CCNM17-CN-107:5 Brain Imaging
Course Description

Aim of the course

Aim of the course: In vivo functional imaging of the brain has dramatically enhanced researchers' ability to examine the neural correlates of cognition and behavior. In particular functional Magnetic Resonance Imaging (or fMRI) is a particularly attractive technique. fMRI relies on the physical and magnetic properties of brain tissue (in particular blood) which change under conditions of neural activity. This Blood Oxygen Level Dependent (BOLD) contrast is endogenous to the brain and unlike Positron Emission Tomography does not demand the injection of radioactive contrast agents. fMRI (based on BOLD) is therefore a perfectly safe technique for studying brain function, can and is easily applied to the study of diverse populations (including children), and has reasonable spatial ("where in the brain") and temporal ("how quickly is something in the brain changing") resolution. We will:
a) Examine the physical and physiological bases of fMRI. That is we will review the physics and technology that makes it possible to measure the fMRI signal and how this signal is correlated with electrophysiological activity in the brain;
b) Review experimental techniques and designs for fMRI. That is, we will learn how to design experiments for fMRI
to answer questions of interest relating to perception and cognition
c) Understand how fMRI data is processed before we can reach a stage where we can draw inferences from it.
Next, we will consider domains of human cognition where fMRI has particularly enhanced our understanding of the brain, and has extended previous understanding gained from other techniques (including animal studies, experimental psychology, and neuropsychology).

Agenda:
An overview of a history of approaches to explore brain-behavior relationships
From neurons to networks: The value of functional magnetic resonance imaging (fMRI)
The basic physics of fMRI: Why does fMRI work?
What does fMRI reflect?: Vascular and electrophysiological correlates of the signal
Overview of principles of experimental design for fMRI: How to design fMRI studies
What to get out of fMRI signals: How to analyze fMRI data
Modeling the brain from fMRI signals: Approaches to investigate brain "connectivity"
Applications of analytic and modeling approaches to psychological and physiological domains.

Learning outcome, competences
knowledge:
- get real research experience
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attitude:
- acquisition of the approach of an active researcher
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skills:
- comprehensive methodological knowledge
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Content of the course

Topics of the course

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Learning activities, learning methods

Lectures and interactive discussions

Evaluation of outcomes

Learning requirements, mode of evaluation, criteria of evaluation:

requirements

- attendance
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mode of evaluation: examination

criteria of evaluation:

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Reading list

Compulsory reading list

- Baars, B. J., & Gage, N. M. (2010). Cognition, Brain, and Consciousness: Introduction to Cognitive Neuroscience. London: Academic Press
- Logothetis, N. K. (2002). The neural basis of the blood–oxygen–level–dependent functional magnetic resonance imaging signal. Philosophical Transactions of the Royal Society of London. Series B: Biological Sciences, 357(1424), 1003-1037.
- Amaro Jr, E., & Barker, G. J. (2006). Study design in fMRI: basic principles. Brain and cognition, 60(3), 220-232.
- Savoy, R. L. (2005). Experimental design in brain activation MRI: Cautionary tales. Brain research bulletin, 67(5), 361-367.
- Stephan, K. E. (2004). On the role of general system theory for functional neuroimaging. Journal of Anatomy, 205(6), 443-470.
- Bányai, M., Diwadkar, V. A., & Érdi, P. (2011). Model-based dynamical analysis of functional disconnection in schizophrenia. Neuroimage, 58(3), 870-877.
- Diwadkar, V. A., et al. (2012). Disordered cortico-limbic interactions during affective processing in children and adolescents at risk for schizophrenia revealed by fMRI and Dynamic Causal Modeling. Archives of General Psychiatry 69, 231-242.
- Diwadkar, V. A., Meintjes, E. M., Goradia, D., Dodge, N. C., Warton, C., Molteno, C. D., ... & Jacobson, J. L. (2013). Differences in cortico-striatal-cerebellar activation during working memory in syndromal and nonsyndromal children with prenatal alcohol exposure. Human brain mapping, 34(8), 1931-1945.
- Diwadkar, V. A., Murphy, E. R., & Freedman, R. R. (2013). Temporal Sequencing of Brain Activations During Naturally Occurring Thermoregulatory Events. Cerebral Cortex, bht155. doi: 10.1093/cercor/bht155.
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Recommended reading list

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