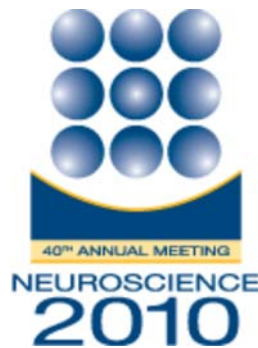


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## Presentation Abstract

Program#/Poster#: 106.8/MMM15

Title: Opto-fMRI: Blood oxygenation level-dependent (BOLD) response is correlated with optically-driven pyramidal spiking activity

Location: Halls B-H

Presentation Time: Saturday, Nov 13, 2010, 4:00 PM - 5:00 PM

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Abstract: Local fluctuations in the blood oxygenation level-dependent (BOLD) signal serve as the basis of functional MRI (fMRI). Understanding the correlation between distinct aspects of neural activity and the BOLD response is fundamental to the use of fMRI. Analysis of this question requires the ability to precisely manipulate the activity of defined neurons. To achieve such control, we combined optogenetic drive of neocortical pyramidal neurons with high-field (9.4 Tesla) high-resolution mouse fMRI. Light-driven activation of pyramidal neurons in primary somatosensory cortex in the barrel field resulted in a positive BOLD response at the stimulated site. As with sensory-driven responses, optically driven BOLD signals demonstrated linear summation following closely temporally (2 s) spaced short (1 s) trains of stimulation. To determine the parameters of neural activity that govern the BOLD signal under these conditions, we employed 15 s light trains of same average frequency (8, 24, 40, 56 and 80Hz) followed by 15 s no-stimulation period, but with periodic vs. Poisson distributed pulse times. These light pulse trains generated dissociable patterns of single-unit, multi-unit and local field potential (LFP) activity, and of BOLD signals. In particular, BOLD activity exhibited the strongest correlation with spiking activity with increasing rate of stimulation for both periodic and Poisson distributed light pulses, and, to a first approximation, was linear with pulse delivery rate, while LFP exhibited a decrease in power with increasing rate of periodic distributed light trains and an inverted-U response peaking at 40-56Hz for Poisson distributed light trains. In making this observation, we emphasize the following points of interpretation. These

observations expand our understanding of the possible modes of neural-to-hemodynamic coupling that can exist in the neocortex, in that they rest on defined activity patterns imposed on the neocortex eliciting cell-type specific neuromodulation. These data raise questions about the common assumption that “subthreshold activity is the correlate of the BOLD signal,” a commonly repeated assertion. Our findings do not, however, suggest a specific mechanism of neural-to-hemodynamic coupling. These data highlight that when a defined set of excitatory neurons is recruited using cell-type specific optical neural control, the BOLD response is correlated with spiking activity of this population, providing insight into conditions where the fMRI BOLD response is likely to be reflecting local spiking activity above and beyond other neural and metabolic modulation.

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