Electronic Posters: Functional

fMRI Signals: Detection & Characteristics
Hall B Monday 14:00-16:00 Computer 19

14:00 3408. The Spatiotemporal Characteristics of Visual Stimulus-Induced BOLD Responses in Cat Visual Areas
Cecil Chern-Chyi Yen1, Hiro Fukuda2, Seong-Gi Kim1,2
1Bioengineering, University of Pittsburgh, Pittsburgh, PA, United States; 2Radiology, University of Pittsburgh, Pittsburgh, PA, United States

BOLD fMRI has been widely used to map the neuronal activity of the cortical visual areas in mammals. In addition, the subcortical visual regions such as lateral geniculate nucleus (LGN) have also been successfully mapped in humans. However, unlike visual cortex, our understanding about the spatiotemporal BOLD response induced by visual stimulus in LGN is relatively poor. In this study, we investigated the BOLD response in the cat primary visual cortex (A17) and LGN. We found the onset time different in these two areas and the contamination of draining vein in LGN.

14:30 3409. Spatiotemporal Exploratory Analysis of FMRI Data
Radu Mutihac1
1Electricity & Biophysics, University of Bucharest, Bucharest, Romania

Spatiotemporal characteristics of brain activity are frequently unknown and variable, which preclude their evaluation by confirmatory methods only. Revealing unanticipated or missed patterns of activation, exploratory data analysis (EDA) allows to improve or even to change the original hypotheses. Artifactual behavior that EDA may easily discover could raise questions on data appropriateness, if additional preprocessing steps are required, or if the preprocessing employed has introduced spurious effects. Spatial independent component analysis (sICA) and temporal fuzzy cluster analysis (tFCA) were comparatively investigated as typifying EDA of neuroimaging data.

15:00 3410. Spatial Variation of BOLD Contrast in the Activated ROI Is Correlated with Voxel-Wise Gray Matter Volume Fraction
Wanyong Shin1, Hong Gu1, Qihong Zou1, Pradeep Kurup1, Yihong Yang1
1Neuroimaging Research Branch, National Institute on Drug Abuse, National Institutes of Health, Baltimore, MD, United States

In this study, we investigate spatial variations of BOLD contrast (β) within individual subjects and correlate it with voxel-wise T1 and fractional volume (fv) of each tissue component using a new brain segmentation technique, FRASIER. Our data show that spatial variation within individual subjects in a ROI activated by a visual task is highly correlated with T1 and fractional volume of GM, as well as resting-state fluctuation amplitude (RSFA). The dependency (slope of the linear regression), however, varies over subjects. These findings may be used to calibrate BOLD signals for improving sensitivity and specificity in detecting brain activity.

15:30 3411. Comparison of the Location and Extent of BOLD Activation in High Spatial Resolution SE and GE FMRI of the Motor Cortex at 7T
Jack Harmer1, Rosa Maria Sanchez-Panchuelo1, Richard W. Bowtell1, Susan T. Francis1
1Sir Peter Mansfield Magnetic Resonance Centre, The University of Nottingham, Nottingham, Nottinghamshire, United Kingdom

Gradient-echo (GE) and spin-echo (SE) EPI based fMRI is used to compare SE and GE BOLD responses at high field strength (7T) and resolution (1.5mm isotropic) using a motor paradigm. We investigate CNR, fractional signal change as a function of echo time, spatial specificity of SE BOLD and the localisation of GE and SE activation in relation to underlying venous blood vessels. Robust activation was detected using both SE and GE EPI. A higher proportion of GE activation was found to occur in voxels classified as having a high venous contribution than in SE data.

Tuesday 13:30-15:30 Computer 19

13:30 3412. A Theoretical Direct Neuronal Detection Study to Estimate Percentage Local Field Perturbations
Syed Muhammad Anwar1, Greg Cook1, Martyn Paley2
1Electronic and Electrical Engineering, University of Sheffield, Sheffield, United Kingdom; 2Academic Radiology, University of Sheffield, Sheffield, United Kingdom

Direct neuronal detection (DND) of nerve impulses using MR techniques to image brain activity is currently under study as an alternative to BOLD based functional MRI. This work theoretically estimates the percentage local signal perturbations caused by the weak transient neuronal fields, and the effect of various axonal firing delays on these perturbations is also studied. The modelling suggests that detection of neuronal fields should be within the capability of current MR technology, and that better post processing may be required for more reliable and reproducible results.
14:00  3413. Investigating the Earthworm (Lubricus Terrestris) as a Model for NeMRI at 9.4T
   Martyn Paley\textsuperscript{1}, Steven Reynolds\textsuperscript{1}, LiSze Chow\textsuperscript{1}, Syed Anwar\textsuperscript{2}, Greg Cook\textsuperscript{2}
   \textsuperscript{1}Academic Radiology, University of Sheffield, Sheffield, Yorkshire, United Kingdom; \textsuperscript{2}Electronics and Electrical Engineering, University of Sheffield, Sheffield, Yorkshire, United Kingdom

The feasibility of performing ncMRI in the intact resting earthworm has been investigated using a high resolution probe at 9.4T.

14:30  3414. Optimization of Echo Time in Direct Detection of Neuronal Currents with MRI
   Qingfei Luo\textsuperscript{1}, Jia-Hong Gao\textsuperscript{1}
   \textsuperscript{1}The University of Chicago, Chicago, IL, United States

To detect the weak neuronal current MRI (ncMRI) signal, the imaging parameters (e.g., echo time) need to be optimized to achieve the maximum detection sensitivity. In this study, by theoretical modeling, we estimated the optimal echo time (TE) in a typical in-vivo ncMRI experiment using gradient-echo EPI pulse sequence. The results show that the optimal TE for detecting ncMRI magnitude/phase signal is 92.56ms in human brain at 3T. Also, the difference of optimal TE between magnitude and phase signals suggests that a dual-echo pulse sequence should be used to achieve the highest sensitivity to both signals in a MRI scan.

15:00  3415. Modeling Neuronal Current MRI Signal with Human Neuron
   Qingfei Luo\textsuperscript{1}, Jia-Hong Gao\textsuperscript{1}
   \textsuperscript{1}The University of Chicago, Chicago, IL, United States

Previously, neuronal current MRI (ncMRI) signal has been modeled with the real neuronal morphology and physiology in animals, such as monkey and rat. This study is an extension of the ncMRI modeling work to human subjects using human pyramidal neurons. The difference of neuron density in different human cortical layers is considered in calculation of ncMRI signal to achieve higher simulation accuracy. Our results show that ncMRI magnitude/phase signal changes are up to 1.8×10^{-5}/0.02° when using the typical gradient echo EPI pulse sequence. In practice, such a small signal change is difficult to be detected using present MRI technology.

Wednesday 13:30-15:30  Computer 19

13:30  3416. Combined Analysis of Breath Hold and Post-Stimulus Undershoot Signals
   Todd B. Harshbarger\textsuperscript{1}, Allen W. Song\textsuperscript{1}
   \textsuperscript{1}BIAC, Duke University, Durham, NC, United States

A previous study indicated that diffusion weighting can be used to separate regions based on the characteristics of the post-stimulus undershoot. These regions were hypothesized to contain separate vascular contributions, and indicated an undershoot metabolic origin. Here, we use a breath hold task (BHT) to further investigate the vasculature within these regions. The BHT produces a vascular response without a metabolic response, and is used in calibrated BOLD methods to even out activity based on varying vasculature. We found regions which, based on undershoot characteristics, are hypothesized to contain larger vessels do show larger breath hold responses, corroborating previous results.

14:00  3417. fMRI of the Human Retina Associated with Oxygen Inhalation
   Yi Zhang\textsuperscript{1,2}, Qi Peng\textsuperscript{2}, Timothy Q Duong\textsuperscript{2}
   \textsuperscript{1}Research Imaging Institute, University of Texas Health science center at San Antonio, San Antonio, TX, United States; \textsuperscript{2}Radiology, University of Texas Health science center at San Antonio, San Antonio, TX, United States

Synopsis: fMRI of the human retina is challenging because the thin retina is located in a region of high magnetic susceptibility, is susceptible to eye motion and high spatial resolution is needed. This study successfully demonstrated a novel fMRI application to image normal human retinas associated with oxygen challenge. fMRI utilized an inversion-recovery balanced steady state precession (IR-bSSFP) acquisition to suppress vitreous signal and to achieve high spatiotemporal resolution free of image distortion and signal dropout. This approach has the potential open up new avenues for retinal research and may have important research and clinical applications.

14:30  3418. Normalisation of BOLD FMRI Data Between Different Baseline Conditions Using Hyperoxia
   Daniel Bullo\textsuperscript{1}, Molly Bright\textsuperscript{1,2}, Peter Jezzard\textsuperscript{1}
   \textsuperscript{1}FMRIB Centre, University of Oxford, Oxford, Oxfordshire, United Kingdom; \textsuperscript{2}National Institutes of Health (NIH), Bethesda, MD, United States

The fact that BOLD FMRI is highly sensitive to resting blood flow levels is a significant limitation in the clinical application of the technique. As many commonly ingested substances can cause significant changes in CBF, correcting for this confound would be a distinct advantage in comparing between subjects, sessions or pharmacological conditions. In this study subjects were imaged during visual stimulation pre and post- caffeine consumption. Short epochs of hyperoxia were used to normalise between these 2 conditions. Despite changes in BOLD response on the order of 10-40%, the normalisation effectively reduced the baseline vascular confounds.
**The Effect of Graded Hypercapnia on Arterial Cerebral Blood Volume (ACBV)-Weighted Inflow Vascular-Space Occupancy (iVASO) Contrast**

Molly Gallogly Bright1,2, Manus J. Donahue2, Daniel P. Bulle2, Jeff H. Duyn1, Peter Jezzard2

1Advanced MRI Section, LFMI, NINDS, NIH, Bethesda, MD, United States; 2FMRIB Centre, Department of Clinical Neurology, University of Oxford, Oxford, United Kingdom

Inflow vascular space occupancy (iVASO) MRI uses arterial spin nulling and dynamic subtraction to create cerebral blood volume (CBV)-weighted images that can be sensitized to pre-capillary vessels. We aim to validate this technique by examining the relationship between the iVASO contrast and graded levels of CO2 inhalation, a common vasodilatory stimulus, in the human visual cortex. Robust correlation between the iVASO measurements and end-tidal CO2 was observed, indicating potential for iVASO techniques to improve our understanding of the role of arterial CBV in regulatory vasoreactivity and cerebrovascular disease.

**Thursday 13:30-15:30  Computer 19**

**A Simple Approach for Mapping CSF Volume Fraction**

Qin Qin1, Peter C.M. van Zijl1

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CSF’s redistribution in response to local blood volume change during activation renders CSF volume fraction in baseline an important factor in fMRI models. Here a simple method of measuring CSF volume maps is proposed, which is based on the fitting of exponential decay of only CSF signal using a non-selective T2 preparation scheme. CSF volume fractions in ventricles were found to be about 1.0, while cortical volumes ranged from 0.05-0.5. The T2 of CSF was found to be 1654±389ms.

**Simultaneous BOLD and ASL for Characterizing Cerebrovascular Responses to Hyperoxia in Normal Brain and in Glioblastoma**

Heisoog Kim1,2, Ciprian Catana1, Grace Kim1, Ovidiu C. Andronesi1, Dominique L. Jennings1, Divya S. Bolar1,2, Elizabeth R. Gerstner1, Tracy T. Batchelor2, Rakesh K. Jain1, A Gregory Sorensen1

1A.A.Martinos center, Massachusetts General Hospital, Charlestown, MA, United States; 2NSE/HST, Massachusetts Institute of Technology, Cambridge, MA, United States; 3EECS/HST, Massachusetts Institute of Technology, Cambridge, MA, United States; 4Neurology, Massachusetts General Hospital, Boston, MA, United States; 5Radiology, Massachusetts General Hospital, Boston, MA, United States

In this study, simultaneous BOLD-ASL method was used to assess quantitatively the characteristic cerebral responses to 100% oxygen exposure in normal brain and in glioblastoma (GB). BOLD and Flow effects in normal brain were detected primarily in the cortex (increased BOLD and decreased CBF responses), which agreed with previously published data. Heterogeneous BOLD signal was observed in GB. The enhancing tumor showed a larger increase in BOLD and a smaller decrease responses in CBF than contralateral normal tissue did, which implies the characteristic properties of the tumor vasculature (i.e. tortuous, large vessels, inefficient blood circulation).

**Detecting Focal Changes in CBF Independently from Tissue Content Using Arterial Spin Labeling (ASL) FMRI**

Ajna Borogovac1, Christian Habeck2, Joy Hirsch3, Iris Asllani4

1Biomedical Engineering, Columbia University, New York, NY, United States; 2Neurology, Columbia University; 3Neuroscience & Psychiatry, Columbia University; 4Radiology, Columbia University

Quantification of inter-subject differences in cerebral blood flow (CBF) separately from respective differences in tissue content presents a known challenge in analysis of group data. Recently, our group has developed an algorithm which corrects for partial volume effects (PVE) in arterial spin labeling (ASL) imaging and also yields tissue specific flow ‘density’ maps (CBFd) which are, theoretically, independent of tissue content. The goals of the present work are to (1) optimize the PVEc algorithm for applications where focal differences in CBFd occur (e.g. in functional imaging) and (2) demonstrate how segmentation can affect accuracy of CBF and CBFd estimation.

**Left/right Asymmetry Measures in Somatosensory Cortex Using MEG, ASL and BOLD FMRI**

Claire M. Stevenson1, Karen J. Mullinger1, Joanne R. Hale1, Peter G. Morris1, Susan T. Francis1

1SPMMRC School of Physics and Astronomy, The University of Nottingham, Nottingham, Nottinghamshire, United Kingdom

Functional asymmetry in the human brain, as measured by fMRI, has been well documented in motor regions but to a lesser extent in the somatosensory cortex. Here we combine ultra-high field BOLD fMRI, CBF and modulations in electrical oscillatory activity as measured by MEG to gain insight into mechanisms of cerebral lateralisation in the somatosensory cortex. fMRI results show an increased response contra-laterally and suggest an increase in lateralisation with dominant hand stimulation. Beta power activity appears to follow this trend reinforcing the importance of considering both phase locked and non-phase-locked neural activity when describing the BOLD response.
There is increasing interest in resting brain activity. However, to our knowledge, ASL has not yet been used to study RSNs across the whole brain with single timeseries acquisitions. In this study, we implemented a novel true whole-brain CASL technique with EPI readout to study dynamic characteristics of cerebral blood flow during the resting state. We extracted the major covarying networks in the resting brain, as imaged in 8 subjects at rest. The major brain networks are highly similar to recent published results obtained using BOLD fMRI. We also characterised very low-frequency RSN temporal behaviour for the first time.

Global signal removal is a widely used and controversial method for resting state functional connectivity analysis. When all voxels are used for the computation of the global signal, removal of the global signal can produce artifactual negative correlations. In this study, we consider the use of an alternative estimate of the global signal that utilizes a random sample of voxels chosen to be outside the regions of interest that are used to compute the correlation. Because this estimate does not include voxels within the regions of interest, its use does not force negative correlations to exist.

