PSY992 Introduction to functional magnetic resonance imaging (fMRI)
Spring 2021

Instructor: Taosheng Liu PhD
Meetings: Tuesday 10:20-1:10, Online synchronous
Office hours: By appointment (please email me)

Course description and objectives
Cognitive neuroscience attempts to give a mechanistic account of how the brain implements computations underlying cognition. A basic requirement in this endeavor is to be able to measure brain activity with appropriate methods. This course is aimed at informing students of one of the primary methods—functional magnetic resonance imaging (fMRI). The objective is to introduce students to the methods of fMRI, including the physical and physiological basis of the measurement, experiment design, and data analysis. At the end of the course, students should be able to 1) critically evaluate an fMRI study; 2) design and implement appropriate fMRI experiments to address cognitive neuroscience questions; 3) analyze the data generated from such experiments.

Prerequisite
This is a theory+method course that focuses on data analysis/manipulation. Background knowledge in the following areas will be helpful: cognitive psychology, neuroanatomy and neurophysiology, math (e.g., linear algebra, probability and statistics), computer programming. Basic concepts of programming will be introduced, however, proficiency with programming is not required as the course will mostly use previously developed programs and codes. Due to the diversity of student background, I will try to adjust the level of coverage to accommodate students' interest and capability.

Text and Readings
Readings will be from handouts, tutorials, and primary literature.
In addition, the following text will be used:
Huettel, S. A., Song, A. W., McCarthy, G. (2014) *Functional Magnetic Resonance Imaging, Third Edition*, Sinauer Associates: Sunderland, MA (referred to as HSM in the schedule below).

Course requirement and assessment

Class participation	30%
Lab assignments	40%
Final paper/project	30%

I fully expect everyone will attend every class session. Indeed, it is critical you attend all the class sessions, otherwise you may fall behind in this type of class. The lecture sessions will introduce theoretical concepts, during which actively participation in the discussion is encouraged. Lab sessions will involve hands-on experience with data analyses, for which everyone is expected to participate and learn. You are expected to write several lab reports throughout the course.

You will work on a final project paper on a topic of your interest; this should be done in consultation with me and should be finalized by the latter half of the semester. This would be an experimental proposal to test some new idea in a field of your interest. Some background reading/analysis of the literature is needed to come up with a reasonable hypothesis. More details on lab report and project paper will be available in a separate document.

~~There is also opportunity to participate in the fMRI experiments for which data we will be analyzing (more details to follow).~~

Class schedule (tentative, subject to change)

Wk	Date	Topic	Reading
1	1/19	Course Introduction	HSM Chap 1
		MR safety, MR physics	HSM Chap 2-3
2	1/26	MR imaging	HSM Chap 4-5
		fMRI BOLD mechanism I	HSM Chap 6-7
3	2/2	fMRI BOLD mechanism II	HSM Chap 8
		Linux Intro I	Hanke & Halchenko, 2011
4	2/9	Linux intro II & AFNI GUI.	
		AFNI GUI	HSM Chap 9
5	2/16	Signal, noise, preprocessing AFNI preprocessing I	Boynton 99
		AFNI preprocessing II	
6	2/23	Preprocessing I: uber_subject	Linear system tutorial
		Preprocessing II: Alignment	HSM Chap 10; fMRITutorial1
7	3/9	Preprocessing III Math of GLM I	Least Square tutorial
		Math of GLM II Block design: simulation	fMRI_tutorial: block designs
8	3/16	***Lab 1***: analyzing block design	
		Lab 1: cont'd	
9	3/23	Correction for multiple comparisons Statistical thresholding	
		Group analysis of block design	
10	3/30	***Lab 2***: group analysis	
		More group analysis	
11	4/6	Event-related design: theory	Wager 03
		Event-related: some math	Matlab tutorial
12	4/13	***Lab 3***: analyzing event-related	
		Lab 3: cont'd	
13	4/20	ROI-based analysis	
		Lab 4: *ROI analysis*	
	4/27	Final project paper due	