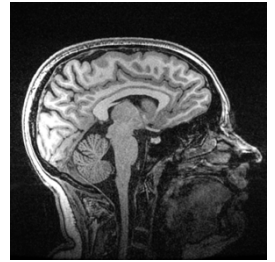


NRSC 4421: Human Neuroimaging



This is me! ☺

Instructor: Arielle Keller, arielleskeller@gmail.com

Office Hours: Mondays 4:00pm - 5:00pm (Virtual) or by appointment

<https://pennmedicine.zoom.us/j/92659445031?pwd=Rk9JTjZHbDI5Qy9jOTBibGdTRWd4dz09>

Class Time: Fridays 12:00pm - 2:59pm

Location: Solomon Laboratories A30

Class Description

Welcome to NRSC 4421: Human Neuroimaging! This course is designed to broaden and deepen your knowledge of human neuroimaging, as well as to develop your scientific thinking and communication skills.

How can we see the human brain in action? What tools do we have available to watch the fast-changing electrical activity generated by neurons, image the brain's fine structural details, follow the dense white matter highways that connect distant brain areas, or identify networks of brain regions that communicate with one another? Together, these many aspects of brain structure and function support all the different things the brain can do: sensing and perceiving the world around us, solving complex problems, feeling emotions, engaging in motor abilities, socializing with our friends and family, and just about everything else we do as humans.

Neuroscience is a highly interdisciplinary field, interacting with psychology, biology, physics, computer science, engineering, chemistry, sociology, medicine, and many more areas of study! For this reason, neuroscience depends upon diverse perspectives and relies on interdisciplinary communication. Our class will therefore be focused on developing and practicing these critical neuroscience skills by sharing our ideas with one another. Each of us will bring to the class a unique set of background knowledge, experiences, and perspectives that together will lead us to rich discussions and innovative ideas as we learn about human neuroimaging.

In NRSC 4421, we will consider several different neuroimaging modalities that allow us to get a full picture (and even video!) of the human brain's structure and function. You will gain both a breadth of understanding of the strengths and shortcomings of different neuroimaging approaches, as well as a depth of understanding about a few of the most common human neuroimaging methods (including fMRI and EEG). Throughout the course, you will gain experience with asking scientific questions, reading scientific papers, presenting scientific ideas to your peers, giving and receiving critical feedback, and designing a human neuroscience study of your own.

Please do not hesitate to reach out to me with any questions or concerns throughout the course. I look forward to meeting each of you!

Course Learning Objectives

By the end of this class, you should be able to...

1. Evaluate the strengths and shortcomings of different human neuroimaging methods and choose an appropriate method for a given scientific question
2. Search for, read and comprehend human neuroimaging research articles
3. Design a human neuroimaging study and write a grant-style proposal
4. Communicate scientific ideas in both written and oral formats

Class Structure

NRSC 4421 will meet on Fridays from 12:00pm - 3:00pm. We will use Canvas for course-related materials and announcements. In each class meeting, we will engage in a variety of activities and discussions related to the day's topic (see Course Schedule, below). You will be engaging with your peers and myself in both large and small groups.

Each week, you will complete a homework assignment, which you should be prepared to discuss in the following class. Homework may involve a short writing assignment, reading a paper, and/or preparing a presentation. Most of the writing assignments will build up toward the **Research Proposal Writing Assignment** (see below). To make the best use of class time for yourself and other students, please be ON TIME and ready to engage in discussion!

What you can expect from me: I am dedicated to providing the best possible learning experience for you. I will come on-time and prepared to each class session, ready to lead discussions and answer your questions about the content to the best of my ability. I will promote an inclusive learning environment by valuing contributions from students from all backgrounds and incorporating a variety of activities in our class sessions. I have designed our course structure and assignments to address our course goals as much as possible, and I am open to your feedback, which I will seek often and actively incorporate in making changes throughout this year's course. Please feel free to contact me if you have any questions or concerns – I am here to help!

What I expect of you: Engaging with your peers during in-class discussions and activities is a critical component of this course. You are expected to complete homework assignments by Friday at 12pm before the start of class, arrive on-time and be ready to discuss with your classmates. The amount of time spent on assignments each week will vary, but I anticipate you will spend at least **1.5 hours per week** on your assignments. If you are unable to attend a class or complete an assignment on time, please communicate with me *beforehand* to arrange alternative solutions. During class, I expect that you will be respectful of other students and acknowledge the diversity of backgrounds and expertise in the room. Taking notes on electronic devices is permitted, but please refrain from texting or using social media during class time. I also expect you to be familiar with and comply with the Penn Code of Academic Integrity:

<https://catalog.upenn.edu/pennbook/code-of-academic-integrity/>

Attendance and Participation

Attendance and participation will constitute 15% of your grade for this course. In order to receive full credit, you must attend all classes and participate in class activities, or complete all make-up assignments if you need to miss class (e.g. if you are sick).*

If you need to miss a class, arrive late, or leave early, I expect you to inform me ahead of time. I will work with you to make sure you are up-to-date on the in-class discussions and assignments. If you are unexpectedly late/absent, expect that I will follow up with you to check-in and make sure everything is okay. If you miss class time, I will expect you to keep up-to-date by reviewing class materials and completing make-up activities on Canvas. This may entail answering short questions related to in-class discussions.

