

NEUROFEEDBACK

Class Times: Th 1:05-4:00pm in Dana 204 | Office Hours: M 3:10-4:10pm/Th 4:30-5:30pm/by appt.

Instructor

Dr. Justin Hulbert
 pronouns: he/his/him
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Course Materials

Course materials will be posted on **Lyceum**.

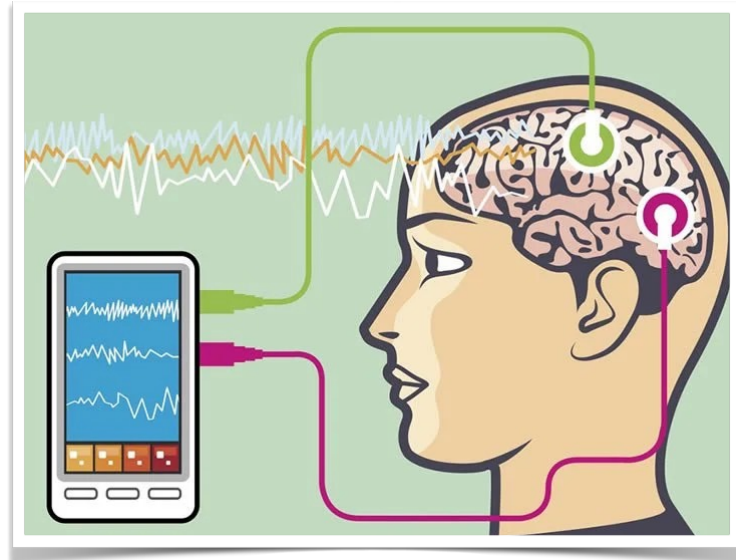
Prerequisite(s)

NS/PY 160 (Introduction to Neuroscience) or PSYC 215 (Medical Psychology). Not open to first-year students.

Assessments

- Weekly Question Response w/ Evidence Slide: **20%**
- Group Project Report‡: **30%**
- Project Checkpoints‡: **15%**
- Poster Presentation‡: **15%**
- Research Participation: **5%**
- Class Engagement: **5%**
- Final Reflection: **10%**
- Extra Credit: **up to 4 extra percentage points**

‡Indicates group assignment



Course Overview

There is much yet to learn by studying how the brain responds to different challenges and opportunities. But can brain signals themselves be used to drive intellectual and physical improvements in healthy individuals, as well as in clinical populations? This seminar explores the evolution of neurofeedback techniques that allow individuals to self-regulate via near real-time representations of their own brain activity. Various methodologies (e.g., electroencephalography, functional magnetic resonance imaging), applications (e.g., rehabilitation, treatment of neuropsychological disorders, meditation, and cognitive and athletic enhancements), theoretical implications, limitations, and ethics of neurofeedback will be examined through in-depth discussion and critical analysis of the empirical literature, case studies, and related texts. Students will also have the opportunity to experience neurofeedback firsthand and propose their own testable implementation of its use.



Learning Objectives

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

- Describe what EEG/ERP/ fMRI signals can and cannot tell us, and why those limits matter for neurofeedback.
- Evaluate neurofeedback claims by separating evidence from interpretation and reasoning under uncertainty.
- Design and justify a feasible neurofeedback study with clear hypotheses, controls, and measurable outcomes.
- Use neurofeedback tools to collect, visualize, and interpret data while identifying artifacts and confounds.
- Formulate, refine, and defend progressively better scientific questions about neurofeedback.

Joint Responsibilities

Achieving the broad aims of this course requires commitments from all of us. Below you will find an outline of some of those responsibilities. Did I leave something out? Let me know—we can discuss additional responsibilities/group norms as a class.

- **Your instructor agrees to...**
 - a) Make himself available outside of class during posted office hours (and by appointment, as necessary) to answer questions, provide extra help, and discuss matters related to the course of study.
 - b) Respond in a timely fashion to email queries. I encourage you to email me with questions, as this is often easier and faster than arranging a meeting. However, I aim to set healthy work-life boundaries, and I do not check email at home. Instead, I check email primarily once per day, usually around 5 or 6pm. This helps me give more focused attention to your messages (instead of fragmented replies throughout the day) and also models good practices for managing time and focus. You generally can expect a response within one business day, and often sooner if your message arrives before my daily email block. Messages sent in the evening or on weekends will be answered the next school day. Don't wait until the last moment (e.g., right before a deadline) to contact me. For questions that require more detailed discussion, I may suggest we meet in person during office hours.
 - c) Facilitate a thoughtful, considerate, and engaging learning environment.
 - d) Provide adequate time to complete assignments, minimize changes to the published schedule/ assignments, and immediately notify students about any such changes.
 - e) Provide comprehensive and fair assessments of materials presented or assigned. Assignments, with a level of feedback commensurate with the nature and aims of the task, will be returned to students in a



Best Practices

You are encouraged to:

- Let me know if I can clarify a concept or slow down
- Ask questions during lecture so that everyone benefits

To make the most of office hours, it is recommended that you:

- Avoid waiting until the last minute (e.g., before a due date) to attend. Seeking help well in advance of deadlines will leave you plenty of time to act on advice discussed.
- Email the instructor in advance or bring with you a concise list of topics/questions you wish to discuss, if possible. Itemizing in this way helps ensure all your questions are addressed and saves you time in the long run. That said, *dropping by for a spontaneous, broader chat is also most welcome.*

timely fashion.