Resting state BOLD data were collected before and after the injection of a 2.5mg/kg dose of caffeine. Caffeine is a known vasoconstrictor and neural stimulant. Correlation analysis was completed that demonstrated global decreases in connectivity. The default mode network had the largest decrease due to changes in physiology and alertness induced by caffeine. The result demonstrates that the resting state BOLD signal is a mixture of neural and physiologic signals and needs to be interpreted with caution.

Many studies have utilized functional connectivity as a tool to uncover brain networks, however limited effort devoted to characterizing the effect of image acquisition parameters such as temporal and spatial resolution on the quality of the connectivity maps. In this work we examine the effect of temporal resolution in the motor network, by modulating TR, number of measurements and acquisition time. Our findings show increased z-scores when TR was shortened for constant acquisition time, and were independent of TR for the acquisitions with a constant number of measurements. Furthermore, z-scores were improved when a 32ch array was used.

Amplitude of low-frequency fluctuations (ALFF) has been used to quantify the strength of spontaneous fluctuations of fMRI signal in the resting state. However, its underlying physiological/biophysical mechanisms are unknown. In this study, the relationship between BOLD fluctuation amplitude and resting-state cerebral blood flow (CBF) were investigated. Our results showed that ALFF of BOLD and CBF were positively correlated within multiple cortical and subcortical networks. These findings provided first evidences that ALFF is related to baseline CBF and likely reflects the level of spontaneous neuronal activity.
In this study we investigate the effect of voxel size, across a range of isotropic resolutions and we determine whether acquisition at high spatial resolution and smoothing in post-processing is a favorable strategy compared to direct acquisition at larger voxel size. The comparisons indicate that at least 3x3x3mm³ voxels are needed to see robust correlations in the unsmoothed maps, but smoothing to 6mm reveals the correlations with approximately equal z-scores regardless of the original acquisition resolution. Acquiring at high spatial resolution and smoothing to low resolution was found to be a favorable strategy compared to direct acquisition at lower resolution.

We investigated the effect of caffeine upon resting-state BOLD connectivity by performing measurements at different anatomic areas (primary motor cortex, primary visual cortex, and thalamus) in combination with multiple TE's. Results showed that the obtained connectivity was more significant when data was collected with a longer TE, and noticeably dropped after caffeine injection. When correlated to resting-state perfusion as measured by the pseudo-continuous arterial spin-labeling technique, the decrease of connectivity was larger in the region where caffeine caused more flow reduction, which suggested the role of vascular regulation in the functional connectivity measured by BOLD.

The thalamus, as the centrally located relay station for transmitting information throughout the brain, participates in communication with many associative brain regions and involves global multi-functional pathways. The purpose of this study was to investigate whether the 7T resting-state functional scans can give us more information on this low frequency resting state network (RSN) associated with thalamic function. This study demonstrates for the first time, the thalamic functional network during resting state obtained from both 3T and 7T scans in healthy volunteers. Thalamus was implicated to be primarily involved with motor control based on results from 3T scans. Meanwhile thalamus was showed to be functionally related to a number of more brain areas from 7T scans. The 7T scan verified the larger functional network of thalamus in brain neural activity and demonstrated that the thalamus is involved in regulating the transmission of information regarding visual, motor control, perception, some cognitive functioning and so forth.

Respiratory noise is a confounding factor in functional MRI data analysis. A novel method is proposed to retrospectively correct for the respiratory noise in fMRI data using linear regression of the phases from different slices. This method can effectively remove noise that correlates with the respiration. This new method is compared with RETROICOR, which requires recording respiration signal simultaneously in an fMRI experiment. The two techniques show comparable performance with respect to the respiratory noise correction for fMRI time series.

Temporal characteristics of the noise in multi-run fMRI scans using GRAPPA are examined with a gel phantom for acceleration factors 2-4 and various number of ACS lines. It is demonstrated that the noise distribution can change significantly from run to run. However, little change is observed from the offline reconstruction if the same reference scans are used. The results indicate that the variation is mainly caused by the noise fluctuation in the reference scans.
14:30  

**3434. The Effect of Repetition Time on Model Selection in Dynamic Causal Modeling**

Christian H. Kasess1,2, Ewald Moser1,2, Christian Windischberger1,2
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Most studies applying DCM have thus far used relatively long repetition times. However, higher sampling rates should provide for a better comparison of different model structures due to better sampling of the hemodynamic response and an increased number of samples. Here we tested the influence of the repetition time on model selection at different noise levels based on simulated data. Results show improved model selection on a group level at short repetition times, in particular at lower signal-to-noise ratios illustrating the benefits of using short repetition times.

15:00  

**3435. Investigating the Feasibility of Correlating Evoked Responses and BOLD Signals Using Simultaneous EEG/fMRI at 7T.**

Karen Julia Mullinger1, Claire M. Stevenson1, Susan T. Francis1, Richard W. Bowtell1
1Sir Peter Mansfield Magnetic Resonance Center, School of Physics and Astronomy, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom

Haemodynamic and electrical responses may show unpredictable variations over repeated trials due to habituation or modulation of attention. Here we investigate if these effects can be measured in the somatosensory cortex using simultaneous EEG/fMRI. An average of 10 trials was required to ensure detection of the evoked response. With this averaging, attenuation of the BOLD response was observed suggesting habituation, but the evoked response did not reflect this. Variance of the evoked response was assessed and found to be similar to that of the baseline prohibiting the determination of whether the evoked response attenuates as observed for BOLD.

Thursday 13:30-15:30  

**Computer 20**

13:30  

**3436. Adaptive Noise Removal IRF-RETROICOR**

Erik B. Beall1, Mark J. Lowe1
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RETROICOR is a good general model for physiologic noise, however it is inefficient and provides no information about actual temporal signatures of noise. We show modifications that provide these signatures and that a small subset of these account for all the RETROICOR modeled noise variance without removing as much non-noise (signal of interest) variance. We show remarkable concurrence of these 4 cardiac and 2 respiratory signatures across 34 subjects, in both fMRI and resting connectivity data. Based on the stability of these, we propose that they may be used to study abnormal physiology of cardiac and respiratory coupling.

14:00  

**3437. The Impact of Physiological Noise Correction on FMRI at 7T**

Chloe Hutton1, Oliver Josephs1, Jörg Stadler2, Eric Featherstone1, Alphonso Reid1, Oliver Speck1, Johannes Bernarding1, Nikolaus Weiskopf1
1Wellcome Trust Centre for Neuroimaging, Institute of Neurology, University College London, London, United Kingdom; 2Special Lab Non-Invasive Brain Imaging, Leibniz Institute for Neurobiology, Magdeburg, Germany; 3Department of Biomedical Magnetic Resonance, Institute for Experimental Physics, Otto-von-Guericke University, Magdeburg, Germany; 4Institute for Biometry and Medical Informatics, Faculty of Medicine, Otto-von-Guericke University, Magdeburg, Germany

This study aims to demonstrate the impact of physiological noise correction on the detection of brain activations for BOLD fMRI studies acquired at 7T. We use fMRI studies of subjects at rest and performing a visual task to estimate temporal SNR (tSNR) as a function of image SNR and the t-scores associated with detected activations after performing physiological noise corrections based on peripheral measurements of subject physiology. The results demonstrate that the corrections lead to an increase in mean tSNR and voxel-wise improvements in t-scores in the visual cortex.

14:30  

**3438. Periventricular Areas Anti-Correlate with Visual Cortex in High Resolution Resting-State FMRI at 7T**

Marta Bianciardi1, Masaki Fukunaga1, Peter van Gelderen1, Jacco A. de Zwart1, Jeff H. Duyn1
1Advanced MRI Section, LFMI/NINDS/NIH, Bethesda, MD, United States

Anti-correlation between the default mode network and an extended dorsal attention system has been previously observed in resting-state fMRI. Here we report on the presence of regions that anti-correlate with the visual cortex in resting-state fMRI at 7T. This activity occurs in proximity of the ependymal vascularization of the ventricular system, is modulated by behavioral state and is not an artifact due to head motion, heartbeat or respiration. The findings are consistent with a blood volume increase of veins downstream from visual areas.
Principal Component Projections Achieve Frequency Decomposition on Resting-State FMRI Data

Yi-Ou Li¹, Pratik Mukherjee¹
¹University of California San Francisco, San Francisco, CA, United States

In this work, we observe that principal component analysis (PCA) on fMRI data not only decomposes the signal fluctuations into principal components ranked by the variance contribution, but also decomposes their temporal dynamics into ordered frequency bands, even within the 0.01 to 0.1 Hz BOLD frequency range. This observation suggests that dimension reduction of fMRI data using PCA should be determined not only based on the variance distribution of the spatial domain principal components, but also based on the frequency distribution of their corresponding projection vectors in the temporal domain.

fMRI Acquisition Techniques

Hall B Monday 14:00-16:00

Direct Comparison of BOLD Measurements Acquired Using Functional Spectroscopy Versus EPI

Oliver Hinds², Aaron Hess², M. Dylan Tisdall³, Hans Breiter³, André van der Kouwe³
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We performed a direct comparison between BOLD signal measured using single-voxel functional spectroscopy (FS) and EPI. A pulse sequence that performed both acquisition methods at each TR was developed and implemented. The FS portion of the sequence was modeled after a PRESS sequence without water suppression. An FS VOI and an EPI slice were positioned to sample the same brain region under visual stimulation. We found that FS gave statistically significantly higher BOLD estimates than EPI, although by a modest amount.

Towards Whole Brain T2-Weighted FMRI at Ultra-High Fields Using an Integrated Approach

Johannes Ritter¹, Pierre-Francois Van de Moortele¹, Gregor Adriany¹, Kamil Ugurbil¹
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Ultra-High Magnetic Fields offer large advantages, including higher image SNR, higher functional contrast and increased spatial specificity (i.e. accuracy) for T2-weighted fMRI. Short transverse relaxation times, increased magnetic susceptibility effects, specific absorption rate and B1 inhomogeneities, however, can all undermine these advantages. Here we present an integrated approach consisting of a T2 weighted sequence that reduces SAR significantly (SPIF-T2), a large volume B1 shim to improve T2 contrast and a 16 channel or a 30 channel transceiver array coil that enable and improve RF shimming for large volumes of the human brain. Robust activation is demonstrated in both the visual and motor areas of the human brain.

Combining Balanced Steady State Free Precession with Parallel Functional Imaging

Michael H. Chappell¹, Anders Kristoffersen², Pål E. Goå², Asta Håberg¹
¹ISB, NTNU, Trondheim, Sør Trondelag, Norway; ²Department of Medical Imaging, St Olav’s University Hospital, Trondheim, Norway

Balanced steady state free precession (bSSFP) is a new method of acquiring functional data. Its advantages over conventional BOLD imaging are its high SNR, its freedom from the signal dropout and distortion artifacts which can affect BOLD in regions of high susceptibility gradient. Previous research has shown bSSFP to be effective for visual imaging. This study takes that a step further to investigate its performance when combined with parallel imaging. We found evidence of increased sensitivity when SENSE was used. This suggests it could be worthwhile to combine the advantages of bSSFP with the advantages of parallel imaging.

FMRI of the Medial Temporal Lobe Using Balanced Steady State Free Precession

Michael H. Chappell¹, Hanne Lehn¹, Pål E. Goå², Anders Kristoffersen², Rob L. Tijssen³, Asta Håberg¹, Karla L. Miller³
¹ISB, NTNU, Trondheim, Sør Trondelag, Norway; ²Department of Medical Imaging, St Olav’s University Hospital, Trondheim, Norway; ³Centre for Functional MRI of the Brain (FMRIB), University of Oxford, Oxford, United Kingdom

Balanced SSFP (bSSFP) acquisitions do not suffer from the signal dropout and distortions that susceptibility gradients can cause in conventional BOLD imaging. This makes bSSFP a strong candidate for high resolution functional imaging in regions such as the medial temporal lobe (MTL). Previous studies have shown that it performs well with visual stimuli and with hypercapnia across the whole brain. This study uses a novelty paradigm to stimulate neuronal activity in hippocampal/parahippocampal and visual regions. We present results with 1.5 mm3 isotropic acquisitions in these regions using bSSFP.
When studying brain function, both the sensitivity and specificity of a technique are essential for improving accuracy. Most fMRI studies use sequences with T2' weighting to maximize BOLD sensitivity, but T2-weighted sequences are more specific to “true” BOLD activation within parenchymal tissue compared to activation in draining veins. Using the ASE Spiral technique three images with matched T2'-weighting, and varying T2-weighting can be acquired in a single excitation. In this work, we analyzed ASE Spiral images obtained during visual checkerboard stimulus using a Receiver-Operator-Characteristic (ROC)-based analysis, to study changes in specificity as a function of varying relaxation weighting.

Identification of digit representation in primary somatosensory cortex is hampered by the small distances between finger representations and the high inter-subject variability. In this study, the high BOLD sensitivity and spatial resolution available at ultra-high field were employed for somatotopic mapping using a natural somatosensory stimulus. Consistent somatotopic maps were acquired in BA 3b for four individual subjects as well as in BA 2 for two subjects. Digits representations were located consecutively in the brain, with the thumb positioned most anterior, inferior and distal. Inter-digit Euclidian distance was XX ± XX mm (mean ± stderr).

A fast, high-resolution fMRI study of human V1 at 3 T is presented showing layer-specific effects. While contrasting grating stimuli versus rest shows activation profiles that inside the cortex peak in the granular layer, differential effects can be seen in the supragranular layer when contrasting coloured versus achromatic stimuli. Using 3D-EPI, 32 slices with 0.75 mm isotropic voxels could be measured with a volume repetition time of only 2.5 seconds opening the door to event related stimulus designs at the laminar level.

Here we examine the echo time dependence of the cortical depth-related grey matter GE BOLD signal change in visual cortex using high resolution (0.35x0.35x1.5 mm3) 2D FLASH imaging at 7 T. A linear dependence of the average fractional signal change with echo time was found for all bands defined across the cortex. There was a reduction in R2* on moving from the pial surface (1.5±0.1)s-1 to the border with white matter (0.59±0.05)s-1, and no evidence of increased R2* in the stria of Gennari. In contrast, the measured R2* showed a clear peak in the stria of Gennari.

Faster acquisitions are desirable for both anatomical and functional scans which can be limited by gradient capabilities and/or SAR, depending on the field strength and/or sequence used. The implementation of Simultaneous Image Refocusing (SIR) EPI, which refocuses multiple slices during a single gradient switch, can be limited at high fields due to the necessary increase in the readout time. However, with the use of parallel imaging and fast switching gradients, we demonstrate here the ability to achieve high quality GE and SE SIR EPI images at 7T.
High Resolution GRE BOLD FMRI Using Multi-Shot Interleaved Spiral In/Out

**Acquisition**

Youngkyoo Jung\(^1\), Thomas T. Liu\(^1\), Giedrius T. Buracas\(^1\)

\(^1\)Radiology, University of California, San Diego, La Jolla, CA, United States

Blood oxygenation level dependent (BOLD) fMRI has been widely used for mapping brain function noninvasively. High resolution also affords increased BOLD contrast due to reduced partial volume effects and more accurate localization of BOLD activation. However, current standard acquisition methods for human brain BOLD fMRI typically have relatively low spatial or temporal resolution. We developed the multi-shot interleaved spiral in/out acquisition for high resolution BOLD fMRI. We tested this technique using visual and memory tasks. The proposed high resolution fMRI technique shows excellent activation with large spatial coverage.

