DALHOUSIE UNIVERSITY

Syllabus

PSYO/NESC 3137
Research Methods in Cognitive Neuroscience

Winter, 2024-25

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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.

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 primarily on non-invasive techniques but also touching on invasive ones. 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. As well we will discuss future applications of neurotechnology, and the ethical implications raised by these advances.

Due to the breadth of techniques covered, the course necessarily provides a broad overview rather than in-depth coverage of most techniques. However, in the lab component we will focus in more depth on two of the most common research methods in cognitive neuroscience, ERP and fMRI. In the labs, students will learn to record and analyze ERP data, and to analyze fMRI data, as well as being exposed to MEG, MRI, and TMS techniques through lab tours/demonstrations.

Learning Objectives

As a laboratory course, there are both "content" and "process" objectives. The primary *content* objective is that you acquire a basic understanding of the imaging and stimulation techniques most commonly used 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 to design and run an event-related potential (ERP) experiment and analyze the data, including best practices for collecting high-quality data; and that you are able to process and analyze functional MRI data.

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

- Explain, for each technique covered, its
    - technical basis
    - physiological basis
    - applications
    - strengths
    - limitations
- Critically evaluate the methods used, and conclusions drawn from, published cognitive neuroscience studies
- Apply an EEG cap and collect high-quality data, as well as being able to identify common sources of noise in EEG data and know how to minimize these
- Process and analyze EEG/ERP data, and explain the rationale for each step
- Process and analyze fMRI data, and explain the rationale for each step
- Design a cognitive neuroscience experiment using any of the techniques taught in the class, taking into consideration the strengths and limitations of the technique
- Evaluate the ethical implications of neurotechnology, with reference to established research ethics guidelines (TCPS 2) and the neuroethics literature

Course Format

The class meets twice per week, on Monday and Wednesday afternoons from 2:35–4:20. In general, Mondays are lecture/discussion sessions and Wednesdays are lab sessions; however pay close attention to the schedule as there are several deviations from this pattern. Like any class, you are required to spend significant time outside of the assigned class time working on the course. In particular for this class, **in the first two months of the term you will have to spend time outside of class on your group ERP projects**, first developing the stimuli and then collecting the data. This is discussed in more detail below.

Lecture/Discussion Sessions
I believe that interactive class formats are optimal for learning, and this is reflected in how I run the course. I will provide the material I expect you to learn in written format, and expect that you read it on your own time outside of class. This way you can absorb information at your own rate and on your own time, and re-read sections that you don't fully understand. Then in lecture/discussion classes, I will review key points in the material I expected you to learn—however, the lectures do not provide all the detailed information that the readings do. For labs and assignments/exams I expect you to demonstrate learning of all the material in the readings, not just what we had time to cover in class.

Lab Sessions
The lab sessions will be used in a variety of ways, all aimed at providing hands-on experience with cognitive neuroscience experiments. In the first part of the term, these will be devoted to learning how to collect and analyze EEG/ERP data. In the latter part of the term, the lab sessions will be devoted to fMRI data preprocessing and analysis. Some lab slots will also be used for demonstrations of different cognitive neuroscience techniques in labs on campus and at local hospitals.

Outside 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 regular, 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 set up and then run the team's EEG/ERP experiment.

Course Materials

Required text:

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

As well, the ERP Lab Report is expected to be written in APA 7 style. Adherence to this style will be graded quite strictly, so it is highly recommended that you own the official style guide. Yes, you can find brief summaries of APA style basics on line, but APA style is a lot more than reference formatting, and we expect *full* adherence to the style:

American Psychological Association. (2020). *Publication manual of the American Psychological Association, Seventh Edition*. Washington, D.C.: American Psychological Association.

I also highly recommend this short book on writing habits and style:

Silvia, Paul. J. (2007). *How to write a lot*. APA Life Tools.

Course Web Site

The course web site is available on Brightspace. This will be the definitive source for assignment instructions, due dates, and materials. However, sometimes things are discussed in class that don't immediately make it on to the web site. Therefore, the onus is on you to attend all classes and consult with classmates or the instructor if you miss a class.

