system in classrooms. A descriptive study of teachers' and students' opinions. Log Phon Vocol. 2002;27:29–36.
3. Jones K, Sigmon J, Hock L, Nelson E. Prevalence and risk factors for voice problems among telemarketers. Arch Otolaryngol Head Neck Surg. 2002;128:571–7.
4. Koufman J, Blalock P. Vocal fatigue and dysphonia in the professional voice users: Bogart-Bacall-syndrome. Laryngoscope. 1998;93(suppl.5):493–8.
5. Mattiske J, Oates J, Greenwood K. Vocal problems among teachers: A review of prevalence, causes, prevention and treatment. J Voice. 1998;12(4):489–99.
6. Morton V, Watson DR. The teaching voice: problems and perceptions. Log Phon Vocol. 1998;23:133–9.
7. Newman C, Kersner M. Voice problems of aerobics instructors: implications for preventive training. Log Phon Vocol. 1998;23:177–80.
8. Sala E, Laine A, Simberg S, Pentti J, Suonpää J. The prevalence of voice disorders among day care center teachers compared with nurses: A questionnaire and clinical study. J Voice. 2001;15(3):413–23.
9. Sapir S, Atias J, Sharhar A. Symptoms of vocal attrition in women army instructors and recruits: results from a survey. Laryngoscope. 1990;100:991–4.
10. Scherer R, Titze I, Raphael B, Wood R, Ramig L, Blager R. Vocal fatigue in a trained and an untrained voice user. In:

