

PSYO/NESC 3137

Research Methods in Cognitive Neuroscience

Winter 2023-24

This document is designed to serve three purposes: (1) An overview of the course content; (2) A contract between instructor and student, detailing the course requirements; and (3) An aid to your learning, providing advice on how to do well in the course.

Instructor:

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Teaching Assistant:

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Course Delivery:

This course will be delivered **in person**. Live lectures and labs will not be recorded.

We will meet three times per week during the Winter semester. All classes will be held in **Room 5260** in the Department of Psychology & Neuroscience.

- Lectures will take place on **Mondays and Wednesdays, 16:35 – 17:25**.
- Labs and journal club will take place on **Thursdays 11:35 – 13:25**. Please note that we will not meet on the first Thursday of the semester (see Schedule).

Office hours:

Office hours will be held on **Mondays, 15:30 – 16:30, Room 4224** in the Department of Psychology & Neuroscience

Course Overview:

Neurotechnologies such as brain imaging, software applications, and wearable or implantable device hardware are poised to play a central role in the future of humankind. What seemed like science fiction only a few years ago has become reality, such as the ability to visualize brain activity in real time, decode it to provide insight into what someone is thinking or feeling, and even using brain activity to directly control devices.

This course will introduce the different technologies and techniques that are available to measure and alter brain activity in humans, focusing on non-invasive techniques. The goals of the course are to provide an overview of how each technique or technology works, what it measures (or stimulates), its limitations, and some example applications.

Course Format:

This class meets three times per week, on Mondays, Wednesdays, and Thursdays. Mondays and Wednesdays will be used for lectures, and Fridays will be used for labs and journal club. As with any class, you are expected to spend a significant amount of time outside the assigned class time working on the course. In particular, **you will have to spend time outside of class collecting and analyzing data for your ERP lab report**. This is discussed in more detail below.

Lectures

Lectures will take place on Mondays and Wednesdays. During lectures I will review the key points of each topic covered in this course, however the course textbook (see “Class Materials”) covers each topic in far greater detail than I could hope to cover in a single lecture. For assignments and the final exam I expect you to demonstrate learning of all the material in the readings, not just what we had time to cover in lectures.

Labs and Journal Club

Our Thursday sessions will be split between labs and journal club.

- During labs we will cover some “hands-on” elements of cognitive neuroscience including scientific writing, presentations, and EEG data analysis.
- During journal club, we will discuss papers from the cognitive neuroscience literature. More precisely, you will be required to present two prescribed papers to the rest of the class throughout the semester (see Evaluation Components for more detail).

Out-of-class EEG time slots.

As noted above, time outside of class is required to complete course requirements. At the beginning of the term, students will organize into teams of 4 people and pick a weekly 2-hour slot from a list provided by the TA to meet outside of regular class time. This slot will not be used every week, but will be used most weeks over the first ~6 weeks of the term to collect EEG data for students' ERP lab reports. **During EEG data collection, all students and the TA are required to adhere to the COVID-19 safety protocol for this class.** This protocol will be released on Brightspace early in the semester.

Course Materials

Brightspace

You will be added to the Brightspace page for this course at the beginning of the semester. This is where I will post course materials such as written assignment instructions, lecture slides, and journal club articles, as well as any course announcements (e.g., scheduling changes or extra credit opportunities). All assignments must be submitted through Brightspace, and we will post grades on Brightspace as soon as they are available.

Course Textbook

Newman, Aaron J. (2019). *Research Methods for Cognitive Neuroscience*. Sage Publications, London.

The course textbook will be available at the Dal Bookstore, or may be purchased from online vendors.

Formatting Guidelines

All assignments for this course are expected to conform to APA 7 style. Therefore, I recommend obtaining a copy of the *Publication Manual of the American Psychological Association*, 7th Edition.

Required Software

This course will require the use of a software package called Anaconda, which you are expected to install on your personal computer. Anaconda is Windows and Mac compatible, and can be downloaded for free. Detailed installation instructions will be posted to Brightspace early in the semester.

Learning Outcomes:

As a laboratory course, there are both “content” and “process” learning objectives. The primary content objective is that you acquire a basic understanding of commonly used imaging and stimulation techniques in cognitive neuroscience: what is measured and/or influenced (physiologically and/or behaviourally), the technical aspects of how it is measured and/or influenced, and its strengths and limitations. The primary process objectives of this course are that you develop the skills and knowledge to design a cognitive neuroscience experiment, analyze and interpret EEG/ERP data, and interpret fMRI data.

At the end of this course, you will be able to:

- Explain, for each technique covered, its technical basis, physiological basis, applications, strengths, and limitations
- Critically evaluate the methods used, and conclusions drawn from, published cognitive neuroscience studies
- Identify common sources of noise for each technique covered, and ways to mitigate them
- Collect, analyze, and interpret high-quality EEG/ERP data
- Design a cognitive neuroscience experiment using any of the techniques taught in the class, taking into consideration the strengths and limitations of the technique

Evaluation Components

Participation (10%)

You can earn 5% of your grade by attending and engaging in lectures, labs, and journal club. “Engagement” in this context means asking questions, providing thoughtful input, and overall contributing to group discussions. You can earn the remaining 5% by attending and participating in the out-of-class group EEG sessions.

