Distributed Information Improves Prediction of Speech Sounds

**Outcome:** Brain imaging responses from different areas of the brain, measured with functional magnetic resonance imaging, contain information related to the speech sounds a person hears and plans to produce. By combining information from two different brain areas, the ability to predict which vowel subjects heard was improved compared to including additional data from either area alone.

**Impact / benefit:** This result demonstrates that using distributed information may benefit the development of augmentative communication devices. These methods can help to determine the best locations for implanting a small number of electrodes for future implanted brain computer interfaces (BCIs). These devices have the potential to provide communication capabilities to people who lose the ability to speak due to injury or disease.

**Explanation:** Functional magnetic resonance imaging (fMRI) measures the blood flow response related to brain activity, producing relatively high resolution 3D images. In recent years, scientists have begun to use “machine learning” technologies to help understand these images. For example, statistical models can be built that try to predict what word or sound a subject was listening to inside the MRI scanner based on the responses from individual brain areas. If the response of a brain region accurately predicts the sound, then it likely contains neurons that encode that information. Here, a method was developed where, first, the brain area that best predicted a vowel sound heard by the subjects was found. Next, a search was conducted for the additional brain area whose response, when included in the model, best improved performance. The results show, for example, that including information from small areas in frontal cortex (in red; associated with speech planning and production) and temporal cortex (in yellow; associated with hearing and speech perception) provides more information than the responses from either area alone.

**Figure 1:** An image of the left side of the cerebral cortex of one human subject. The region in red provided the most information about which vowel the subject heard. The region in yellow, completely separated from the one in red, provided new information that helped to improve predictions.

**Image Credits:** Christopher Johnson, Boston University.