Bear T, Sasakei C, Harris K, editors. Laryngeal Function in Phonation and Respiration. A College-Hill Publication. Boston/Toronto/San Diego: Little, Brown and Company; 1987. p. 533–53.
11. Simberg S, Laine A, Sala E, Rönnemaa A-M. Prevalence of voice teachers among future teachers. J Voice. 2000;14(2): 231–5.
12. Smith E, Lemke J, Taylor M, Kirchner HL, Hoffman H. Frequency of voice problems among teachers and other occupations. J Voice. 1998;12(4):480–8.
13. Titze IR, Lemke J, Montequin D. Populations in the U. S. workforce who rely on voice as a primary tool of trade: A preliminary report. J Voice. 1997;11:245–59.
14. Ma EP-M, Yiu EM-L. Voice activity and participation profile: assessing the impact of voice disorders on daily activities. J Speech Lang Hear Res. 2001;44:511–24.
15. Verdolini K, Ramig LO. Review: Occupational risks for voice problems. Log Phon Vocol. 2001;26:37–46.
16. International Classification of Impairment, Disability and Handicap. Geneva: World Health Organization; 1980.
17. Dekker J. Application of the ICIDH in survey research on rehabilitation: The emergence of the functional diagnosis. Disabil Rehabil. 1995;17:195–201.
18. International Classification of Impairment, Disability and Handicap. Geneva: World Health Organization; 2001.
19. Russel A, Oates J, Greenwood K. Prevalence of voice problems in teachers. J Voice. 1998;12(4):467–79.
20. Ramig LO, Verdolini K. Treatments efficacy: Voice disorders. J Speech Lang Hear Res. 1998;41:S101–16.
21. Vilkman E. Occupational risk factors and voice disorders. Log Phon Vocol. 1996;21:137–41.
22. Vilkman E. A survey on the occupational safety and health arrangements for voice and speech professionals in Europe. In: Dejonckere PH, editor. Occupational voice—care and cure, 1–9. The Hague, The Netherlands: Kugler Publications; 2000.
23. Ohlsson A-C, Löfqvist A. Work-day effects on vocal behaviour in switchboard operators and speech therapists. Scand J Log Phon. 1987;12:70–9.
24. Council Directive: On the introduction measures to encourage improvements in the safety and health of workers at work. 89/391/EEC. Brussels: European Economic Community; 1989.
25. Gotaas C, Starr CG. Vocal fatigue among teachers. Folia Phoniatr. 1993;45:120–9.
26. Pekkarinen E, Himberg L, Pentti J. Prevalence of vocal symptoms among teachers compared with nurses: A questionnaire study. Scand J Log Phon. 1992;17:113–7.
27. Rantala L. Voice at work. Female teachers' use and loading of voice. [In Finnish]. Dissertation. Acta Universitatis Ouluensis. Humaniora. B 37. Oulu: University of Oulu; 2000.
28. Sapir S, Keidar A, Mathers-Schmidt B. Vocal attrition in teachers: survey findings. Eur J Disord Commun. 1993;28: 177–85.
29. Smith E, Gray S, Dove H, Kirchner L, Heras H. Frequency and effects of teachers' voice problems. J Voice. 1997;11(1): 81–7.
30. Smith E, Kirchner HL, Taylor M, Hoffman H, Lemke J. Voice problems among teachers: Differences by gender and teaching characteristics. J Voice. 1998;12(3):328–34.
31. Södersten M, Granqvist S, Hammarberg B, Szabo A. Vocal behaviour and vocal loading factors for pre-school teachers at work studied with binaural DAT recordings. J Voice. 2002; 16(3):356–71.
32. Lehto L, Rantala L, Vilkman E, Alku P, Bäckström T. Experiences of a short vocal training course for call-centre customer service advisors. Folia Phoniatr. 2003;55:163–76.
33. Richter B, Löhle E, Maier W, Klieman B, Verdolini K. Working conditions on stage: climatic considerations. Log Phon Vocol. 2000;25(2):80–6.
34. Verdolini-Marston K, Sandage M, Titze I. Effects of hydration treatments on laryngeal nodules and polyps and related voice measures. J Voice. 1994;8(1):30–47.
35. Verdolini K, Titze IR, Fenell A. Dependence of phonatory effort on hydration level. J Speech Hear Res. 1994;37:1001–7.
36. Vintturi J. Studies on voice production. With special emphasis on vocal loading, gender, some explosure factors and intensity regulations. Dissertation. Helsinki: The Medical faculty of the University of Helsinki; 2001.
37. Lemiere C, Desjardins A, Cloutier Y, Drolet D, Perrault G, Cartier A, et al. Occupational asthma due to formaldehyde resin dust with and without reaction to formaldehyde gas. Eur Resp J. 1995;8(5):861–5.
38. Dejonckere P, Lebacq J. Acoustic, Perceptual, aerodynamic and anatomical correlations in voice pathology. Otol Rhinol Laryngol. 1996;58:326–32.
39. Gould D, Kelly D, Goldstone L, Gammon J. Examining the validity of pressure ulcer risk assessment scales: developing and using illustrated patient simulations to collect the data. J Clinical Nursing. 2001;10:697–706.
40. Carding P, Horsley I. An evaluation study of voice therapy in non-organic dysphonia. Eur J Dis Comm. 1992;27:137–58.
41. Martin S, Darnley L. The Teaching Voice. London: Whurr Publishers Ltd; 1996.
42. Coyle S, Weinrich B, Stemple J. Shifts in relative prevalence of laryngeal pathology in a treatment-seeking population. J Voice. 2001;15(3):424–40.
43. Vilkman E. Voice problems at work: A challenge for occupational safety and health arrangement. Folia Phoniatr. 2000; 52:120–5.
44. Rantala L, Vilkman E. Relationship between subjective voice complaints and acoustic parameters in female teachers' voice. J Voice. 1999;13:484–95.
45. Yiu E, Chan R. Effect of hydration and vocal rest on the vocal fatigue in amateur karaoke singers. J Voice. 2003;17(2):216–27.
46. Titze I. Toward occupational safety criteria for vocalization. Log Phon Vocol. 1999;24:49–54.
47. Sapir S. Vocal attrition in voice students: Survey findings. J Voice. 1993;7(1):69–74.
48. Scott S, Robinson K, Wilson JA, Mackenzie K. Patient-reported problems associated with dysphonia. Clin Otolaryngol. 1997;22:37–40.
49. Broaddus-Lawrence PL, Treole K, McCabe RB, Allen RL, Toppin L. The effects of preventive vocal hygiene education on the vocal hygiene habits and perceptual vocal characteristics of training singers. J Voice. 2000;14(1):58–71.
50. Carding P, Horsley I, Docherty G. A study of the effectiveness of voice therapy in the treatment of 45 patients with non-organic dysphonia. J Voice. 1999;13(1):72–104.
51. Chan R. Does the voice improve with vocal hygiene education? A study of some instrumental voice measures in a group of kindergarten teachers. J Voice. 1994;8:279–91.
52. Peppard RC, Bless DM, Milenkovic P. Comparison of young adult singers and nonsingers with vocal nodules. J Voice. 1988;2:250–60.
53. Roy N, Weinrich B, Gray S, Tanner K, Stemple J, Sapienza C. Three treatments for teachers with voice disorders: a randomized clinical trial. J Speech Lang Hear Res. 2003;46:670–88.