Evaluation Components

Due dates for all assessment components are described below or in the schedule. The final exam will be scheduled by the university and posted.

Laboratory Techniques (10%)
In this course you will be taught how to use EEG and fNIRS technologies to record functional data from the human brain. You will be assessed on your understanding of the steps involved in acquiring each type of data, and your performance in conducting them. These assessments will occur during the final data collection session for each technique (week 3 for EEG and week 10 for fNIRS), and will involve the teaching team observing you as well as asking questions about what you are doing.

- EEG: 5%
- fNIRS: 5%

ERP Lab Report (15%)
You will collect data from your classmates in an EEG experiment during the lab component of the course, analyze it, and write it up in a lab report.

fNIRS Lab Report (15%)
You will collect data from your classmates in an fNIRS experiment during the lab component of the course, analyze it, and write it up in a lab report.

Exams (60%)
Exam 1 (15%) will cover the material in chapters 1-5 of the textbook.

Exam 2 (15%) will cover the material in chapters 6-9 of the textbook.

Exam 3 (30%) will be a cumulative final exam covering material from all textbook chapters, as well as the labs.

Bonus Points (3%)
- You may earn a bonus worth 1% of your final grade for participating in a university-run "self improvement" class. Please ask the instructor of the class to email me confirmation of your attendance. Email is preferred because I can't verify written notes easily; it is your job to ensure the instructor follows up with the email to me.

Options for these workshops include the following, but others may be possible — feel free to ask the instructor if an idea you have will count:

- Studying for Success Program (time management, note-taking, study skills)
- University Writing Centre (help on choosing a topic, organizing ideas, clear and accurate written expression, proper referencing and citation)
- Counselling Services (Speak Easy program for public speaking, Exam Anxiety program)

- You may earn an additional **2%** for participating in research studies offered by the Department of Psychology & Neuroscience through the SONA system.

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+

Expectations

- Be *proactive*. Stay on top of the course, ask questions sooner than later, use all of the resources available to you. Requests for advice should be made prior to the due date, not the day before the assignment is due.

- Be *prepared*. View and/or read what is assigned prior to coming to class. With the class format, it will be very apparent if you have not properly prepared.

- *Attend* and actively participate in all classes.

- Be *engaged!* I love questions. Answering them makes me feel smart. Feel free to ask questions even if you're not called on, or engage in discussion concerning another student's question.

- For all assignments and exam questions, *pay attention to what is asked* of you and address these points/ questions directly, respecting length requirements. Do not simply dump everything you can remember about a topic in an unorganized fashion, or go on at length about things only tangentially related to the question.

- *Strive to excel.* Even if you have done well thus far in University, keep in mind that we continue to "raise the bar" in higher-level courses. This class emphasizes higher-level cognitive skills like questioning, analyzing, and evaluating information, rather than just memorizing and regurgitating it.

- Be *respectful* of your group members, other classmates, the TA, and the instructor. This includes the way you speak, the thought you put into emails, and consideration of other people's busy schedules. In looking for answers to questions, try to find them yourself first (e.g., on the calendar or discussion boards of the class website), rather than dashing off a question to the instructor before bothering to look for the answer. The instructor may respond frostily (or not at all) to questions that have obvious/easily-accessible answers. I have provided you with my cell number; feel free to call or text but again, be respectful of personal time and don't respect an instant response, especially during "off" hours.

Class Policies

Attendance/Declaration of Absence

If you have to miss class or another class-related commitment for reasons including short-term physical or mental health conditions, or other extenuating circumstances (such as caregiving duties; immediate family illness, injury or death; involvement in an accident; legal proceedings; being a victim of a crime, domestic or intimate partner violence.) that may affect their ability to complete required graded academic requirements. you may submit a **Student Declaration of Absence (SDA)** form. You may submit a maximum of two separate SDA forms per course during a term. These can be submitted online through the class Brightspace page.

Since a significant portion of your final grade is based on participation, failure to attend classes regularly will adversely affect your grade. If you need to miss a significant number of classes (3 or more), please discuss this

with the instructor, ideally beforehand. In most cases some form of documentation supporting your request (e.g., doctor's note) will be required for consideration. Requests made after due dates have passed are unlikely to be granted except in exceptional circumstances.