Functional Magnetic Resonance Imaging Using Super-Resolved Spatially-Encoded MRI

Noam Ben-Eliezer\(^1\), Ute Goerke\(^2\), Michael Garwood\(^2\), Lucio Frydman\(^1\)

\(^1\)Chemical Physics, Weizmann Institute of Science, Rehovot, Israel; \(^2\)Center for Magnetic Resonance Research, Radiology, University of Minnesota, Minneapolis, MN, United States

The sensitivity and specificity needed to detect neuronal activation is affected by the type of fMRI sequence and reconstruction algorithm used. Recent development of a new single-scan imaging scheme provides an alternative fMRI tool, based on spatial encoding, which offers higher robustness to B0 field inhomogeneities. A new post-processing procedure was combined onto this scheme based on super-resolution image reconstruction algorithms, which improves the ensuing spatial-resolution while reducing the initially higher hardware requirements and SAR constraints. We analyze the performance afforded by super-resolution using two novel spatially-encoded based sequences for human fMRI studies, as compared to standard EPI.

Rapid Full-Brain FMRI with Multi-Shot 3D EPI Accelerated with UNFOLD and GRAPPA

Onur Afacan\(^1,2\), Dana Brooks\(^3\), Scott Hoge\(^1\), Istvan A. Morocz\(^1\)

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Cognitive imaging desires both whole brain coverage, relatively high spatial resolution, and high temporal resolution. In an effort to achieve these goals with multi-shot 3D-EPI, we implemented: i) UNFOLD (in the slice encoding direction) and ii) Parallel imaging (in both the 3D slice and phase encoding directions). We decreased the volume TR from 3s to 0.82s. We demonstrate the results on healthy volunteer subjects using two different fMRI paradigms: a) event related complex cognitive stimuli where the events lasted for a time period of up to twenty TRs and b) a simple visuospatial-motor task in a random-length block design.

Rapid Full-Brain FMRI with Multi-Shot 3D EPI Accelerated with UNFOLD and GRAPPA

Onur Afacan\(^1,2\), Dana Brooks\(^3\), Scott Hoge\(^1\), Istvan A. Morocz\(^1\)

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optimization algorithm. In conclusion, our method not only can amend the signal losses problem successfully but also provide rapider searching time and higher accuracy of optimal z-shim value.

15:00 3455. Understanding the Limitations of the Effectiveness of Z-Shim for Use with FMRI
Kimberly Brewer1,2, James Rioux1,2, Ryan D'Arcy1,3, Chris Bowen1,4, Steven Beyea1,4
1Institute for Biodiagnostics (Atlantic), National Research Council of Canada, Halifax, Nova Scotia, Canada; 2Physics and Atmospheric Science, Dalhousie University, Halifax, Nova Scotia, Canada; 3Psychology and Radiology, Dalhousie University, Halifax, Nova Scotia, Canada; 4Physics and Atmospheric Science, Radiology and Biomedical Engineering, Dalhousie University, Halifax, Nova Scotia, Canada

Over the past decade, the application of z-shim gradients has been successfully used to reduce susceptibility field gradient (SFG) effects. Recently, work has been done to add z-shim to spiral-in, a technique that was designed to recover signal in susceptibility regions. However, questions remain as to whether the potential benefits of combining multiple signal recovery techniques are worth the effort and time to use both techniques. We demonstrate that although z-shim may be efficient at recovering signal in sequences prone to SFG effects, its use does not offer significant benefits at the group level when combined with spiral-in.

Tools & Techniques for fMRI Applications

Hall B Monday 14:00-16:00 Computer 22

14:00 3456. Standard Space and Individually-Derived Regions of Interest: An Experimental Comparison
Joanna Lynn Hutchison1,2, Traci Sandoval1, G. Andrew J. Hillis1, Ehsan Shokri Kojori1, M. Amanda E. Colby1, Michael A. Motes1, Mary Jo Maciejewski1,2, Bart Rypma1,2
1BrainHealth, University of Texas at Dallas, Dallas, TX, United States; 2Psychiatry, University of Texas Southwestern Medical Center, Dallas, TX, United States

Using a standard space brain-template is an efficient way of determining anatomical ROIs for functional data analyses. Although individually-derived ROIs would be preferable, such ROIs are time-intensive to acquire. The present analysis examined whether or not Colin-derived and individually-derived anatomically-based ROI methods differed significantly from one another in terms of both the number of voxels and beta values contained within a Brodmann-area (BA) ROI. Results suggest that utilizing standard-space normalization/ROI boundary determination can affect the outcome of statistical analyses in terms of numbers of voxels and beta values. Caution should be exercised when using standard-space BA ROIs for PFC.

14:30 3457. Brainstem Specific Warping Improves Locus Coeruleus Functional Imaging in Humans
Évelyne Balteau1, Christina Schmidt1, Pierre Maquet1, Christophe Phillips1
1Cyclotron Research Centre, University of Liege, Liege, Belgium

The locus coeruleus (LC), a specific but small brainstem structure, has recently attracted much interest because the LC is involved in attention processes and attention modulations. The accurate localisation of LC activity with functional imaging in group studies was questioned since the LC is anatomically difficult to localise on standard functional (EPI) or structural (T1-weighted) MR images. We aim to show here that standard EPI-based normalisation leads to approximate alignment of the LC across subjects, and that using a T1-based brainstem specific normalisation improves the match of the group averaged LC localisation, in line with an independent LC template.

15:00 3458. Fluid Delivery System for Gustatory Tasks in FMRI
Jonathan Worth Howard1, John D. Beaver1, Rexford D. Newbould1
1GlaxoSmithKline, Clinical Imaging Centre, London, United Kingdom

Although the response to taste stimulus may be useful in several areas of neuroscience, fMRI is rarely used in conjunction with gustatory stimulus. A major problem with gustatory stimulus apparatus is the use of long tubing, connecting computer-controlled pumps in the control room to the subject’s mouth. This results in a messy and difficult setup, imprecise liquid delivery, and problems with off-cue drips eliciting responses. In this study these problems are overcome using a hydraulic relay system that allows the use of short tubing, for rapid setup, replacement, and precise delivery of reward stimuli.

15:30 3459. EPI Distortion Correction by Constrained Nonlinear Coregistration Improves Group FMRI
Eelke Visser1,2, Shaozheng Qin1,3, Marcel P. Zwiers1,2
1Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, Netherlands; 2Department of Psychiatry, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands; 3Department of Neurology, Radboud University Nijmegen Medical Centre, Nijmegen, Netherlands

Susceptibility gradient induced distortions are a well-known problem of EPI. We show that group fMRI results can be improved using a variation on an existing method for estimating the displacements using the mutual information between the EPI images and a reference T1 image.
Tuesday 13:30-15:30  Computer 22

13:30  3460.  Is Use of a Site-Specific EPI Template Still Beneficial for Group FMRI Studies?
David F. Abbott1,2, Sarah J. Wilson1,3, Graeme D. Jackson1,4
1Brain Research Institute, Florey Neuroscience Institutes (Austin), Melbourne, Victoria, Australia; 2Department of Medicine, The University of Melbourne, Melbourne, Victoria, Australia; 3School of Behavioural Science, The University of Melbourne, Melbourne, Victoria, Australia; 4Departments of Medicine and Radiology, The University of Melbourne, Melbourne, Victoria, Australia

Voxel-based analysis of group fMRI requires spatial normalisation to a common space. A standard template is most often used to permit comparison between studies. A popular approach is normalisation of EPI images directly to the standard template. Other options have included use of a site-specific template to provide better inter-subject registration, at the expense of systematic differences between its co-ordinates and standard space. However, with advances in registration algorithms, is it still worth using a site-specific template? We used SPM8 to analyse 3T fMRI data of 26 healthy controls and found a site-specific template still provided increased significance of group activation.

14:00  3461.  Visual Attention for Brain-Computer Interface: Towards Using 7T FMRI to Localize Electrode Implant Sites
Patrik Andersson1, Jeroen Siero2, Josien Pluim1, Max Viergever1, Nick Ramsey3
1Radiology, Image Sciences Institute, Utrecht, Netherlands; 2Radiology, Rudolf Magnus Institute, Utrecht, Netherlands; 3Neurology and Neurosurgery, Rudolf Magnus Institute, Utrecht, Netherlands

Brain-Computer interface technology is moving towards implantable systems with electrodes placed directly on the cortex. For correct placement, prior knowledge is required about the exact location of a targeted brainfunction. In this study we test whether subjects can control a cursor by directing visual attention to the left or the right. Brain regions activated by attention in a localizer task are identified with a 7T MRI system. 8 subjects then received feedback about their attention-related brain activity and performance was measured. Results suggest that 7T fMRI can be used to identify regions for invasive BCI.

14:30  3462.  Kohs' Block Design Task for FMRI: Implemented for Naturalistic Execution Using Game Control Techniques
John A. Jesberger1,2, Matthew Stokes, Sonia Minnes1, Marc Buchner4, Jean A. Tkach,5
1Radiology, Case Western Reserve University, Cleveland, OH, United States; 2Case Center for Imaging Research, Cleveland, OH, United States; 3Psychology, Case Western Reserve University; 4Electrical Engineering, Case Western Reserve University; 5Biomedical Engineering, Case Western Reserve University

The Kohs Block Design Task is one of the most well understood and characterized neuropsychological tests of visual spatial reasoning, used widely for intelligence testing, with early sensitivity to brain injury. Comprehensive models of cognitive subprocesses entailed in its execution have been developed. Task variables critical to various aspects of execution have also been identified. As one of the most well understood and characterized neuropsychological tests it is an excellent candidate for application in functional neuroimaging. We report a realistic 3D virtual version of the task for fMRI based on computer game interface design methods.

15:00  3463.  An LCD Monitor for Visual Stimulation FMRI at 7 Tesla
Jens Groebner1, Moritz Berger2, Reiner Umathum2, Michael Bock2, Wolfhard Semmler2, Jaane Rauschenberg2
1Medical Physics in Radiology , German Cancer Research Center, Heidelberg, Germany; 2Medical Physics in Radiology, German Cancer Research Center, Heidelberg, Germany

Visual stimulation at high fields is challenging due to the long magnet bores. In this work an LCD system for fMRI at 7T is presented which can be placed close to magnet iso-center. MR-compatible LCD illumination is achieved with 100 white LEDs. RF Noise measurements did not show RF-induced artifacts. Visual stimulation fMRI studies could be performed with the new presentation tool.

Wednesday 13:30-15:30  Computer 22

13:30  3464.  Reducing the Gradient Artefact in Simultaneous EEG-FMRI by Adjusting the Subject’s Axial Position.
Karen Julia Mullinger1, Winston X. Yan1, Takayuki Ohma1, Richard W. Bowtell1
1Sir Peter Mansfield Magnetic Resonance Center, School of Physics and Astronomy, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom

EEG data recorded simultaneously with fMRI acquisition are contaminated by large voltages generated by the time-varying magnetic field gradients. Here, we show that this gradient artefact (GA) can be reduced in magnitude by adjusting the subject’s axial position in the scanner. Experiments carried out on four subjects show that the average GA produced by a multi-slice EPI acquisition can be reduced by 36% by moving the subject 4 cm towards the feet, starting with the nasion at iso-centre. A significant reduction in the residual gradient artefact after average artefact subtraction was also found with the subject at the optimal position.
Effect of EEG Electrodes Density (32 and 64 EEG Channels) on the FMRI Signal

Abdelmalek Benattayallah\textsuperscript{1}, Nino Bregadze\textsuperscript{2}, Aureliu Lavric\textsuperscript{3}

\textsuperscript{1}Physics, Peninsular MR Research Centre, Exeter University, Exeter, Devon, United Kingdom; \textsuperscript{2}School of Psychology, Exeter University, Exeter, Devon, United Kingdom; \textsuperscript{3}School of Psychology, Exeter University, Exeter, Devon, United Kingdom

We examined the effect of the number of EEG electrodes on the FMRI image quality, by employing a simple validation procedure. Each participant performed the same cognitive task in two runs during the same scanning sessions, wearing in one run a 32-electrode EEG cap and in the other run a 64-electrode EEG cap. FMRI activations in response to the experimental conditions in the task were contrasted within each run and across runs. Statistical analysis of the FMRI data revealed that overall there was adequate correspondence between the activations in the 32-electrode run and the 64-electrode run. Of the 13 regions that contained clusters of statistically significant differences in activation (‘nogo’ > ‘go’ or ‘go’ > ‘nogo’), 10 contained such clusters in both runs, 6 in the ‘nogo’ > ‘go’ contrast and 4 in the ‘go’ > ‘nogo’ contrast.

Withdrawn by Author

Concurrent fMRI and Optical Imaging Spectroscopy at High Field (7T):
Investigation of the Haemodynamic Response Underlying the BOLD Signal

Aneurin James Kennerley\textsuperscript{1}, David Keith Johnston\textsuperscript{1}, Michael Port\textsuperscript{1}, Luke William Boorman\textsuperscript{1}, Ying Zheng\textsuperscript{1}, John Edward Mayhew\textsuperscript{1}, Jason Berwick\textsuperscript{1}

\textsuperscript{1}Psychology, University of Sheffield, Sheffield, South Yorks, United Kingdom

We have developed a methodology for concurrent high field (7T) functional magnetic resonance imaging and 2D optical imaging spectroscopy for the investigation of the haemodynamics underlying BOLD signal changes to neuronal activation. The technique has been used to investigate the negative BOLD phenomenon and haemodynamic interactions between two adjacent cortical regions. Data were used to test and refine biophysical models of the BOLD signal important in interpreting measurements of the BOLD signal as reflecting changes in metabolic activity.

Thursday 13:30-15:30 Computer 22

Visualization of Stripe of Gennari-Like Structure in the Primary Visual Cortex by High-Resolution MRI: Correlation of Structure Vs. Function

Tae Kim\textsuperscript{1}, Seong-Gi Kim\textsuperscript{1}

\textsuperscript{1}Radiology, University of Pittsburgh, Pittsburgh, PA, United States

Stripes of T1-dependent contrast were detected in the cat primary visual cortex by high-resolution imaging at 9.4 T. These stripes were well-matched with the regions of highest stimulus-induced CBV fMRI percentage changes. The persistent presence of in stripes paraformaldehyde fixed brains shows that they arise from structural features.

High-Resolution FMRI of Visual Stimulation and Attention in Human Superior Colliculus

David Ress\textsuperscript{1,2}, Sucharit Katyal\textsuperscript{2}, Clint Greene\textsuperscript{3}

\textsuperscript{1}Imaging Research Center, University of Texas at Austin, Austin, TX, United States; \textsuperscript{2}Neurobiology, University of Texas at Austin, Austin, TX, United States

We measured the retinotopic organization of superior colliculus to direct visual stimulation using a 90°-wedge of moving dots that rotated around fixation. The retinotopy of covert attention was measured using a full-field array of moving dots. Subjects were cued to perform a task within a 90° portion of the stimulus, and only the cue rotated around fixation. FMRI (1.2 mm voxels) data shows retinotopic maps of both visual stimulation and covert attention that are in registration with each other. Visual attention and stimulation produced activity primarily in the superficial and intermediate laminae, but attention activity was more superficial than stimulation.