*** If you are feeling sick for any reason, have been exposed to COVID-19, or have any COVID-related symptoms, please do not come to class in person.** Reach out to me and I will provide make-up materials and make sure you are up-to-date.

Mask Requirement: In light of current Covid-19 conditions, **I will be requiring that masks be worn at all times during class.** More information can be found on [Penn's Covid-19 FAQ page](#). If you have concerns about this policy, please talk with me.

Assignments and Grading

All assignments will be due by Friday at 12pm on Canvas, one week after the homework is assigned. Because class lessons will be based on the assignments, completing assignments to the best of your ability and on-time is an important part of your learning experience. If you cannot complete your assignment due to extenuating circumstances, please talk to me (at office hours or by email) **beforehand**. I will do my best to accommodate you within reason, especially given the COVID-19 situation.

The grading breakdown for the course assignments is as follows:

- 15% Attendance and Participation
- 15% Journal Club Presentation
- 10% Classroom Proposal (5% Presentation; 5% Peer Review)
- 60% Research Proposal Writing Assignment
 - 5% Paper Summaries
 - 5% Initial Proposal
 - 10% Specific Aims draft
 - 10% Methods draft
 - 10% Introduction draft
 - 10% Discussion draft
 - 10% Final proposal



Note #1: Grades will be based on your own work and will not be curved.

Teamwork and collaboration are encouraged!

Note #2: Coding exercises will not be graded for correctness, only completeness.

Completion of all three coding assignments (Signal Processing, Signal/Noise, and Linear Systems) are worth +5 extra credit (e.g., bringing a final grade of 90 to 95).

Setting up for an EEG experiment

Research Proposal Writing Assignment

The purpose of the Research Proposal Writing Assignment is to synthesize your learning throughout this class and will give you an opportunity to showcase your progress in human neuroimaging study design and scientific communication. For this assignment, you will identify a research question that can be answered using a human neuroimaging study. You will present your ideas in the form of a research proposal that you will develop and receive feedback on throughout the semester. We will build up to the final written proposal through the weekly homework assignments:

1. Introduction (1-2 pages): Background about the field and question, and a summary and evaluation of two background papers.
2. Identification of an open question and your testable hypotheses (1-2 paragraphs)
3. Specific Aims (1 page): Two to three key objectives: for each aim, state the question, proposed experimental design, measurements, and potential results. Connect your potential results to how they will help answer the stated question.
4. Methods (1 page): Elaborate on the neuroimaging method you chose and why, including details about your experiment setup and variables you will control for.
5. Discussion (1-2 pages): This section will summarize the research question, hypotheses, proposed experiments, potential outcomes, limitations and significance.

Classroom Proposal

The purpose of this assignment is to practice communicating your research ideas with other scientists, including giving and receiving peer review feedback. You will each prepare a (15min) presentation of your proposed research study. Your presentation should cover relevant background, an explanation of the open question your study will address, your testable hypotheses and specific aims, the human neuroimaging method you've chosen to address your open question, potential outcomes and their significance, and the limitations of your approach. Be sure to include a brief explanation for why you chose the human neuroimaging method that you did and the pros/cons of this choice. Following the peer review guidelines we will go over in class, you will provide peer review feedback for your classmates' Classroom Proposals.

Journal Club Presentation

The purpose of this presentation is for you to practice reading and comprehending scientific articles and communicating about science with your peers. You will each prepare a short (5-7min) overview of a human neuroimaging primary research article, provide your own critical evaluation of the scientific research study, and lead a discussion about it (3-5min) with your peers.

Accommodations: University of Pennsylvania provides reasonable accommodations to students with disabilities who have self-identified and been approved by Student Disabilities Services (SDS). If SDS has approved your request for accommodations, please make an appointment to meet with me to discuss the arrangements for your accommodations. If you have not yet contacted SDS and would like to request accommodations or have questions, please visit <https://www.vpul.upenn.edu/lrc/sds/>.