54. Herrington-Hall B, Lee L, Stemple J, Niemi K, Miller McHone M. Description of laryngeal pathologies by age, sex, and occupation in a treatment-seeking sample. J Speech Hear Disord. 1988;53:57–64.
55. MacKenzie K, Millar A, Wilson J, Sellars C, Deary I. Is voice therapy an effective treatment for dysphonia? A randomised controlled trial. BMJ. 2001;323:658–61.
56. Roy N, Gray S, Simon M, Dove H, Corbin-Lewis K, Stemple J. An evaluation of the effects of two treatment approaches for teachers with voice disorders: A prospective randomized clinical trial. J Speech Lang Hear Res. 2001;44:286–96.
57. Raaijmakers M, Dekker J, Dejonckere P. Diagnostic assessment and treatment goals in logopedics: Impairments, disabilities and handicaps. Folia Phoniatr. 1998;50:71–9.
58. Pannbacker M. Voice treatment techniques: A review and recommendations for outcome studies. Am J Speech Lang Pathol. 1998;7:49–64.

Appendix A

Voice symptoms during a working day before vocal training (females $N=34$, males $N=10$). The maximum score for each moment of the day is 7.5 measured with Visual Analogue Scale. The maximum score for the sum variable is 30. SD denotes standard deviation. The level of significance is mentioned if there is a significant rise between the moment in question and the previous time of the day (t-test: $\star p \leq 0.05$; $\star\star p \leq 0.005$).

		Females			Males		
Symptom	Moment of the day	mean	SD	range	mean	SD	range
1) strained	Morning	1.1	1.2	0.2–5.0	1.1	1.2	0–3.8
	Before lunch	1.8**	1	0.5–4.0	1.4	0.6	0.4–2.2
	After lunch	2.2*	1.1	0.3–5.3	1.3	0.5	0.6–2.0
	End of the working day	3.0**	1.4	0.3–7.0	1.8	1.3	0.6–5.1
	Sum variable	8.1	3.9	1.4–19.7	5.6	2.7	2.2–11.6
2) hoarse	Morning	1.8	1.5	0.2–6.0	1.8	1.5	0.2–5.3
	Before lunch	2	1.2	0.5–6.5	1.7	0.7	0.7–3.2
	After lunch	2.6**	1.4	0.3–7.2	1.3	0.7	0.4–2.8
	End of the working day	3.1**	1.6	0.3–7.5	2.2*	1	0.7–4.5
	Sum variable	9.5	4.8	1.9–27.2	7	3.4	4.2–15.8
3) lump	Morning	0.8	1.1	0–5.2	1.2	1.5	0.1–5.0
	Before lunch	1.1	0.8	0–3.8	1.3	1	0.2–3.5
	After lunch	1.6**	1	0–4.3	1.2	0.7	0.3–2.6
	End of the working day	2.1**	1.4	0–5.9	1.3	0.9	0.1–3.1
	Sum variable	5.5	3.7	0–16.5	4.9	3.3	1.4–11.2
4) choker	Morning	0.6	0.7	0.1–3.7	0.5	0.4	0.1–1.1
	Before lunch	0.8	0.7	0–3.2	0.6	0.5	0.1–1.5
	After lunch	1.2**	0.9	0.2–3.8	0.8	0.4	0.3–1.4
	End of the working day	1.6**	1.2	0–5.2	1	0.5	0.3–1.8
	Sum variable	4.2	3.2	0.8–14.0	3	1.5	0.8–5.1
5) mucus	Morning	2.1	1.6	0.1–7.1	2.1	2.1	0.2–7.2
	Before lunch	2.2	1.4	0.3–6. 7	2	1.3	0.5–4.4
	After lunch	2.8**	1.6	0.2–6.2	2.2	1.8	0.4–5.4
	End of the working day	3	1.6	0.3–7.5	2.2	1.6	0.1–4.8
	Sum variable	10.1	5.3	1.2–26.3	8.5	6.6	2.7–21.8
6) dry	Morning	1.1	1.4	0–7.1	1.6	1.8	0.3–6.2
	Before lunch	1.4 **	1.4	0–6.5	2.1	1.5	0.5–4.6
	After lunch	1.7	1.3	0–5.6	1.7	1.3	0.5–5.3
	End of the working day	2.4**	1.4	0.3–5.8	2.1	1.6	0.7–6.2
	Sum variable	6.6	5.1	0.8–24.3	7.4	5.6	2.4–22.3
7) weak	Morning	1.3	1.3	0–6.2	0.8	0.7	0.2–2.5
	Before lunch	1.6	1.2	0–5.5	0.8	0.5	0.3–1.8
	After lunch	1.9*	1.2	0–5.9	0.9	0.4	0.2–1.4
	End of the working day	2.3**	1.7	0–6.9	0.9	0.5	0–1.8
	Sum variable	7	4.6	0–21.1	3.4	1.2	2.6–5.8

