

# 2007 Regional Symposium on MRI

September 28 - 29, 2007

Holiday Inn

3600 Plymouth Road • Ann Arbor, Michigan.

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## Organizing committee:

Luis Hernandez-Garcia, University of Michigan  
Mary Mohrbach, University of Michigan  
Mark Griswold, Case Western Reserve University  
Seong-Gi Kim, University of Pittsburgh

## Sponsors:

University of Michigan FMRI laboratory  
University of Michigan Biomedical Engineering Department

## Directions and Hotel Information:

<http://www.hiannarbor.com/>

## Registration

There is no charge for this event, but please **register** by sending email to [hernan@umich.edu](mailto:hernan@umich.edu) . Please include your name and affiliation in the message and put the following in the subject line of your message:

Registration\_2007\_Symposium

**Session 1: "Parallel Acquisition and Reconstruction"**

8:30 - 9:00 : *Breaking the Speed Limits of MRI*

*Mark Griswold*  
*Professor*  
*Radiology Department*  
*Case Western Reserve University*

Magnetic Resonance Imaging (MRI) provides a non-invasive window into in vivo anatomy and function. However, especially in the area of functional imaging, MRI has traditionally been severely limited in terms of imaging speed. In this talk, we will discuss modern methods to increase imaging speed in MRI. First, we will discuss the general topic of parallel MRI. This class of methods uses multiple detectors to partially encode the image. To date, around an order of magnitude improvement in imaging speed compared to the previous limits of imaging speed has been achieved in practice. Besides potentially shortening the exams for each patient, we will also discuss how this can potentially allow new types of measurements which were previously impossible. In the last section of the talk, we will discuss the new class of methods based on compressed sensing. Compressed sensing is based on the principle that many images are sparse, meaning that significant parts of the image are either constant over time or that there is substantial spatial correlation between parts of the image. MR angiography is an example of this type of image, since most of the signal is background and is therefore close to zero. In these cases, the imaging time can be reduced by an additional several orders of magnitude. Besides this increase in imaging speed, these methods additionally provide a way to break through the limits of signal to noise ratio which were established over a decade ago. While still in their infancy, these methods have the potential to completely revolutionize MRI and medical imaging in general.

9:15 – 9:45: *“Advanced methods for image reconstruction in fMRI”*

*Jeff Fessler*  
*Professor*  
*Electrical Engineering and Computer Science Dept.*  
*University of Michigan*

In this talk I will first review briefly some of the potential applications for iterative image reconstruction in MRI, particularly in cases like fMRI when the physics underlying the signal are modeled more completely than by the usual Fourier transform. I will also review some of the recent methods for reducing computation time for such iterative methods.

10:00 - 10:15 : Coffee Break

**Session 2: "Alternatives to BOLD"**

10:15 – 10:45 : *“Fast ASL”*

*Gregory R. Lee*  
*Research Associate*  
*Case Center for Imaging Research*  
*Case Western Reserve University*

Arterial spin labeling (ASL) is a noninvasive, quantitative perfusion imaging technique. It has a number of potential benefits over the more commonly used blood oxygenation level dependent (BOLD) technique for functional neuroimaging studies. These advantages include improved localization, quantification of a single physiological parameter and applicability to very low-frequency experimental paradigms. The chief drawbacks of ASL for functional imaging are lower signal to noise ratio and temporal resolution. For this reason, a novel variant of ASL, dubbed Turbo-CASL is proposed to allow a 2-3 fold increase in temporal

resolution and a moderate increase in sensitivity compared to traditional continuous-labeling ASL techniques. A model for the ASL signal in the presence of dynamic transit time and cerebral blood flow changes will also be presented.

*11:00 – 11:30: “Imaging functionally related blood flow with FENSI and diffusion”*

*Brad Sutton*

*Asst. Professor, Bioengineering*

*University of Illinois at Urbana-Champaign*

Arterial spin labeling is the gold standard of measuring blood flow for functional or pathological considerations using MRI. However, the measure reflects bulk delivery of blood to the tissues in a slice and includes many different delivery vessels, not all of which are relevant to function. In this talk I will explain our recent efforts in obtaining highly-localized measures directly reflecting blood velocity in the microvasculature with directional sensitivity. These methods include diffusion weighted imaging and FENSI, a flow enhancement technique.

