Optical Measurements in Functional Neuroimaging

Joseph P. Culver culverj@wustl.edu

- Who will benefit from this information?

This talk is designed for people who have an interest in recent advancements in Optical Neuroimaging from mouse to man.

- In mouse, wide field optical neuroimaging of the mouse cortex, can map both spontaneous and task related brain activity using a variety of contrasts including; hemoglobin, blood flow and the metabolite FAD.
- In humans, deep tissue optical methods, using Near Infrared Spectroscopy (NIRS), provide bedside, portable and wearable functional neuroimaging.

- How was a problem determined?

These optical techniques are being developed to complement fMRI techniques by addressing scenarios that are difficult to address with fMRI.

- In mouse, whereas fcMRI techniques struggle to provide the exacting combination of resolution and signal-to-noise, fairly simple reflectance imaging methods, based on optical intrinsic signals (OIS), can image spontaneous brain activity and map functional connectivity.
- In humans, NIRS, and the more recent advancements in Diffuse Optical Tomography (DOT), provide a portable bedside technique for mapping both functional tasks and resting state functional connectivity. While historically NIRS has been limited to resolutions of >3.5 cm, new DOT imaging has demonstrated resolution of <1.5 cm with improved brain specificity and methods for co-registering function to reference anatomy.

- Examples of how these issues have been addressed;

- In mouse, OIS methods have been used with stimulus paradigms to study systems such as the whisker barrel cortex in both health and disease. A newer spontaneous mapping method, fcOIS, has been used to study disruptions in functional networks during disease including amyloid precursor protein models of Alzheimer's, and stroke.
- In humans, NIRS has been used in a great variety of cognitive science studies including language development in children and ambulatory studies in stroke patients. Using the improved performance of DOT, validation studies have shown voxel-to-voxel correlations between DOT and fMRI in visual, motor and language tasks. Most recently these techniques been extended to clinical situations with initial feasibility demonstrated in functional connectivity studies of preterm infants.

- What will learners be able to do differently because of this information?

The attendees will understand and be able to explain the basic concepts in six areas:

1-Tissue optics.
2-Mouse optical imaging systems.
3-Human optical imaging systems.
4-Functional Connectivity methods for optical approaches.
5-Comparative merits of optical-vs-fMRI and multi-modal optical/fMRI.