**Specialized high-level processing of speech and music revealed with EEG**

Nathaniel Zuk, Emily Teoh, Edmund Lalor

Recent evidence with fMRI demonstrates specialized processing of speech and music in the auditory cortex of humans. This is revealed by using unsupervised methods to identify weightings across the cortex best capturing the variability in neural responses to a wide variety of sounds (Norman-Haignere et al, 2015, Neuron, 88:1281-1296). While there are clear spatial differences in neural activity for speech and music, the temporal responses are not well understood, and it is not clear if they are unique for speech and music. We hypothesized that neural responses measured with electroencephalography (EEG) may capture this high-level processing that produces unique and discriminable responses to speech and music stimuli.

Subjects listened to 30 different two-second-long sounds, including speech, music, and other environmental sounds. EEG responses were recorded for 100 presentations of the sounds, randomly presented across trials. Using linear discriminant analysis to classify the two-second EEG responses to each sound, we found that the speech and music sounds, in addition to human-produced impact sounds, produced higher classification accuracies than all other environmental sounds. Separately, we repeated this experiment using scrambled versions of the speech, music, and impact sounds. The scrambled sounds were resynthesized using a model of low-level processing with identical spetrotemporal statistics to the originals (McDermott & Simoncelli, 2011, Neuron, 71:926-940). Scrambled impact sounds were classified identically to their original counterparts, showing that the EEG responses were dominated by the processing of low-level statistics. In contrast, scrambled music and speech sounds were classified worse than the originals. Additionally, the patterns of classification accuracy persisted when spatial information was removed by averaging the EEG data across channels. Thus, EEG captures temporal differences in activity for speech and music, in addition to the spatial differences.

Our study demonstrates that neural responses measured with EEG uniquely capture speech and music processing more strongly than other environmental sounds. Furthermore, the unique responses are dominated by regions in the brain acting beyond the processing of low-level statistics. These results highlight the importance of using naturalistic sounds when studying the neural processing of speech and music in humans.