11:45 –13:00 : Lunch Break

### **Session 3: "Tailored excitation"**

*13:00 – 13:30 : “Spectral-spatial pulse design for signal recovery in T2\*-weighted BOLD fMRI”*

*Chun-Yu Yip*

*Graduate Research Assistant*

*Electrical Engineering and Computer Science Dept.*

*University of Michigan.*

T2\*-weighted BOLD functional MR images are plagued by signal loss artifacts caused by susceptibility-induced through-plane dephasing. The loss can be recovered if through-plane dephasing is pre-compensated by the phase pattern created by a "tailored" excitation pulse. Our group demonstrated that such pre-compensation could be achieved with a 3D spatially selective excitation pulse (3D Tailored RF (3DTRF) pulse). In this talk we propose a novel pulse design approach for phase pre-compensation. Instead of spatially selective pulses, it involves iteratively designed spectral-spatial pulses that create pre-compensatory phase variations not based on where dephasing spatially occurs, but instead based on "where it occurs spectrally". The new approach is potentially more powerful in signal recovery, and less demanding in terms of computation.

*13:45 – 14:15 : "Parallel Imaging with three dimensional trajectories: Implementation and Performance Benefits"*

*Yongxain Qian*

*Research Instructor*

*MR Research Center*

*Department of Radiology*

*University of Pittsburgh*

Three dimensional (3D) trajectories have potential advantages in acceleration and signal-to-noise ratio (SNR) for parallel imaging. This work demonstrates the benefits of parallel imaging with 3D trajectories through the implementation of the twisted projection imaging (TPI) trajectory and sensitivity encoding (SENSE) image reconstruction. Our computer simulations, phantom and human studies on 1.5T/3T scanners showed that the TPI trajectory, based on a 4-element coil array, produces higher acceleration factor and lower SNR loss in parallel imaging than Cartesian sampling schemes.

14:30 – 14:45 : Coffee break

### **Session 4: "High field/high resolution/high speed imaging"**

Note – all talks are 30 minutes long followed by 15 minutes of discussion

*15:00 – 15:30: "Origins of Functional Blood Volume Changes: Arterial vs. Venous Vessels"*

*Tae Kim*

*Research Associate*

*Department of Radiology*

*University of Pittsburgh*

Total cerebral blood volume (CBV) can be determined using a contrast agent, and CBV-based fMRI has been used to determine the underlying mechanism of BOLD signals as well as to improve spatial specificity to the parenchyma. Since the BOLD signal depends on venous CBV (not total CBV), it is crucial to separate total CBV into arterial and venous volumes. To measure arterial CBV, we developed the MODulation of TIssue and VEssels (MOTIVE) technique, which relies on ASL with magnetization transfer effects. Then, arterial and total CBV changes were measured during somatosensory stimulation in the isoflurane-anesthetized rat at 9.4 T. Basis of the new arterial blood volume measurement technique as well as our findings of CBV sources will be presented.

*15:45 – 16:15: "Neuroimaging of ALS"*

*Robert C. Welsh*

*Assistant Research Professor*

*Dept. of Radiology, University of Michigan*

The proposed research will use neuro-imaging techniques to map and longitudinally study regions of cortex (M1, pre-motor, SMA) in persons with ALS that could provide controls signals for a brain computer interface (BCI). Using functional magnetic resonance imaging (fMRI) in conjunction with a series of motor control experiments over a period of three years we will longitudinally map brain activation patterns to examine functional stability, atrophy and plasticity. We will also be collecting fcMRI (resting state) data, as well as diffusion tensor data. The specific aims of this project will explore the overall research question "What effect does ALS progression have on the reorganization of the cortex in areas related to the production of actual and imagined movements?" The results of this study will benefit the use of many different designs of BCI technology based on motor imagery related brain activity with people with ALS.

