Application for QIBA Project Funding

Title of Proposal: Generation and Testing of Advanced Digital Reference Objects for fMRI		
QIBA Committee/Subgroup: fMRI Technical 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 differences in post-processing procedures on the ability to achieve claims		
Project Coordinator or Lead Investigator Information:		
Last Name: DeYoe	First Name: Edgar	Degree(s): PhD
e-mail:	Tel #:	
Institution/Company: Medical College of Wisconsin		
Amount Requested:		

Project Description

Previous work by this committee (QIBA Year 3 project) has begun to develop digital reference objects (DROs) in the form of synthetic fMRI image data sets with realistic known signal qualities and noise features. A typical DRO consists of a whole-brain set of anonymous high-resolution (e.g. 1x1x1 mm) T1-weighted images, plus one or more lower-resolution BOLD T2*-weighted fMRI image time series, with associated functional task descriptors. By creating DROs we are able to combine different sources of empirically-derived fMRI signal variance into realistic data sets for which the true signal and noise properties are completely known. Our goal has been to incorporate many common types of variance and then use the DROs as standard reference data sets in order to evaluate: (1) which sources of variance and analysis factors significantly affect reproducibility and bias; (2) which analysis methods in current use are best suited for obtaining consistent quantitative results; and (3) how scanner and subject-related sources of variance and our analytical methodological considerations impact clinical performance of fMRI as a biomarker. The current proposal covers the second year of a 2 year project to create DROs and address these issues.

In the first year we have resolved IRB data-sharing issues and established the infrastructure for extracting different types of empirical variance signals from real fMRI data and for recombining them into realistic synthetic images. We have developed software for making DRO data sets in standard DICOM format and making those data sets available for network download for analysis at multiple sites. We are in the process of creating multiple DROs based on real fMRI scans for which we have identified realistic brain activity signals and manipulated several common noise parameters. For each digital "subject" we create 2 DROs with the same brain activity pattern but different noise signals in order to assess inter-scan reproducibility. Ten pairs of DROs will be analyzed during Year 1 using procedures outlined in our current fMRI profile plus additional procedures currently in use at several (~7) institutions that routinely perform fMRI analyses. The results from all sites will be collected and compared to evaluate each methodology in terms of precision, bias, and reproducibility.

In Year 2, we propose to continue this DRO project to incorporate additional important sources of fMRI signal variance and to use the DROs to test the reproducibility and bias properties of a broad range of fMRI processing algorithms. Year 2 will build on the methodological comparisons of Year 1 to optimize and extend our QIBA fMRI profile and protocol,and generate a collection of reference DROs in the QIDW that will enable benchmark testing for quantitative fMRI by all stakeholders involved in developing this biomarker. This project will be coordinated across three sites: Medical College of Wisconsin (MCW), Duke University, and Johns Hopkins University (JHU). The 3 sites will collaborate to address 2 Aims.