The Ability of FMRI at 7T to Detect Functional Differences Between Areas 1 and 3b of Primary Somatosensory Cortex

Elizabeth Ann Stringer\textsuperscript{1,2}, Li Min Chen\textsuperscript{1}, Robert M. Friedman\textsuperscript{2}, J Christopher Gatenby\textsuperscript{1}, John C. Gore\textsuperscript{1}

\textsuperscript{1}Institute of Imaging Science, Vanderbilt University, Nashville, TN, United States; \textsuperscript{2}Psychology, Vanderbilt University, Nashville, TN, United States

Previously we have demonstrated the ability of ultra-high field fMRI to detect topographical organization of digits within areas 1 and 3b of human primary somatosensory cortex. Here we test the feasibility of 7T fMRI to detect functional differences between these neighboring areas. Functional images were acquired using a 7T Philips Achieva scanner while air puffs were delivered to individual distal fingerpads. Magnitude and temporal differences in the BOLD signal were detected between areas 1 and 3b. The data support previous finding that using fMRI at high fields allows the detection of more stimulus selective responses.
In this study, we demonstrate a laminar-specific BOLD response using resting state measurements of functional connectivity within visual cortex by exploiting the known anatomical connectivity pattern between output Layer II/III in cortical area V1 and input Layer IV in area MT observed by invasive studies. This laminar correlation signature was absent from cross-hemispheric laminar correlations measured between left and right V1. These V1-to-MT laminar-specific resting state correlations demonstrate the ability of high-resolution rs-fMRI to probe laminar-specific connections and to infer the directionality of the connectivity, and provide evidence that the BOLD signal is controlled, to some degree, on the laminar level.

fMRI Quantitation/Calibration

Hall B Monday 14:00-16:00  Computer 23

14:00  3472. Combined Interactions of Respiratory and Cardiac Signals Measured by High-Temporal Resolution FMRI

Pierre LeVan¹, Thimo Grotz¹, Benjamin Zahneisen¹, Maxim Zaitsev¹, Juergen Hennig¹
¹Medical Physics, University Hospital Freiburg, Freiburg, Germany

This study investigates the effect of respiratory and cardiac artifacts in the fMRI signal using very high-temporal resolution acquisitions (TR=80ms). It is shown that high-order harmonics of the respiratory (up to order 5) and cardiac (up to order 10) signals account for widespread, statistically significant effects in the fMRI signal (p<0.05). Moreover, the amplitude of the cardiac artifact is shown to be significantly modulated by the respiratory signal. This effect was seen in 81% of the studied brain volume in 7 healthy subjects. The proper modeling of these artifacts could increase the sensitivity of fMRI studies.

14:30  3473. Hypercapnic Scaling of Task Induced FMRI BOLD Signals and Its Dependence on Task Design

Sridhar S. Kannurpatti¹, Michael Motes², Bart Rypma², Bharat B. Biswal¹
¹Radiology, UMDNJ-New Jersey Medical School, Newark, NJ, United States; ²Behavioral and Brain Sciences, University of Texas at Dallas, Dallas, TX, United States

Blocked and event related stimulus designs are typically used in fMRI studies depending on the importance of detection power or estimation efficiency. The extent of vascular contribution to variability in blocked and event related fMRI-BOLD response is not known. Using hypercapnic scaling, the extent of vascular weighting in the fMRI-BOLD response during blocked and event related design paradigm was investigated. BOLD data from healthy volunteers performing a block design motor paradigm and an event related memory paradigm that needed the performance of a motor task were analyzed from the region of interest (ROI) surrounding the primary and supplementary motor cortices.

15:00  3474. Susceptibility-Induced BOLD Sensitivity Variation in Breath Hold Task

Yue Zhuo¹, Bradley P. Sutton¹
¹Bioengineering, University of Illinois at Urbana-Champaign, Urbana, IL, United States

Magnetic field inhomogeneity exists near the interface of air/tissue, leading to susceptibility artifacts including echo time shift. BOLD sensitivity has strong dependence on echo time, and thus is changed by the susceptibility gradients. We examined BOLD sensitivity change in a breath hold task among different subjects. The breath hold fMRI experiment analyzed to determine if susceptibility gradient induced BOLD sensitivity changes are observable within susceptibility regions in subjects. Results show a significant relationship between susceptibility gradients and BOLD signal in 81% of the subjects, which means the effect of susceptibility gradients on BOLD signal robustly exist among subjects.

15:30  3475. Modeling the Effect of Changes in Hematocrit, O₂ Extraction Fraction, and Blood Volume Distribution on the BOLD Signal and Estimates of CMRO₂ Change with a Calibrated BOLD Method

Valerie Griffeth¹, Richard Buxton³
¹Department of Bioengineering, University of California, San Diego, La Jolla, CA, United States; ³Medical Scientist Training Program, University of California, San Diego, La Jolla, CA, United States

We applied a calibrated-BOLD methodology to assess effects of caffeine consumption on coupling of CBF and cerebral metabolic rate of O₂ (CMRO₂) responses to a visual stimulus. Although the BOLD responses were similar, we found an increase in CMRO₂ change after administration of caffeine, both as a fraction of the current baseline state and in a more absolute sense referred to the pre-caffeine baseline. More modest changes were found in the CBF response, leading to a decrease of the CBF/CMRO₂ coupling ratio.
Tuesday 13:30-15:30 Computer 23

13:30 3476. A New Method for Measuring Changes in Venous Cerebral Blood Volume Using Hyperoxia
Nicholas P. Blockley1, Ian D. Driver1, Susan T. Francis1, Penny A. Gowland1
1Sir Peter Mansfield Magnetic Resonance Centre, School of Physics & Astronomy, University of Nottingham, Nottingham, United Kingdom

Venous cerebral blood volume (CBVv) is key to the BOLD response, but could not be measured directly until the advent of the VERVE technique. We present a new method for measuring changes in CBVv using hyperoxia. This new method has a high signal-to-noise ratio enabling high spatial (2×2×3mm) and temporal (TR=2.4s) resolution. In this work we show measurements of relative changes in CBVv. However with refinements to the acquisition and analysis it will be possible to measure the percentage change in CBVv.

14:00 3477. Spatial and Temporal Responses of Arterial and Venous Blood Volume Changes
Tae Kim1, Seong-Gi Kim1
1Radiology, University of Pittsburgh, Pittsburgh, PA, United States

Spatial and temporal responses in arterial (CBVa) and total blood volume (CBVt) were measured in the same animals. Cortical depth profile analysis of ΔCBVa and ΔCBVt was performed to examine spatial specificity. The highest signal changes were detected at the middle of cortex in both ΔCBVa and ΔCBVt, and spatial specificity to the middle of the cortex appears to improve with time for both parameters. The venous blood volume response (ΔCBVv) was calculated by subtracting ΔCBVa from ΔCBVt. Rapid initial increases were obtained for CBVa, while slow prolonged increases were observed for CBVv.

14:30 3478. Investigating the Temporal Characteristics of the BOLD Response with Field Strength
Ian Driver1, Kay Head1, Penny Gowland1, Susan Francis1
1Sir Peter Mansfield Magnetic Resonance Centre, University of Nottingham, Nottingham, United Kingdom

There has been much interest in how spatial extent of activation and the shape of the haemodynamic response alters with field strength, due to differing extravascular and intravascular signal contributions. We apply an event-related visual stimulus with long inter-stimulus-interval to assess the temporal features of the BOLD response. Findings show high similarity between hrf shapes across field strength, despite a decrease in relative IV/EV fraction of BOLD contrast with increased field. Time-to-peak maps show tissue areas are highly homogenous, with large deviances occurring only in the large vessels.

15:00 3479. Adding Transients to Model BOLD FMRI Time Courses for Somatosensory-Motor Activations
Michael Marxen1,2, Ryan J. Cassidy1, Tara L. Dawson1, Bernhard Ross1,2, Simon J. Graham1,2
1Rotman Research Institute, Baycrest, Toronto, Ontario, Canada; 2Heart and Stroke Foundation Centre for Stroke Recovery, Toronto, Ontario, Canada

BOLD fMRI time courses for somatosensory stimuli of variable lengths are modeled using the general linear model with a latency optimized hemodynamic impulse response function and three different neuronal input functions: boxcar (model A), boxcar + offset transient (model B), onset transient + boxcar + offset transient (model C). Only model C is capable of fitting the bimodal nature of the response to the 7s stimulus and the relative peak amplitudes for all stimulus lengths in key areas of the somatosensory-motor system. Therefore, including onset and offset transients provides a more comprehensive picture of the underlying brain activity.

Wednesday 13:30-15:30 Computer 23

13:30 3480. The Effects of Basal Vascular Tone on Hypercapnic and Hypocapnic Cerebrovascular Reactivity: Implications for Clinical Autoregulation Studies
Molly Gallogly Bright1, Daniel P. Bulle1, Manus J. Donahue1, Jeff H. Duyn1, Peter Jezzard1
1Advanced MRI Section, LFMI, NINDS, NIH, Bethesda, MD, United States; 1FMRIB Centre, Department of Clinical Neurology, University of Oxford, Oxford

The cerebrovascular reactivity response to arterial gas tensions offers insight into vascular compliance and may be useful for experimentally simulating conditions of hemodynamic compromise. We utilize BOLD fMRI and CO2 inhalation in healthy volunteers to understand how an increase in basal vasodilation influences the response to both vasoconstrictive (Cued Deep Breathing) and vasodilatory (Breath Hold) challenges. Three repetitions of each challenge were performed at 0% and 4%CO2 inhalation, and voxelwise %BOLD/dtΔCO2 mmHg maps were averaged across gray matter. BH-reactivity responses were significantly greater during 4% CO2 inhalation while CDB-reactivity responses were not significantly affected, indicating these challenges may offer complementary diagnostic information.
14:00  3481. **High Resolution Cerebral Blood Volume Mapping in Humans at 7T with Hyperoxic Contrast**  
David Thomas Pilkinton¹, Santosh Gaddam¹, Mark A. Elliott¹, Ravinder Reddy¹  
¹Center for Magnetic Resonance and Optical Imaging, University of Pennsylvania, Philadelphia, PA, United States  

It has recently been shown that hyperoxic contrast allows for an accurate measurement of cerebral blood volume using low resolution (4x4x6mm) standard T2*-weighted EPI at 3T. The increase in BOLD contrast at 7T can potentially allow for significantly increased spatial resolution with this technique. However, the standard EPI approach used at 3T is unsuitable for 7T due to shorter venous blood T2* and increased B0 inhomogeneity. We have shown here that these problems can be addressed with steady-state acquisition segmented 3D EPI with partial-Fourier encoding in the phase direction, which produced robust high resolution (1x1x2mm) CBV maps at 7T.

14:30  3482. **Negative Contrast Enhancement in T2*-Weighted Images of the Human Brain During Hyperoxia**  
David Thomas Pilkinton¹, Santosh Gaddam¹, Mark A. Elliott¹, Ravinder Reddy¹  
¹Center for Magnetic Resonance and Optical Imaging, University of Pennsylvania, Philadelphia, PA, United States  

Hyperoxia is known to provide positive contrast enhancement (CE) on T2*-weighted images based on the BOLD effect. We have shown here that hyperoxic contrast, despite producing positive CE across most of the brain, generates significant negative CE in T2*-weighted images in inferior regions of the brain located near large arteries, even at lower FiO2 levels (<0.6). We believe this effect is due to the shortening of T2* in arterial blood from excess paramagnetic molecular oxygen dissolved in the plasma. Hyperoxic contrast on T2*-weighted images may therefore produce negative or positive CE depending on the characteristics of the local blood volume.

15:00  3483. **Determination of Maximum BOLD Calibration Constant Using Hyperoxia.**  
Daniel Bulte¹, Molly Bright¹,², Peter Jezzard²  
¹FMRIB Centre, University of Oxford, Oxford, Oxfordshire, United Kingdom; ²National Institutes of Health (NIH), Bethesda, MD, United States  

Calculation of the maximum theoretical BOLD signal change (M) has been achieved using short epochs of mild hyperoxia. This value can be used to produce estimates of the change in CMRO2 during functional tasks. This study seeks to minimise the number and duration of hyperoxic blocks needed to determine this value. 2x2 minute blocks of mild hyperoxia are shown to be sufficient to produce reliable results, reducing the total time needed to be added to a scan to 8 minutes.

Thursday 13:30-15:30  Computer 23

13:30  3484. **Comparison of Active Voxel Composition Using BOLD Vs. VASO and VAST/GMN FMRI**  
Ronald A. Meyer¹,², Jill M. Slade², Robert W. Wiseman¹,²  
¹Physiology, Michigan State University, East Lansing, MI, United States; ²Radiology, Michigan State University, East Lansing, MI, United States  

Vascular Space Occupancy (VASO) and VASO with Tissue suppression (VAST, or Gray Matter Nulling, GMN) are fMRI methods which detect blood volume changes, and hence are thought be more localized to gray matter than conventional BOLD fMRI. However this study shows that at the typical spatial resolution of fMRI studies, these methods are no better localized to gray matter voxels than BOLD.

14:00  3485. **Arterial Cerebral Blood Volume (ACBV)-Weighted Inflow Vascular-Space-Occupancy (IVASO) Provides Complementary Hemodynamic Information to Dynamic Susceptibility Contrast in Patients with Stenotic Artery Disease.**  
Manus Joseph Donahue¹,², Bradley J. Macintosh³, Ediri Sideso⁴, James Kennedy⁴, Peter Jezzard¹,²  
¹Clinical Neurology, Oxford University, Oxford, United Kingdom; ²Physiology Division, FMRIB Centre, Oxford, United Kingdom; ³Imaging & Brain Sciences, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada; ⁴Nuffield Department of Clinical Medicine, Oxford University, Oxford, United Kingdom  

Inflow vascular-space-occupancy with dynamic subtraction (iVASO-DS) has been proposed as a non-invasive approach for measuring arterial cerebral blood volume (aCBV). Here, we compare iVASO-DS contrast with DSC-measured CBF, CBV and MTT in patients with stenotic artery disease. We find consistency between iVASO and DSC-CBV, especially when MTT discrepancies are accounted for. Finally, in patients with moderate-to-severe stenoses, CBF is generally symmetric between unaffected and affected hemispheres (R=0.85), yet iVASO contrast is more asymmetric (R=0.69). This finding is consistent with autoregulatory vasodilation and indicates that aCBV adjustments may precede CBF reductions in patients with stenotic artery disease.
Magnetization Transfer Enhanced Vascular-Space-Occupancy (MT-VASO) MRI with Whole Brain Coverage
Jun Hua, Domenico Zaca, Samson Jarso, Jay J. Pillai, Peter C.M. van Zijl
1Department of Radiology, The Johns Hopkins University, Baltimore, MD, United States

Vascular-space-occupancy (VASO) MRI is an inversion-recovery based method that employs tissue signal changes during blood nulling to image blood volume changes. By adding an MT pulse before the VASO inversion pulse, the recovery process of tissue can be accelerated, which leads to increased tissue SNR. Recent work showed that gradient-spin-echo (GraSE) imaging may be a better choice for VASO-MRI than the conventional EPI. We combined the MT-VASO technique with 3D-GraSE sequence to extend it from single-slice to whole-brain coverage. Compared to the commonly used 2D multi-slice EPI-VASO approach, this new whole-brain VASO sequence drastically improved SNR/CNR by 60-150%.