8) effort	Morning	1.2	1.5	0–6.4	0.9	0.8	0.2–2.5
	Before lunch	1.5	1.2	0.2–6.8	1	0.6	0.2–2.0
	After lunch	1.8**	1.3	0.2–7.0	1.1	0.5	0.4–2.3
	End of the working day	2.3*	1.6	0.2–7.5	1.2	0.8	0.2–2.5
	Sum variable	6.8	5.1	0.8–27.7	4.2	1.1	2.4–5.6
9) creaky	Morning	1.2	1.3	0.1–5.5	0.8	0.8	0–2.4
	Before lunch	1.4	1.2	0.2–5.9	0.8	0.4	0.3–1.4
	After lunch	1.7	1.1	0.2–6.2	1.2	0.7	0.6–3.0
	End of the working day	2.2**	1.5	0.3–6.5	1.1	0.6	0–1.9
	Sum variable	6.5	4.6	1.7–24.1	4	0.9	2.8–5.4
10) breaks	Morning	1	1.1	0–4.6	0.9	0.9	0–2.8
	Before lunch	1.3	0.9	0–4.4	1.1	0.7	0.3–2.3
	After lunch	1.8**	1.1	0–6.0	1	0.5	0.2–1.8
	End of the working day	2.1*	1.3	0.3–7.0	1.1	0.7	0.3–2.2
	Sum variable	6.2	3.6	1.5–20.0	4.1	1.5	1.8–6.4
11) no air	Morning	0.7	0.7	0–2.9	0.7	0.7	0.1–2.2
	Before lunch	0.9	0.7 0.8	0–2.9	0.8	0.5	0.2–1.5
	After lunch	1.2**	1.2	0–3.6	1.2	0.6	0.6–2.4
	End of the working day	1.4		0–4.5	1.2	0.8	0–2.5
	Sum variable	4.1	2.9	0–12.8	4	1.6	1.8–7.0

Appendix B

Voice symptoms during a working day five weeks after vocal training (females $N = 30$, males $N = 8$). The maximum score for each moment of the day is 7.5 measured with Visual Analogue Scale. The maximum score for the sum variable is 30. SD denotes standard deviation. The level of significance is mentioned if there is a significant rise between the moment in question and the previous time of the day (t-test: $^{*}p \leq 0.05$; $^{**}p \leq 0.005$).

		Females			Males		
Symptom	Moment of the day	mean	SD	range	mean	SD	range
1) strained	Morning	0.9	1	0–4.8	1.4	1.7	0.3–5.3
	Before lunch	1.3**	0.9	0–4.2	1.8	0.3	0.7–4.5
	After lunch	1.7**	1.1	0–5.1	2	0.3	0.9–4.0
	End of the working day	2.2**	1.3	0–5.1	2.3*	0.4	0.7–4.5
	Sum variable	6.2	3.8	0–19.2	7.5	5.2	3.3–17.8
2) hoarse	Morning	1.7	1.6	0.1–6.5	1.7	1.7	0.3–5.4
	Before lunch	1.8	1.2	0.1–4.6	1.9	1.3	0.7–4.6
	After lunch	2.1*	1.3	0.1–5.1	2.1	1.1	1.0–3.7
	End of the working day	2.5*	1.4	0.4–5.5	2.6*	1.4	0.7–4.5
	Sum variable	8.1	4.9	0.8–20.1	8.3	4.9	3.6–17.5
3) lump	Morning	0.9	0.9	0–3.2	1.4	1.5	0.2–4.7
	Before lunch	1.1*	0.8	0–2.7	1.7	1.1	0.4–4.0
	After lunch	1.4*	1.1	0–4.1	2.1	0.9	0.6–3.0
	End of the working day	1.7*	1.2	0–4.6	2.4	1.3	0.6–4.1
	Sum variable	5	3.4	0–13.3	7.5	4	2.0–15.4
4) choker	Morning	0.5	0.4	0–2.0	0.8	0.9	0.2–2.8
	Before lunch	0.8**	0.6	0–2.6	1	0.7	0.5–2.5
	After lunch	0.9*	0.7	0–2.8	1.2	0.6	0.5–2.2
	End of the working day	1.1	0.8	0–2.8	1.5	1	0.7–3.7
	Sum variable	3.3	2.1	0–8.2	4.5	2.2	2.3–7.9