- f) Create and welcome opportunities for students to provide feedback on the course/teaching throughout the semester.
- **You are responsible for...**
 - a) Showing up to class regularly, on time, and prepared, as detailed in the below Attendance policy.
 - b) Checking your **Bates email** and **Lyceum** regularly for important announcements about the course, including alterations due to weather emergencies and other Unforeseen Events.
 - c) Giving your participation, readings, and assignments the time and effort they deserve. There is no substitute for a deep and focused consideration of the material, spaced out over time and considered actively.
 - d) Substantively participating in class discussions and other relevant activities. This could, for instance, involve asking/answering questions related to the offered course materials. Note that a top-notch level of participation does not necessitate responding to every question raised in class or online; active or passive efforts to welcome contributions from everyone in the class are also looked upon favorably. Though you are welcome to challenge your fellow students' or your instructor's thoughts and conclusions, please do so in a fashion that is respectful. Challenge ideas, not the person raising them. More information can be found in the Diversity and Inclusion section, below.
 - e) Submitting assignments on time, digitally via Lyceum. Extensions may be granted for extenuating personal circumstances or illness. Please reach out as soon as you think you may need an extension so we can work out an arrangement. Otherwise, any late assignment will immediately be subject to a 10% penalty, with an additional 10% penalty leveled



against that assignment's score for every 24 hours it remains late. *No late work will be accepted after 11:59pm on day final examinations end for the semester (according to the published academic calendar).*

- f) Using electronic devices wisely and respectfully. See section on In-Class Electronic Device Policy, below.
- g) Upholding academic integrity. See the sections on Academic Integrity and Use of Artificial Intelligence (AI), below.

Assessments

- **Weekly Question Response with Evidence Slide** (20% of your final grade). Most weeks, you will submit (before class, via Lyceum) a short preliminary response that represents your best current answer to the guiding question for that class (see Tentative Course Schedule). Think of this as a "snapshot" of your thinking before we work on the question together in class. I fully expect your view to evolve—sometimes dramatically—over the course of the semester, but that only works if you arrive having genuinely thought about the question. Your response (roughly 200–250 words) should be grounded in the assigned material and may also draw on your own initial explorations outside of class (e.g., a relevant paper you found, a credible media source, a claim made by a company, your lived experience using the devices, or a conversation that helped you sharpen the question). I'm not looking for a "right" answer; I'm looking for a careful, defensible answer that shows you engaged with evidence and can reason under uncertainty. Along with your response, you will submit one Evidence Slide (do not submit a link to Google Slides; export to PDF). The slide should highlight one piece of evidence that is most relevant to your response (for example, an annotated figure from the assigned reading, a well-chosen excerpt, or a clearly labeled visualization you created from our Muse work; in some weeks, a vetted outside claim may serve as the "evidence object" you are evaluating). Your evidence slide should be something you can point to and interpret (a figure/table/short excerpt/plot). Avoid slides that are mostly text. You should be prepared to present and defend your slide in about two minutes during class and to respond respectfully to questions that probe assumptions, confounds, or alternative interpretations. These submissions will be graded using a broad rubric. In general, you will receive full credit when (a) the response clearly addresses the guiding question and reflects real effort, (b) the evidence slide is relevant and interpretable, and (c) you include at least one qualification (a limitation, confound, or alternative explanation). Submissions that are vague, ungrounded, or appear rushed will earn less credit. I may occasionally add brief notes, but the primary feedback will come through in-class discussion and your evolving work over

time. Specifically, they will be scored on a simple three-level scale: Meets expectations (full credit), Developing (partial credit), or Incomplete/late (little or no credit).

- **Group Project Report** (30% of your final grade; one submission per group). The group project report is the “full version” of your poster in written form. It is where you demonstrate that your group can translate a big question into a workable, interpretable neurofeedback learning project and then communicate what happened with appropriate rigor. From an IRB standpoint, this is not a research study aimed at producing generalizable findings; it is an educational experience designed to demonstrate that you can think like careful scientists: define what you were trying to test, make your methods transparent, present evidence clearly, and draw conclusions that match the strength (and limitations) of your design.
 - Groups (typically 3 students) will be assigned one Muse device to share for the semester. Each group will designate at least two participants (typically group members) who will complete the repeated sessions needed for your project, trading off access to your group’s Muse device as needed. However, all group members are expected to contribute meaningfully to the full report, including writing and revision, not only data collection. In some cases, groups may choose to have one member take a larger role in the design/analysis while another member stays less involved in certain details in order to preserve whatever limited “blinding” is feasible (for example, reducing expectancy effects or demand characteristics). Given the constraints of this course and the available resources, perfect blinding and perfect controls are unlikely; this is expected. The key is that your group should be explicit about these tradeoffs, explain how they may affect interpretation, and discuss how you would address them in a future, scaled-up study with more time and resources. By default, your group will run a parallel design comparing one participant completing Muse neurofeedback sessions to a second participant completing a matched active control practice without neurofeedback. Given our timeline, plan for ~12 sessions per participant as the goal. The minimum expectation is 9 sessions per participant (plus at least 2 baseline sessions and one transfer/generalization check). A typical plan is 2-3 short sessions per week per participant starting after Checkpoint #1; some groups will also use a portion of class time for sessions. If your group proposes a different plan, get approval in advance and justify why it remains interpretable.
 - Each group may request reimbursement for up to \$50 total in project-related expenses, provided you submit itemized receipts to your instructor. This small budget is meant to support practical needs that improve the quality or feasibility of your project (e.g., a low-



cost app for viewing/logging data such as Mind Monitor, basic supplies for standardized session setup, or other minor materials that make your procedures more consistent).