ERP lab report (35%)

The major assignment for this course is a lab report describing results from an EEG/ERP experiment. The assignment will be spread across multiple components, detailed below.

Group work

Early in the semester, you will work in teams to collect EEG data from a pre-prepared experiment over a number of weeks. Later on, you will work together to analyze the collected EEG data in such a way that it may be presented in a written lab report (see below).

Written lab report

You will submit and receive feedback on **one draft lab report** (worth 10% of your final grade) and **one final lab report** (worth 25% of your final grade). Detailed requirements for these documents will be provided in the lab on “How to write a lab report” (see Schedule). **Please note that both drafts should reflect the individual work of each student.**

Journal Club presentations (20%)

The majority of our Thursday classes will be dedicated to journal club, in which we will discuss published research articles focussing on applications of the neuroimaging techniques covered in this course. **Early in the semester, you must sign up for two articles that you will present to the rest of the class.** Each presentation is worth 10% of your grade. Presentations must be approximately 15 minutes each, use PowerPoint (or similar) slides, and cover the Introduction, Methods, Results, and Discussion of the presented paper.

Final Exam (35%)

The final exam is a take-home assignment designed to assess your ability to analyze, evaluate, and synthesize information from the class. It will cover all course material from the entire term. It is composed of a set of short and long-answer questions (½ page and 1-1½ pages, respectively). These are broken into sections with a choice of which question to answer in each section. **Please note that this exam should reflect the individual work of each student.**

Expectations

Be engaged! You are expected engage with course material, get involved in seminar discussions, and contribute your fair share to group work.

Don't be a stranger! If you don't understand something, ask a question. If you need advice on an assignment, ask for it sooner rather than later.

Be proactive! It is your responsibility to adhere to assignment instructions and deadlines. Always read the question, sure make you've checked all the boxes in the assignment guidelines, and ask the instructor if something is not clear.

Be respectful to your classmates, the TA, and the instructor. This includes how you communicate (both verbally during classes and with group members, and over email), consideration of other people's busy schedules, and showing up on time for class.

Class schedule (subject to change)

Mondays			Wednesdays			Thursdays	
Date	Topic	Reading	Date	Topic	Reading	Date	Topic
08 Jan	Welcome & Syllabus review	Ch 1	10 Jan	Experimental Design	Ch 2	11 Jan	No class!
15 Jan	EEG I	Ch 3	17 Jan	EEG II	Ch 4	18 Jan	Writing & presenting
22 Jan	MEG I	Ch 5	24 Jan	MEG II	Ch 5	25 Jan	EEG data analysis
29 Jan	OPMs	Ch 5	31 Jan	Oscillatory signals		01 Feb	Journal club
05 Feb	MRI basics	Ch 6	07 Feb	fMRI I	Ch 7	08 Feb	Journal club
12 Feb	fMRI II	Ch 8	14 Feb	Guest lecture: Colin Conrad		15 Feb	Journal club
<i>19 – 23 Feb Reading Week</i>							
26 Feb	sMRI	Ch 9	28 Feb	dMRI	Ch 10	29 Feb	Journal club
04 Mar	PET	Ch 11	06 Mar	fNIRI	Ch 12	07 Mar	Journal club
11 Mar	TMS	Ch 13	13 Mar	tES	Ch 14	14 Mar	Journal club
18 Mar	MVPA I		20 Mar	Guest lecture: Jack Solomon		21 Mar	Journal club
25 Mar	MVPA II		27 Mar	Big data		28 Mar	Journal club
01 Apr	Guest lecture: Lindsey Power		03 Apr	Class TBA *		04 Mar	Class TBA *
08 Apr	Friday classes held, meaning no class for us!						

* Days marked with “Class TBA” are indented as buffers in the event of cancellations caused by snow days, power outages, etc., which are not unheard of during the Winter semester at Dalhousie. These days may be used to catch up on missed classes / accommodate scheduling changes. If no cancellations occur, there will be no class on these days (you may consider them as free study time!).

Assignment Dates

All assessment components are due by 5 PM (AST) on the due date indicated in the table below, with the exception of journal club presentations. Due dates for journal club presentations will vary between students: see Brightspace for your scheduled presentation day.

