Application for QIBA Project Funding

Title of Proposal: Quantitating Clinical fMRI Mapping of Language: Center, Spatial Extent, and Relative Strength of Active Areas		
QIBA Committee/Subgroup: fMRI Biomarker Committee		
NIBIB SOW Objective which this project addresses: Overall this will address QIBA Objective 2 – refining protocol and qualifications by measuring the impact of methodological differenced in behavioral tasks and post-processing procedures on the ability to achieve claims		
Project Coordinator or Lead Investigator Information:		
Last Name: Voyvodic	First Name: James	Degree(s): PhD
e-mail:	Tel #:	
Institution/Company: Duke University		
Amount Requested:		

Project Description

Version 1.0 of the QIBA Profile on quantitative fMRI has focused on mapping motor cortex function. Because motor cortex mapping is relatively straightforward in terms of both anatomical organization and the scan protocols and tasks involved, focusing on motor mapping has allowed us to analyze many important sources of variance in fMRI in a simple brain system. Our Year-4 QIBA-funded project is using synthetic digital reference objects (DROs) to quantitate the influence of scanner noise, head motion, task performance, and neurovascular uncoupling on the reproducibility and bias of fMRI, using relatively simple models of brain activity as seen in the motor cortex. That effort will allow us to complete our first Profile, specifying quantitative constraints on scanner SNR, subject compliance (motion and performance), and tissue neurovascular coupling (NVC) necessary to achieve our Claim for quantitative localization of the center of hand motor cortex. Identifying such quantitative data quality constraints is an important advance in fMRI.

Having established this first claim for localizing centers of activations, the next step is to address the other two quantitative claims central to fMRI mapping: measuring the spatial extent of active cortex and the relative activation amplitude of different areas activated (e.g. hemispheric dominance). These questions are less important in motor mapping, but they are critically important for mapping language areas of the brain. In Year-5, therefore, we propose to address these language mapping issues in order to add these two important quantitative claims to our Version 1.1 fMRI Profile. To do so we will use approximately 100 patient and healthy volunteer fMRI sessions in which each subject has performed a language mapping task more than once within the same scan session. We will apply the optimized analysis methods identified by our DRO studies to preprocess and identify active areas in each language scan. For each subject we will use the maps of statistically significant activation to extract BOLD amplitude and statistical parameters in 4 speech-related ROIs (posterior temporo-parietal cortex and inferior frontal cortex in both hemispheres). We will parameterize the spatial distribution of signal amplitude within each ROI using the AMPLE algorithm as in our Year-1 Reproducibility studies (i.e., center of activation, peak location, peak amplitude, spatial extent as function of amplitude). We will then compare these quantitative parameters across ROIs

as a function of lobe (frontal vs temporal), hemisphere (left vs right), and scan (repeatability). We will address:

1) Claims: what are the test-retest repeatability coefficients achievable for center, spatial extent, and laterality of activation in language fMRI?
2) Conditions: what are the quantitative data quality constraints (e.g. SNR, performance, NVC, head motion) for meeting those claims?
3) Algorithms: which analysis and normalization strategies (e.g. AMPLE or alternatives) yield best repeatability?

This study will be carried out at 2 sites in parallel: Duke and Johns Hopkins, with each site using their own test-retest language fMRI data and carrying out their own analyses. Results from both sites will be compared and combined into the Language fMRI Profile (1.1) and for publication.