The motor-sensory control of speech and its role in learning a new language

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Abstract

Articulatory movements necessary for producing native speech can involve repeated simple motor-to-sensory mappings (such as infant babble), repeated sequences of syllables and the non-repeating complex sequences that make up connected speech. This hierarchy of overlearned speech motor control is dependent on Brodmann's areas 6, 44 and 45 in left inferior frontal cortex (IFC). The left IFC is a central component of a distributed network, consisting of higher-order prefrontal regions, subserving the cognitive control of thoughts and internal goals of communication, and posterior cortex (temporal and inferior parietal) which stores long-term phonological, syntactic and semantic representations. In addition, there is an essential link between the IFC and the sensory regions - the planum temporale and parietal operculum at the temporo-parietal junction (TPJ) – that allows a comparison between the intended motor speech goal and the one achieved, signaled by afferent feedback. Previous work has shown that regions involved in integrating motor feedforward with sensory feedback signals are more active during non-native speech production, even in proficient bilinguals, relative to native speech. This work has been extended to a prospective training fMRI paradigm, exploring rapid regional cortical plasticity and changes in functional connectivity as subjects underwent an intense period of training in the production of non-native words. The emphasis was on correct articulation, with no training on the meaning or grammatical properties of the foreign words. This study explores rapid, experience-dependent plasticity in the so-called 'dorsal language stream', and the results will have relevance to recovery of speech production after aphasic stroke.

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