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C. CRICO-THYROID AND VOCALIS MUSCLE ACTIVITY IN THE PRODUCTION OF SWEDISH TONAL ACCENTS: A PILOT STUDY

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The purpose of the present study was to investigate whether electromyographic correlates of the Swedish tonal accents could be found in the crico-thyroid and vocalis muscles of the larynx. A male speaker of the Stockholm dialect was chosen as subject. Thin concentric needle electrodes (Disa Type 13K03) were inserted into the two muscles about 20 minutes after a local anaesthetic (Xylocain spray) had been distributed over the vocal folds and surrounding tissue by means of an injection syringe inserted through the crico-thyroid ligament. The electromyographic signals were amplified by means of Grass (P9) amplifiers and recorded together with the audio signal on (three) separate channels of a PI (6200) FM tape-recorder.

To test that the EMG needles were in place the following procedure was used. One of the needles was inserted through the crico-thyroid ligament and the subject was asked to hold his breath or to strain. The needle was then pushed into the infraglottal tissue at various places until distinct motor unit potentials were seen on the monitoring oscilloscope. This signal came and went with the subject’s closing and opening of the glottis and was therefore taken to represent the activity of the vocalis muscle.

The other needle was inserted into the crico-thyroid muscle the location of which was determined by means of palpation and visual inspection.

The subject was then asked to repeat utterances that were read aloud by one of the investigators. These utterances were all of the form [de vz _____ ja sa:], "it was _____ (that) I said" in which one of the following (nonsense) words had been embedded. (The sign "*" denotes the acute accent and "**" the grave accent.)

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Results

When the subject was at rest and was breathing calmly, a tonic EMG activity was observable in both the vocalis and the crico-thyroid muscles. About 200 msec before the phonation started there was always an increase in vocalis activity, and a pronounced decrease in crico-thyroid activity (actually the signal disappeared). At the very moment of phonation onset the inhibited phase of the crico-thyroid EMG record ended and was followed by a strongly active phase. Similarly, during the last two syllables of the utterances (i.e., during [ja sa:]), crico-thyroid activity was strongly reduced, though generally not completely inhibited. At the very end of phonation this inhibitory phase was followed by the (stronger) tonic activity pattern. Complete disappearance of the motor unit spikes was never observed in the vocalis traces. The activity seemed to increase in this muscle with increasing pitch and especially during glottal stops (as in [my:-?ama]). The EMG activity also increased in the crico-thyroid records when the pitch went up. However, during glottal stops this muscle was apparently completely inhibited.

The subject tended to make a phonation pause immediately after [de va] and immediately before [ja sa:]. In the majority of the utterances, however, his pronunciation was legato and phonation pauses were absent. This was checked both by listening to the tape and by examination of wide-band sound spectrograms of the utterances. Only utterances of the latter type were used for the study of the tonal accents.

The crico-thyroid activity patterns could never be correlated with the feature voiced/voiceless of consonants. The vocalis records usually displayed a weak activity decrease during the voiceless stops,
Fig. II-C-1. Examples of vocalis and crico-thyroid motor unit activity during the production of acute and grave accented words. The crico-thyroid inhibition phase related to the two accents is marked by arrows in the two figures.
however. On the other hand, there was a very conspicuous reduction (often complete inhibition) of the crico-thyroid activity for about 200 msec that was very well correlated with the acute/grave accent contrast. That is to say, this inhibition segment occurred near the first consonant of the stressed syllable of the acute accented words. In the grave accented words it occurred in the middle of the vowel of this syllable. This inhibitory phase usually had a somewhat briefer duration in the acute accented words than in the grave accented words. An example is shown in Fig. II-C-1.

Regular correlates of the accents were not as clear in the vocalis muscle records. In many cases, however, a brief activity increase followed by a reduced phase could be observed concomitantly with the inhibitory phase of the crico-thyroid record. The brief vocalis activity increase usually preceded the crico-thyroid inhibition by some 20 msec.

The measurements reported here were motivated by the theories presented in an earlier section of this issue of QPSR (Section II.B). The vocalis muscle was selected because it was thought to be a good representative of the valve function as opposed to the pitch function of the larynx. This assumption is probably too simple. In future experiments other intrinsic laryngeal muscles should be recorded from during production of the tonal accents.