New analysis reveals clearer picture of brain's language areas

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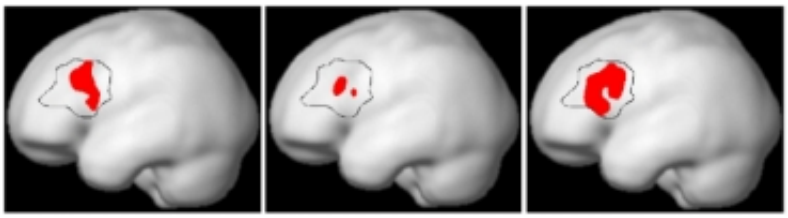

Sample brain activations of a left frontal language area in three subjects. Activations vary substantially in their precise locations, plausibly due to brain anatomy differences between subjects. Traditional group analyses would only capture a small proportion of each subject's activations and would underestimate the functional selectivity of these regions. Image courtesy Evelina Fedorenko

(PhysOrg.com) -- Language is a defining aspect of what makes us human. Although some brain regions are known to be associated with language, neuroscientists have had a surprisingly difficult time using brain imaging technology to understand exactly what these 'language areas' are doing. In a new study published in the *Journal of Neurophysiology*, MIT neuroscientists report on a new method to analyze brain imaging data — one that may paint a clearer picture of how our brain produces and understands language.

Research with patients who developed specific language deficits (such as the inability to comprehend passive sentences) following brain injury suggest that different aspects of language may reside in different parts of

the brain. But attempts to find these functionally specific regions of the brain with current neuroimaging technologies have been inconsistent and controversial.

One reason for this inconsistency may be due to the fact that most previous studies relied on group analyses in which brain imaging data were averaged across multiple subjects — a computation that could introduce statistical noise and bias into the analyses.

“Because brains differ in their folding patterns and in how functional areas map onto these folds, activations obtained in functional MRI studies often do not precisely ‘line up’ across brains,” explained Evelina Fedorenko, first author of the study and a postdoctoral associate in Nancy Kanwisher’s lab at the McGovern Institute for Brain Research at MIT. “ Some regions of the brain thought to be involved in language are also geographically close to regions that support other cognitive processes like music, arithmetic, or general working memory. By spatially averaging brain data across subjects you may see an activation ‘blob’ that looks like it supports both language and, say, arithmetic, even in cases where in every single subject these two processes are supported by non-overlapping nearby bits of cortex.”

The only way to get around this problem, according to Fedorenko, is to first define “regions of interest” in each individual subject and then investigate those regions by examining their responses to various new tasks. To do this, they developed a “localizer” task where subjects read either sentences or sequences of pronounceable nonwords.

Sample sentence: THE DOG CHASED THE CAT ALL DAY LONG
Sample nonword sequence: BOKER DESH HE THE DRILES LER CICE FRISTY’S

By subtracting the nonword-activated regions from the sentence-

activated regions, the researchers found a number of language regions that were quickly and reliably identified in individual brains. Their new method revealed higher selectivity for sentences compared to nonwords than a traditional group analysis applied to the same data.

“This new, more sensitive method allows us now to investigate questions of functional specificity between language and other cognitive functions, as well as between different aspects of language,” Fedorenko concludes. “We’re more likely to discover which patches of cortex are specialized for language and which also support other cognitive functions like music and working memory. Understanding the relationship between language and the rest of condition is one of key questions in cognitive neuroscience.”

Fedorenko published the tools used in this study on her website. The goal for the future, she argues, is to adopt a common standard for identifying language-sensitive areas so that knowledge about their functions can be accumulated across studies and across labs. “The eventual goal is of course to understand the precise nature of the computations each brain region performs,” Fedorenko says, “but that’s a tall order.”

More information: Fedorenko E, Hsieh P, Nieto-Castañón A, Whitfield-Gabrieli S, Kanwisher N. A new method for fMRI investigations of language: defining ROIs functionally in individual subjects. J Neurophysiol (April 21, 2010). DOI:10.1152/jn.00032.2010

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