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Speech perception in the brain:

Temporal and spatial organization of the neural processing of phonetic and speaker-related information

Sonja Lattner, Thomas Knoesche, Burkhard Maess, Michael Schauer, Kai Alter and Angela D. Friederici

Max-Planck-Institute of Cognitive Neuroscience, Leipzig, Germany

*lattner@cns.mpg.de, knoesche@cns.mpg.de, maess@cns.mpg.de, schauer@cns.mpg.de,
alter@cns.mpg.de, orendi@cns.mpg.de,*

Listeners do not only decode the message contained in a speech signal, but in addition, they automatically infer certain characteristics of the speaker. An interesting, yet poorly understood aspect of speech perception is how exactly the perceptual system deals with 1) phonetic cues, and 2) speaker-related features contained in the speech signal. The aim of the present study was to investigate the temporal and spatial organization of the underlying neural processes of decoding phonetic and speaker-related information, i.e. of the detection of a change in the acoustic parameters manifesting a deviance in one or the other domain. For this purpose, a magnetoencephalography (MEG) experiment was conducted using an auditory oddball design: The stimuli consisted of spoken single words uttered by either a male or female speaker, so that the infrequent deviants in the series of identical standard stimuli comprised a sudden change of (1) WORD, (2) VOICE, or (3) both word and voice COMBINED. The magnetic mismatch fields (MMFs), which have been defined as the characteristic brain responses to deviants in a stream of standard stimuli, were evaluated from 11 subjects using a 148 channel whole-head magnetometer. The early component N1m/MMF of the auditory brain responses was modeled as equivalent current dipoles.

The results show that both speaker-related (VOICE) and phonetic (WORD) deviations evoked a mismatch-related response and are therefore detected early. The mismatch fields could be explained by equivalent dipoles located in the auditory cortex of each hemisphere. Localization and lateralization patterns did not differ significantly between the deviant conditions.

However, the analysis of the temporal course of activation indicated that the two-dimensional deviation (COMBINED) evoked a response that cannot be explained by a mere superposition of the other two. The peak latency was shorter than in all other conditions, and it showed significantly less variance across subjects. The localization of the corresponding dipole was most distinct from the one in response to the standard. In conclusion, we suggest an integral model that explains the observed patterns as parallel, contingent processes. Although the model has primarily been developed to explain the processing of the acoustic parameters transmitting phonetic and voice information, it might also be appropriate for explaining the gestalt-like processing of other features or feature combinations.