5) mucus	Morning	1.9	1.7	0–7.2	2.1	1.3	0.3–4.0
	Before lunch	1.9	1.4	0–6.6	2.3	0.9	1.1–3.7
	After lunch	2.5**	1.6	0–7.5	3	1.3	1.2–5.4
	End of the working day	2.6	1.6	0–7.0	3.1	1.5	0.8–5.0
	Sum variable	8.8	5.3	0–27.3	10.4	3.9	5.9–15.3
6) dry	Morning	1.1	1.2	0–4.3	1	0.8	0.3–2.2
	Before lunch	1.5*	1.2	0–4.7	1.4*	0.7	0.7–2.5
	After lunch	1.7	1.2	0–5.1	1.7	0.9	0.7–3.0
	End of the working day	2	1.3	0–4.8	2.2	1.2	0.5–3.8
	Sum variable	6.2	4.2	0–17.1	6.3	3	2.9–11.1
7) weak	Morning	1.4	1.5	0–5.4	0.9	0.8	0.3–2.8
	Before lunch	1.5	1.2	0–4.8	1.3	0.5	0.7–2.3
	After lunch	1.8*	1.3	0–5.1	0.6	0.6	0.8–2.8
	End of the working day	1.9	1.4	0–5.8	2	1.1	0.9–4.5
	Sum variable	6.6	5	0–21.1	5.7	1.9	3.7–9.3
8) effort	Morning	1.3	1.4	0–4.9	1	0.8	0.2–2.2
	Before lunch	1.6*	1.3	0–4.6	1.3	0.5	0.8–2.2
	After lunch	1.7	1.2	0–4.2	1.9	1.5	0.8–5.5
	End of the working day	2.1*	1.4	0–5.3	1.7	0.8	0.6–3.5
	Sum variable	6.6	4.8	0–18.3	5.9	2.4	3.4–10.6
9) creaky	Morning	1.4	1.5	0–5.0	1.1	0.8	0.2–2.2
	Before lunch	1.6*	1.4	0–5.2	1.4	0.6	0.8–2.5
	After lunch	1.6	1.2	0–4.7	1.9	1.2	0.6–4.5
	End of the working day	1.9*	1.3	0–5.1	1.9	1	0.2–3.3
	Sum variable	6.6	4.8	0–18.1	6.3	2.8	3.4–10.7
10) breaks	Morning	1.1	1.1	0–4.6	0.9	0.6	0.3–1.9
	Before lunch	1.3	0.8	0–3.0	1.4	0.8	0.7–2.8
	After lunch	1.4	0.9	0–3.6	1.7	1.5	0.2–4.5
	End of the working day	1.6	1	0–4.2	1.9	1.5	0.2–4.3
	Sum variable	5.4	3.2	0–12.3	5.8	3.8	1.8–12.5
11) no air	Morning	0.9	1.1	0–4.7	0.7	0.4	0.2–1.2
	Before lunch	1.2*	1.1	0–4.7	1	0.5	0.4–2.0
	After lunch	1.2	1.1	0–5.2	1.5	0.8	0.5–2.8
	End of the working day	1.4	1.1	0–4.1	1.8	1.1	0.1–3.4
	Sum variable	4.8	4	0–17.4	5.1	2.3	2.2–9.3

Appendix C

Voice symptoms during a working day 1.5 years after vocal training (females $N = 26$, males $N = 7$). The maximum score for each moment of the day is 7.5 measured with Visual Analogue Scale. The maximum score for the sum variable is 30. SD denotes standard deviation. The level of significance is mentioned if there is a significant rise between the moment in question and the previous time of the day (t-test: $*p \leq 0.05$; $**p \leq 0.005$).