First Application of Whole Brain CBV Weighted fMRI to a Cognitive Stimulation Paradigm: Robust Activation Detection in a Stroop Task Experiment Using 3D GRASE VASO
Benedikt A. Poser, David G. Norris
1Donders Institute for Brain, Cognition and Behaviour, Radboud University Nijmegen, Nijmegen, Netherlands; 2Erwin L. Hahn Institute for Magnetic Resonance Imaging, University Duisburg-Essen, Essen, Germany

Using a recently developed multi-slice variant of VASO that enables single-shot whole-brain coverage by virtue of a 3D GRASE readout, we here present the first application of VASO to an fMRI study with a ‘real cognitive’ stimulation paradigm on twelve subjects. Within acceptable measurement times of ~12 min, the numerous clusters brain activation during a Stroop color-word matching task could be detected reliably both on the group (N=12) and single subject level, as evident from a qualitative comparison with separately acquired BOLD data and literature reports.

Resting State BOLD Fluctuations in Large Draining Veins Are Highly Correlated with the Global Mean Signal
Hongjian He, David D. Shin, Thomas T. Liu
1Physics Department, Zhejiang University, Hangzhou, Zhejiang, China; 2Center for functional MRI, UC San Diego, La Jolla, CA, United States

Removal of the global mean signal is a common step in the processing of resting-state fMRI data. However, its usage can produce spurious negative correlations. Here we propose the use of BOLD signal fluctuations in the large draining veins as an alternative to the global mean signal that does not force the existence of negative correlations. We show that signals from two vein regions (sagittal sinus and great vein of Galen) are significantly correlated with the global mean signal and may therefore represent a useful alternative for the analysis of resting-state fMRI studies.

Network-Level Comparisons of Functional Connectivity Differences Between Cognitive Tasks
Johanna M. Zumer, Svetlana V. Shinkareva, Vladimir Gudkov, Matthew J. Brookes, Paul S. Morgan, Peter G. Morris
1Sir Peter Mansfield Magnetic Resonance Centre, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom; 2Psychology, University of South Carolina, Columbia, SC, United States; 3Physics and Astronomy, University of South Carolina, Columbia, SC, United States; 4Radiology and Radiological Science, Medical University of South Carolina, Charleston, SC, United States

A network-level information approach is applied to functional connectivity data from 7T fMRI to discern differences in processing of a semantic task comprising words with either abstract or concrete meaning. Structurally, network nodes are similar between tasks, however functional processing differences between the nodes are distinguishable in each subject.

Functional Connectivity Between Structures in Auditory Pathway Using fMRI Technique
Michalina Justyna Ryn, Michael Erb, Uwe Klose
1Diagnostic and Interventional Neuroradiology, University Hospital Tuebingen, Tuebingen, Baden-Wuerttemberg, Germany; 2Sektion Experimentelle Kernspinresonanz des ZNS, University Hospital Tuebingen, Tuebingen, Baden-Wuerttemberg, Germany; 3Diagnostic and Interventional Neuroradiology, University Hospital Tuebingen, Tuebingen, Baden-Wuerttemberg, Germany

Analysis of functional connectivity can be useful tool which can describe the correlation between functionally related regions. This study was performed with seven volunteers on a 3T scanner. Time courses from auditory cortex were used as references in correlation analysis in individual subject. Similarity of the time courses demonstrated the connection between structures in auditory pathway and gives the reason to applied correlation analysis. Results demonstrate a tight functional relation between auditory cortex and brainstem in the human brain and provide an improvement in the t-test analysis about location of activated areas within the brainstem by correlation analysis.
15:30 3491. Thalamic Functional Connectivity in Healthy Volunteers with and Without Task Engaged
Lin Tang1, Yulin Ge1, Daniel Sodickson1, Kellyanne McGorty1, Joseph Reaume1, Robert Grossman1
1Department of Radiology, The Center for Biomedical Imaging of New York University, New York City, NY, United States

The thalamus is important to communication among many associative brain regions including sensory, motor, cognitive, and behavior and it is one of the key elements of neuronal organization in the global function of the brain related to the rich thalamocortical interconnectivity[2]. This study demonstrates for the first time the thalamic functional network during both resting state and task related sessions in healthy volunteer.

Tuesday 13:30-15:30 Computer 24

13:30 3492. Hierarchical Clustering for Network Analysis in Functional Connectivity MRI
Garth John Thompson1,2, Matthew Magnuson1,2, Shella Dawn Keilholz1,2
1Biomedical Engineering, Georgia Institute of Technology, Atlanta, GA, United States; 2Biomedical Engineering, Emory University, Atlanta, GA, United States

Functional connectivity MRI promises to elucidate networks in the healthy and diseased brain, but the large amounts of data collected prove difficult to analyze. To solve this problem a hierarchical clustering algorithm is proposed which requires neither manual definition of anatomical regions nor manual determination of correlation threshold. When this algorithm was run on data from anaesthetized rats, it was able to create groups that corresponded to bilateral primary somatosensory cortex, motor cortex and secondary somatosensory cortex in a majority of the rats. It was also able to flag merges between these groups without having prior knowledge of anatomical regions.

14:00 3493. Adaptive Seeding for Resting-State Network Correlation Analysis with Empirical Mode Decomposition
Hsu-Lei Lee1, Jürgen Hennig1
1Department of Diagnostic Radiology, Medical Physics, University Hospital Freiburg, Freiburg, Germany

The widely-used seed voxel correlation analysis for resting-state fMRI data requires priori seed ROI assumptions, and the result is strongly susceptible to the choice of this ROI. In this study we used empirical mode decomposition to separate low-frequency BOLD signals into different intrinsic mode functions before analyzing for underlying coherent networks. We also propose an adaptive weighted seeding scheme for generating the correlation map that’s less susceptible to cut-off threshold and seed ROI selection, and can potentially provide a more reliable correlation map for further functional analyses.

14:30 3494. Instantaneous and Causal Connectivity in Resting State Brain Networks Derived from FMRI Data
Gopikrishna Deshpande1, Priya Santhanam1, Xiaoping Hu1
1Department of Biomedical Engineering, Georgia Institute of Technology and Emory University, Atlanta, GA, United States

Granger causality, though not requiring a priori assumptions, is influenced by the zero-lag correlation in resting state networks (RSNs) such as default mode (DMN), hippocampal cortical memory (HCMN), dorsal attention (DAN) and fronto-parietal control (FPCN) networks. We simultaneously derived functional and effective connectivities in these RSNs using correlation-purged Granger causality, a measure capable of reliably inferring causality without interference from correlation. Our results show extensive causal interactions between RSNs with the posterior cingulate and inferior parietal areas acting as major transit hubs. In addition, our results also support the role of FPCN in the control of DMN and DAN.

15:00 3495. Stimulus-Independent Functional Connectivity in the Rat Brain
Adam J. Schwarz1,2, Alessandro Gozzi3, Angelo Bifone3
1Neuroscience CEDD, GlaxoSmithKline, Verona, Verona, Italy, Italy; 2Translational Imaging, Eli Lilly, Indianapolis, IN, United States

To what extent functional connectivity is determined by neuronal wiring constraints, or by the dynamical features of the brain functional processes is an open question. To this end, we have investigated functional connectivity in the rat brain under various pharmacological challenges to identify stimulus-independent patterns of connectivity that may mirror general features of the brain organization. Complex network analysis revealed two networks of tightly connected voxels that were independent of the particular neurotransmitter system engaged, and likely to reflect the organization of the underlying neuronal substrate.
Wednesday 13:30-15:30   Computer 24

13:30  3496.  A Fixed-Point Iteration Based Constrained Independent Component Analysis and Its Application in FMRI
Zei Wang  
1Department of Psychiatry, University of Pennsylvania, Philadelphia, PA, United States

We presented a new constrained independent component analysis (cICA) in this work. Evaluated with synthetic data, it demonstrated better performance than the original cICA in terms of higher SNR and faster convergence time. Using synthetic fMRI data, the proposed cICA also demonstrated a superior activation detection sensitivity/specificity performance. Applied to sensorimotor fMRI data, it yielded spatially more extended activation patterns in the target functional regions than standard univariate general linear model approach.

14:00  3497.  On the Relationship Between Seed-Voxel and ICA Measures of Functional Connectivity
Suresh Emmanuel Joel1,2, Brian S. Caffo3, Peter CM van Zijl1,2, James J. Pekar1,2  
1Radiology, Johns Hopkins University, Baltimore, MD, United States; 2FM Kirby Research Center for Functional Brain Imaging, Kennedy Krieger Institute, Baltimore, MD, United States; 3Biostatistics, Johns Hopkins University, Baltimore, MD, United States

Two methodologies are widely used for evaluating brain functional connectivity from BOLD fMRI data: Correlation with the time series of a specified “seed voxel” (or small region of interest); and spatial independent component analysis (ICA). While results from seed-voxel and ICA methodologies are generally similar, they can also differ, and we are unaware of a discussion of the relationship between them. The present study is intended to elucidate and illustrate the relationship between seed-voxel and ICA derived measures of FC and to show that FC measures from the two methods are complementary.

14:30  3498.  Effect of HRF Spatial Variability on the Accuracy of Multivariate Granger Causal Networks Obtained from FMRI Data
Gopikrishna Deshpande1, Xiaoping Hu1  
1Department of Biomedical Engineering, Georgia Institute of Technology and Emory University, Atlanta, GA, United States

The hemodynamic response of fMRI is known to vary across brain regions. This has the potential to confound inferences about neuronal causality obtained from Granger causality analysis of fMRI. We investigated this aspect in a multivariate model using a simulated neuronal system. The results suggest that Granger causality inferred from fMRI data had accuracies well above chance and up to 90%, provided the data had low measurement noise, was sampled at a TR less 2 s, the causal influences were strong and the hemodynamic delay variation is within its normal physiological range.

15:00  3499.  Unsupervised Clustering of FMRI Time Series with the Granger Causality Metric
Santosh B. Katwal1,2, John C. Gore3, Baxter P. Rogers1,2  
1Electrical Engineering and Computer Science, Vanderbilt University, Nashville, TN, United States; 2VUHS, Nashville, TN, United States; 3Biomedical Engineering, Vanderbilt University, Nashville, TN, United States

Unsupervised clustering methods such as Self-Organizing Map (SOM) or Hierarchical Clustering (HC) use the conventional Euclidean distance or correlation as the similarity metric to cluster data. The Euclidean distance cannot fully represent the noise points and correlation metric cannot efficiently detect small timing variability in fMRI time-series data. High field fMRI provides high signal-to-noise ratio (SNR) measurements. With high TR during acquisition, small temporal differences, down to 100 ms, can be resolved using the directed influence measure from the Granger causality approach. We use the Granger causality as a similarity metric in SOM or HC to cluster fMRI data with small timing variability.

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13:30  3500.  A Novel Variational Bayesian Method for Spatiotemporal Decomposition of Resting-State FMRI
Yi-Ou Li1, Pratik Mukherjee, Srikantan Nagarajan, Hagai Attias2  
1University of California San Francisco, San Francisco, CA, United States; 2Golden Metallic Inc

We apply a new variational Bayesian factor partition (VBFP) method to the sparse spatiotemporal decomposition of resting state fMRI data. The VBFP method estimates sources with sparse distributions in both spatial and temporal domain and incorporates automatic relevance determination in a fully Bayesian inference framework. Hence it achieves dimension reduction as an integrated part of the inference. We apply VBFP to the resting state fMRI data and compare it with a maximum likelihood independent component analysis (ICA) algorithm [Bell and Sejnowski, 1998] and show that VBFP indentifies similar functional coherent brain networks and their temporal fluctuations. The potential advantages of VBFP on the integrated inference of noise model and robustness on small sample size motivate further investigation.
Statistical parametric mapping (SPM) is widely used for the statistical analysis of brain activity with fMRI. However, if the general linear model employs a fixed form of a canonical HRF, the ignorance of experimental and individual variance can lead to inaccurate detection of the real activation area. A variety of data-driven methods, which combine independent component analysis (ICA) with statistical analysis of fMRI dataset, were suggested to overcome the problem, such as the 'HYBICA' approach and the unified 'SPM-ICA' method. However, recent study demonstrates that representation of the brain fMRI using sparse components is more promising rather than independent components. Also, the real brain fMRI signal may be regarded as a combination of small set of dynamic components, where each of them has different signal patterns and sparsely distributed in each voxel. Hence, we employ the K-SVD, a powerful sparse dictionary learning algorithm, to decompose the neural signal into dictionary atoms with specific local responses. Using the trained sparse dictionary as a design matrix in SPM, we extract which signal components contribute to the neural activation.

We show the proposed method adapts the individual variation and extract the activation better than conventional methods. We find that significant functional connectivity, both within and between legs, is observed. This result indicates that vascular fluctuations seen within the brain, it is unclear if functional connectivity can be observed based on vascular changes alone. In this study, we perform resting state connectivity analysis on human legs. This model provides vascular changes without neuronal input. We find that significant functional connectivity, both within and between legs, is observed. This result indicates that vascular contributions alone can produce functional connectivity, and future studies of connectivity in brain should consider methods to reduce possible confounding vascular contributions.

We show that both performance of an auditory oddball task as well as traumatic brain injury modulate the function of the default mode network. Performance of the task results in recruitment of additional frontal regions, while the presence of TBI alters the functional connectivity.
15:00 3506. **DMN Is Affected Incongruently by Either Internal or External Environments**

Tun Jao1,2, Ya-Chih Yu1, I-Ning Tang1, Chang-Wei Wu1, Jiann-Shing Jeng3, Jyh-Horng Chen1

1MRI/MRS Lab, NTU, Taiwan, Taipei, Taiwan; 2Department of Neurology, National Taiwan University Hospital, Taipei, Taiwan; 3National Taiwan University Hospital, Stroke Center and Department of Neurology, Taipei, Taiwan

In this study, we deprive subjects from light and aim to investigate possible fluctuations of DMN under visual deprivation. 10 healthy subjects underwent 4 resting-state scans: 1) eyes-closed in dark, 2) eyes-open in dark, 3) eyes-closed in light, and 4) eyes-open in light. PCC was chose as the seed to generate PCC-FC map. FC between PCC and PCu, thalamus, and prefrontal cortex fluctuated significantly but incongruently. Besides the effect of physiological conditions, DMN also showed changes upon light. To sum up, DMN fluctuates incongruently across different situations. Both intrinsic physiological activities and external environments contribute to these changes.

15:30 3507. **Resting State Network and Human Intelligence, and FMRI Study**

Cheuk Ying Tang1, David C.M. Carpenter2, Emily Eaves2, Johnny Ng2, Chris A. Condon3, David H. Schroeder3, Roberto Colom4, Richard Haier5

1Radiology & Psychiatry, Mt. Sinai School of Medicine, New York, NY, United States; 2Radiology, Mt. Sinai School of Medicine, New York, NY, United States; 3Johnson O'Connor Research Foundation, Chicago, Il, United States; 4Psychology, Universidad Autonoma de Madrid, Madrid, Spain; 5School of Medicine (Emeritus), UC Irvine, Irvine, Ca, United States

fMRI using a N-Back paradigm as well as resting state were obtained on 40 normal control subjects. Cognitive performance scores were also recorded on these subjects. Significant correlations were found between measures of the coherence of the resting state network and cognitive scores. General intelligence scores were also correlated with functional connectivity measures between the parietal cortex and the DLPFC.