Assignment	Release date	Due date	% final grade
ERP lab report 1 st draft	18 January	01 March	10%
ERP lab report final draft	15 March *	30 March	25%
Final exam	05 April	16 April	35%
Journal club presentations	See sign-up sheet	See sign-up sheet	20%

* Indicates date on which feedback on 1st draft will be released

Grading Scale

0-49	50-54	55-59	60-64	65-69	70-72	73-76	77-79	80-84	85-89	90-100
F	D	C-	C	C+	B-	B	B+	A-	A	A+

Class Policies

Late Work and SDAs

Time management is one of the many life skills you are expected to demonstrate (and/or develop) in this course. Due dates are firm, and 5% per day will be deducted from your maximum possible mark on any assignment that is turned in late. **If you need an extension on an assignment, you must submit a Student Declaration of Absence (SDA), and then contact the course instructor to arrange a suitable extended deadline. Each student may submit a maximum of two SDAs for this course.**

Academic Freedom

Freedom of speech and of thought are cornerstones of academic institutions such as Dalhousie. Our goal in science is to observe and characterize the world accurately and objectively. However, we must realize that our perceptions of reality are often coloured by our beliefs and assumptions, some of which we may not be aware of. Academic freedom includes not only your freedom to think as you please, but others' freedom to express their beliefs as well. Please do not hesitate to express your ideas, but do so in a way that is respectful of others. This is the only avenue for the free expression and exchange of ideas.

University Policies and Statements

This course is governed by the academic rules and regulations set forth in the University Calendar and by Senate

Academic Integrity

At Dalhousie University, we are guided in all of our work by the values of academic integrity: honesty, trust, fairness, responsibility and respect (The Center for Academic Integrity, Duke University, 1999). As a student, you are required to demonstrate these values in all of the work you do. The University provides policies and procedures that every member of the university community is required to follow to ensure academic integrity. Information: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Accessibility

The Advising and Access Services Centre is Dalhousie's centre of expertise for student accessibility and accommodation. The advising team works with students who request accommodation as a result of a disability, religious obligation, or any barrier related to any other characteristic protected under Human Rights legislation (Canada and Nova Scotia). Information: https://www.dal.ca/campus_life/academic-support/accessibility.html

Student Code of Conduct

Everyone at Dalhousie is expected to treat others with dignity and respect. The Code of Student Conduct allows Dalhousie to take disciplinary action if students don't follow this community expectation. When appropriate, violations of the code can be resolved in a reasonable and informal manner—perhaps through a restorative justice process. If an informal resolution can't be reached, or would be inappropriate, procedures exist for formal dispute resolution. Code: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Diversity and Inclusion – Culture of Respect

Every person at Dalhousie has a right to be respected and safe. We believe inclusiveness is fundamental to education. We stand for equality. Dalhousie is strengthened in our diversity. We are a respectful and inclusive community. We are committed to being a place where everyone feels welcome and supported, which is why our Strategic Direction prioritizes fostering a culture of diversity and inclusiveness. Statement: <http://www.dal.ca/cultureofrespect.html>

Recognition of Mi'kmaq Territory

Dalhousie University would like to acknowledge that the University is on Traditional Mi'kmaq Territory. The Elders in Residence program provides students with access to First Nations elders for guidance, counsel and support. Visit or e-mail the Indigenous Student Centre (1321 Edward St) (elders@dal.ca). Information: https://www.dal.ca/campus_life/communities/indigenous.html

Important Dates in the Academic Year (including add/drop dates)

https://www.dal.ca/academics/important_dates.html

University Grading Practices

https://www.dal.ca/dept/university_secretariat/policies/academic/grading-practices-policy.html

Student Resources and Support

Advising

General Advising https://www.dal.ca/campus_life/academic-support/advising.html

Science Program Advisors: <https://www.dal.ca/faculty/science/current-students/academic-advising.html>

Indigenous Student Centre: https://www.dal.ca/campus_life/communities/indigenous.html

Black Students Advising Centre: https://www.dal.ca/campus_life/communities/black-student-advising.html

International Centre: https://www.dal.ca/campus_life/international-centre/current-students.html

Academic supports

Library: <https://libraries.dal.ca/> Writing Centre: https://www.dal.ca/campus_life/academic-support/writing-and-study-skills.html

Studying for Success: https://www.dal.ca/campus_life/academic-support/study-skills-and-tutoring.html

Copyright Office: <https://libraries.dal.ca/services/copyright-office.html>

Fair Dealing Guidelines <https://libraries.dal.ca/services/copyright-office/fair-dealing.html>

Other supports and services

Student Health & Wellness Centre: https://www.dal.ca/campus_life/health-and-wellness/services-support/student-health-and-wellness.html

Student Advocacy: <https://dsu.ca/dsas> Ombudsperson: https://www.dal.ca/campus_life/safety-respect/student-rights-and-responsibilities/where-to-get-help/ombudsperson.html

Safety

Biosafety: <https://www.dal.ca/dept/safety/programs-services/biosafety.html>

Chemical Safety: <https://www.dal.ca/dept/safety/programs-services/chemical-safety.html>

Radiation Safety: <https://www.dal.ca/dept/safety/programs-services/radiation-safety.html>

Scent-Free Program: <https://www.dal.ca/dept/safety/programs-services/occupational-safety/scent-free.html>

Dalhousie COVID-19 information and updates: <https://www.dal.ca/covid-19-information-and-updates.html>