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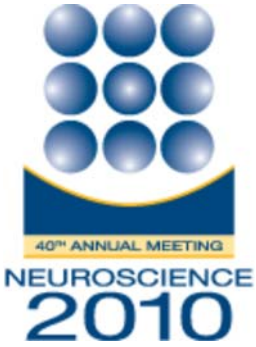

Presentation Abstract

Program#/Poster#:	106.7/MMM14
Title:	Opto-fMRI: Ultra-high resolution causal circuit mapping, and application to analysis of network dynamics
Location:	Halls B-H
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Abstract: To enable functional characterization of the networks causally linked to a specific neural projection pathway or cell class, we developed a new method combining optical neural activation of specific cells, with functional magnetic resonance imaging (fMRI) of distributed brain activity, or 'Opto-fMRI.' We describe means for achieving ultra-high resolution fMRI (up to 100 x 100 µm2 in-plane resolution) across multiple brain areas in mice at 9.4 Tesla during optical activation of a single cell type. We established optical sensitivity in mouse barrel cortex by expression of Channelrhodopsin-2 (ChR2) conveyed by genetic means (under control of the Thy1 promoter) or by viral transduction (under control of the CaM kinase II promoter). Key innovations include the hardware, surgical strategies, pulse sequences, and clustering and cross-correlation data analytic methods appropriate for determining how the activity in a neural network is influenced by optically-controlled stimulation of a defined node within a neural circuit. Optical stimulation of ChR2-expressing excitatory neurons in the somatosensory cortex reliably and consistently revealed fMRI activation patterns in a functional network of neocortical areas. We demonstrate how different parts of a neural network are modulated by a single upstream target site, and we also use this technology to

explore how such network coupling is influenced by isoflurane anesthesia level. We demonstrate that the Opto-fMRI method provides a general strategy for characterizing the strength of connections in a fashion that is amenable to repeated assessment, potentially over long time periods in both anesthetized and awake animals. Opto-fMRI will be useful for monitoring the distributed network impact of a given cell type or pathway as a function of behavioral state, plasticity, or brain pathology. In addition, given that fMRI can uniquely serve as a high-resolution bridge between animal and human brain dynamics, Opto-fMRI will facilitate the translation of causal circuit insights from animal neuroscience to the improvement of human health.

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