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13:30 3508. **Spontaneous Low-Frequency BOLD Signal Fluctuations: Changes in Default Mode Network in Brain Diseased with Glioblastoma**

Heisoog Kim1,4, Alexander E. Drzezga1,2, Ciprian Catana1, Grace Kim1, Ovidiu C. Andronesi1, Dominique L. Jennings5, Elizabeth R. Gerstner1, Tracy T. Batchelor3, Rakesh K. Jain1, Alma Gregory Sorensen1

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This pilot study investigated quantitative changes in the “default mode network (DMN)” in patients with glioblastoma (GB) to understand how brain tumors and their associated treatment affect the integrity of the DMN. In general, it was possible to identify coherent BOLD DMN-activity in brain tumor patients in a similar pattern as demonstrated previously in healthy subjects. However, distinct asymmetry of the DMN was observed with a decreased connectivity of the inferior parietal cortex in tumor-affected hemisphere. The z-score values were reduced in a hemisphere diseased with GB compared to those in a contralateral hemisphere.

14:00 3509. **Acute Social Stress Increases Amygdala Functional Connectivity with Posterior Cingulate Cortex and Medial Orbitofrontal Cortex**

Ilya Milos Veer1,2, Nicole Y. Oei1,3, Mark A. van Buchem1,2, Bernet M. Elzinga1,2, Serge A. Rombouts1,2

1Leiden Institute for Brain and Cognition (LIBC), Leiden, Netherlands; 2Department of Radiology, Leiden University Medical Center (LUMC), Leiden, Netherlands; 3Leiden University - Institute of Psychology, Leiden, Netherlands

The amygdalae are crucial in mediating stress effects and have extensive interplay with brain regions involved in emotion and memory. The present study investigated whether acute stress alters amygdala functional connectivity with these areas. Healthy males underwent acute social stress (n=18) or a control procedure (n=20). Hereafter, resting-state fMRI data were acquired. Group differences were analyzed in a priori regions of interest (p<0.001, uncorrected). After stress, increased amygdala connectivity with the posterior cingulate cortex and medial orbitofrontal cortex was found. Acute social stress thus has prolonged effects on amygdala functional connectivity with areas involved in emotion processing and regulation.

14:30 3510. **Investigating the Deactivation of Default Mode Network Across Multiple Cognitive Task**

Pan Lin1, Simon Robinson1, Jorge Jovicich1,2

1Center for Mind/Brain Sciences, University of Trento, Trento, TN, Italy; 2Department of Cognitive and Education Sciences, University of Trento, TN, Italy

Recently the task independent deactivation (TID) properties of the default mode network (DMN) have attracted increased attention in the neuroscience community because of their potential functional interpretations. TID refers to a decrease in brain activity during an active task relative to a baseline. However, most deactivation studies have used one or only a few cognitive tasks in the same subjects,
which makes difficult the study TID features. In this study a series of different cognitive systems (language, memory, emotion, mathematics and mental rotation) were tested in a group of subjects to investigate the TID characteristics in DMN, specifically in terms of spatial differences across the various tasks.

15:00  **3511. A Comprehensive Study of Whole-Brain Functional Connectivity and Grey Matter Volume in Children and Young Adults**  
1Leiden Institute for Brain and Cognition (LIBC), Leiden, Netherlands; 2Department of Radiology, Leiden University Medical Centre, Leiden, Netherlands; 3Leiden Institute for Brain and Cognition (LIBC), Leiden, Netherlands; 4Developmental and Educational Psychology, Leiden University, Leiden, Netherlands

In the present study we investigated voxel-wise whole-brain functional connectivity in children (11-13 years) and adults (19-25 years), without a priori restriction to specific seed regions or networks. In addition we examined to what extent observed changes in functional brain connectivity could be explained by changes in local grey matter. We show that networks in children were more widespread than adult networks. Moreover, several networks showed altered connectivity in children compared to adults. The majority of the observed changes in functional connectivity could not be explained by changes in grey matter volume.

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*Pan Lin*1, *Simon Robinson*1, *Nicola De Pisapia*1, *Jorge Jovicich*1,2  
1Center for Mind/Brain Sciences, University of Trento, Trento, TN, Italy; 2Department of Cognitive and Education Sciences, University of Trento, Italy

Characterization of the default mode network (DMN) as a complex network of functionally interacting dynamic systems has received great interest. However, it is still unclear how DMN sub-regions interact during resting state and how these interactions change when task performance. In this study, we used Granger causality method to explore how intrinsic causal temporal interactions within DMN sub-regions during resting state may change when subjects perform a task. We find that although the spatial scale of DMN maps during rest and task are similar, the causal relationships in sub-regions show significant changes, suggesting potential markers for potential clinical applications.

14:00  **3513. The Effect of Ethanol on Resting State Brain BOLD Signal**  
*Alex M. Weber*1, *Peter Sheffield*1, *Michael D. Noseworthy*2  
1School of Biomedical Biomedical Engineering, McMaster University, Hamilton, Ontario, Canada; 2Electrical and Computer Engineering, School of Biomedical Engineering, McMaster University, Hamilton, Ontario, Canada

Herein we present the effects of ethanol on resting state blood oxygen level dependent fMRI signal using a novel fractal dimension (FD) analysis technique, correlated with proton MRS detection of ethanol. The FD structure of the resting state BOLD signal in normal healthy males decreased post ethanol ingestion. This correlated with significant ethanol concentration presence in the anterior cingulate cortex and basal ganglia. These findings, although only suggestive, shed further light on alcohol’s effect on the brain, specifically the brain’s functional connectivity.

14:30  **3514. A Multivariate Approach Reveals Interactions of Brain Functional Networks During Resting and Goal-Directed Conditions**  
1Biomedical Engineering, UNC-Chapel Hill, Chapel Hill, NC, United States; 2Biosciences and Biomedical Research Imaging Center, University of North Carolina-Chapel Hill; 3Psychology and Biomedical Research Imaging Center, University of North Carolina-Chapel Hill; 4Radiology and Biomedical Research Imaging Center, University of North Carolina-Chapel Hill

The brain is intrinsically organized by functional networks. However, most of the brain functional imaging studies thus far have largely focused on the interaction of different brain regions instead of among different brain networks. In this study, a multivariate approach was developed to discern the interaction of five predefined brain functional networks, including the default (D), fronto-parietal control (FPC), motor-sensory (MS), visual (V), and language (L) networks during resting, movie watching and finger tapping, respectively. The ability to elucidate the interaction of different brain networks and assess the dynamic perturbations of their interactions under different cognitive statuses should complement our understanding of brain functional interaction on a regional level and offer a more comprehensive insight into how the brain works at a different scale.

15:00  **3515. Localization and Detrending of Physiological Noise in Resting State FMRI Using Machine Learning**  
*Thomas WJ Ash*1, *John Suckling*1, *Martin Walter*1, *Cinyl Ooi*2, *T Adrian Carpenter*1, *Guy B. Williams*1  
1Wolfson Brain Imaging Centre, University of Cambridge, Cambridge, Cambridgeshire, United Kingdom; 2Brain Mapping Unit, University of Cambridge, Cambridge, Cambridgeshire, United Kingdom; 3Department of Psychiatry, University of Magdeburg

Using machine learning tools on fMRI imaging data, we can predict the output of a physiological monitoring device with accuracy far better than chance. The model thus derived shows physiological noise to be localized mainly to the cerebrovascular system, CSF and
the brain edge. Upon detrending this noise to the extent that it is no longer predictable, voxel autocorrelation as measured by the Hurst exponent is significantly decreased in the brain parenchyma, in contrast to results when using common physiological noise correction tool RETROICOR, which does not affect autocorrelation in our dataset.

Thursday 13:30-15:30  Computer 25

13:30  3516  Neural Oscillatory Basis of Functional Connectivity MRI Differences Between Semantic Word Tasks

Johanna M. Zumer1, Svetlana V. Shinkareva2, Matthew J. Brookes1, Paul S. Morgan3, Peter G. Morris1
1Sir Peter Mansfield Magnetic Resonance Centre, University of Nottingham, Nottingham, Nottinghamshire, United Kingdom; 2Psychology, University of South Carolina, Columbia, SC, United States; 3Radiology and Radiological Science, Medical University of South Carolina, Charleston, SC, United States

The neural basis of functional connectivity in a semantic word processing task is examined, by comparing whole-brain connectivity matrices obtained from both MEG and fMRI data acquired in the same task and subjects. Novel methods are used for computing the connectivity in both modalities. Changes were observed between task vs rest as well as between task types in relevant brain areas and in multiple neural oscillatory frequency bands.

14:00  3517  Resting State ICA Enhanced with Multi-Echo FMRI

Prantik Kundu1, Peter Bandettini
1Laboratory of Brain and Cognition, NIMH, Bethesda, MD, United States

It is proposed that the multiple voxel timecourses obtained from multi-echo (ME) fMRI can be input to Independent Components Analysis (ICA) to enhance decomposition quality. Robust hemodynamic activity should be expressed across all contrasts within the TE range for BOLD, and providing fMRI data of multiple TEs should enhance ICA by increasing the representation of true hemodynamic sources, decreasing relative ratios of TE-specific RF noise, and weighting contribution of non-hemodynamic physiological signal towards one TE. The hypothesis is verified, and it is shown that ME fMRI greatly enhances ICA decomposition without prolonging resting fMRI acquisitions otherwise required for larger datasets.

14:30  3518  Discrepancy of Functional Connectivity in Sensorimotor Network Between Pre-And Post-Sleep Conditions

Po-Yu Liu1, Yu-Chin Wu2, Changwei Wesley Wu3, Chia-Ju Chen4, Ching-Po Lin1
1Department of Biomedical Imaging and Radiological Sciences, National Yang-Ming University, Taipei, Taiwan; 2Institute of Nuclear Engineering and Science, National Tsing-Hua University, Hsinchu, Taiwan; 3Department of Electrical Engineering, National Taiwan University, Taipei, Taiwan; 4Department of Medical Imaging and Radiological Sciences, Kaohsiung Medical University, Kaohsiung, Taiwan

Sleep usually refreshes our daily fatigue and rejuvenates our body, which is achieved due to physiological alterations in the sensorimotor network. However, the detailed mechanism of sleep under the brain circuit level remains unclear. To disclose the sleep effects on the sensorimotor system, the functional connectivity in bilateral primary motor cortex (M1) and supplementary motor area (SMA) were compared between Pre- and Post-sleep conditions using the resting-state fMRI. Results showed that connectivity strengths between motor areas were significantly decreased after sleep, implying a relaxing effect after an effective sleep.

15:00  3519  fMRI BOLD Correlates of Individual EEG Alpha Frequency Reveal Working Memory and Attention Related Resting State Networks

Kay Jann1, Thomas Koenig1, Thomas Dierks2, Chris Boesch1, Andrea Federspiel1
1Department of Psychiatric Neurophysiology, University Hospital of Psychiatry, University of Bern, Bern, Switzerland; 2Department of Psychiatric Neurophysiology, University Hospital of Psychiatry, University of Bern, Bern, Switzerland; 3Department of Clinical Research (AMSM), University and Inselspital Bern, Bern, Switzerland

The individual EEG alpha frequency (IAF) is a potential marker for a person’s cognitive abilities. It has been demonstrated that subjects with a higher IAF perform better in working memory tasks. Additionally, there exist resting state networks (RSNs) that are involved in task execution. However, little is known about the functional networks that underlie the IAF. We performed simultaneous EEG-fMRI recordings in 20 subjects and correlated the intra-individual IAF fluctuations to fluctuations in the fMRI BOLD signal. The results were spatially compared to RSNs. Our results highlighted a positive association of IAF with RSNs important for attention and working memory.
14:00  3520  Methylphenidate Causes Changes in the Amplitude and Latency of the Breath-Hold Response Function

Thalia Van der Doef1,2, Fernando Osmin Zelaya2, Sarah Lee2, Astrid Pauls2,3, Mitul Mehta2
1VU University Medical Centre, VU University, Amsterdam, Netherlands; 2Centre for Neuroimaging Sciences, Institute of Psychiatry, London, United Kingdom; 3VU University, Netherlands

A modified breath-hold (BH) paradigm was used to assess the effect of methylphenidate administration on the BH response function. An oral dose of 40mg of methylphenidate or a placebo were randomly administered to a group of 16 male subjects who took part in two separate scans one week apart. Whilst no statistically significant effect was found on the averaged temporal signal of grey matter, a significant increase in the amplitude of the BH response in the frontal-superior medial cortex (FSMC) was observed; as well as a significant reduction in latency in the putamen, the caudate nucleus and the FSMC.

14:30  3521  Cerebellar Abnormalities in Adolescents with Marijuana Dependence

Melissa Lopez-Larson1,2, Jadwiga Rogowska3, Deborah Yurgelun-Todd1,2
1Brain Institute, University of Utah, Salt Lake City, UT, United States; 2VISN 19 MIRECC, Salt Lake City, UT, United States; 3Brain Imaging Center, McLean Hospital/Harvard Medical School, Belmont, MA, United States

This is one of the first studies to evaluate cortico-cerebellar circuits in a group of adolescents with heavy marijuana (MJ) use utilizing a bilateral finger tapping fMRI task. Nineteen MJ using adolescents and 19 aged-matched healthy controls (HC) had functional (f)MRI scans on a 3T Siemens Trio scanner, including a standard bilateral fMRI finger tapping sequence. HC were found to have greater activation than MJ for Broadmann’s areas 4 and 6 and in the cerebellum. Furthermore, our findings suggest that age of first use and amount of MJ used may have an impact on functioning in the developing brain.

15:00  3522  Methamphetamine Abuse Impacts Glial Metabolism

Napapon Sailasuta1, Osama Abulseoud2, Kent Harris1, Martha Hernandez2,3
1Clinical MR Spectroscopy, Huntington Medical Research Institutes, Pasadena, CA, United States; 2University of Southern California, Keck School of Medicine, Los Angeles, CA, United States; 3Rudi Schulte Research Institute, Santa Barbara, CA, United States

Molecular Imaging in CNS depends upon selective probes which penetrate the blood brain barrier and document receptors, transporters enzymes or metabolic flux rates. 1-13C enriched acetate, a normal cerebral fuel has the unique property of cellular transport into glia and exclusion from neurons. Advances in 13C MR have brought this assay to routine use whereby glial metabolic rate can be assayed in frontal brain without unsafe heat deposition conventionally associated with the 13C method. 50% reduction frontal metabolism of glia was detected in severely methamphetamine dependent patients during the initial phase of abstinence.

