WESTERN UNIVERSITY
LONDON CANADA
Department of Psychology

Psychology 9223
Neuroimaging of Cognition
Fall 2020

1.0 CALENDAR DESCRIPTION

Brain imaging, particularly functional magnetic resonance imaging (fMRI), has become a common tool to study specialized human brain regions involved in cognitive functions. The course will be comprised of a combination of lectures, tutorial development, and tutorials. The lectures will cover brain imaging technology, current techniques for experimental design and analysis, and a discussion of the merits and limitations of neuroimaging as a tool for cognitive neuroscientists. By the end of the class, students should be able to read, understand, and critique papers in brain imaging and have a sufficient foundation to begin to use fMRI as a tool in their own research.

2.0 COURSE INFORMATION

Instructor: Dr. Jody Culham

Office: Western Interdisciplinary Research Building 4118, but working at home during COVID-19
Phone Number: 519-661-3979
E-mail: jculham@uwo.ca
Office Hours: By appointment through http://jodyculham.youcanbook.me/

For Fall 2020, due to COVID-19, the course will be entirely online.

Pre-recorded Lectures: Online, posted Thursday before Q&A
Online Q&A: Monday 11:30 am -12:30 pm, Zoom
Online Tutorials: Wednesdays 1:30– 3:30 pm, Zoom

Recurring Zoom link (do NOT share publicly or we might get Zoom-bombed)

https://westernuniversity.zoom.us/j/99262771689?pwd=WmVHS2QxeGtkdzhTT3gxdlhvb1BhZz09
Meeting ID: 992 6277 1689
Passcode: newbi4fMRI

Prerequisites: Formally none, though some background in psychology, neuroscience and basic statistics (p values, correlations, t-tests, ANOVAs) will be assumed.

Teaching Assistant: Rebekka Lagace Cusiac

E-mail: rlagacec@uwo.ca
Office Hours: By appointment

Resources for the Teaching Assistant and data collection were generously provided by the Canada First Research Excellence Fund (CFREF) BrainsCAN grant to Western and by Jody Culham's unrestricted funding account. http://www.uwo.ca/brainscan/

Tutorials will utilize a free educational version of BrainVoyager, BrainVoyager EDU (for Mac, PC or Unix/Linux) that works with the teaching data set. A download link will be provided once BV EDU has incorporated the course data.

You will need a non-crappy computer (i.e., no netbooks or tablets) but the most computationally intensive steps will have been run for you. If necessary, external hard drives with data can be provided.

Although the course utilizes BrainVoyager EDU, this is NOT a course on how to use BrainVoyager. The emphasis is on concepts that generalize across software platforms.

3.0 TEXTBOOK AND READINGS

Core material will be presented in lectures and a textbook is not necessary but may help to reinforce concepts discussed in class.

Time permitting, free drafts of chapters of the following textbook will be made available. Suggestions and corrections about textbook drafts will be most welcome.

> Culham, J. C. & Goebel, R. (In preparation). *Working with fMRI*. Psychology Press (Taylor & Francis).

An optional alternative textbook is available on http://www.amazon.ca/ for ~C$172 (!). Note the current edition (3rd) is overdue for an update so students may want to get a used copy or utilize an older edition.

> Huettel, S. A., Song, A. W., & McCarthy, G. (2014). *Functional magnetic resonance imaging*. 3rd edition. Sinauer/Oxford. https://global.oup.com/ushe/product/functional-magnetic-resonance-imaging-9780878936274?q=huettel&lang=en&cc=us
>
> https://www.amazon.ca/Functional-Magnetic-Resonance-Imaging-Huettel/dp/0878936270/

A subscription to the Huettel e-textbook is available from vitalsource.com for ~C$60 (180 days).

> https://www.vitalsource.com/en-ca/products/functional-magnetic-resonance-imaging-scott-a-huettel-allen-w-v9781605354170

Additional optional course readings will also be provided on Dropbox in pdf format.

