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Presentation Abstract

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Presentation Title:	Modeling BOLD-fMRI on real vascular stacks measured with two-photon microscopy during functional activation
Location:	Halls B-H
Presentation time:	Saturday, Nov 09, 2013, 2:00 PM - 3:00 PM
Topic:	++G.06.a. Computation, modeling, and simulation
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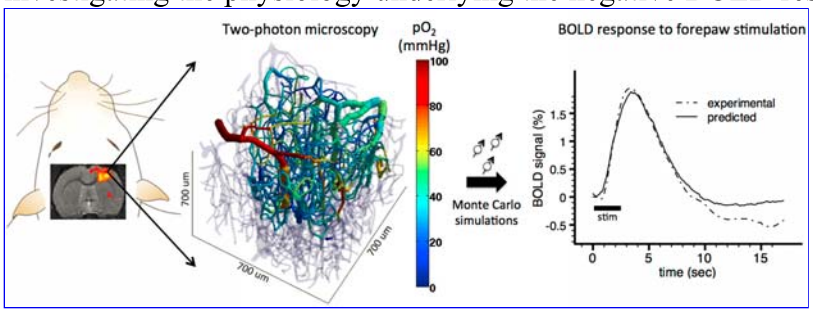
Abstract:	INTRODUCTION Functional Magnetic Resonance Imaging (fMRI) based on the Blood Oxygenation Level Dependent (BOLD) response has become a widely used tool for exploring brain function, and yet the physiological basis of this technique is still poorly understood. Developing a realistic model of the BOLD signal has been challenging. A major difficulty is to take into account the complex morphology of the cortical microvasculature, the distribution of oxygen in those microvessels and its dynamics during neuronal activation. METHODS To overcome this difficulty, we measure microvascular morphology and oxygen distribution in vivo on rodents, at rest and during forepaw stimulation, using two-photon microscopy. These measurements are used together with biophysical modeling and Monte Carlo simulations to predict the BOLD response based on the physiological changes occurring at the microvascular level during neuronal activation. RESULTS The signal modeled was first validated against experimental BOLD-fMRI data measured during the same forepaw stimulation. The power of our model was then demonstrated by quantifying the individual contribution of arteries, capillaries and veins to the BOLD response, for different field strengths, for different cortical

orientations with respect to the main magnetic field, and for gradient-echo and spin-echo pulse sequences. We found that the venous contribution depends on the angle between the cortical surface and the main magnetic field. Since the angle between the cortical surface and the main magnetic field is not the same for every voxel, the same neuronal-induced physiological change will give rise to different amplitudes of the BOLD response in different voxel. These variations in the BOLD amplitudes computed with our model can be used to correct for angle differences between subjects in a group analysis.

CONCLUSION

The model developed in this work opens the door for other possibilities, including validating analytical BOLD models used in the calibrated BOLD experiments and investigating the physiology underlying the negative BOLD response.



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SIMULATION

Two-photon microscopy

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