Neural substrates for syllable sequence planning and production

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The production of fluent speech is an inherently serial behavior that involves the assembly and production of sound sequences that are composed from a finite alphabet of learned words, syllables, and phonemes. The brain thus requires mechanisms to organize and enact properly ordered and properly timed sequences of these phonological items. While the formulation of spoken language plans has been explored in some detail, most of the evidence for theoretical proposals is derived from behavioral measures such as reaction times or error rates, data which help to constrain theoretical information processing models but offer little insight into the functional brain circuits involved in task performance. In this presentation I will describe an experiment aimed at investigating the cortical and subcortical regions involved in organizing and producing sequences of simple speech sounds. Sparse event-triggered functional magnetic resonance imaging (fMRI) was used to measure responses to preparation and overt production of non-lexical three-syllable utterances that varied in complexity at two levels: within each syllable and across the syllables in the sequence. A factorial analysis revealed a network of brain regions that responded differentially to the changing task demands. This network included left-hemisphere prefrontal and posterior parietal regions, and bilateral anterior insula, medial premotor cortices, basal ganglia, thalamus, and cerebellum. The investigation of response patterns across conditions in this network provides new and useful information concerning functional localization of processes involved in planning and producing speech. These results are compared with previous experimental and clinical findings in an attempt to bring together various data regimes into a unified model.