		Females			Males		
Symptom	Moment of the day	mean	SD	range	mean	SD	range
1) strained	Morning	0.7	0.6	0–2.3	0.8	0.8	0–2.5
	Before lunch	1.2**	0.7	0.4–2. 6	1.4	0.7	0.8–2.9
	After lunch	1.5**	0.7	0.4–2.9	2.0*	0.8	1.2–3.6
	End of the working day	2.0**	1	0.2–4.2	2.9*	1.2	1.9–5.5
	Sum variable	5.5	2.5	2.2–11.2	7.1	3.1	4.7–13.0

2) hoarse	Morning	1.3	1	0.3–5.2	1.3	1.2	0.3–3.5
	Before lunch	1.5	0.6	0.3–3.0	1.8	1.1	0.8–3.7
	After lunch	2.0*	1	0.3–4.5	2.3*	1.2	1.2–4.7
	End of the working day	2.1	1	0–3.5	3.0*	1.4	1.6–5.2
	Sum variable	6.9	2.7	2.6–14.0	8.3	4.5	4.2–15.8
3) lump	Morning	0.8	0.9	0–4.6	1.1	1.1	0.2–3.3
	Before lunch	1.2**	1	0.2–4.3	1.3	0.9	0.4–3.0
	After lunch	1.7**	1.2	0.2–4.3	1.7	0.9	0.4–2.8
	End of the working day	1.8	1.1	0.2–4.3	2.5*	1.6	0.4–5.0
	Sum variable	5.6	3.7	0.6–16.3	6.5	4.2	1.6–12.6
4) choker	Morning	0.5	0.5	0–2.3	0.9	1	0.3–3.0
	Before lunch	0.9**	0.7	0–2.7	1.1	0.5	0.4–2.1
	After lunch	1.1**	0.7	0–2.5	1.4*	0.7	0.4–2.6
	End of the working day	1.3	1	0–3.3	2.0*	1.2	0.4–4.2
	Sum variable	3.8	2.4	0–10.4	5.4	3.2	1.6–11.9
5) mucus	Morning	1.8	1.2	0.2–5.6	1.9	1.3	0.3–3.8
	Before lunch	2	1	0.2–4.4	2	0.9	1.0–3.3
	After lunch	2.8**	0.3	0.7–5.1	2.7	1.5	1.5–5.7
	End of the working day	2.8	1.1	0.3–5.1	3.5	1.2	1.8–5.0
	Sum variable	9.5	3.6	4.4–17.8	10.1	4.3	5.1–17.8
6) dry	Morning	1.1	0.9	0.2–3.2	1.4	1.4	0.4–4.2
	Before lunch	1.4*	0.8	0.4–3.6	1.8	1	0.4–3.0
	After lunch	1.8**	0.9	0.4–4.2	2.3*	1.3	0.4–3.7
	End of the working day	2	1.1	0.2–4.8	2.9*	1.7	0.4–5.5
	Sum variable	6.4	3.3	1.6–13.9	8.5	5.1	1.6–16.4
7) weak	Morning	0.9	0.8	0.1–3.9	1.3	1.1	0.3–3.5
	Before lunch	1.3**	0.8	0.2–3.4	1.7	0.6	1.0–2.5
	After lunch	1.5**	0.9	0.2–3.7	2.1	0.8	1.0–3.2
	End of the working day	1.6	1.1	0–3.7	2.7*	0.8	1.6–4.2
	Sum variable	5.3	3.3	0.8–14.2	7.9	2.9	5.1–13.3
8) effort	Morning	0.9	0.8	0–2.7	1	0.7	0.4–2.5
	Before lunch	1.2**	0.8	0–2.9	1.5	0.7	0.4–2.7
	After lunch	1.5**	0.9	0–3.4	1.9	0.9	0.4–3.1
	End of the working day	1.7	1.2	0–4.4	2.5*	1.1	0.4–3.7
	Sum variable	5.4	3.2	0–11.4	6.9	3	1.6–10.9
9) creaky	Morning	0.9	1	0–4.8	1	0.7	0.4–2.2
	Before lunch	1.4**	1	0–4.3	1.4	0.4	0.8–2.1
	After lunch	1.6*	1	0–4.5	1.7	0.5	1.1–2.4
	End of the working day	1.8	1.2	0–5.0	2	0.8	0.7–2.8
	Sum variable	5.7	3.8	0–18.6	6.1	2.1	3.7–9.1
10) breaks	Morning	0.8	0.9	0–4.3	0.8	0.6	0–1.7
	Before lunch	1.1*	0.8	0–2.8	1.3	1.2	0.3–3.7
	After lunch	1.4**	0.8	0–3.2	1.6	0.9	0.5–2.9
	End of the working day	1.4	1	0–3.5	2.3*	1.4	0.5–4.8
	Sum variable	4.7	3.1	0–12.5	5.9	3.8	2.0–12.9
11) no air	Morning	0.8	0.8	0–3.7	0.8	0.5	0.3–1.7
	Before lunch	1.1**	0.8	0–3.9	1.1	0.6	0.5–2.1
	After lunch	1.5**	1	0–4.2	2.0*	1.3	0.5–4.5
	End of the working day	1.5	1.1	0–4.4	2.1	0.9	0.5–2.8
	Sum variable	4.8	3.4	0–16.2	6	2.9	2.0–10.7

