Psychology 610-27 Current Issues in Brain Imaging
Fall Semester, 2016

Class meetings: Tuesday 2:30 – 5:30 pm Psych A, Room 141

Instructor: Dr. Hoi-Chung Leung
Office: Psych B, Room 314
Office Hours: Thursday 1:20-2:50 p.m. or by appointment

Course Description

This is a multidisciplinary graduate-level course that aims to survey the current advances and issues related to human brain imaging. The course will cover several imaging techniques and their applications. The course starts by an overview of *in vivo* neuroimaging in animals and humans. It then covers the basics of magnetic resonance imaging (MRI): physics of image formation, resolution limits, and physiological basis of image signals. Students will receive training on fMRI experimental design, data processing and analysis, and statistical models. Other topics include diffusion and perfusion MRI, MRS, PET, optical imaging, pharmacological imaging, genetic imaging, etc.

Class Format

The class will be in the format of seminar style lectures, laboratory exercises and discussions. Students will conduct a group project in the form of a small scale experiment to practice the basic neuroimaging skills.

Credits: 0-1: lectures only; 3: lectures and lab (mandatory)

COURSE PREREQUISITE: Cognitive and Behavioral Neuroscience II (562) and Neuroanatomy are required prerequisites. Probability, linear algebra, differential equations, and introductory or college-level subjects in neurobiology, physiology, and physics required.

COURSE LEARNING OBJECTIVES:

Obtain a basic understanding of various brain imaging approaches and techniques used for studying human and animal brain function.

After completing the course, students should be able to:

- describe the basic neuroimaging techniques and applications;
- explain the significance, contribution and application of various neuroimaging techniques in studying brain function and behavior;
- explain the advantages and disadvantages of different imaging methods and their limitations;
- evaluate data acquisition, image quality and analytical issues;
- conduct various basic image processing steps and analyses;
- formulate a plausible neuroimaging question and design simple experiments;
- complete a simple neuroimaging experiment, conduct corresponding image processing and analysis, and write up reports and present results

Assignments

1. Weekly Readings

There is no textbook requirement. Weekly readings will be assigned in advance. Please check blackboard frequently for updates (http://blackboard.stonybrook.edu/).

2. Weekly lab work

Class members are expected to write short essays, complete lab exercises and write up short reports each week.

3. Group project

A group of 2 students will design and conduct a simple neuroimaging experiment. It is important to plan ahead and prepare the behavioral task before actual scanning. The final topic needs approval from the course instructor. *Each group will (a) prepare an imaging protocol, (b) formulate and prepare a computerized behavioral task, (c) conduct the short experiment (20-30 minutes total), (d) perform image data processing and analysis, and (e) write up final report and give a class presentation. See deadlines in the lab schedule.*

Grading:

Attendance and participation 30%
Lecture essays and lab assignments/reports 40%
Term project report and presentation 30%

All students should keep in mind that the principle of Academic Honesty requires that this paper be the original work of the student who submits it, and must include appropriate citations for statements and ideas that are the original work of others. If in doubt, cite your sources.

University Policies:
Americans with Disabilities Act: If you have a physical, psychological, medical or learning disability that may impact your course work, please contact Disability Support Services, ECC (Educational Communications Center) Building, room128, (631) 632-6748. They will determine with you what accommodations, if any, are necessary and appropriate. All information and documentation is confidential. Students who require assistance during emergency evacuation are encouraged to discuss their needs with their professors and Disability Support Services. For procedures and information go to the following website: http://www.sunysb.edu/ehs/fire/disabilities.shtml.

Academic Integrity: Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Faculty are required to report any suspected instances of academic dishonesty to the Academic Judiciary. For more comprehensive information on academic integrity, including categories of academic dishonesty, please refer to the academic judiciary website at http://www.stonybrook.edu/uaa/academicjudiciary/

Critical Incident Management: Stony Brook University expects students to respect the rights, privileges, and property of other people. Faculty are required to report to the Office of Judicial Affairs any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn.

