Reliability and Variability of Repeated fMRI of Language in Aphasic Adults

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Introduction
Aphasia, an acquired language disorder, is a common sequela of stroke. Aphasia causes tremendous handicaps and stress for victims and caregivers. Unfortunately, aphasia rehabilitation typically shows limited functional improvements. However, promising outcomes in aphasia rehabilitation are now being reported. Further improvements in aphasia rehabilitation may be aided by technical advances in functional magnetic resonance imaging (fMRI). One area of fMRI technical advancement that could improve our knowledge of aphasia recovery and neurorehabilitation is documenting the stability of repeated fMRI among individuals with a stroke. Repetition of fMRI, e.g. pre- and post-neurorehabilitation, is essential for discerning underlying principles of neural plasticity that facilitate neurorehabilitation, for measuring the time course of neurorehabilitation, and for elucidating the differential effects of neurorehabilitation methodologies on neural reorganization.

Experimental
This study’s objective is measuring the stability of repeated fMRI during language tasks (pseudo word reading and pseudo word repetition) and a motor task (finger tapping). These measurements occur across several intervals, e.g. between runs in one day’s scanning session, between scanning sessions that are one week apart, and between scanning sessions that are 12 weeks apart. Measurement of fMRI signal change will be quantified in several ways by calculating: 1) time-to-peak-amplitude, 2) maximum amplitude, 3) and gross number of active voxels within regions of interest (ROI). The ROI’s will include inferior parietal cortex, superior temporal cortex, visual word form area, the supplementary motor area and the hand bump region. In addition to measuring reliability within a task across scanning session, we’ll measure the stability of fMRI across the tasks within a time period, e.g. comparing fMRI stability between motor and language tasks within the initial scanning session.

A subproject of this study investigates the MRI hardware reliability in parallel with human blood oxygenation level dependent (BOLD) fMRI reliability. An innovative technology named Smart Phantom simulates the human BOLD fMRI response within a fluid filled sphere by magnetic dephasing induced by electric coils on either side of the phantom.

Results and Discussion
A systematic study of the stability in fMRI of language and motor functions in stroke patients is underway and presently data has been collected on 25 healthy adults and 8 adults with aphasia. Complete analyses are in progress, but preliminary results indicate that selected fMRI data analysis parameters, such as the chosen R-squared threshold, lead to differential stability findings for both healthy adults and adults with aphasia. However, until the complete dataset of acquired, it is unknown whether this pattern will be maintained and specific results on the specified outcome variables are not yet available. Preliminary comparisons of Smart Phantom simulated and human BOLD fMRI found greater reliability within the human BOLD fMRI.

Conclusions
The stringent analyses of the stability of fMRI proposed in this study will advance knowledge of brain function and dysfunction, will provide a reliable means for measuring neural reorganization and behavioral effects of neurorehabilitation, will further fMRI’s potential role in prescribing neurorehabilitation, and most importantly will enhance fMRI’s contributions to the development of efficacious neurorehabilitation methods to benefit functional recovery for individuals with a stroke.

A lack of calibration in Smart Phantom positioning was determined to have contributed to variability in simulated BOLD fMRI. Future works are focusing on a calibrated means of positioning the Smart Phantom to data integrity.

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