ABSTRACT

Levels of Processing in Speech Perception: Neurophysiological and Information-Processing Analyses*

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The relation between an acoustic speech signal and its phonetic message appears to be a complex and highly efficient code, based on parallel transmission of phonetic information in the speech signal. Previous experiments have suggested that the perception of this "speech code" involves specialized phonetic decoding mechanisms located in the dominant cerebral hemisphere, mechanisms that are not involved in the perception of nonspeech sounds. This suggestion has received additional support from the demonstration that some components of a speech signal require specialized phonetic processing for their perception, while other components can be processed by the general auditory system alone. For example, recent experiments by the author have shown that different levels of processing underlie the perception of auditory and phonetic dimensions of synthetic speech stimuli. In one experiment, reaction time (RT) data indicated that while the auditory dimension could be processed independently of the phonetic dimension, the phonetic dimension could not be processed independently of the auditory dimension. In a second experiment, averaged evoked potentials were recorded during the processing of the same auditory and phonetic dimensions.

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This experiment demonstrated that the processing of the phonetic dimension was accompanied by neural events in the left hemisphere which did not occur during the processing of the auditory dimension. Thus, using very different response measures, both experiments suggest that perception of the phonetic dimension involved an additional level of processing which was not required for the auditory dimension.

The present investigation was designed to substantiate the distinction between auditory and phonetic levels of processing made by the initial experiments, and to provide additional information concerning the nature of the specialized phonetic level. Instead of collecting the RT and evoked potential data separately, the present experiments employed a single paradigm to obtain both sets of data. The first experiment completely replicated the RT and evoked potential results for auditory and phonetic dimensions obtained separately in the initial experiments. The second experiment provided control data demonstrating that the results attributed to the phonetic level did not occur for two auditory dimensions. The third experiment showed that the phonetic level is specialized for the extraction of abstract phonetic features, not for the detection of particular acoustic features in the speech signal. The fourth experiment suggested that while the phonetic level is linguistic in nature, it is not required for the processing of all acoustic dimensions that can convey linguistic information. Additional analyses of the neurophysiological data demonstrated that the evoked potential differences between auditory and phonetic dimensions were not associated with differences in: 1) frequency spectra or amplitude distributions of the background electroencephalogram (EEG); 2) pre-stimulus baseline changes related to the contingent negative variation (CNV); or 3) averaged activity synchronized to subjects' motor responses. Taken together, the RT and evoked potential data of the present experiments provide a strong set of converging operations upon the distinction between auditory and phonetic levels of processing in speech perception, and upon the idea that the phonetic level involves specialized language mechanisms which are lateralized in one cerebral hemisphere.