Setting up for an fMRI experiment

Course Schedule

Date	Content	Assignment (due next class)
January 13 th	<p>Introductions</p> <p>An overview of brain imaging</p> <p>What can we learn from human neuroimaging?</p>	<p>Scientist Spotlight Activity</p> <p>Download Matlab: https://computing.sas.upenn.edu/matlab-student</p> <p><i>DUE: 1/20</i></p>
January 20 th	<p>Scientist Spotlight Discussion</p> <p>Introduction to MRI</p> <p>Types of MRI (fMRI, sMRI)</p> <p>Activation, Functional Connectivity, and Functional Topography</p> <p>How to read a scientific paper</p>	<p>Choose a broad topic area for your Research Proposal. Upload to Canvas 1 short paragraph describing your chosen topic area and why it drew your interest.</p> <p>Read assigned scientific paper and be prepared to discuss at the next class session. Submit on Canvas a minimum of three questions and your “Muddiest point” (a part of the paper that was challenging to understand).</p> <p><i>DUE: 1/27</i></p>
January 27 th	<p>Electrical activity in the brain</p> <p>Introduction to EEG/ECoG</p> <p>Scientific paper discussion I</p> <p>How to use PubMed to search for scientific papers</p> <p>Anatomy of an abstract</p>	<p>Use PubMed to search for two scientific papers that will serve as the background for your Research Proposal.</p> <p>Upload your two research papers to Canvas and write 1 paragraph for each, briefly summarizing the findings.</p> <p><i>DUE: 2/3</i></p>

February 3 rd	<p>Statistical methods for analyzing human neuroimaging data</p> <p>Review: fMRI and EEG</p> <p>Debate: fMRI vs. EEG</p>	<p>Write the Initial Proposal (1-2 paragraphs). Identify an Open Question and your testable hypotheses that you will address in your Research Proposal.</p> <p><i>DUE: 2/10</i></p>
February 10 th	<p>Matching measurements to scientific questions</p> <p>Guest Lesson: Imaging Psychiatric and Neurological Disorders</p> <p>How to write "Specific Aims"</p>	<p>Write a rough draft of your 2-3 Specific Aims (1 sentence each).</p> <p>Elaborate on your 2-3 Specific Aims by writing a paragraph each, including proposed experiments and potential results.</p> <p><i>DUE: 2/17</i></p>
February 17 th	<p>Other brain imaging modalities: MEG, PET</p> <p>Scientific Communication I: Written</p> <p>Mind-Reading! (Intro to Decoding)</p>	<p>Write a paragraph about the Significance of your proposed study</p> <p>Read assigned scientific paper and be prepared to discuss at the next class session. Submit on Canvas a minimum of three questions and your "Muddiest point" (a part of the paper that was challenging to understand).</p> <p><i>DUE: 2/24</i></p>
February 24 th	<p>Guest Lesson: Introduction to white matter imaging</p> <p>Scientific Paper Discussion II</p> <p>Scientific Communication II: Oral</p>	<p>Write a rough draft of your Methods.</p> <p>Read assigned scientific paper and be prepared to discuss at the next class session. Submit on Canvas a minimum of three questions and your "Muddiest point" (a part of the paper that was challenging to understand).</p> <p><i>DUE: 3/3</i></p>

March 3 rd	<p>Guest Lesson: Introduction to Time Series Analysis</p> <p>Scientific Paper Discussion III</p> <p>Brain stimulation: TMS/TDCS</p>	<p>Write a rough draft of your Introduction.</p> <p>Coding exercise: Signal Processing</p> <p><i>DUE: 3/17</i></p>
March 10 th	NO CLASS, SPRING BREAK	
March 17 th	<p>Challenges in neuroimaging I: Head Motion, Artifacts</p> <p>Challenges in neuroimaging II: Reproducibility Crisis</p> <p>Open Science</p>	<p>Write a paragraph about the Limitations of your proposed study. For each limitation or challenge you discuss, include a comment about 1) how you will attempt to overcome this limitation in your proposed study and/or 2) how future studies may address the limitation.</p> <p>Coding exercise: Signal and Noise</p> <p><i>DUE: 3/24</i></p>
March 24 th	<p>Tour MRI facility!</p> <p>Tour EEG Lab!</p>	<p>Prepare Journal Club Presentations</p> <p><i>DUE: 3/31</i></p>
March 31 st	<p>Journal Club Presentations</p> <p>What is peer review?</p>	<p>Prepare Proposal Presentations</p> <p>Coding exercise: Linear Systems</p> <p>OPTIONAL coding exercise: GLM</p> <p><i>DUE: 4/7</i></p>

April 7 th	Proposal Presentations and Peer Review I	<p>Group 1: Edit your Research Proposal based on your peer reviews</p> <p>Group 2: Submit your peer reviews on Canvas</p> <p><i>DUE: 4/14</i></p>
April 14 th	Proposal Presentations and Peer Review II	<p>Group 2: Edit your Research Proposal based on your peer reviews</p> <p>Group 1: Submit your peer reviews on Canvas</p> <p><i>DUE: 4/21</i></p>
April 21 st	Celebration and review!	<p>Post-class reflection + feedback</p> <p>Final Research Proposal Writing Assignment</p> <p><i>DUE: 5/5</i></p>