Brain areas that predict speech elements in a syllable repetition task

**Outcome:** A number of different brain areas are shown to encode information about the identity of individual speech sounds during a syllable repetition task. Using functional MRI, researchers from CELEST, an NSF Science of Learning Center, found that distinct brain areas contain such information either at the time of onset of the syllable that a subject heard or at the time the subject produced that syllable. Such results reflect the use of different neural representations for speech sounds during speech perception and speech production.

**Impact / benefit:** This result highlights areas of the cerebral cortex that are used to represent speech sounds in either sensory or motor processes. Information is transmitted between these regions to allow for successful repetition in healthy subjects. For individuals who lose the ability to speak due to injury or disease, we can attempt to harness either sensory or motor information from these brain areas to drive brain computer interfaces for augmentative communication.

**Explanation:** Typical fMRI results are based on estimates of brain areas that respond more strongly to one stimulus condition than another. These approaches are not well-suited to studying how the brain represents speech and other linguistic materials. Machine learning methods learn the statistical relationship between the patterns of activation in different brain areas and different aspects of the stimulus – in this case the identity of different consonants and vowels contained in a syllable. By moving a small “searchlight” across the surface of the cerebral cortex, we can locate those areas whose responses predict the speech sound the subject heard or planned to produce better than would be expected by chance. In this work we train classifiers separately based on either sensory or motor responses in each trial, revealing different brain areas that contain information about speech sounds at different times in the trial.

**Figure 1:** Images of the left hemisphere of the cerebral cortex, inflated to reveal the complete surface. Overlaid on these surfaces are: (Left) areas found to contain significant information about the vowel contained in a syllable based on hearing that syllable, and (Right) areas found to contain significant information about the vowel based on planning and overtly producing the syllable. **Image credits:** Christopher Johnson, Boston University.