

## Electromyographic investigation of Danish consonants, stress, and stød

As part of a physiological investigation of Danish consonants, stress, and stød a series of electromyographic (EMG) recordings from some selected laryngeal muscles have been made in cooperation with Hajime Hirose, who visited our laboratory in May-June, 1974. These studies constitute a continuation of the experiments started by Hajime Hirose and Eli Fischer-Jørgensen at the Haskins Laboratories in 1972 (see Haskins SR, forthcoming) and also a continuation of the glottographic investigation undertaken by Frøkjær-Jensen, Ludvigsen and Rischel (1971, see ARIPUC 7). The material has not yet been processed, and this processing may take some time, but some preliminary conclusions can be drawn on the basis of visual inspection of the individual raw EMG traces and the integrated curves recorded on the mingograph.

### 1. Consonants

Most of the consonants in question were placed in word-initial position in a stressed syllable in vocalic surroundings. We obtained very good recordings from the interarytenoid (INT) for two Danish subjects and a tolerably good recording for one subject. All three showed a dip in INT curves for the consonants, and the general tendency is that the dip is most pronounced in the aspirated stops p, t, k and in f, s, h, slightly smaller for (unvoiced) b, d, g, somewhat smaller for v, and almost non-existing for l and m. For the same subjects we obtained good recordings from the posterior cricoarytenoid (PCA), showing a peak of short duration corresponding to the dip in INT, and with the same tendency in the amplitudes, i.e., highest for p, t, k, f, s, h, slightly lower for b, d, g, v,

and rarely present for l and m.

These findings are in agreement with the results obtained for one subject in the Haskins experiment, and this means that the hypothesis tentatively advanced by Frøkjær-Jensen, Ludvigsen and Rischel in 1971, on the basis of glottographic recordings (viz. that the relatively small glottal opening found in the production of b, d, g might be accounted for solely by the aerodynamics of the production of these plosives) is not corroborated: there is a pronounced activity in PCA for b, d, g.

Moreover, the activity of the vocalis muscle (VOC) was recorded for seven Danish subjects. For one subject, the VOC pattern was not very clear with respect to the consonant production. The VOC tracings of the remaining subjects showed a pattern of suppression of EMG activity in the consonants similar to that observed for INT, the relationship between different categories of consonants being of the same kind, but with a larger degree of individual variation.

The cricothyroid (CT) activity was recorded from some of the subjects, but its behaviour for consonants does not show any consistent picture.

## 2. Stress

As far as word stress is concerned, the preliminary impression is that INT tends to show higher peaks for vowels with main stress than for those with secondary or weak stress, whereas VOC and, particularly, CT show EMG peaks in connection with high pitch irrespective of the degree of stress. The text material contained a number of disyllabic words with stress on the first syllable (e.g. ['p<sup>h</sup>anə]), which were often pronounced with relatively low pitch on the stressed syllable and a rise on the unstressed syllable. Both VOC and CT showed higher activity at the beginning of the weak syllable in these cases.

### 3. Stød

Recordings from VOC for test words with and without stød were made for seven Danish subjects in order to see whether there was any difference in the activity of the laryngeal muscles. (The stød has been assumed by S. Smith (1944) to be due to an increased activity of the respiratory muscles, cp. also the report by P. Riber-Petersen in ARIPUC 7 on the acoustic characteristics of the stød.)

Four of the seven subjects showed a very clear peak in vowels with stød. Most of the subjects pronounced the stød syllables on a higher pitch than corresponding stød-less syllables, but the peak in the VOC curves cannot be due to the rise in pitch alone. The VOC peak for stød is generally very sharp and of a short duration (of a kind similar to that found for subject PM in the Haskins experiments), whereas some subjects had only a modest activity of VOC in high pitched syllables without stød. In cases where the stød is produced in a syllable with secondary stress, spoken at a relatively low pitch, the peak is usually lower, but at least one of the subjects has a clear peak also in this case, e.g. for ['ma:ləbø:ʔyʊ] VOC showed a peak in the third syllable, but CT had its peak in the first syllable.

The remaining three subjects did not show any obvious difference in VOC activity between stød and stød-less words. For one of the subjects the VOC curve did not seem very reliable, but for the other two it seemed all right. For one of the two subjects a short list of stød and stød-less words was recorded in two separate sessions with almost the same result. Thus, it seems as if VOC activity is subjected to individual differences. Both of these latter subjects had a very pronounced VOC activity for high pitch, approximately similar to the CT activity.

For one of the subjects a simultaneous recording of subglottal pressure was made. There seems to be a peak in the subglottal pressure at the beginning of a vowel segment with stød. Unfortunately, this subject was one of the three subjects who did not show any clear difference in VOC activity in stød and stød-less words, so that the timing cannot be compared with certainty. For the same subject an attempt was made to record activity from the intercostal muscles by means of subcutaneous needle electrodes, but the recording was not successful.

More details will be given in later reports.

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