This budget may not be used for participant payments or incentives. If you're considering an expense and you're not sure whether it fits the spirit of the assignment, check with me before purchasing (it's better to ask me first than to be surprised/disappointed that you can't get reimbursed after you've already spent the money). If paying up front is a barrier, talk to me in advance, I'm happy to explore options for arranging an advance or another workaround within College policy.

- Your report should include a title page, brief literature-grounded Introduction (including at least 5-8 scholarly sources, of which at least 3 are empirical articles) that motivates why the question matters and identifies what your project is testing as a proof-of-concept, followed by clear Methods (design, measures, procedure, quality control/confounds), descriptive Results with well-labeled figures, and a Discussion that interprets findings cautiously, connects back to the literature, and explicitly addresses limitations before ending with a reminder as to why this line of research could be important (theoretically and/or in the real world). Don't forget References at the end, as well as at least one appendix (not included in the maximum page count) including a simple session log listing session dates, duration, condition (neurofeedback vs. control), and any major confounds (e.g., sleep/caffeine/stress), along with brief engagement/expectancy ratings if you used them. Because neurofeedback research is especially vulnerable to artifacts, expectancy effects, and over-interpretation, your report should be honest about what you can and cannot conclude, what would be necessary to scale your project up into a more rigorous study, and how you would responsibly communicate the implications to a non-expert audience. We will look at published papers as models for structure and tone; however, your expectations are proof-of-concept clarity and scientific reasoning, not polished "journal-ready" results.
- Your Group Project Report should be written in a standard scientific report format using APA 7th edition style (see "Additional Resources" later in the syllabus). As a guideline, the main text of the report should be approximately 8-12 double-spaced pages (12-pt font, reasonable margins), not including the title page, references, appendices, figures, or tables. The goal is not to produce a journal-ready manuscript; the goal is to produce a clear, interpretable, literature-grounded write-up that shows careful scientific reasoning. Figures and tables are strongly encouraged and may be embedded in the text or placed at the end, as long as they are clearly labeled and referenced in the Results section. Submit one PDF per group that includes the full report, figures/tables, references, and any appendices.
- **Project Checkpoints** (15% of your final grade; 5% each). Three times during the semester, your group will submit a short, low-stakes checkpoint report (one submission per group) designed to

keep your Project (see above) interpretable and on track before you invest too much time in a weak design. These checkpoints are meant to be structured and fast. Each submission should be one page, single-spaced (11–12 pt font, reasonable margins) and may include a small figure (e.g., a procedure flowchart counted toward the one-page limit) if it helps clarity. Please submit as a single PDF and include a clear header at the top of the page with a title + course + checkpoint number + date + the names of all group members. (No separate title page—just a professional header. This is a habit you should use for all written work.) Ask yourself: Can an informed reader tell what you're trying to test, what you will measure, how you'll interpret outcomes, and what you're doing to reduce the most obvious confounds? These checkpoints are meant less as major evaluations and more as structured planning moments that let you get timely feedback before you invest a lot of time in a weak or ambiguous design. I will score them for completion and clarity, but the main purpose is formative: to identify problems early, sharpen your logic, and help you revise your project in a way that makes your final poster/report stronger.

- **Checkpoint #1, mini pre-registration:** State your group's guiding question and primary hypothesis, define your primary outcome measure, describe your planned procedure at a high level, and specify your control/comparison strategy (even if imperfect). Include one sentence on what result would support your hypothesis and one sentence on what result would make you doubt it.
- **Checkpoint #2, measurement & quality-control plan:** Identify the specific signal/features you intend to use (and why), describe the top artifacts/confounds that could contaminate your measure (movement, muscle, expectation/demand, practice effects, missed sessions, participant dropout, etc.), and describe how you will detect and handle them in practice. Include a brief "feasibility check" (what you can realistically accomplish with our devices and time) and any revisions you're making to your plan based on early piloting.
- **Checkpoint #3, analysis & interpretation plan:** Lay out how you will summarize your data (what comparisons/plots you will produce), what your "minimum viable analysis" will be, and how you will avoid over-interpreting noisy results. Include one transfer/generalization test (i.e., how you'll check whether anything changes outside the training context) and the most important limitation you expect you'll need to state on your poster/report.
- **Poster Presentation (15% of your final grade).** Your group will create a scientific poster that distills a semester's worth of work on your Group Project (see above) into a clear, engaging, and informative visual summary of your neurofeedback project—something a scientifically literate person outside our class could follow. The poster format is designed to be highly visual: you should rely primarily on well-chosen figures, diagrams, and tables rather than dense blocks of text. Your group will be present at the poster to explain details, answer questions, and provide

context, so the goal is not to write a mini-paper on the poster; it is to use visual aids to make your project legible at a glance. A strong poster clearly states your guiding question and rationale (with a few key citations where appropriate), provides a clean and interpretable overview of your methods, shows evidence (not just claims), and communicates conclusions that are appropriately scoped (including limitations, alternative explanations, and what you would do next to strengthen the evidence). Because our class projects are designed as structured learning experiences rather than studies aimed at producing generalizable findings, your poster should be explicit about uncertainty and limits: what you observed, what you think it might mean, and what remains unclear. You should include at least one clear graph or table (or other well-labeled visualization) that helps the audience see the relevant patterns for themselves.

