

TMH-QPSR Abstracts

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MUSIC

Effects of lung volume on the glottal voice source and the vertical laryngeal position in male professional opera singers

Monica Thomasson

Lung volume (LV) has been shown to have an effect on the glottal voice source and vertical laryngeal position (VLP) in normal, vocally untrained subjects. If this would apply also to operatic singing, an audible change of vocal timbre would occur as the LV changes during a phrase. This investigation examines LV effects on the voice source and the VLP in 9 professional operatic singers. The subjects sang a sequence of /pae:/-syllables at different loudness levels and pitches using their full vital capacity range. Subglottal pressure, VLP and glottal voice source characteristics were analysed at high and low LV. With regard to VLP and peak-to-peak flow, the results were similar to those found for untrained subjects, the former rising and the latter decreasing with decreasing LV. With regard to subglottal pressure, closed quotient, glottal leakage, and H1-H2 level difference the results differed from those found for untrained subjects in that these parameters did not change with decreasing LV.

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Research on the singing voice in retrospect

Johan Sundberg

Many years have elapsed since the first articles on various aspects of the singing voice were published. Here my own research on singer's formant, formant tuning, breathing, and voice source are reviewed in the light of later

contributions. Detweiler's and Wang's studies of the singer's formant are commented. The idea that singers tend to tune F1 and/or F2 to harmonic partials is analysed and some open questions are pointed out. Various investigations of the voice source and breathing are discussed and some attractive topics for future research are described. The article was written at the request of the recent conference on Physiology and Acoustics of Singing in Groningen, where researchers were asked to review their own research on the singing voice.

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The self-to-other ratio applied as a phonation detector for voice accumulation

Svante Granqvist

A new method for phonation detection is presented. The method utilises two microphones attached near the subject's ears. In short, phonation is assumed to occur when the signals appear mainly in-phase and at equal amplitude. Several signal processing steps are added in order to improve the phonation detection, and finally the original signal is sorted in separate channels corresponding to the phonated and non-phonated instances. The method is tested in a laboratory setting to demonstrate the need for some of the stages of the signal processing and to examine the processing speed. The resulting sound file allows for measurement of phonation time, speaking time and fundamental frequency of the subject and sound pressure level of the subject's voice and the environmental sounds separately. The present implementation gives great freedom for adjustment of analysis parameters, since the microphone signals are recorded on DAT tape and the processing is performed off-line on a PC. In future versions, a voice accumulator based on this principle could

be designed in order to shorten analysis time and thus make the method more appropriate for clinical use.

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Simultaneous analysis of vocal fold vibration and transglottal airflow; Exploring a new experimental set-up

Svante Granqvist, Stellan Hertegård^o, Hans Larsson & Johan Sundberg

Preliminary results of this study were presented at the 30th annual symposium: Care of the Professional Voice 2001, Philadelphia, Pennsylvania, USA

The purpose of this study was to develop an analysis system for studying the relationship between vocal fold vibration and the associated transglottal airflow. Recordings of airflow, electro-glottography (EGG), oral air pressure and acoustic signals were performed simultaneously with high speed imaging at a rate of approximately 1900 frames/s. Inverse filtered airflow is compared with the simultaneous glottal area extracted from the high speed image sequence. The accuracy of the synchronization between the camera images and the foot pedal synchronization pulse was examined, showing that potential synchronization errors increase with time distance to the synchronization pulse. Therefore, analysis was limited to material near the synchronization pulse. Results corroborate previous predictions that air flow lags behind area but also reveal that relationships between these two entities may be complex and apparently varying with phonation mode.

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Musician's and computer's tone inter-onset-interval in Mozart's Piano Sonata K 332, 2nd mvt, bar 1-20

Johan Sundberg, Anders Friberg, Roberto Bresin

The Director Musices generative grammar of music performance is a system of context dependent rules that automatically introduces expressive deviation in performances of input score files. A number of these rules concern timing. In this investigation the ability of such rules to reproduce a professional pianist's timing deviations from nominal note inter-onset-intervals

is examined. Rules affecting tone inter-onset-intervals were first tested one by one for the various sections of the excerpt, and then in combinations. Results were evaluated in terms of the correlation between the deviations made by the pianist and by the rule system. It is found that rules reflecting the phrase structure produced high correlations in some sections. On the other hand, some rules failed to produce significant correlation with the pianist's deviations, and thus seemed irrelevant to the particular performance analysed. It is concluded that phrasing was a prominent principle in this performance and that rule combinations have to change between sections in order to match this pianist's deviations.