4.0 COURSE OBJECTIVES

- To provide students with a critical overview of how brain imaging research can contribute to cognitive neuroscience research.
- To provide students with a strong foundation in understanding the logic of the General Linear Model (GLM) for statistical analysis
- To use the GLM logic as a foundation for understanding the effects of artifacts, preprocessing, choice of model parameters, and experimental design
- To provide students with sufficient understanding of neuroimaging approaches that they can read and critique articles on the topic and make appropriate choices regarding experimental design and analysis
- To give students a conceptual understanding of the technical details of fMRI (like MR physics, the BOLD response, and preprocessing steps) without requiring a strong background in physics, biology, or mathematics.
- To give students a hands-on understanding of brain imaging analysis, with an emphasis not on "which buttons to push" in any particular software package but rather on why one might make certain decisions about design and analysis regardless of the software.
- To contribute to the new development of classroom and online tutorials that can be used for future teaching of fMRI at Western and worldwide

5.0 EVALUATION

Weekly Assignments: Pass/Fail (Fail = Deduction of 20 percentage points from course grade)

Students will complete hands-on tutorials that reinforce their understanding of concepts from the lectures. Each student will get a free copy of BrainVoyager EDU software for their preferred computer (typically

their own laptop/desktop). Data will be downloadable online (or on request, may be provided on an external drive). Students can complete tutorials on their own or do the tutorials at a weekly online session (Wednesdays) where the TA and professor will be available to answer questions and provide guidance.

Final Project Proposal: 10%
Final Project Presentation: 90%

Each student will work alone or in a team (up to 4 people) to do one of the following projects:

1) Perform an analysis of the course data, justifying choices about analysis strategy and preprocessing steps.
2) Analyze existing data (e.g., from the human connectome project or other extant data from your supervisor). The analysis **can not** be part of the student's thesis or other coursework.
3) Write a proposal for an fMRI project. The project **can not** be part of the student's thesis or other coursework.
4) Develop a new teaching module to highlight key issues in fMRI design and analysis. Tutorials should provide step-by-step instructions to teach specific theoretical concepts using actual data, with more of an emphasis on foundational ideas rather than "which buttons to click." As one example, a tutorial may include a new module that could be given as an optional assignment for students in future years (e.g., analyzing DTI data). As another example, a tutorial may convert an existing tutorial in Brain Voyager into a different software platform (SPM, FSL, AFNI). Tutorials should include an assignment to gauge whether tutees have successfully mastered core concepts. The professor and TA will be available to provide assistance and advice with concepts, software, and development.

The scope of the tutorials should be commensurate with the number of team members. Tutorials may be adapted for future classes and for www.fMRI4newbies.com, with appropriate credit to the developers; thus submission of a tutorial includes consent for this. Grading will be based on the demonstrated mastery of the key concepts and will take into consideration the students' level of past fMRI experience.

A brief (1-page, single-spaced) proposal will be due midway through the course to ensure students start planning projects with ample time for completion.

The final project will be presented in a prerecorded online presentation of up to 15 minutes, followed by a live question and answer period with the professor and TA. Presentation grade will be based on the demonstration of mastery of fMRI design and analysis concepts (70/90 points) and the quality of the presentation (20/90 points). Presentations will be given in slots booked on December 11 and 14.

Grading

<=78	Disappointing
79-81	Okay
82-83	Solid
84-86	Good – typical of expectations for average graduate student (without grade inflation)
87-88	Great
89-90	Excellent
91-94	Outstanding
>=95	Walks on water, stops speeding locomotives with mind power alone, should be teaching the course instead of Dr. Culham [i.e., Mark Daley ☺]