**Session 1: "fMRI processing strategies / data integration"**

8:30 – 9:00: *"Resting-state functional connectivity in fMRI: Applications and extensions"*

Scott Peltier

Assistant Research Scientist

Functional MRI Laboratory, University of Michigan

Functionally connected brain networks have been identified in fMRI that are active even when subjects are not performing an overt task. This talk will present the results of some resting-state connectivity studies, and also discuss possible extensions and complements, such as multimodal acquisitions.

9:15 – 9:45: *"Imaging Language Processes with Event-related Optical Signal (EROS)"*

Chun-Yu Tse

Beckman Institute & Department of Psychology,

University of Illinois at Urbana-Champaign

The event-related optical signal (EROS) is a recently developed non-invasive brain-imaging technique, which uses near infra-red light to detect changes in the optical properties associated with neuronal activity. Most brain-imaging techniques provide either superior temporal or spatial resolution. Thus, multiple techniques are often needed to investigate the different aspects of cognitive processes. EROS, however, provides both excellent spatial and temporal resolution, allowing processes based on the rapid interaction of multiple brain regions to be revealed with the use of a single technique. EROS has been used to study cognitive processes in various domains, but the present study is the first to apply EROS to investigate language comprehension. Specifically, we studied the interaction of left inferior frontal and superior temporal cortices during language comprehension by presenting participants with semantically or syntactically anomalous and non-anomalous control sentences. The correspondence of ERP and EROS data was also investigated through their simultaneous recordings. The EROS results showed increased activity in the temporal cortices (corresponding in time with the ERP responses) followed by frontal activity for both semantic and syntactic contrasts. However, the temporal activity elicited by semantic anomalies was more ventral than that elicited by syntactic anomalies. These data suggest that activation related to anomaly processing proceeds from temporal to frontal brain regions for both semantic and syntactic anomalies and indicates that EROS can be used to image rapid interactions across different cortical areas.

10:00 – 10:15 – Coffee Break

**Session 2: "Attention and Learning"**

10:15 – 10:45: *"Fronto-parietal activity evoked by challenges on sustained attention performance: a continuous arterial spin labeling perfusion fMRI study"*

Elise Demeter

Graduate Research Assistant

Neuroscience Program,

University of Michigan.

We report the results of a pilot study using continuous arterial spin labeling (ASL) perfusion to examine the neural substrates of the brain's response to challenges to sustained attention. The experimental task has been adapted from rodent studies of acetylcholine's role in attention and response to challenge. On each trial, participants attempt to detect the presence or absence of a small, brief (17, 29, or 50 ms) signal presented in the center of the screen. Trials are presented under either standard (static grey background) or distracting (flickering background; 20 Hz alternating between grey and black) conditions. Participants alternated between 150 ± 10 s task blocks and 40 s fixation baseline blocks. Early results indicate that task

performance activated regions in inferior frontal, parietal, and temporal regions and in thalamus. The distractor condition impaired the subjects' task accuracy and increased activity in frontal regions. These findings indicate that attentional challenges activate a distributed fronto-parietal network and form the basis for experiments designed to test the hypothesis that a significant proportion of the distractor-evoked fronto-parietal activity reflects cholinergic activation.

*11:00 – 11:30: “ Mapping Brain System Specialization and Connective Topology with fMRI and DSI.”*

*Walter Schneider  
Professor, Psychology Department  
University of Pittsburgh*

We are using new methods in connectivity analysis (e.g., Granger causality) and spectrum imaging (Q-BALL and Probabilistic anatomical connectivity Index) to identifying the operations of cognitive control and the anatomical structure and connectivity to support those operations. A fundamental distinction of human cognition and cortical processing is the interaction of representation specific areas (e.g., visual object, motor action) and domain general control systems (e.g., attention, decision, response mapping, affect coding). We detail the function, anatomy, and interaction of these cortical systems based on behavioral, fMRI, anatomical (DSI), and functional connectivity methods. The representation areas are involved in representation specific encoding, recognition, similarity judgment, episodic recall, and automatic coding. The control system components are tightly coupled, showing differential activity based on comparison decision (anterior cingulate cortex and pre-supplementary motor area (ACC/pSMA)), goal processing (dorsolateral prefrontal cortex (DLPFC)), stimulus filtering (inferior frontal junction (IFJ)), arousal (anterior insular cortex (AIC)), attentional control (posterior parietal cortex (PPC)), and affect assessment (amygdala and orbitofrontal cortex). This brain activity and connectivity topology provide detailed constraints for models of cognitive executive control.