- During the semester, we'll discuss effective poster design principles and you'll have opportunities to workshop drafts in class. Keep in mind that research posters are not exhaustive—they're carefully curated to showcase the key messages. Part of this assignment is learning to judge which details are essential and which can be omitted (without becoming misleading). The poster presentations will take place during our scheduled final exam period, and your group should be ready to explain the poster conversationally and answer questions in a way that demonstrates real understanding rather than memorization.
- **Research Participation** (5% of your final grade) is a valuable way to get first-hand exposure to the variety of research conducted within the Psychology and Neuroscience programs. There will be a number of student and faculty research projects recruiting participants this semester. You are expected to be involved in the equivalent of 2 credits worth of participation or do an alternative assignment. Additional participation credits will be considered for Extra Credit (see below). A brief video overview of the participation credit system can be found at <https://youtu.be/foLi2deanR8>. Importantly:
 - You only get credit for participating in approved studies. All eligible studies are listed on <https://www.bates.edu/psychology/participate-in-research/student-participation/>. Participation in any experiment that is not included in that list of approved experiments will *not* count for credit.
 - It will take some time for research studies to be posted as students finalize their thesis experiments, so do not worry if you don't see any experiments posted right away. But don't wait until the end of the semester. Keep checking the website every week or so, and things will pick up as thesis students post their projects mid-semester.
 - Each study has a fixed number of units assigned to it based on the average length of time that it will take to participate. Typically, 1 hour worth of participation is equal to 1 credit, with each quarter hour represented by 0.25 credits. Be sure to check the number of credits when you sign up for the experiment. If an experiment is worth 0.5 credits, for

instance, you will get 0.5 credits whether it takes you 25 minutes or 35 minutes to complete it.

- Please note the restrictions listed for each experiment and do not participate in projects for which you are not eligible.
- To sign up for an experiment, please follow the link to the online appointment scheduler for that project. Please be respectful of the experimenter's time and make sure that you *keep your appointment and arrive punctually*. If you are unable to keep your appointment, please notify the experimenter as soon as possible.
- Please note that, for online studies in which your participation is entirely Internet-based, you will be given the experiment number and a code word for that study at the end of the survey. You will then be asked to enter that information in another web form in order to get credit for the project (the separation is meant to maintain the confidentiality of your data). If you don't enter the correct experiment number and code word, you will not receive credit.
- If you would prefer to opt out of this research participation requirement (or if you're not eligible for any available studies), you may instead complete alternative assignments designed to familiarize you with the other side of research participation: running a study involving human participants. Specifically, you would be asked to summarize chapters from Ritter et al.'s (2012) "How to Run Experiments: A Practical Guide to Research with Human Participants." Each reasonable summary would yield the equivalent of 1 participation credit (i.e., you'd need to submit two solid summaries to earn 2 credits, participate in 2 credits worth of eligible research, or complete a combination of the two—note that no partial credit will be given for summaries). The goal is not to rewrite what has already been written; instead, you will be asked to summarize the chapter in another modality: *as a slideshow, as a video, or as a podcast*. Get creative—for instance, you could act out or sing a song about the dos and don'ts around interacting with participants. Further details for the "Research Participation Alternative Assignments" can be found under the "General" section at the top of our Lyceum page.
- For credit, you must have completed your research participation and/or alternative assignment(s) by the last day classes are held for the semester—but don't wait until the last minute!
- **Class Engagement** (5% of your final grade). Because this is a small seminar with a strong hands-on and group-project component, the quality of the course (and your group's progress) depends on consistent preparation and active participation from everyone. Class Engagement is not a "personality score," and it is not about being the loudest voice in the room. It reflects whether you come prepared to contribute, participate constructively in small-group work, and help create a classroom culture where real questioning can happen. In practice, this includes being ready to discuss your weekly question work when called upon, contributing meaningfully

during in-class project sessions (including setup and troubleshooting when relevant), listening carefully and building on others' ideas, and engaging respectfully with disagreement. Regular attendance is a baseline expectation, but engagement goes beyond showing up. It's about reliably doing your part so that your group can function.

- To make this component as fair and transparent as possible, you will complete a self-reflection on your engagement and offer peer feedback about group functioning during the semester. These reflections will inform (but not solely determine) your engagement score, alongside my observations of preparation and participation in class. If you attend regularly, come prepared, participate constructively (even if you're quieter), and consistently pull your weight in group work, you should expect a high engagement score. Because our progress depends on shared effort, patterns of consistently taking a back seat in group work (without contributing in other ways) will lower this score. If you're unsure how you're doing, I'm happy to talk.
- **Final Reflection** (10% of your final course grade) provides a space for a thoughtful, well-organized reflection on what you learned in this course and how your thinking changed over time. I am not looking for you to simply restate course content; I am looking for a reflective narrative that shows how you updated your views as you encountered new evidence, ideas, and firsthand experience with neurofeedback tools. A strong reflection typically includes: (a) your initial definition of "neurofeedback" (or your starting assumptions) and your revised definition by the end of the semester, (b) specific "turning points" that influenced your thinking (for example, a particular reading, a class discussion, something surprising you noticed during Muse work, or a moment where your interpretation was challenged), (c) an honest assessment of what you can and cannot claim about neurofeedback based on your current understanding, and (d) how you see these lessons applying to your education, personal life, and/or career going forward. You are welcome to write in a personal voice, but your claims should be clear and grounded in specifics rather than general impressions. To give you a guideline, your submission should be roughly equivalent to a 4-6 page double-spaced paper (11- or 12-point font, reasonable margins). If you choose a different medium (video, podcast, website, etc.), aim for a comparable level of substance (for example, a 6-10 minute video/podcast, or a website that would reasonably take a reader 10-15 minutes to move through carefully). It is OK to submit a link to your reflection; however, you should not continue editing the material after the deadline (at least until I've had a chance to grade it). If you're unsure whether your plan is appropriate, check with me.
- **Extra Credit** (up to 4 additional percentage points added to your final course grade) **Additional research participation credits** (or alternative assignments) above the required 2 credits worth will be considered extra credit counted toward your final course grade (up to a maximum of 4 additional percentage points, 1 for each additional credit equivalent; e.g., an 88% becomes up to 92%). While research participation will be accepted in increments of .25 credits, there is no

partial credit for the alternative assignments; each satisfactory summary earns the equivalent of 1 credit (so don't try turning in half a summary and expect .5 credits ;-).

