Research Proposal M2R Cognitive Sciences 2017–2018

Title: Sensory basis of speech motor learning: fMRI studies of the somatosensory working memory network

Background: One of the curiosities of human speech production is that individuals that lose their hearing as adults retain much of the capacity for intelligible speech, following hearing loss. This ability points to the importance of the somatosensory system in addition to that of the auditory system in the process of speech motor learning and control. While there are inter-individual differences in reliance on auditory versus somatosensory feedback in situations involving speech motor adaptation, there is broad empirical support for the idea that both the auditory and the somatosensory system play a central role in speech motor learning.

The work proposed here examines the sources of the plasticity associated with speech motor control and learning. Our experimental manipulations will involve tests of adaptation to both altered auditory and altered somatosensory feedback as these enable us to probe both of the sensory channels involved in speech motor learning.

The proposed study specifically focus on sensory working memory processing. Sensory working memory presumably plays a role in the maintenance of information for purposes of learning. However, apart from a small set of studies on working memory in visuomotor adaptation and sequence learning, there has been little work on sensory working memory in the context of motor learning and none in relation to speech motor learning. We expect prefrontal cortex to contribute both to sensory working memory and learning.

Purpose: The function of prefrontal cortex (ventro-lateral area) will be examined by demonstrating that it is active during speech motor adaptation, that its resting-state functional connectivity with other somatosensory related-regions changes with learning.

Method: As the model of speech motor learning, we will study speech motor learning by altering subjects' auditory feedback in real-time during speech production. In the auditory manipulation of vowel sounds, an acoustical-effects software will be used to shift portions of the frequency spectrum of the signal from the microphone and play it back to subjects in real-time. Resting state imaging relies on spontaneous fluctuations of hemodynamic signal in the brain at rest and uses correlations in the time course of hemodynamic signals between different regions of the brain as a measure of functional connectivity. We will record the resting state imaging before and after the speech motor adaptation task and then compared how connectivity was changed due to the adaptation.

Outputs: The results will illuminate novel function of working memory in speech motor learning. The student will learn an original and sophisticated technique concerning functional MRI and speech motor learning model using altered auditory feedback. The internship will combine psychophysical experiments and use of various software for MRI analysis (FSL, SPM) and for a stimulus presentation (Python, Matlab). This experiment, if successful, could drive towards studies using TMS and possible developments for speech processing and speech learning. The project is a part of NIH Project funded by National Institute of Health, USA.

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Location: LPNC, GIPSA-lab for office and IRMaGe platform at the CHU/Grenoble for experiment

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