Design of a Clinical Vocal Loading Test With Long-Time Measurement of Voice

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Summary: Objectives. The aim of this study was to design a clinical vocal loading task (VLT) and to track vocal loading and recovery in voice-healthy subjects.

Study Design. Pilot study.

Methods. Voice-healthy subjects (six female, five male) took part in a controlled VLT in the voice clinic. The VLT was designed to induce vocal fatigue. The subjects read aloud while making themselves heard through ambient speech-babble aired at 85 dB sound pressure level (SPL). Reading was terminated by the subjects when or if they felt any discomfort from the throat. The subjects wore a voice accumulator and filled out a voice activity questionnaire 1 day preceding and for 2 days following the VLT. Expert panels assessed vocal quality and laryngeal physiology from recordings.

Results. The subjects endured the VLT for 3–30 minutes. All subjects perceived vocal loading in the VLT. All subjects raised the fundamental frequency and SPL of their speech during the VLT. No match was shown between assessment of voice quality and laryngeal physiology. The subjects showed phonation quotients of 64–82% in the task. Measurements of phonation threshold pressure (PTP) were unstable and were not used. Self-perceived vocal loading receded after 24 hours.

Conclusions. An authentic vocal load was simulated through the chosen method. Onset and recovery from self-perceived vocal loading was traceable through the voice activity questionnaire. The range of endurance in the VLT was an unexpected finding, indicating the complexity of vocal loading.

Key Words: Vocal loading task–Vocal recovery–Long-time measurement of voice–Clinical voice assessment.

INTRODUCTION

In literature covering vocal loading, this concept is defined by a combination of prolonged voice use with added loading factors, such as high phonation at high sound pressure levels (SPLs). These factors may affect fundamental frequency, loudness, phonation modality, and/or laryngeal features, such as vibratory characteristics of the vocal folds or the external frame of the larynx.[1]

Prolonged voice use is commonly regarded as one of the most relevant factors in functional voice disorders.[2,3] Similarly we expect prolonged voice use to cause vocal fatigue also in voice-healthy subjects. Assuming typical loudness, the healthy, adult voice is expected to be fatigued after roughly 4–6 hours of use.[4,5] Numerous studies have tested vocal loading in voice-healthy subjects,[6–15] however a test of 4–6 hours is impractical to perform and administer in a clinical or laboratory setting.[6] Many studies have documented increased fundamental frequency and speech SPLs following vocal loading. This vocal behavior may follow the principle of the Lombard effect, which entails an involuntary rise of speaking pitch and loudness as a speaker strives to increase vocal audibility in ambient noise.[16] This has been regarded as adequate adaptation to loading[11,17,18] and has also been interpreted as being part of the voice function's circadian rhythm.[18]

Objective changes to the phonatory function are often sought in tests of vocal loading. It has been examined by many,[2,6,7,9–15,17–40] with little conformity,[41] making cross-study comparisons difficult.[21] In laboratory settings a time-limit has traditionally been set for intersubject comparability.[2,6,25,38]

It is essential to investigate symptom-based signs of vocal fatigue. By letting subjects phonate at high SPLs for a prolonged period of time in a controlled environment the vocal function can be studied for indirect evidence of vocal fatigue, before and after vocal loading. No previous studies have let subjects themselves set the time-limit for a controlled vocal loading task (VLT) to gain knowledge of what amount of increased phonation loudness will induce vocal fatigue. Asking subjects about the condition of their own voice is of great importance when assessing voice problems based on vocal fatigue. Solomon,[41] p. 254, argues that researchers and clinicians need to agree that vocal fatigue is a symptom-based voice problem, stemming from the self-report of an increased sense of effort with prolonged phonation, that is, symptoms voice professionals can neither hear, nor see.

The use of voice accumulation along with voice activity questionnaires could verify vocal loading and trace it from onset to regression. Although vocal behavior and spontaneous vocal load have been examined in the field through several different methods and for varying amounts of time,[8,19,42–47] the progression of controlled vocal loading has not yet been tracked through long-time voice accumulation.

Objectives

This pilot study was aimed to design a VLT which by extension should be possible to use in diagnostics of voice disorders.

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Another aim is to track onset of vocal loading and vocal recovery.

The task was aimed to induce vocal fatigue in voice-healthy subjects by letting them read loudly until they perceive discomfort from the throat. Increased phonation loudness and vocal fatigue were tracked to observe objective changes in vocal acoustics and physiology following controlled vocal loading. Self-assessment was used to provide information on how the subjects experienced the program.

We wanted to learn how this method affects the subjects' time of participation, self-assessment of vocal function, fundamental frequency, speech SPL, perceived voice quality, and vocal fold physiology.

Method queries

- How do we design a VLT which is suitable for the voice clinic and which allows subjects to set the time limit for increased speaking loudness?
- How can recovery processes from potential vocal load/strain inflicted on voice-healthy individuals by a VLT be tracked?

Hypotheses

- The VLT will cause the subjects to experience vocal fatigue.
- Vocal recovery processes are traceable through voice accumulation and a structured voice activity questionnaire.

METHODS

In this study voice-healthy individuals were tracked during four working days with a VLT taking place midway. Processes involved in recovery from vocal loading have in previous research been tracked through self-evaluation of voice function.[14] The controlled vocal loading in this study was meant to represent vocal load accumulated over time, here compressed into a reading task of a maximum of 30 minutes in length. To learn more about what amount of increased phonation loudness will induce vocal fatigue in voice-healthy subjects, a timing aspect was also introduced, whereby the subjects themselves discontinued phonation if and when they perceived any discomfort from the throat while phonating.

Subjects

In total n = 11 subjects took part in this pilot study. Five male (mean age 37 years, range 28–55 years) and six female (mean age 36 years, range 28–47 years) were recruited among colleagues and friends through verbal inquiry and agreement. The subjects all had to meet the following requirements: adult (>18 years), voice-healthy, nonsmokers with or without vocal training. The exclusion criteria were: children (≤17 years), laryngeal pathologies, smokers, and professional singers. Vocal health was determined by oral interviews on medical history, carried out by the first author (S.W.) followed by a phoniatrical

TABLE 1.
Demographics of All Subjects (N = 11), Who Were All Voice-Healthy Nonsmokers

Subject	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11
Gender	F	F	F	F	F	F	M	M	M	M	M
Age	33	36	36	34	47	28	33	55	34	28	34
Better ear HL	25	20	20	20	20	20	20	20	20	20	20
Vocal work load	Low	Moderate	Low	Low	Moderate	Low	Some	Moderate	Moderate	Moderate	Moderate
Allergies	Pollen, nutritional, fur	None	None	Pollen, cat	Asthma, pollen, fur	Penicillin V	None	None	None	None	Undiagnosed: cat, horse
Medication	Antihistamines	None	None	None	Omeprazole	None	None	None	None	None	None
Stress level	Moderate, fluctuates	High, constant	High, fluctuates	Moderate, fluctuates	High, slow fluctuation	High, fluctuates	Moderate, fluctuates	High, constant	Moderate, constant	High, fluctuates	High, constant