Speech: Behavior of Middle Ear Muscle during Stuttering

Abstract. *Behavior of the middle ear muscle during speaking was observed in five stutterers by means of the Zwislocki acoustic impedance bridge. Change in impedance did not always parallel precisely the changes in speech sound level. Impedance changed during the initiation and during the course of the stuttering block.*

The middle ear reflex, once considered almost exclusively a protective reaction to loud sound, has become the subject of considerable investigation, and many new modes of activity for the middle ear muscles have been discovered. Increased interest in this subject is in part due to the development of the acoustic impedance bridge, by which small movements within the middle ear can be observed.

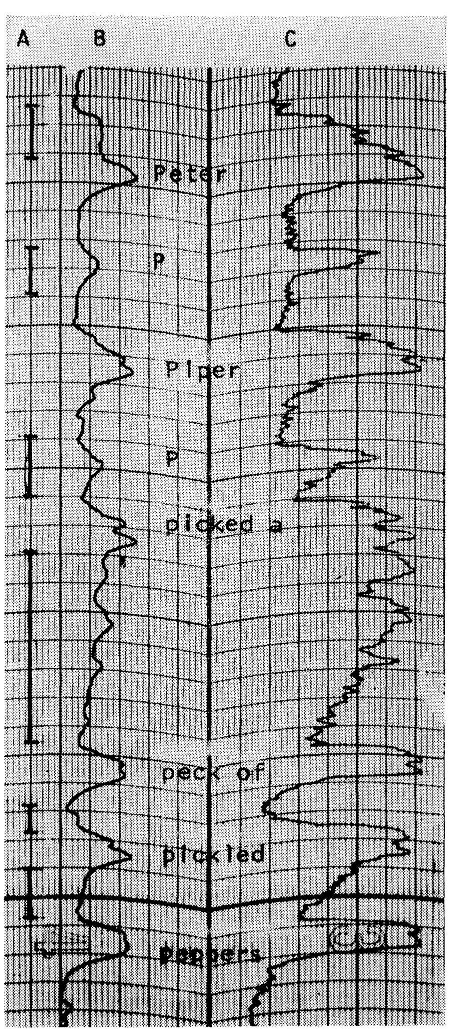

Fig. 1. Change in acoustic impedance during stuttering. Graphic lines show (*A*) stuttering periods, (*B*) speech signal, and (*C*) impedance change. Direction of the chart paper is from top to bottom.

Contraction of the stapedius muscle is directly linked to the initiation of speech and may actually precede the speech sound by a small fraction of a second (*1, 2*). Further, the middle ear reflex appears consistently even during whispered speech but not during random tongue and jaw movements; hence the production of speech rather than the motor movement itself is the key factor in the reflex. The question of muscle activity during stuttering is therefore particularly intriguing, for the stutterer is presumably caught between saying and not saying the word (*3*).

I have studied middle ear activity, during speech, in five stutterers, aged 18 to 22, who have normal hearing. Contractions of the middle ear muscle were observed by means of the Zwislocki acoustic impedance bridge (*4*). The instrumentation (*2*) may be briefly described as a microphone pick-up from the external ear canal, which records the subject's own speech as well as the carrier signal from the impedance bridge. The carrier signal is effectively separated from the speech by means of a tuned amplifier set at the carrier signal frequency.

Speech samples, which included some stuttering, were obtained by asking each subject to recite several familiar passages, after he had been informed that his speech was to be recorded for research purposes. The impedance bridge was held firmly in the ear canal; no gross head movements occurred during the recording.

Contraction of the middle ear muscle in the presence of stuttering and fluent speech was noted in all subjects. Although the relative amplitude of the middle ear reflex varied considerably among subjects (*5*), it appeared consistently both in voiced and unvoiced phonemes.

In Fig. 1, showing impedance change during several stuttering blocks on initial [p] sounds, it may be seen that impedance change did not always parallel the sound level of speech in a precise manner. This is particularly evident in the tracings for the words *Peter* and *pickled*. The graphic pattern preceding the word *peck* is also of particular interest, for it illustrates a much longer and more tonic block. In this instance the subject reported that the block became unexpectedly more severe and that he therefore made a conscious effort to relax prior to successful completion of the word. This description of the block appears to be reflected in the persistently high impedance tracing, followed by a gradual downward slope.

It is evident that the acoustic reflex during stuttering is not simply an indirect way of viewing speech sound but is rather the representation of a specific mode of activity within the speech process. Clearly, the tracings for impedance change and for speech sound are not entirely parallel. This observation applies also to normal speech, but it is much more readily demonstrated in stuttering.

It is conceivable that impedance change may afford a more precise method than sound recording for studying the initiation and course of the stuttering block; it may also provide greater objective information about this much researched but little understood speech disorder.

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References and Notes

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Evoked Potential in Relation to Subsequent Alpha Frequency

Abstract. *A series of 24 visually evoked potentials was obtained from a normal human subject under a set of unvarying experimental conditions. The 24 trials were ordered according to the alpha frequency subsequent to presentation of the stimulus. The evoked potentials from the 12 higher- and 12 lower-frequency trials were averaged separately. These two average curves differed significantly at each of the six nodal points.*

For a given set of experimental conditions, considerable stability is shown by the average evoked potential (EP), the electrocortical response to a brief stimulus. This reliability over time has been found to hold over minutes (*1*), hours (*2*), weeks (*3*), and months (*1*). Whatever the interval, stability increases with an increase in the number of evoked potentials averaged. While the