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Belly-in or belly-out? Effects of inhalatory behaviour and lung volume on voice function in male opera singers

Monica Thomasson, Department of Speech, Music and Hearing, KTH, Stockholm, Sweden

Both effects of inhalatory abdominal wall (AW) behaviour and lung volume (LV) on voice function during singing were investigated. Nine professional opera singers phonated throughout their vital capacity range at different pitches and loudness levels using two polar inhalatory AW conditions, belly-in and belly-out. Subglottal pressure, vertical laryngeal position and voice source parameters were analysed. No significant effect of AW behaviour was found. However, in this non-habitual inhalatory behaviour significant effects of LV were found. High LV was associated with higher subglottal pressures and higher peak-to-peak flows than low LV. Also trends towards significant differences were found, such that high LV was associated with a lower vertical laryngeal position and a smaller closed quotient than low LV. These LV effects of singers' non-habitual inhalatory behaviour are compared both with those previously found for the same singers' habitual inhalatory behaviour, as well as with those found for vocally untrained subjects.

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Effects of family therapy on children's voices

Anke Nienkerke-Springer, Anita McAllister & Johan Sundberg

This article is a condensed version of the first author's doctoral dissertation in Sprachwissenschaft at the University of Dortmund, Germany. The work was presented as a poster at the 29th Annual Symposium Care of the Professional Voice, arranged by The Voice Foundation in Philadelphia, June 2000, where it was awarded the Best Poster Prize.

The families of nine children with deviant voice qualities were selected for family treatment according to the SYGESTI model. Recordings of the children's speech were made before and after therapy. Perceptual evaluation of their voice quality showed significant improvement in various perceptual parameters after the therapy. Acoustical analysis confirmed changes of voice quality and mean fundamental frequency in speech. The therapy also was found to improve relations between family members, conflict management and other aspects of communication. The results suggest that these children's deviant voices were related to family conditions.

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Vocal fold vibration and voice source aperiodicity in phonatorily distorted singing

Zangger Borch D, Sundberg J, Lindestad PA & Thalén M

The acoustic characteristics of so-called distorted tones, commonly used in singing rock music, are analysed in one experiment. The results revealed that distorted tones contain aperiodicity. SPL @ 0.3 m varied between 90 and 96 dB, produced by a subglottal pressure in the range of 20 to 43 cm H₂O, approximately. A doubling of subglottal pressure yielded, on average, an SPL increase of 2.3 dB. In another experiment, the associated vocal fold vibration patterns were recorded by digital high-speed imaging. Inverse filtering of the simultaneously recorded audio signal showed that the aperiodicity was caused by a low frequency modulation of the flow glottogram pulse amplitude. This modulation was produced by an aperiodic or periodic vibration of the

supraglottic mucosa. This vibration reduced the pulse amplitude by obstructing the airway for some of the pulses produced by the periodically vibrating vocal folds. The supraglottic mucosa vibration can be assumed to be driven by the high airflow produced by the elevated subglottal pressure.

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Effect on LTAS of vocal loudness variation

Maria Nordenberg & Johan Sundberg

Long-term-average spectrum (LTAS) is an efficient method for voice analysis, revealing both voice source and formant characteristics. However, the LTAS contour is non-uniformly affected by vocal loudness. This variation was analysed in 15 male and 16 female untrained voices reading a text 7 times at different degrees of vocal loudness, 62 = mean Leq = 91 dB @0.3m. In all frequency bands up to 4 kHz spectrum level was strongly and linearly correlated with overall equivalent sound level (Leq). The gain factor, i.e., the rate of level increase, varied with frequency, from about 0.5 at low frequencies to about 1.5 between 1.5 and 3 kHz. Using the gain factors for a voice, LTAS contours could be predicted at any Leq within the measured range, with an average accuracy of 2 to 3 dB below 4 kHz. Mean LTAS calculated for an Leq of 70 dB for each subject showed considerable individual variation for both males and females. On the other hand, the results also indicate that meaningful comparisons of LTAS, recorded e.g., before and after voice therapy, can be made, provided that the documentation includes a minimum of three recordings at different loudness levels from one recording session.

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