15:30  3523  Correlation of Changes in Brain Activation and Cognitive Impairment During 30 Hours of Continuous Sleep Deprivation Using Latent Growth Curve Analysis

Jason Glenn Parker1, Eric Zalusky1, J. Lynn Caldwell2, Regina M. Schmidt2, Laurie Quill3, Cemil Kirbas4, Ke Cheng Liu4
1Innovation Center, Kettering Health Network, Kettering, OH, United States; 2Human Effectiveness Directorate, Wright-Patterson AFB, Dayton, OH, United States; 3Research Institute, University of Dayton, Dayton, OH, United States; 4Siemens Medical Solutions, United States

Previous studies correlating changes in fMRI activation with sleep deprivation-induced cognitive impairment have assumed a linear increase in cognitive impairment over a period of sleep deprivation, but this method fails to model the nonlinear effects of circadian rhythm on cognition. In this work, we seek to use a latent growth curve analysis which models each individual subject's fatigue vulnerability profile using a 3rd order polynomial to correlate changes in brain activation and deactivation between rested wakefulness and 30 hours of sleep deprivation with cognitive impairment.

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13:30  3524  Functional Imaging of Fibromyalgia Using Empathy for Pain

Hui-jin Song1, Joo-hyun Kim1, Jeeyhye Seo1, Moon-jung Hwang1, Young-ju Lee2, Kyung Jin Suh1, Sung Woo Kim3, Young Hwan Lee4, Dong Soo Yoo5, Yongmin Chang1
1Medical & Biological Engineering, Kyungpook National University, Daegu, Korea, Republic of; 2GE healthcare, Seoul; 3Dongguk University, Gyungju; 4Radiology, College of Medicine, Catholic University, Daegu; 5Radiology, College of Medicine, Dankook University, Chunan; 6Diagnostic Radiology, Kyungpook National University, Daegu, Korea, Republic of

Fibromyalgia(FM) is disorder of unknown etiology, characterized by chronic widespread pain and are often accompanied by symptoms of sleep disturbance, anxiety, memory problems, fatigue, and exhaustion. Previous functional imaging studies of FM mainly focused on pain by applying pressure to specific FM tender point. However, there is no emotional and cognitive functional imaging study with FM. Therefore, the aim of this study investigates difference of pain perception between fibromyalgia patient and
healthy controls using empathy for pain task. Based on our finding that the FM group did not show activation in the several pain empathy related areas during the empathy for pain task, the current study suggest that DLPPC and ACC hypoactivity in FM group is associated with a deficit in cognitive function in empathizing and evaluating other’s pain.

14:00  3525  Interpersonal Relationships and Intimacy Affect Top-Down Processing of Empathy

J-Yun Chen1, Kun-Hsien Chou1, Chun-Wei Lan1, Ya-Wei Cheng1, Ching-Po Lin1,2
1Institute of Neuroscience, National Yang-Ming University, Taipei, Taiwan; 2Institute of Biomedical Engineering, National Yang-Ming University, Taipei, Taiwan

Being in a close relationship is essential to human life. Such closeness can be described as including other in the self. To what extent does imagining a loved one differ from imagining an unfamiliar individual being in painful situations? In this functional MRI study, participants were exposed to animated stimuli depicting hands or feet in painful and non-painful situations, and instructed to imagine the scenarios perceived from three different perspectives: self, loved one and stranger. The results demonstrate that interpersonal relationships and intimacy affect top-down processing of empathy, as indicated by greater overlap between neural representations of self and other.

14:30  3526  Improved Methods and Analysis in FMRI Studies to Assess Taste and Aroma

Integration
Sally Eldeghaidy1,2, Luca Marciani1, Johann C. Pfeiffer3, Joanne Hort4, Kay Head2, Andy J. Taylor4, Robin C. Spiller1, Penny A. Gowland2, Sue Francis3
1Physics Departement, Suez Canal University, Ismailia, Egypt; 2Sir Peter Mansfield Magnetic Resonance Centre, Nottingham, United Kingdom; 3Nottingham Digestive Diseases Centre NIHR Biomedical Research Unit, Nottingham University Hospitals, Nottingham, United Kingdom; 4Flavour Research Group, Division of Food Sciences, University of Nottingham, Nottingham, United Kingdom

Improved paradigms (including dual-echo EPI, spray delivered samples and an immediate swallow) and subtraction and conjunction analysis methods have been used to study the crossmodal, supra-additive response to a congruent flavour. We show the control stimulus may cancel out some cortical responses of interest, and that a conjugate analysis is advantageous to subtraction analysis. We show the improved paradigms and analysis methods have been used to study the crossmodal, supra-additive response to a congruent flavour. We show the control stimulus may cancel out some cortical responses of interest, and that a conjugate analysis is advantageous to subtraction analysis.

15:00  3527  Representation of Sweet and Salty Taste Intensity in the Brain

Maartje Sara Spetter1, Paul A.M. Smeets2, Cornelis de Graaf2, Max A. Viergever3
1Radiology, Image Sciences Institute, Utrecht, Netherlands; 2Human Nutrition, Wageningen University, Wageningen, Netherlands

Sucrose and salt are commonly used to season foods. We investigated the brain representation of sweet and salty taste intensity using fMRI. 14 subjects visited twice and tasted a range of four solutions of either sucrose or salt (0 – 1 M). Insula activation increased with increasing concentration for both salt and sucrose. Moreover, despite similar subjective intensity ratings, insula activation by salt fMRI. 14 subjects visited twice and tasted a range of four solutions of either sucrose or salt (0 – 1 M). Insula activation increased with increasing concentration for both salt and sucrose. Moreover, despite similar subjective intensity ratings, insula activation by salt.

Wednesday 13:30-15:30  Computer 26

13:30  3528  The Neural Correlates of Everyday Recognition Memory.

Abdelmalek Benattayallah1, Fraser Milton1, Nils Muhlert1, Chris Butler1, Adam Zeman
1Peninsula Medical School, Exeter, Devon, United Kingdom; 2Psychology, University of Exeter, Exeter, Devon, United Kingdom; 3Peninsula Medical School, University of Exeter, Exeter, Devon, United Kingdom; 4University of Oxford

We used an automatic camera, SenseCam, to create a recognition memory test for real-life events. Using fMRI, participants classified images as strongly or weakly remembered, strongly or weakly familiar or novel, 36 hours and 5-6 months after image acquisition. At 36 hours, diverse neocortical regions were activated by recollected and familiar stimuli. There was increasing activation in right hippocampus/ posterior parahippocampal gyrus (pPHG) with increasing memory strength. Strong recollection elicited greater activity in left posterior hippocampus/pPHG than weak recollection. At 5-6 months, MTL activated for familiarity but not recollection memory. Neocortical regions were recruited for both recollection and familiarity processes.

14:00  3529  Altered Working Memory Process in Welders Using N-Back FMRI

Jeehye Seo1, Jae-jun Lee1, Hui-jin Song1, Joo-hyun Kim1, Kyung Jin Suh1, Sung Woo Kim1, Young Hwan Lee2, Dong Soo Yoo2, Yongmin Chang3,4
1Medical & Biological Engineering, Kyungpook National University, Daegu, Korea, Republic of; 2Radiology, College of Medicine, Dongguk University, Gyujeungu; 3Radiology, College of Medicine, Catholic University, Daegu; 4Radiology, College of Medicine, Dankook University, Chunan; 5Diagnostic Radiology, Kyungpook National University, Daegu, Korea, Republic of

Excessive accumulation of Mn in the globus pallidus(GP) is known to cause cognitive and motor deficits in human. Until now pallidal index(P1) in terms of T1 bright signal intensity at GP is only imaging diagnostic measure to manganism. Currently no functional
measure is available for motor behavior of manganese exposure in vivo. The aim of this study investigates motor behavior of manganese exposure compared to normal group using simple motor task. Compared to normal controls, the welder groups showed widespread activations in the supplementary motor area, cingulate motor areas and bilaterally increased activation in the parietal lobe and frontal lobe. This observation suggests the change of motor network in response to Mn accumulation. Therefore, motor fMRI is quite sensitive measure to change of motor network of Mn exposed brain even without T1 high signal at GP and has a great potential as functional diagnostic tool of damaged motor system in occupational exposure to Mn.

14:30  3530  Hippocampal Functional Networking in Wakefulness and Sleep
Kátia Cristine Andrade1, Victor I. Spoormaker2, Martin Dresler1, Roberto Goya-Maldonado1, Renate Wehrle2, Florian Holsboer2, Philipp G. Sämann1, Michael Czisch1
1Max Planck Institute of Psychiatry, Munich, Bavaria, Germany; 2Institute of Pharmacology and Toxicology, University of Zurich, Zurich, Switzerland

Simultaneous EEG/fMRI resting state data reveal varying hippocampal functional connectivity during wakefulness and NREM sleep. Our data suggest a transition from DMN bound hippocampal connectivity during the waking state to neocortical networking during sleep stage 2. These findings may signify memory consolidation processes hypothesized to occur during sleep.

15:00  3531  Improved BOLD Detection in the Working Memory Network Using a 32 Channel Phased Array Head Coil
Sheeba Arnold1, Susan Whitfield-Gabrieli2, Steven Shannon1, John Gabrieli2, Christina Triantafyllou1
1A.A. Martinos Imaging Center, McGovern Institute for Brain Research, MIT, Cambridge, MA, United States; 2Department of Brain and Cognitive Sciences, MIT, Cambridge, MA, United States; 3A.A. Martinos Center for Biomedical Imaging, Department of Radiology, MGH, Charlestown, MA, United States

BOLD activations cannot be located precisely with fMRI at low-resolutions. Improved sensitivity of 32-channel coil with high-resolution has been reported, but is yet to be demonstrated using fMRI at 3T. We used the n-back task to evaluate if this combination would identify the working memory (WM) network. 12- and 32-channel data at low- and high-resolutions were acquired in 18 subjects. Paired t-test revealed WM activation for high-resolution to be significantly more with 32-channel compared to 12-channel. When both coils are used at 3T, the increased SNR offered by 32-channel coil produces the greatest benefit for experiments in the high-resolution regime.

Thursday 13:30-15:30  Computer 26

13:30  3532  Cross-Modal Plasticity for Auditory Processing Is Present in Normal-Hearing Children for Non-Speech Stimuli
Vincent Jerome Schmithorst1, Scott Kerry Holland1, Elena Plante2
1Radiology, Children's Hospital Medical Center, Cincinnati, OH, United States; 2Speech, Language, & Hearing Sciences, University of Arizona, Tucson, AZ, United States

An fMRI investigation of cross-modal plasticity (the recruitment of visual areas for auditory processing tasks) was conducted in normal-hearing children ages 7-11. Activation patterns from a narrow-band noise task were correlated with two audiological measures of performance on comprehension of degraded speech: speech-in-noise, and time-compressed sentences at 40% comprehension. For both audiologic tests, the visual cortex displayed a negative correlation with test performance, with positive activation present in the worst-performing children. Results indicate that cross-modal plasticity is present even in normal-hearing children and even for non-speech stimuli and that it negatively correlates with comprehension of degraded speech.

14:00  3533  The Rostral Supplementary Motor Area Supports the Repetition of Visually and Auditorily Presented Pseudowords
Gesa Hartwigsen1, Stephan Ulmer2, Annette Baumgaertner1, Hartwig Roman Siebner1
1Department of Neurology, Christian-Albrechts-University Kiel, Kiel, Germany; 2Institute of Neuroradiology, University Hospital of Schleswig-Holstein, Kiel, Germany; 1Danish Research Centre for Magnetic Resonance, Hvidovre University Hospital, Copenhagen, Denmark

We used functional magnetic resonance imaging to delineate areas involved in modality-independent pseudoword repetition in healthy right-handed subjects. A conjunction analysis revealed that the rostral supplementary motor area (rSMA) was activated during pseudoword repetition. Activity in the right rSMA showed increased task-related coupling with activity in the ipsilateral primary motor cortex (M1) and contralateral ventral premotor cortex (PMv) as revealed by a psychophysiological interaction. We show that rSMA is involved in modality-independent pseudoword repetition. The increased task-related influence of rSMA on M1 and PMv during pseudoword repetition suggests a supervisory role of the rSMA on executive motor areas in language production.
14:30 3534. Single Word Reading in Reading Disability Depends on Word Frequency

Aanandhi Venkatadri1, Sheryl L. Rimrodt2, Amy Clements3, Kenneth R. Pugh3, Laurie E. Cutting6

1F.M.Kirby Center, Kennedy Krieger Institute, Baltimore, MD, United States; 2Division of Developmental Medicine, Children's Hospital of Vanderbilt, Nashville, TN, United States; 3Department of Cognitive Neurology, Kennedy Krieger Institute, Baltimore, MD, United States; 4Brain Sciences Institute , Johns Hopkins University, Baltimore, MD, United States; 5Haskins Laboratories, New Haven, CT, United States; 6Education and Brain Research Laboratory, Vanderbilt University, Nashville, TN, United States

Reading Disabled (RD) and Typically Developing Readers (TDR) were tested on a word discrimination task using high and low frequency words and pseudowords. ANOVAs were used to analyze differences in activation patterns between words versus pseudowords and between high versus low frequency words. For low frequency words, RDs showed greater activation than TDRs in right angular gyrus. For pseudowords, RDs also showed greater activation than TDRs in left superior temporal gyrus and several right hemisphere regions. Our findings suggest modulation of neurobiological response depending on the type of words presented; however, our findings also suggest that this modulation was present regardless of the word imageability level.

15:00 3535. Speech Perception in Noise, SNR Dependent Activity

Mattias Ragnehed1, Stefan Stenfelt1, Ingrid Johnsrude, 1,2, Jerker Rönnberg1

1Linköping University, Linköping, Sweden; 2Queens University, Canada

Brain activity induced by auditory speech perception at different noise levels was captured by fMRI. The analysis revealed noise modulated activity in a number of relevant areas. In response to increased noise level reduced activity was found in auditory cortex and lingual gyrus whereas increased activity was observed in dorsolateral prefrontal cortex. This is in line with the idea that higher cognitive functions are engaged in order to extract the available lingual information in an degraded auditory signal.

Animal fMRI

Hall B Monday 14:00-16:00 Computer 27

14:00 3536. Anesthesia Modulated Correlation Between Spontaneous fMRI BOLD and Local Field Potentials in Rat Somatosensory Cortex

Wen-Ju Pan1, Garth Thompson1, Matthew Magnuson1, Waqas Majeed1, Dieter Jaeger2, Shella Keilholz1

1BME, Georgia Institute of Technology / Emory University, Atlanta, GA, United States; 2Biology, Emory University, Atlanta, GA, United States

To investigate the relationship between spontaneous fMRI BOLD and neural electrophysiological signal, we developed a combined imaging and recording techniques for the rodent model. By comparing BOLD and local field potential (LFP) in rat somatosensory cortex under different anesthesia states, the studies showed close relationship between the measurements from different modalities and demonstrated that the time lag of the correlation may be modulated by anesthesia types of probe, which provided insights on the neural base of spontaneous BOLD fluctuations.

14:30 3537. Stimulus-Evoked CMRO2 Changes in Non-Human Primate (Baboon): Isoflurane Versus Ketamine

Hsiao-Ying Wey1,2, Timothy Q. Duong1,2

1Research Imaging Institute, UT Health Science Center at San Antonio, San Antonio, TX, United States; 2Radiology, UT Health Science Center at San Antonio, San Antonio, TX, United States

Brains of large non-human primates are highly evolved with extensive gyrations that are most similar to humans compared to other species, resulting in better recapitulation of many human diseases compared to the more commonly used rodent models. This study compared the stimulus-evoked CMRO2 changes in baboons under isoflurane versus ketamine. Visual and somatosensory stimulations were employed. BOLD and CBF were measured simultaneously using the arterial-spin-labeling technique on a Siemens 3T TIM-Trio. Davis' biophysical BOLD model was used to calculate CMRO2 changes via hypercapnic calibration. The comparisons of various physiological parameters were made between isoflurane and ketamine anesthetics.