Grading Scale

A+	≥97%
A	93-96.99%
A-	90-92.99%
B+	87-89.99%
B	83-86.99%
B-	80-82.99%
C+	77-79.99%
C	73-76.99%
C-	70-72.99%
D+	67-69.99%
D	63-66.99%
D-	60-62.99%
F	<60%

You can easily calculate your current grade by inserting the assignments/exams, grades received, and weights (given above, in percentages) by hand or using this handy calculator: <https://www.rapidtables.com/calc/grade/grade-calculator.html>.

Attendance

Your attendance and preparation are critical to your learning and, in turn, your grade in the course. As such, you are expected to attend each class having completed the assigned reading for the day. The more active your reading (by thinking deeply about the issues raised, connections to broader themes and examples, and identifying/answering questions arising) and engagement during class, the more you will be able to gain. So, even if I don't take formal attendance, it is to your advantage to be fully present and prepared in class on a regular basis.

Of course, I recognize that illness, serious family emergency, or other extenuating circumstances may sometimes keep you from attending class. Because we meet once per week, missing more than one class will significantly affect your learning and your group's ability to complete the project. If you are going to miss more than one class in a row, please provide me with official notification from the Health Services, Counseling and Psychological Services, or the Office of Student Support and Community Standards. Again, you remain responsible for working with me to address missed work under these circumstances. For additional information on the Bates College policy regarding course attendance and student responsibilities in cases of expected and unexpected absence, please consult <https://www.bates.edu/dof/course-attendance-policy-guideline-for-absences/>.

All Bates students are expected to take the final examinations (or, in our case, Poster Presentations) at the time scheduled by the Registrar's office. Exceptions are made for students who have two exams at the same time or three exams in one day. Final examinations cannot be rescheduled to accommodate the travel plans of students. Students should not make any travel plans until they have full knowledge of their final examination schedule. For more information or to submit a request to move a final examination, please visit the college's policy on final exams (<https://www.bates.edu/accessible-education-student-support/request-to-move-a-final-examination/>).

Religious Holiday Observance

Bates recognizes the right of students to fulfill their religious obligations and practices. In recognition of Bates' commitment to a diverse and inclusive student body and the variety of religions observed and practiced by our students, I have consulted the Multifaith Calendars posted online by the Office of the Multifaith Chaplain when developing this syllabus so that conflicts between in class examinations and major religious holidays may be avoided. Given the range of faiths embraced by members of our community, however, it may not be possible to avoid all conflicts between scheduled examinations and religious holidays. *Please let me know within the first three weeks of the semester if there is a conflict between a scheduled examination, paper, or project due date and a significant religious holiday you observe.* The Office of Accessible Education will continue to be available to proctor makeup exams for students who miss an exam due to observance of a significant religious holiday.

Unforeseen Events

Should an unforeseen event (e.g., a weather emergency) force us to cancel class or alter the venue, I will inform you via the class email list as soon as possible. Please check your Bates email regularly, as important class-related communications will come through this channel.

Accessibility

Bates College is committed to creating a learning environment that meets the needs of its diverse student body. If you anticipate or experience any barriers to learning in this course, please feel welcome to discuss your concerns with me.

If you have a disability, or think you may have a disability, you may also want to meet with the Director of Accessible Education, to begin this conversation or request an official accommodation. You can find more information about the Office of Accessible Education and Student Support (AESS), including contact information, here: <https://www.bates.edu/accessible-education/>. Note that processing time for new accommodation requests is generally 2 weeks according to the AESS website. And, once approved, some types of accommodations may take several weeks to fulfill, so it is important to make the request as soon as

possible. Once approved through the Office of Accessible Education, AESS will email me an official Letter of Accommodations (copying you). Although accommodations may be approved at any point in the semester, they are *not* retroactive.

Diversity and Inclusion

It is essential that our classroom be a place in which people feel comfortable expressing their thoughts, feelings, and opinions without fear of unduly critical or judgmental responses. Everyone in the classroom (students and instructors, alike) are expected to be respectful of the widely varied experiences and backgrounds represented by the classroom members as a group. Disrespect or discrimination on any basis will not be tolerated. Whether inside or outside the classroom, if you encounter sexual harassment, sexual violence, or discrimination based on race, color, religion, age, national origin, ancestry, sex, sexual orientation, gender identity/expression, or disability, you are encouraged to report it to Gwen Lexow, Director of Title IX and Civil Rights Compliance at Bates, at glexow@bates.edu or 207- 786-6445. Additionally, please remember that Bates faculty are concerned about your well-being and development, and we are available to discuss any concerns you have. Students should be aware that faculty are legally obligated to share disclosures of sexual violence, sexual harassment, relationship violence, and stalking with the college's Title IX Officer to help ensure that your safety and welfare are being addressed.

