Neural Correlates of Phonemic Categorization

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Objective:
Identify the neural mechanisms of phoneme categorization in normal hearing adult listeners and determine how context influences these neural mechanisms. Once a baseline neural mechanism for phoneme categorization is established in normal-hearing adults, this baseline can be compared to other relevant populations such as infants and children, specifically infants and children with hearing loss who have a degraded signal input and are at risk for speech and language delays.

Method:
A novel Electroencephalography (EEG) paradigm was created and consisted of three speech continua that differed along a single phonological contrast (e.g. voice, manner, place). Each participant passively listened to each speech continua within three different contexts. By comparing the cortical evoked responses to the same acoustical stimulus within different phonetic contexts, a top-down influences on the categorical perception of phonemes could be determined. An analyses on the full time-course of the EEG signals was conducted by comparing congruent vs. incongruent cases at each timepoint using a cluster-based permutation test.

Results/Conclusion:
Significant clusters were found at two (out of three) phonological contrasts: voicing (/ba/ → /pa/) and manner (/ba/ → /wa/). Interestingly, such clusters appeared as early as 50ms after the phoneme onset. Our findings suggest that cortical auditory evoked potentials provide a neural signature that reflect phonological categorical perception. The relatively short latency (~50ms) of neural responses to phonetic categorical violation may indicate that phonetic categorical perception takes an early stage in the language processing chain. Assuming that phonemic categorization influences language development and outcomes, these findings have significant implications for individuals with hearing loss, who have a degraded signal input. In particular, children with hearing loss who are learning language may have significantly poorer phonemic categorization compared to their peers, ultimately impacting their language development. This novel paradigm does not involve active participation by the participant, and thus, may be utilized as a clinical measure of phoneme categorization for infants and young children.