6.0 TEST AND EXAMINATION SCHEDULE

There will be no examinations

7.0 LECTURE AND TUTORIAL SCHEDULE

Date	Topic
Mon. Sept. 14	Live Organizational Meeting; Course format and expectations; Why fMRI?
Wed. Sept. 16	*No Tutorial*
Mon. Sept. 21	Prerecorded Lecture and Live Q&A: Basics of fMRI and data structures; Course experiment
Wed. Sept. 23	*Tutorial 1: fMRI data structures*
Mon. Sept. 28	Prerecorded Lecture and Live Q&A: General Linear Model
Wed. Sept. 30	*Tutorial 2: General Linear Model (single participant)*
Mon. Oct. 5	Prerecorded Lecture and Live Q&A: fMRI preprocessing and quality assurance
Wed. Oct. 7	*Tutorial 3: Statistical corrections (Multiple comparisons; Temporal autocorrelation)*
Mon. Oct. 12	No Lecture (Thanksgiving)
Wed. Oct. 14	*Tutorial 4: fMRI preprocessing and quality assurance: Motion artifacts*
Mon. Oct. 19	Prerecorded Lecture and Live Q&A: Block designs
Wed. Oct. 21	*Tutorial 5: Spatiotemporal smoothing*
Mon. Oct. 26	Prerecorded Lecture and Live Q&A: Event-related designs
Wed. Oct. 28	*Tutorial 6: Event-related designs; event-related averages, deconvolution*
Mon. Nov. 2	No lecture (Reading Week)
Wed. Nov. 4	*No tutorial (Reading Week)*
Mon. Nov. 9	Prerecorded Lecture and Live Q&A: Group data; ROI vs. Voxelwise approaches
Wed. Nov. 11	*Tutorial 7: Spatial normalization and group GLM*
Fri. Nov. 13	*Final project proposal due (10%)*
Mon. Nov. 16	Prerecorded Lecture and Live Q&A: Multivoxel pattern analysis (MVPA)
Wed. Nov. 18	*Tutorial 8: Multivoxel pattern analysis (MVPA)*
Mon. Nov. 23	Prerecorded Lecture and Live Q&A: Advanced Design, Analysis and Interpretation
Wed. Nov. 25	*Tutorial 9: Understanding interactions; Non-independence error; ROI vs. voxelwise approaches*
Mon. Nov. 30	Prerecorded Lecture and Live Q&A: ICA, Connectivity and Resting State
Wed. Dec. 2	*Tutorial 10: ICA, Connectivity and Resting State*
Mon. Dec. 7	Prerecorded Lecture and Live Q&A: fMRI physics and the BOLD signal
Fri. Dec. 11 and Mon. Dec. 14	*Final project presentations (90%)*

8.0 ACADEMIC OFFENCES

Scholastic offences are taken seriously and students are directed to read the appropriate policy, specifically, the definition of what constitutes a Scholastic Offence, at the following Web site: http://www.uwo.ca/univsec/pdf/academic_policies/appeals/scholastic_discipline_grad.pdf

All required papers may be subject to submission for textual similarity review to the commercial plagiarism-detection software under license to the University for the detection of plagiarism. All papers submitted for such checking will be included as source documents in the reference database for the purpose of detecting plagiarism of papers subsequently submitted to the system. Use of the service is subject to the licensing agreement, currently between Western University and Turnitin.com (http://www.turnitin.com)."

For the purposes of this course, the following are NOT allowed:

- The utilization of resources (including wording) developed by others without appropriate attribution (if you don't understand what plagiarism is, find out and make sure you don't do it). This includes copying methods from other papers in any proposals. The professor may google advanced methods-speak to see if it is copied from extant papers or may ask the student to explain the concepts to ensure understanding. It is better to write a simple, modern methods section that you understand than to copy a complex, possibly outdated, approach from a published paper.
- The utilization of work done towards the student's thesis or other courses for credit in this course. This does not preclude later benefits to students' proposals from the work done for this course; for example, students in past years have written project proposals and later decided to actually conduct the study.
- The utilization of ideas discussed in depth with colleagues or supervisors without due credit.

If in doubt, consult the professor early.