15:00 3538. Spontaneous Fluctuations of BOLD Signal: Effect of Anesthesia and Functional Significance

Robert N.S Sachdev1, Basavaraju G. Sangamahalili2, Peter Herman2,3, Fahmeed Hyder2,4

1Neurobiology, Yale University, New Haven, CT, United States; 2Diagnostic Radiology, Yale University, New Haven, CT, United States; 3Human Physiology, Semmelweis University, Budapest, Hungary; 4Biomedical Engineering, Yale University

We measured spontaneous fluctuations of BOLD signal together with whisker functional stimulation in rat cortex with two slightly different baseline states: lightly anesthetized with domitor and awakened animals (from domitor) to explore the connection between power of spontaneous fluctuations and magnitude of functional response. The same experimental paradigm was applied during the anesthesia and the waking the rats. Both anesthetized and awakened rodents showed similar power in the frequency spectrum of spontaneous fluctuations, but the awakened animals showed higher variability in their functional responses. Therefore difference in functional response cannot be explained by the effect of baseline.
This work is an examination of the spatio-temporal dynamics of low-frequency hemodynamic fluctuations of the anesthetized rat brain. Applying independent component analysis to baseline BOLD fMRI timecourses, synchronous bilateral cortical and subcortical networks were observed including: primary and secondary somatosensory cortices; motor cortices; striate cortices; posterior and anterior cingulate; hippocampi; caudate putamen; and thalamic nuclei. Networks were preserved under two different anesthetic regimes: isoflurane and ketamine/xylazine. This technique has allowed a complete exploration of the resting networks in the rat brain that was not afforded by previously used correlational techniques that have been used for rat imaging.

**Tuesday 13:30-15:30**  
**Computer 27**

### 13:30  
**3540. Somatosensory Stimulus Frequency-Dependent Neural, CBF, and BOLD FMRI Responses in Isoflurane-Anesthetized Rat**  
*Tae Kim1, Kazuto Masamoto2, Alberto Vazquez3, Mitsuhiro Fukuda4, Seong-Gi Kim1*  
1Radiology, University of Pittsburgh, Pittsburgh, PA, United States; 2The University of Electro-communications, Chofugaoka, Japan  

Frequency-dependence of neural, CBF, and BOLD fMRI responses on stimulation duration were measured in the isoflurane-anesthetized rats. Higher frequency stimulation produced a larger neural activity per unit time during the early stimulation period, but dramatically decreased for later periods, while lower frequency stimulation induced smaller, but similar field potential amplitude responses maintained over the entire stimulation period. Similar frequency-dependent trends were observed in CBF and BOLD responses. Our findings suggest that the optimal stimulation frequency is dependent on stimulus duration, and it should be aware on the experiment design under isoflurane anesthesia.

### 14:00  
**3541. BOLD Temporal Dynamics of Superior Colliculus and Lateral Geniculate Nucleus During Monocular Visual Stimulation**  
*Condon Lau1,2, Kyle Xing1,2, Kevin C. Chan1,2, Ed X. Wu1,2*  
1Laboratory of Biomedical Imaging and Signal Processing, The University of Hong Kong, Hong Kong SAR, China; 2Department of Electrical and Electronic Engineering, The University of Hong Kong, Hong Kong SAR, China  

The superior colliculus (SC) and lateral geniculate nucleus (LGN) are the main destinations for fibers from the optic nerves. Their functions are important for processing and responding to visual stimuli. BOLD fMRI with TR = 200ms is used to measure the temporal dynamics of the SC and LGN (of Sprague-Dawley rats) in response to monocular visual stimuli to better understand their functions. The results show that the LGN response has smaller amplitude and is delayed relative to the SC response by approximately 0.8s. This shows that the neuronal and/or hemodynamic responses in the SC and LGN are temporally different.

### 14:30  
**3542. Functional MRI of Substantia Nigra Upon Visual Flash Illumination**  
*Kevin C. Chan1,2, Matthew M. Cheung1,2, Ed X. Wu1,2*  
1Laboratory of Biomedical Imaging and Signal Processing, The University of Hong Kong, Hong Kong SAR, China; 2Department of Electrical and Electronic Engineering, The University of Hong Kong, Hong Kong SAR, China  

In the mammalian midbrain, increasing evidence suggested a direct projection from the superior colliculus (SC) to the substantia nigra (SN), yet their functional characteristics remain largely unknown. This study explores the capability of blood oxygenation level–dependent (BOLD) fMRI to detect simultaneous activations in SC and SN upon visual flash illumination in order to understand the basic visual properties and hemodynamic responses in this functional connection. Upon monocular stimulation, activations were found predominantly in the contralateral SC and SN, whereas upon binocular stimulation activations were observed in SC and SN of both hemispheres. Significantly lower BOLD percent changes were also observed in the SN of both groups than SC before reaching similar peak heights after stimulation. The current results of having the same visual event initiating afferent inputs to both SC and SN could have important implications for interpreting the responses to biologically salient sensory events in relation to novelty, intensity or reward within the SC-SN connection.

### 15:00  
**3543. Cortical and Subcortical Activations by High Field FMRI for Different Sensory Stimuli**  
*Basavaraju G. Sanganahalli1, Peter Herman1,2, Christopher J. Bailey1,3, Douglas L. Rothman4,5, Hal Blumenfeld6,8, Fahmeeed Hyder1,4*  
1Diagnostic Radiology, Yale University, New Haven, CT, United States; 2Human Physiology, Semmelweis University, Budapest, Hungary; 3Center of Functionally Integrative Neuroscience, Aarhus University, Denmark; 4Biomedical Engineering, Yale University; 5Neurology, Yale University, New Haven, CT, United States; 6Neuroscience, Yale University  

We used 11.7T fMRI to study subcortical activations during tactile and non-tactile stimuli. Forepaw stimulation activates medial portions of the lateral thalamic nucleus. Whisker stimulation activates broader regions within the thalamus. Visual stimulation
activates superior colliculus and lateral geniculate nucleus. Comparison with atlas-based anatomy shows that thalamic activations were in different parts of ventroposterior and laterodorsal nuclei, as well as medial and dorsal parts of the geniculate nucleus, anterior and posterior regions of the pretectal nucleus, and the periaqueductal gray region. Mainly top layers of the superior colliculus were activated. These subcortical regions are implicated in integration of sensory stimuli.

Wednesday 13:30-15:30  Computer 27

13:30  3544. Thalamo-Cortical Responses to Deep Brain Stimulation of the Posterior Hypothalamic Nuclei in Rats—An FMRI Study of Neuroconnectivity

Jeff F. Dunn1,2, Calvin K. Young3, Ursula I. Tuor1,4, Campbell Teskey1,5, Brian H. Bland1,3
1Hotchkiss Brain Institute, University of Calgary, Calgary, Alberta, Canada; 2Department of Radiology, University of Calgary, Calgary, Alberta, Canada; 3Department of Psychology, University of Calgary; 4Institute of Biodiagnostics, University of Calgary; 5Departments of Cell Biology and Anatomy/Psychology, University of Calgary

Deep brain stimulation has been successful at treating Parkinson’s disease and has potential for treating other disorders. Neuroconnectivity between regions is important in understanding functional outcome. We stimulated within the posterior hypothalamic nuclei in a rat model (which has been shown to reduce haloperidol and 6-OHDA lesion induced akinesia). We used a novel implantable electrode suitable for use at 9.4T. fMRI responses in the cortex and other regions were monitored. Large regions of the cortex (bilateral) and hippocampus show a positive BOLD response. This extensive neuroconnectivity helps explain the positive response to DBS in the posterior hypothalamic nuclei.

14:00  3545. Combining EEG and FMRI Data from a Wistar Rat: A New Tool for Comparative Neuroimaging

Akira Sumiyoshi1, Takeshi Ogawa1, Ryuta Kawashima1, Jorge Javier Riera1
1The Institute of Development, Aging and Cancer (IDAC), Tohoku University, Sendai, Japan

Concurrent recordings of EEG and fMRI are nowadays possible in numerous laboratories for humans. However, its extension to rodents has been limited in terms of the number and the characteristics of the utilized electrodes. Here, we introduce a methodology to obtain EEG recordings from a dense array of scalp electrodes concurrently with fMRI-BOLD in a 7T MRI. We evaluate the performance of the proposed methodology using a conventional forepaw stimulation paradigm in a Wistar rat. By means of the proposed methodology one can have brain electrical source reconstruction in addition to their coupled hemodynamic responses at the level of single voxels.

14:30  3546. The Role of GABA and Glutamate Neuromediators in Generating the BOLD Response

Daniil P. Aksenov1, Limin Li1, George Iordanescu1, Xiaomu Song1, Alice Wyrwicz2
1Center for Basic MR Research, NorthShore Univ. RI, Evanston, IL, United States

Many questions remain about the relationship between the local cellular metabolic and hemodynamic changes measured by fMRI and the underlying neuronal electrical activity. In this study we examined the effect of neuromediators on BOLD and neuronal activity. Simultaneous fMRI and electrophysiological measurements of whisker stimulation were performed before and after localized injection of the GABA agonist and antagonist and glutamate antagonists into the somatosensory cortex. The cocktail of the GABA agonist and antagonist removed stimulus-dependent GABA-ergic responses without affecting the neuronal baseline level and magnitude of the BOLD signal. Glutamate antagonists decreased or abolished BOLD response.

15:00  3547. Power of Spontaneous BOLD Signal and Neural Activity Fluctuations Is Baseline-Dependent

Peter Herman1,2, Robert N. S. Sachdev3, Basavaraju G. Sanganahalli4, Fahmeed Hyder1,4
1Department of Diagnostic Radiology, Yale University, New Haven, CT, United States; 2Institute of Human Physiology, Semmelweis University, Budapest, Hungary; 3Department of Neurobiology, Yale University, New Haven, CT, United States; 4Department of Biomedical Engineering, Yale University, New Haven, CT, United States

Evoked responses in functional studies show baseline dependence, we asked if we can observe baseline differences in power of spontaneous fluctuations of BOLD signal. We compared spontaneous neural and BOLD signal fluctuations in high and low energy baseline states of light (domitor) and deep (α-chloralose) anesthesia. Extracellular electrodes were used to measure local field potential (LFP) and multi-unit activity (MUA) from middle cortical layers of rat brain and compared these neural signals with BOLD signal (11.7T). Results show that the power of spontaneous LFP or MUA activities is correlated with the magnitude of BOLD signal fluctuations in a baseline-dependent manner.
Thursday 13:30-15:30  Computer 27

13:30  3548.  Repeatability of ASL Cerebral Blood Flow and BOLD Cerebrovascular Reactivity Measurements Using a Computer-Controlled Gas Delivery System in a Pediatric Animal Model

Jeff D. Winter1, Jorn Fiestra2,3, Stephanie Dorner4, Joseph A. Fisher5,6, Keith St. Lawrence7,8, Andrea Kassner1,9
1Physiology and Experimental Medicine, The Hospital for Sick Children, Toronto, Ontario, Canada; 2Department of Medical Imaging, University Health Network, Toronto, Ontario, Canada; 3Department of Neurosurgery, University Health Network, Toronto, Ontario, Canada; 4Respiratory Therapy, University Health Network, Toronto, Ontario, Canada; 5Anaesthesiology, University Health Network, Toronto, Ontario, Canada; 6Physiology, University of Toronto, Toronto, Ontario, Canada; 7Imaging Division, Lawson Health Research Institute, London, Ontario, Canada; 8Medical Biophysics, University of Western Ontario, London, Ontario, Canada; 9Medical Imaging, University of Toronto, Toronto, Ontario, Canada

Cerebrovascular reactivity (CVR) caused by a CO2 stimulus may improve the assessment of childhood cerebrovascular disease. Reliable BOLD-based CVR measures may be obtained using precise model-driven prospective end-tidal CO2 targeting (MPET). In this study, we adapted the method of MPET of CO2 to anesthetised and ventilated animals. BOLD CVR repeatability was assessed in nine mechanically ventilated juvenile pigs. We found excellent BOLD-CVR repeatability (intra-class correlation coefficient > 0.84), which was similar to baseline ASL cerebral blood flow repeatability. Translation of this method to pediatric imaging will enable CVR imaging in small children who require anesthetic for imaging procedures.

14:00  3549.  Impact of Tube Hematocrit on Calibrated fMRI

Peter Herman1,2, Basavaraju G. Sangamahalli1, Daniel Coman1, Fahmeed Hyder1,3
1Department of Diagnostic Radiology, Yale University, New Haven, CT, United States; 2Institute of Human Physiology, Semmelweis University, Budapest, Hungary; 3Department of Biomedical Engineering, Yale University, New Haven, CT, United States

Oxygen consumption has become an important measure of brain function and can be measured by multi-modal measurement of BOLD, blood flow and volume. While discharge hematocrit is unchanged, the tube hematocrit in microvessels (Hetmicro) can decrease during activation because it depends on velocities of RBC and plasma. We combined laser-Doppler and fMRI measurements of RBC and plasma velocities to estimate Hetmicro. Our results show that Hetmicro decrease, corresponding to reduced blood viscosity, needs to be included in functional hyperemic response of the BOLD signal, as without it \( \delta \text{CMRO}_2 \) can be underestimated by as much as 30%.

14:30  3550.  Nonlinear Model for Preprocessing of Cerebral Blood Volume Weighted Functional MRI Data and for Evaluating Pharmacokinetic Properties of USPIO

Adriana Teodora Perles-Barbacaru1, Daniel Procissi1, Andrey Valentinovich Demyanenko1, Russell E. Jacobs1
1Caltech Brain Imaging Center, California Institute of Technology, Pasadena, CA, United States

In cerebral blood volume (CBV) weighted pharmacological MRI (phMRI), the R2*-weighted signal is a nonlinear function of the USPIO concentration in tissue that changes with cerebral activity. The signal recovery caused by USPIO elimination from the blood pool is modeled to assay the USPIO dependent functional sensitivity of the technique and to establish its applicability to study psychoactive drugs in mouse models of disease. The relaxivities and pharmacokinetic properties of three USPIO (MION, MoldayION and P904) are derived and maps of the CBV response to cocaine in mice are computed.

15:00  3551.  Sustained Negative BOLD, CBF, CBV, and CMRO2 fMRI Responses to the Noxious Stimuli in the Rat Striatum at 11.7T

Yen-Yu Ian Shih1, Hsiao-Ying Wey1, Qiang Shen1, Timothy Q. Duong1
1Research Imaging Institute, University of Texas Health Science Center at San Antonio, San Antonio, TX, United States

We recently reported that noxious forepaw electrical stimulation increases spike activity but, surprisingly, decreases CBV fMRI signals in the striatum. The present study focused on investigating this apparent discrepancy by performing BOLD, CBF, CBV, and CMRO2 fMRI on the same animals associated with noxious electrical forepaw stimulation at 11.7T. Neurovascular coupling among these hemodynamic and metabolic parameters were analyzed. The animal model and multiparametric fMRI protocol herein may prove useful to study neurovascular uncoupling and dysfunction of the striatum in various neurological disorders.