In-Class Electronic Device Policy

Although there are many benefits to taking handwritten notes and potential distractions associated with the use of devices like laptops, tablets, and phones in class (e.g., Mueller & Oppenheimer, 2014; Fried, 2008), you may still opt to use a laptop or tablet in this class *as long as it contributes to learning*. If it is seen to invite distraction to you or others, however, you may be asked to refrain from using it in class. There will be some class sessions where we will use technology together, and in those instances, all students should make arrangements to bring a laptop or tablet to class (smartphones may not be suitable for some of these in-class activities). If you do not have access to such a device or have any questions or concerns, please email me so that we may find a suitable workaround. For example, the library has several Chromebooks available to check out to Bates students for 1-week loan (with a 1-week renewal). And students who don't own a laptop have the option of checking out a long-term loaner (either laptop or Chromebook) from the IT Service Desk.

Academic Integrity

Academic integrity isn't just a policy—it's about building trust and fairness in our learning community. All members of the Bates community benefit from an environment of trust, honesty, fairness, respect, and responsibility. You are expected to present your own work and acknowledge the work of others in order to preserve the integrity of scholarship. Your academic work is governed by The Bates College Statement on

Academic Integrity (<https://www.bates.edu/student-conduct-community-standards/student-conduct/academic-integrity-policy/>) and by any additional standards I set in this syllabus or in individual assignments.

Academic integrity includes:

- Following quiz/exam/assignment rules
- Using only permitted materials during an quiz/exam/assignment
- Viewing quiz/exam materials only when permitted by your instructor
- Keeping what you know about a quiz/exam to yourself
- Incorporating proper citation of all sources of information
- Submitting your own original work
- Not submitting work produced for another course—even if it is entirely your own—without prior, explicit permission from the instructor

Academic misconduct includes, but is not limited to, the following:

- Disclosing quiz/exam content during or after you have taken an quiz/exam
- Accessing quiz/exam materials without permission
- Copying/purchasing any material from another student, or from another source including generative Artificial Intelligence, that is submitted for grading as your own
- Plagiarism, including use of Internet material without proper citation
- Using cell phones or other electronics to obtain outside information during a quiz/exam or assignment without explicit permission from the instructor
- Submitting your own work in one class that was completed for another class (self-plagiarism) without prior permission from the instructor

Violations of academic integrity are serious and can result in severe consequences at both the course and College levels. Depending on the circumstances of the violation, I will assign a failing grade for the assignment and/or the course, require work to be redone, and/or impose other consequences; in addition, I will refer the matter to the Dean of Students for possible institutional action. The Bates College Statement on Academic Integrity and procedures for suspected violations can be found here: <http://www.bates.edu/student-affairs/student-conduct/academic-integrity-policy/>.

Use of Artificial Intelligence (AI)

Generative artificial intelligence (AI) tools (e.g., ChatGPT, Copilot, Claude) can be powerful aids for brainstorming, fact-checking, and learning. However, AI must be used thoughtfully and responsibly in this course. You are expected to:

- Use AI as a learning partner, not a shortcut: AI can help clarify concepts or spark ideas, but it should not replace your own critical thinking, writing, or data analysis.

- Maintain academic integrity: Submitting AI-generated work as if it were your own original writing or analysis is *not* allowed. AI tools can make mistakes, fabricate references, and lack critical nuance—you are responsible for verifying all information.
- Be transparent: If you use AI to help generate ideas, outlines, or drafts, you must acknowledge it (e.g., "I used ChatGPT to brainstorm topic ideas for this assignment").

You may use AI for:

- Brainstorming and refining your ideas
- Fine tuning your research questions
- Finding information on your topic (noting that AI is subject to hallucinations)
- Drafting an outline to organize your thoughts
- Checking grammar and style
- Generate practice quiz questions or concept checks

The use of generative AI tools is *not* permitted in this course for the following activities:

- On timed quizzes/exams for any purpose
- Submitting AI-written responses or analyses as your own (even if you introduce superficial changes to the writing)
- Using AI to generate citations or references without verifying their accuracy
- Relying on AI to replace your own critical thinking or engagement with the material

Remember that *you* are responsible for any work you submit, and you may be asked to explain the points you raised in contexts that do not afford you the support of AI (e.g., on a quiz/exam, in discussion).

Student Services

- **The Student Academic Support Center (SASC)** provides peer-led support for introductory and intermediate level courses in mathematics, statistics, programming, natural sciences, life sciences, and quantitative social sciences. Additionally, SASC provides support for students using a variety of quantitative skills required for courses across the curriculum. The Student Academic Support Center also provides a variety of workshops in quantitative skills, time management, note-taking, and study skills. Course-Attached Tutors (CATs) are embedded in courses with the highest demand for tutoring. CATs provide assistance outside of class in the form of weekly help sessions and private appointments. SASC is located in the Peer Learning Commons (PLC) on the Ground Floor of Ladd Library. Students are invited to stop by, without an appointment, to the drop-in hours in Ladd to meet with a tutor, study independently, meet up with classmates, or to discuss learning strategies. Students who wish to set up an individual appointment can discuss options with a Resource Representative at the PLC check-in desk. For more information go to www.bates.edu/sasc or email sasc@bates.edu.

