Laterality Effects in Perception of Speech and Other Sounds

Several investigators in recent years, using dichotic stimulus presentation, have found small but reliable differences in the responses to various acoustic stimuli depending upon the ear --and so the cerebral hemisphere -- to which the stimuli were presented (Kimura, 1961a,b; Bryden, 1963; Broadbent and Gregory, 1964). Such findings lend support to the hypothesis of different perceptual processes for speech and nonspeech acoustic material.

Kimura (1961b, 1964) has found that if different sets of digits are presented simultaneously to the two ears (i.e., dichotically) those presented to the right ear -- and so predominantly to the temporal lobe in the dominant left hemisphere for speech -- are more accurately recalled than those presented to the left ear. When brief melodies (1964) were presented dichotically to the same Ss, the melodies which arrived at the left ear were more often recognized than those which arrived at the right. These lateral differences in efficiency of perception under conditions of stimulus competition were shown to depend upon the nature of the stimulus materials (speech or tonal patterns), presumably reflecting the greater strength of the crossed auditory pathway and the specialization of the auditory areas of each hemisphere for processing different classes of stimuli.

Confirming evidence has been obtained from neurosurgical patients with damage localized to the left and right temporal lobes. Patients with lesions of the dominant left temporal lobe were selectively impaired on the dichotic digits task (Kimura,

1961a,b), whereas patients with comparable lesions of the right temporal lobe were selectively impaired in recognition of dichotically-presented melodies (Shankweiler, 1964). There is thus direct evidence for functional asymmetry of the temporal lobes in auditory perception; not only is one hemisphere dominant for speech -- as has long been known -- but it would seem that the opposite hemisphere plays a greater role in processing some non-speech sounds.

Since the method of dichotic stimulation has proved to be a valuable tool for the analysis of the part played by each temporal lobe in auditory perception, it should be of value in identifying those cues which give speech its special distinctiveness. There is here the possibility of specifying by a neurologically meaningful measure the acoustic boundary between speech and non-speech. Our general intent in the experiments underway and those planned for the future is to close in on this boundary by systematic investigations to determine the parameters of laterality effects in audition.

Two preliminary experiments have been done with the following purposes in mind: to find out whether the technique is feasible when very brief stimuli are used; to find out whether the effects can be obtained with synthetic speech stimuli of rather unnatural quality; to gather preliminary data on the position of selected phonemes on the speech-nonspeech acoustic continuum. A set of 5 vowels (/i, ɛ, æ, a, u/) and the 6 stop consonants (/b, d, g, p, t, k/), all preceding the same vowel (/a/), were synthesized on the Haskins Pattern Playback. A first test was made up with the vowels and a second with the stop-consonant-plus-vowel syllables. The stimuli were recorded on magnetic tape in synchronous pairs and were cut and spliced into tests which were presented by means of dichotically-wired earphones. Both tests were given to a group of 10 right-handed subjects, who first had been given

practice in labeling the stimuli presented singly.

A prediction was made that the vowel test would yield no laterality difference or only a slight right-ear advantage and that the stop-consonant test would yield a substantial right-ear advantage. The preliminary results are in agreement with the prediction. Right-ear superiority was found for both tests, but in the case of the consonant syllables, the difference was substantially greater (15 percent as against 6 percent for the vowels). Because the consonant syllables were of better quality than the vowels and because of certain procedural differences, the findings can only be taken as suggestive. In the case of the stop consonants, there was a positive relationship between accuracy of identification of a given syllable and the size of the right-ear advantage. We plan to repeat the experiments with new stimuli (both synthetic and real) to determine whether these early findings can be generalized. Control stimuli will be generated by inverting the frequency spectra of the speech sounds. The expected outcome of control experiment would be a left-ear advantage.

The results of these preliminary experiments indicate that laterality effects can be obtained with stimuli of segment length, and they suggest that differences in the magnitude of the effects may provide a sensitive scale for ordering speech sounds on the speech-nonspeech continuum. The general purpose of subsequent experiments will be to use laterality tests to close in on the acoustic boundary between speech and nonspeech by comparing subjects' performances on different types of nonspeech sounds and different classes of segmental phones, both synthetic and real.

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