Appendix D

The sum variables before the training, five weeks after the training and 1.5 years after the training. The maximum score for the sum variable is 30. SD denotes standard deviation. The level of significance is mentioned if there is a significant change between the moment in question and the previous moment. (t-test: $^{\star}p \leq 0.05$).

		Females			Males		
Symptom		before training N = 34	5 weeks after training N = 27	1.5 years after training N = 27	before training N = 10	5 weeks after training N = 8	1.5 years after training N = 7
1) strained	mean	8.1	6.2*	5.5	5.6	7.5	7.1
	SD	3.9	3.8	2.5	2.7	5.2	3.1
	range	1.4–19.7	0–19.2	2.2–11.2	2.2–11.6	3.3–17.8	4.7–13.0
2) hoarse	mean	9.5	8.1*	6.9	7	8.3	8.3
	SD	4.8	4.9	2.7	3.4	4.9	4.5
	range	1.9–27.2	0.8–20.1	2.6–14.0	4.2–15.8	3.6–17.5	4.2–15.8
3) lump	mean	5.5	5	5.6	4.9	7.5	6.5
	SD	3.7	3.4	3.7	3.3	4	4.2
	range	0–16.5	0–13.3	0.6–16.3	1.4–11.2	2.0–15.4	1.6–12.6
4) choker	mean	4.2	3.3	3.8	3	4.5	5.4
	SD	3.2	2.1	2.4	1.5	2.2	3.2
	range	0.8–14.0	0–8.2	0–10.4	0.8–5.1	2.3–7.9	1.6–11.9
5) mucus	mean	10.1	8.8	9.5	8.5	10.4	10.1
	SD	5.3	5.3	3.6	6.6	3.9	4.3
	range	1.2–26.3	0–27.3	4.4–17.8	2.7–21.8	5.9–15.3	5.1–17.8
6) dry	mean	6.6	6.2	6.4	7.4	6.3	8.5
	SD	5.1	4.2	3.3	5.6	3	5.1
	range	0.8–24.3	0–17.1	1.6–13.9	2.4–22.3	2.9–11.1	1.6–16.4
7) weak	mean	7	6.6	5.3	3.4	5.7*	7.9
	SD	4.6	5	3.3	1.2	1.9	2.9
	range	0–21.1	0–21.1	0.8–14.2	2.6–5.8	3.7–9.3	5.1–13.3
8) effort	mean	6.8	6.6	5.4	4.2	5.9	6.9
	SD	5.1	4.8	3.2	1.1	2.4	3
	range	0.8–27.7	0–18.3	0–11.4	2.4–5.6	3.4–10.6	1.6–10.9
9) creaky	mean	6.5	6.6	5.7	4	6.3	6.1
	SD	4.6	4.8	3.8	0.9	2.8	2.1
	range	1.7–24.1	0–18.1	0–18.6	2.8–5.4	3.4–10.7	3.7–9.1
10) breaks	mean	6.2	5.4	4.7	4.1	5.6	5.9
	SD	3.6	3.2	3.1	1.5	3.8	3.8
	range	1.5–20.0	0–12.3	0–12.5	1.8–6.4	1.8–12.5	2.0–12.9
11) no air	mean	4.1	4.8	4.8	4	5.1	6
	SD	2.9	4	3.4	1.6	2.3	2.9
	range	0–12.8	0–17.4	0–16.2	1.8–7.0	2.2–9.3	2.0–10.7