- **The Student Writing & Language Center (SWLC)** empowers Bates students in becoming more effective writers, speakers, language-users, and language-learners. Tutors provide a supportive environment for you to understand and generate ideas for your writing assignments in any subject or course; to draft, revise, and edit your writing for any purpose, context, or audience; to practice and get feedback on your oral presentations; and to study or practice writing and communicating. SWLC tutors are Bates students just like you, trained to listen to and guide you in using writing and language to achieve your personal and academic goals. Drop in to the SWLC anytime we're open to meet with a writing or language tutor. They're located in the Peer Learning Commons on the Ground Floor of Ladd Library. You can also search for subject-specific support hours or make appointments with a tutor using the Penji app: <https://web.penjiapp.com/>. For more information about the SWLC please visit www.bates.edu/swlc or email swlc@bates.edu.
- **Bates Counseling and Psychological Services (CAPS)** offers assistance and referral to address students' personal, social, career, and study skills needs. CAPS is located on the second floor of the Health Services Building (31 Campus Ave). You can contact them at 207-786-6200 for assistance M-F from 9:00 to 5:00 (out of hours emergency assistance can be obtained via Campus Security at 207-786-6254 or by calling 988). For additional information, see: <https://www.bates.edu/counseling-psychological-services/>. Services for students include:
 - Crisis and same-day emergency mental health consultations
 - Confidential assessment, counseling services (individual and small group), and referrals



Course Planning

This course requires you spend a good amount of time outside of our class meetings reading, studying, completing major assignments, and otherwise preparing to participate fully and get the most out of the experience (and a commensurate grade). For every hour you spend in class (2.92 hours/week), federal regulations specify that you spend *at least* 2 hours outside of class doing coursework/preparation. That alone would account for 5-6 hours of time spent outside of class. But this is Bates, which has its own standard of 10-15 hours of academic work per week per course credit. That includes class time, meaning that you should be spending roughly 7.08-12.08 hours per week outside of class doing the reading, assignments, studying, etc. Some weeks (e.g., before a major deadline) may require more of your time outside class, but if you plan in advance and commit to dedicating regular outside time to your studies each week, it will be more manageable, with fewer week-to-week fluctuations.

The material we cover in class and the types of assigned readings (which include peer-reviewed research articles) may be unfamiliar to many students and therefore take extra time to grasp fully. If you find you need to read the material slowly and multiple times, that's not a bad sign—it means you're putting in the effort

required to succeed and retain the knowledge/skills for later (go you!). If you are worried about falling behind or want more advanced work, please email me and/or drop by office hours so we can discuss the way forward. I am happy to discuss study/reading strategies and/or find additional materials to support your journey through the course and toward your personal goals.

Prospective memory involves remembering to carry out some intended action in the future. There's no reason you can't take steps now to improve your ability to carry out the appropriate actions on time, even before we cover the topic. So please, please, please take the time to review all the deadlines provided in the schedule at the end of this syllabus. Transfer them to your personal calendar immediately (and add reminders). Doing so will help you avoid scheduling conflicts and allow you to carve out the necessary time to perform your best.

Additional Resources

There are treasure troves of information about neuroscience, psychology, and related disciplines sprinkled around the interwebs—much of it can be accessed for free. If you find yourself struggling to understand a concept, I'd encourage you to search around, carefully evaluate the quality of the sources, and share useful finds with the rest of the class. Below are some resources I have identified:

- APA formatting and general reference:
 - Purdue Online Writing Lab (OWL): https://owl.purdue.edu/owl/research_and_citation/apa_style/apa_formatting_and_style_guide
 - I posted some additional reference materials inside the "APA Style/Scientific Paper Writing Tips" submodule inside of the "Course Introduction" of Lyceum.
 - Middlebury Library: <https://middlebury.libguides.com/citation/apa7>
 - ECU Library: <https://libguides.ecu.edu/c.php?g=982594&p=7463742>
 - Video Tutorials: <https://apastyle.apa.org/instructional-aids/tutorials-webinars>
 - APA Dictionary of Psychology: <https://dictionary.apa.org>
- Searchable article databases (and tutorials):
 - Neuroscience: <https://libguides.bates.edu/neuroscience>
 - Psychology: <https://libguides.bates.edu/psychology>
 - Psychology Resources: <https://www.bates.edu/psychology/resources-for-students/technical-resources/>
 - APA Database Tutorials: <https://www.apa.org/pubs/databases/training/tutorials>
 - Google Scholar: <https://scholar.google.com>
- Free textbooks & related resources:
 - Neuroscience/Biological Psychology/Medical Psychology:
 - Introduction to Neuroscience (Hutchins): <https://uen.pressbooks.pub/introneuro/> (this book has many excellent figures)