Readings: *See blackboard posting for weekly reading assignment.*

(Optional) Functional Magnetic Resonance Imaging by Scott A. Huettel, Allen W. Song, Gregory McCarthy. 2nd edition. 2009. Sinauer Associates Inc.: Sunderland, MA
(**Required**) NIH fMRI summer course 2016 https://fmrif.nimh.nih.gov/public/fmri-course

Class Schedule: *(NOTE: This schedule is subject to change. Revisions will be announced in class)*

Session	Date	Topic	Speaker
Week 1	8/30	Course organization and introduction to neuroimaging	Leung
Week 2	9/6	Optical imaging: intrinsic imaging of animal brain (Allen Institute video) (NIH video #15 by Silva)	*Reid*
Week 3	9/13	fMRI paradigm designs *(NIH video #3 by Bandettini)*	Leung
Week 4	9/20	Neural activity and hemodynamic activity *(NIH video #8)*	*Handwerker*
Week 5	9/27	Pharmacological imaging: Current advances in PET	DeLorenzo
Week 6	10/4	Sample size and big data issues (slides from UCLA training camp)	Leung
Week 7	10/11	Functional connectivity and resting State fMRI *(NIH videos #6, #9)*	Leung
Week 8	10/18	Brain reading with fMRI – classification *(NIH video #16 & 14)*	Leung
Week 9	10/25	Diffusion MRI *(video from Visualization of Biological Data - Bastin)*	Leung
Week 10	11/1	Neurovascular coupling (including Perfusion MRI - ASL)	Xiang He
Week 11	11/8	Human spectroscopy *(NIH video #27)*	*Shen*
Week 12	11/15	No lecture (SFN annual meeting)	
Week 13	11/22	*Neuromodulation methods (NIH video #12 & 18)*	*Luber & Lisanby*
Week 14	11/29	The future of fMRI in cognitive neuroscience *(NITP video)*	*Poldrack*

Readings and Supplementary Materials are on blackboard.

(Lab schedule on the next page)

Lab schedule: *(NOTE: This schedule is subject to change. Revisions will be announced in class)*

Session	Date	Task	Notes
Week 1	8/30	*Video:* A history of neuroimaging *(NIH video #1)* Introduction to Matlab and PsychoPy (see primers & online resources)	*Bandettini* Elizabeth?
Week 2	9/6	*Video:* MR contrasts and limits of spatiotemporal resolution *(NIH video #2)* *Lab*: Examine MR images: T1, T2, EPI; identify some brain structures *tools: MRIcron, Atlases (MNI vs Talairach, michigan state, Mai Brain Navigator)* ***Group work**: Topic selection*	*Bandettini*
Week 3	9/13	*Video: B*asics of MRI and fMRI data acquisition *(NIH videos #4 & 5)* *Lab*: View more brain images (from different age and disease state) *Imaging Protocol:* picking parameters and tradeoffs ***Group work***: *Submit research question by email*	*Evans & Vinai*
Week 4	9/20	*Video: What fMRI can and cannot do (NIH Cox; or SPM)* *Lab*: Image preprocessing (SPM/AFNI), motion correction & artifact issues Evaluate and discuss image quality and processing issue *tools: AFNI, SPM (with ART), FSL, MRIcron* ***Group work***: *Project planning (define variables and parameters)*	
Week 5	9/27	*Lab:* Registration, segmentation & labeling *tools: SPM (VBM, DARTEL)/FSL, freesurfer, mindboggle* ***Group work**: Project planning (finalize protocol) and share and evaluate each other's study design* ***Submit a draft of your group's study design and NMR protocol***	
Week 6	10/4	*Lab*: Single subject analysis & General Linear Model *tools*: SPM, AFNI, FSL ***Group work:** Task programming*	*SPM video*
Week 7	10/11	*Lab*: Second level analysis (use SPM or AFNI sample datasets) *tools*: SPM or AFNI ***Group work***: *Finish task programming and show the instructor*	*SPM video (advance methods)*
Week 8	10/18	*Lab*: Functional connectivity: rsFC and PPI; examine various networks (e.g., frontoparietal, motor, sensory, DMN) *tools*: HCP, INSTACOR (discuss head motion issues and artifact control) ***Submit final design report, MRI protocol and computerized task***	
Week 9	10/25	*Video: What you can and cannot do with diffusion MRI (NIH video #36)* *Lab*: DTI preprocessing and tracking *tools*: TORTOISE	*Pierpaoli*
Week 10	11/1	SCAN center - Data Collection!!	
Week 11	11/8	*Video: Statistics of fMRI (NIH video #24)* *Lab*: overview of advance fMRI statistics: PPI, DCM, ICA, network	*Gang*
Week 12	11/15	*Self-serve lab*: Work on your project (aim to complete data analysis)	
Week 13	11/22	Discuss neuroethics and application of fMRI Work on projects: ***Finish data analysis and write up final lab reports***	
Week 14	11/29	Student project presentations	