11:45 – 13:00 : Lunch Break

### **Session 3: "Aging Brains"**

*13:00 – 13:30 : "Aging and the Default Network."*

*Denise Park  
Professor  
Psychology Department, University of Illinois at Urbana-Champaign*

In a series of fMRI studies, we have demonstrated that younger adults show less engagement of the default network (a pattern of activation associated with rest or daydreaming) than old adults on a demanding line judgment task. At the same time, old adults show greater activation of frontal sites relative to young on this demanding task. Finally, in a large cross-cultural study of over 200 adults, we provide evidence that East Asians show less engagement of the default network than Westerners, congruent with the notion that Asians spend more time monitoring external information than westerners.

*14:15 – 14:45: “Rapidly acquired false memories: Mind and matter”*

*Alexandra S. Atkins  
Graduate Research Assistant  
Psychology dept.,  
University of Michigan.*

False memories are well-documented long-term memory phenomena (cf. Roediger & McDermott, 1995). Semantically related lures are erroneously remembered as studied items. Recently, we have reported false memory effects in working memory as well (Atkins & Reuter-Lorenz, in press). In this talk, I will present behavioral findings demonstrating false recognition and recall for lures associated with members of sub-span lists presented 3-4 seconds prior to test. I will also present preliminary findings from an ongoing event-related fMRI investigation of the neural substrates of this rapid form of memory distortion.

Note – all talks are 30 minutes long followed by 15 minutes of discussion

#### **Session 4: "Clinical fMRI"**

*15:00 – 15:30: "Cognitive-emotional network interactions in schizophrenia"*

*Stephan Taylor*

*Associate Professor*

*Psychiatry Dept.*

*University of Michigan*

Schizophrenia is a psychiatric disorder marked by profound disruptions in cognitive and emotional functioning. As functional neuroimaging has begun to characterize the large scale networks responsible for cognitive and emotional behavior, we have begun to understand the disorder in functional anatomic terms. We will present recent work using simple tasks that illustrate abnormal interactions and connectivity of these networks in the prefrontal cortex.

*15:45 – 16:15: "Changes in fMRI BOLD Signal in the Posterior Insula Correlate with Changes in Posterior Insula Glutamate Levels, Pressure-Pain Sensitivity, and Clinical Pain in Fibromyalgia."*

*Michael Hsu*

Our objective was to examine whether fMRI changes within the posterior insula correlate with changes in clinical and experimental pain measures, and with corresponding glutamate (Glu) levels on proton magnetic resonance spectroscopy (H-MRS), in individuals with fibromyalgia. 10 right-handed female patients with fibromyalgia received either 9 acupuncture or 9 sham acupuncture treatments over 4 weeks. All participants underwent two fMRI and H-MRS sessions, both before and after treatment. The H-MRS protocol was performed at rest, using single voxel spectroscopy (SVS) with a 2x2x3cm volume of interest placed over the right posterior insula. Each fMRI session involved two 6.4-minute runs (256 scans each), during which varying amounts of discrete pressure were applied for 25 sec to the left thumbnail in a pseudorandom order, alternating with a no-pressure baseline. Significant positive correlations were found between BOLD contrast changes in the left posterior insula and changes in Glu/Cr in the right posterior insula ( $\rho=0.806$ ,  $p=0.005$ ), clinical pain scores ( $\rho=0.866$ ,  $p=0.001$ ), and pressure-pain sensitivity ( $\rho=0.811$ ,  $p=.004$ ). Lack of sufficient statistical power may explain the absence of ipsilateral correlations between fMRI and proton spectroscopy findings.