Quantitatively Assessing the DIVA Model with Neuroimaging

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Functional neuroimaging provides a powerful means for evaluating neural models of speech and other cognitive tasks. To date, however, such evaluations have been qualitative. Quantitative evaluations have been hampered by the absence of a computational framework for generating predicted functional activation from a model that can be quantitatively compared to empirical functional neuroimaging data. Here we present a computational framework to overcome these issues, with a specific application to the DIVA model of speech production. Within this framework, the brain network responsible for speech is broken into a set of computational nodes, each of which is localized to a stereotactic coordinate in the brain. Associated with each node is a computational load function that links the node's activity to a computation involving quantifiable measures from the tasks being modeled. Fits from competing models are evaluated based on the overall fit level and number of free parameters using the Akaike Information Criterion. The framework was used to demonstrate the DIVA model's ability to fit functional magnetic resonance imaging data collected during normal and perturbed speech tasks. The DIVA model was shown to provide a better account of the data than two alternative models derived from prior meta-analyses of speech neuroimaging studies.