IDENTIFYING FUNCTIONAL REGIONS OF INTEREST WITHIN THE SPEECH MOTOR CONTROL NEURAL NETWORK

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Neuroimaging has revealed a reliable core network of cortical regions that contribute to speech production (Guenther, 2016). However, relatively little progress has been made toward identifying functional “units” within this network, due, in part, to relatively small sample sizes and resulting low statistical power. Here we describe efforts to identify functionally homogenous regions of interest (fROIs) within the speech motor control network. fROIS were derived from pooled “mega-analysis” (Costafreda, 2009) of a large set of overt speech production functional magnetic resonance imaging (fMRI) data using hierarchical clustering.

Data were pooled over 13 fMRI experiments in which blood oxygen level dependent responses (BOLD) were measured while subjects overtly produced single and bi-syllabic words and pseudowords. In total, 180 individual datasets from 153 unique subjects were included in the analysis. Estimates of the contrast between BOLD responses for Speech and Baseline conditions (silently viewing letter or symbol strings) were derived for each subject, then mapped to an average template using FreeSurfer. The cortex was then parcellated using between-subjects hierarchical clustering that minimized within-ROI variability in the Speech – Baseline contrast (Seghier & Price, 2009). Population-level boundary distributions were constructed to find the optimal number and location of region boundaries and an estimate of the reliability of these boundaries. A representative whole-brain parcellation was obtained from these boundary probability maps using watershed-based segmentation with adaptive smoothing to maximize the joint likelihood of the parcellation boundaries. ROI-level statistics were computed to assess within- and between-region functional homogeneity and functional sub-networks within the speech motor control network. Boundary-level statistics were also computed to determine between-subject variability in boundary positions and their relationship with macro-anatomical cortical landmarks.

The resulting functional cortical parcellation provides insights into functional “maps” and networks within the speech motor control network. More generally, the method has the potential to improve the detection of BOLD response effects by providing a better means of aligning data across subjects. This was explored by comparing the sensitivity of detecting group-level differences in the Speech – Baseline contrast between fluent controls and persons who stutter using typical vertex-wise comparisons, ROIs based on macro-anatomical landmarks, and our fROIs. [Supported by NIH grants R01 DC002852 and R01 DC007683.]

References

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