

Course: *Single-Subject Neuroimaging*

Day: *Saturday, 20 April 2013*

Syllabus:

Pre-surgical planning: movement, language and the power of localization
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Target Audience:

Both clinical scientists (neuroradiologists, neurologists, neuropsychologists) and basic scientists (neuroscientists, MRI physicists, computer scientists) with knowledge of fMRI acquisition and analysis. This talk will present the primary issues raised in single-subject analysis of fMRI for pre-surgical planning, the only approved clinical application.

Problems Addressed:

This talk will address current practices as well as remaining challenges in acquisition, analysis and interpretation of single subject clinical fMRI for pre-surgical planning, reviewing existing literature and presenting clinical examples. Successful applications of fMRI for motor mapping prior to surgery will be discussed with clinical examples of both common and problematic cases. The talk will further address the more challenging problems faced in mapping language and other complex functions. These include:

- 1) Identifying best practices for choosing task and control conditions, and interpretative problems that arise from these choices. Currently, there are no standards of practice for language mapping. Tasks vary from passively listening to speech, to word generation, semantic decision, and naming; control conditions reported include simple rest or fixation, active controls with non-linguistic tasks such as tone discrimination. The choice of both tasks and control conditions can have a major effect on lateralization and intrahemispheric localization results.
- 2) Identifying technical problems in signal loss and in localization of function due to specific lesion effects. The most common technical problems (aside from head motion) are signal loss due to mass effect and possible restriction of blood flow in large lesions, potential contralateral activation due to disinhibition that may result in false lateralization, and signal loss due to susceptibility artifacts in critical functional regions and near vascular lesions.
- 3) Decisions regarding choosing statistical thresholds, integrating data across different tasks, and how to interpret localized and lateralized results. In single subject studies, statistical thresholds necessary to reveal language areas may vary substantially across individuals. The absolute need to avoid false negatives, in contrast to typical group analysis approaches that minimize false positives, further complicates thresholding choices.

4) Integrating base rates into decision-making. Depending on the nature of the lesion, age of lesion onset, and handedness of the patient, the likelihood of atypical language lateralization varies substantially. Very few studies to date have taken base rates into account in analysis, particularly using single-subject approaches.

5) Integrating diffusion tensor imaging into interpretation and visualization. While fMRI focuses on identifying cortical regions essential for functions, disconnection of critical fiber tracks can be equally devastating to function. Approaches for integrating DTI into a clinical visualization and interpretive plan are discussed, as well as areas in which such visualization can be improved.

6) Gold-standard validation of fMRI protocols with invasive procedures. The gold standard methods for identifying “eloquent cortex” for language are Wada testing (used for lateralization) and electrocortical stimulation mapping (used for intrahemispheric localization). Both techniques differ fundamentally from fMRI, as they are disruption methods, identifying only regions that are absolutely essential for a function, while fMRI identifies all regions engaged including those that may not be essential. The talk will review studies validating fMRI methods, discuss common solutions employed to differentiate active from essential regions, and weaknesses of these approaches.

Outcomes:

Attendees will understand the current clinical needs, practices, strengths and weaknesses of the state of the science. The talk will emphasize areas in which further technical and analytic development can benefit the field.