For major and chronic physical or mental health conditions, or other long-term or recurring absences, you should refer to the University's *Missed or Late Academic Requirements due to Student Absence* regulation and the Accommodation Policy.

Group Participation and Etiquette

You are expected to show up for all of the meetings organized by and for your team for the ERP experiment and other group work. If you experience difficulties with other group members (e.g., you think someone is not pulling her or his weight) please bring this to the attention of the instructor ASAP. This being said, working in teams is a necessity in most jobs and this involves dealing with personality types and styles that may rub you the wrong way. You will be rewarded (personally and professionally) by learning how best to adapt yourself to such situations and find strategies that get the work done.

Late Work

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 **10% *per day* will be deducted from your maximum possible mark on any assignment that is turned in late**. Deadlines are specified on Brightspace to the minute, and the margin of error is 5 minutes. If you are having technical difficulties submitting, email the instructor (and cc the TA) within 5 minutes of the deadline. You are given ample time to complete the assignments, so waiting until the last minute, then having your computer crash or getting sick etc. is not an excuse. Since the only exam is a take-home exam that will be handed out the last day of class, and you will be given over a week to complete it, you can expect very little tolerance for requests for extensions.

All hard drives fail, usually with no warning, and usually very soon before some deadline. In this day and age, **there is no excuse for losing work due to a computer failure**. Dalhousie provides you with free cloud storage via OneDrive. You should set up OneDrive on your computer and use that folder as the place where you save all your school-related files. Then, things are automatically backed up to the cloud every time you save a file, and will be accessible from other computers or via my.dal.ca if and when disaster strikes. There are many other, also-free options like Dropbox, Google Drive, and iCloud, but OneDrive is Dal's officially-supported one.

Late work *may* be accepted by prior arrangement (preferred), or after the fact under exceptional circumstances. You must provide documentation from a physician or other person qualified to judge your inability to work on the assignment for a significant portion of the period that you were given to work on it. The Teaching Assistant does not have the authority to consider such requests, so please direct them to the instructor.

Class Disruptions

Respect for others extends to consideration of the fact that we come together in this class to learn. Behaviours that get in the way of this will not be tolerated. These include annoyances such as talking during lectures or when others are talking, messaging in class, phones ringing, wearing heavily scented products, surfing the net, watching movies, or doing something else not class-related . If you find the actions of someone else in the class distracting or otherwise disruptive of the goals of the class, you may bring it to the instructor's attention and it will be dealt with anonymously.

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 do 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.

Tentative Schedule
Subject to change - check class website regularly

Week	Date	Topic	Reading
1	8-Jan-25	Introduction to the course	Chapters 1-2
	10-Jan-25	EEG/ERP	Chapter 3
	10-Jan-25	Lab: Introduction to EEG	
2	15-Jan-25	EEG/ERP	
	17-Jan-25	EEG/ERP	Chapter 4
	17-Jan-25	Lab: Our EEG experiment	
3	22-Jan-25	EEG/ERP	
	24-Jan-25	MEG	Chapter 5
	24-Jan-25	Lab: EEG data collection	
4	29-Jan-25	MEG	
	31-Jan-25	Exam 1	
	31-Jan-25	Lab: EEG data analysis	
5	5-Feb-25	MRI	Chapter 6
	7-Feb-25	fMRI	Chapter 7
	7-Feb-25	Lab: EEG data analysis	
6	12-Feb-25	fMRI	
	14-Feb-25	fMRI	Chapter 8
	14-Feb-25	Lab Tour	
		Reading week	
7	26-Feb-25	fMRI	
	28-Feb-25	fNIRS	Chapter 12
	28-Feb-25	Lab Tour	
8	5-Mar-25	fNIRS	
	7-Mar-25	Structural MRI	Chapter 9
	7-Mar-25	Lab: Introduciton to fNIRS	
9	12-Mar-25	Exam 2	
	14-Mar-25	Connectomics	Chapter 10
	14-Mar-25	Lab: Our fNIRS experiment	
10	19-Mar-25	Connectomics	
	21-Mar-25	PET	Chapter 11
	21-Mar-25	Lab: fNIRS data collection	
11	26-Mar-25	TMS	Chapter 13
	28-Mar-25	TMS	
	28-Mar-25	Lab: fNIRS data analysis	
12	2-Apr-25	TES	Chapter 14
	4-Apr-25	TES	
	4-Apr-25	Lab: fNIRS data analysis	

University Policies

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 at 1321 Edward St or elders@dal.ca. Additional information regarding the Indigenous Student Centre can be found at: https://www.dal.ca/campus_life/communities/indigenous.html

Internationalization
At Dalhousie, 'thinking and acting globally' enhances the quality and impact of education, supporting learning that is "interdisciplinary, cross-cultural, global in reach, and orientated toward solving problems that extend across national borders." Additional internationalization information can be found at: https://www.dal.ca/about-dal/internationalization.html

Academic Integrity
At Dalhousie University, we are guided in all our work by the values of academic integrity: honesty, trust, fairness, responsibility, and respect. As a student, you are required to demonstrate these values in all 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. Additional academic integrity information can be found at: https://www.dal.ca/dept/university_secretariat/academic-integrity.html

Use of Generative Artificial Intelligence
The use of generative AI in writing lab reports or exams is not permitted for this course. Your written work submitted for evaluation should not include text produced by generative AI.

You are permitted to use AI coding assistants (such as GitHub Copilot) to help you understand and modify the code provided for data analysis, to analyze data collected in this class for the lab reports.

Accessibility
The Student Accessibility Centre is Dalhousie's centre of expertise for matters related to student accessibility and accommodation. If there are aspects of the design, instruction, and/or experiences within this course (online or in-person) that result in barriers to your inclusion, please contact the Student Accessibility Centre (https://www.dal.ca/campus_life/academic-support/accessibility.html) for all courses offered by Dalhousie with the exception of Truro. For courses offered by the Faculty of Agriculture, please contact the Student Success Centre in Truro (https://www.dal.ca/about-dal/agricultural-campus/student-success-centre.html)

Conduct in the Classroom – Culture of Respect
Substantial and constructive dialogue on challenging issues is an important part of academic inquiry and exchange. It requires willingness to listen and tolerance of opposing points of view. Consideration of individual differences and alternative viewpoints is required of all class members, towards each other, towards instructors, and towards guest speakers. While expressions of differing perspectives are welcome and encouraged, the words and language used should remain within acceptable bounds of civility and respect.

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 (Strategic Priority 5.2). Additional diversity and inclusion information can be found at: http://www.dal.ca/cultureofrespect.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. The full Code of Student Conduct can be found at: https://www.dal.ca/dept/university_secretariat/policies/student-life/code-of-student-conduct.html

Fair Dealing Policy

The Dalhousie University Fair Dealing Policy provides guidance for the limited use of copyright protected material without the risk of infringement and without having to seek the permission of copyright owners. It is intended to provide a balance between the rights of creators and the rights of users at Dalhousie. Additional information regarding the Fair Dealing Policy can be found at: https://www.dal.ca/dept/university_secretariat/policies/academic/fair-dealing-policy-.html

Originality Checking Software

The course instructor may use Dalhousie's approved originality checking software and Google to check the originality of any work submitted for credit, in accordance with the Student Submission of Assignments and Use of Originality Checking Software Policy. Students are free, without penalty of grade, to choose an alternative method of attesting to the authenticity of their work and must inform the instructor no later than the last day to add/drop classes of their intent to choose an alternate method. Additional information regarding Originality Checking Software can be found at: https://www.dal.ca/about/leadership-governance/academic-integrity/faculty-resources/ouriginal-plagiarism-detection.html

Student Use of Course Materials

Course materials are designed for use as part of this course at Dalhousie University and are the property of the instructor unless otherwise stated. Third party copyrighted materials (such as books, journal articles, music, videos, etc.) have either been licensed for use in this course or fall under an exception or limitation in Canadian Copyright law. Copying this course material for distribution (e.g. uploading to a commercial third-party website) may lead to a violation of Copyright law.