- Interdisciplinary Explorations of Neuroscience (May): <https://opentextbooks.rug.nl/interdisciplinaryexplorationsofneuroscience/>
- Open Neuroscience Initiative (Lim): https://drive.google.com/file/d/1n08qgzhG5-RgkoqL_Aa4y1UBSycUcy5g/view
- Neuroscience Online: <https://nba.uth.tmc.edu/neuroscience/toc.htm>
- Neuroanatomy Online: <https://nba.uth.tmc.edu/neuroanatomy/index.html>
- Neuroscience (Ju): [https://med.libretexts.org/Bookshelves/Pharmacology_and_Neuroscience/Neuroscience_\(Ju\)](https://med.libretexts.org/Bookshelves/Pharmacology_and_Neuroscience/Neuroscience_(Ju))
- Foundations of Neuroscience (Henley): [https://med.libretexts.org/Bookshelves/Pharmacology_and_Neuroscience/Foundations_of_Neuroscience_\(Henley\)](https://med.libretexts.org/Bookshelves/Pharmacology_and_Neuroscience/Foundations_of_Neuroscience_(Henley))
- Psychology as a Biological Science (Lindberg): <https://nobaproject.com/textbooks/psychology-as-a-biological-science>
- Biological Psychology (Hove & Martinez): <https://open.umn.edu/opentextbooks/textbooks/biological-psychology>
- Introduction to Biological Psychology (Hall): [https://socialsci.libretexts.org/Bookshelves/Psychology/Biological_Psychology/Introduction_to_Biological_Psychology_\(Hall_Ed.\)](https://socialsci.libretexts.org/Bookshelves/Psychology/Biological_Psychology/Introduction_to_Biological_Psychology_(Hall_Ed.))
- Biological Psychology (Keys): [https://socialsci.libretexts.org/Courses/Sacramento_City_College/Psyc_310:_Biological_Psychology_\(Keys\)](https://socialsci.libretexts.org/Courses/Sacramento_City_College/Psyc_310:_Biological_Psychology_(Keys))
- The Nervous System in Action (Mann): <https://michaeldmann.net/The%20Nervous%20System%20In%20Action.html>
- Neuroscience for Pre-Clinical Students (<https://open.umn.edu/opentextbooks/textbooks/neuroscience-for-pre-clinical-students>)
- Computational Cog Neuro (O'Reilly et al.): <https://compcogneuro.org/>
- Science of Sleep (Shook): <https://open.umn.edu/opentextbooks/textbooks/the-science-of-sleep>
- Society for Neuroscience's Brain Facts: <https://www.brainfacts.org/>
- Research methods:
 - Crump et al.: <https://crumplab.github.io/ResearchMethods/index.html>
 - Cuttler et al.: <https://open.umn.edu/opentextbooks/textbooks/75>
 - University of Minnesota: <https://open.lib.umn.edu/psychologyresearchmethods/>
 - Bhattacharjee: https://scholarcommons.usf.edu/oa_textbooks/3/
- Statistics:
 - De Anza: <https://openstax.org/details/introductory-statistics>
 - Saylor: https://saylordotorg.github.io/text_introductory-statistics/index.html
 - Brown University Statistics Visualizations: <https://seeing-theory.brown.edu>
 - VassarStats: <http://vassarstats.net>
 - Effect Size Calculator: https://katherinemwood.shinyapps.io/lakens_effect_sizes/

- Jamovi Open Stats: <https://www.jamovi.org>
- Power analysis guide using G*Power: https://www.psychologie.hhu.de/fileadmin/redaktion/Fakultaeten/Mathematisch-Naturwissenschaftliche_Fakultaet/Psychologie/AAP/gpower/GPowerManual.pdf
- Help choosing an appropriate statistical test:
 - <http://www.statsflowchart.co.uk>
 - <https://stats.idre.ucla.edu/other/mult-pkg/whatstat/>
 - <https://www.statstutor.ac.uk/resources/uploaded/tutorsquickguidetostatistics.pdf>
- Cognitive neuroscience methods/tools:
 - Functional Neuroimaging: <https://imaging.mrc-cbu.cam.ac.uk/imaging/Cbulmaging>
 - FSL fMRI Analysis (free, multi-platform software and tutorials):
 - <https://fsl.fmrib.ox.ac.uk/fsl/fslwiki>
 - https://open.win.ox.ac.uk/pages/fslcourse/website/online_materials.html
 - Brain viewers:
 - Allen Brain Atlas: http://human.brain-map.org/mri_viewer
 - Gallant Lab: <https://gallantlab.org/brain-viewers/>
 - Neurosynth: <https://neurosynth.org/>
 - Event-related potentials (ERPs): <https://erpinfo.org>
 - Neurofeedback: Open-source Python/Matlab framework (OpenNFT): <http://opennft.org/>
- Videos:
 - 2-Minute Neuroscience: <https://www.youtube.com/channel/UCUgZq9PkDp1xaEivtcfJPSg>
 - Nancy's Brain Talks: <https://nancysbraintalks.mit.edu/>
 - TED Studies: <https://www.ted.com/read/ted-studies/neuroscience>
 - Khan Academy: <https://www.khanacademy.org/test-prep/mcat/behavior#concept-intro>
 - HarvardX Neuroscience: <https://vimeo.com/mcb80x>
- Effective studying:
 - <https://www.samford.edu/departments/academic-success-center/how-to-study>

About the Instructor

Well, hello there! I'm excited to be your instructor for this course. In case you're wondering who's lecturing excitedly about action potentials and cats multiple times a week, here's a bit about me (I'll save you the trouble of Googling since your coursework will likely keep you busy enough). I joined Bates College in 2024 after spending nine years at Bard College, where I served as chair of the Psychology Program (I'm now chair of the Neuroscience Program). My background is in psychology, with a focus on the cognitive neuroscience of human memory—especially the fascinating (and often misunderstood) process of forgetting. I earned my

bachelor's degree from the University of Pennsylvania in 2005 on full scholarship, completing two theses: one on memory consolidation during sleep and another on how children learn mentalizing verbs like "to think." While at Penn, I also worked as a wedding videographer and held several research positions, including clinical research at the Children's Hospital of Philadelphia. My path through graduate school was quite the adventure—both literally and figuratively (ask me about it sometime!). I received my Ph.D. from the University of Cambridge, where I was affiliated with St John's College and the Medical Research Council's Cognition and Brain Sciences Unit. Afterward, I returned to New Jersey (where I grew up) for a postdoc at the Princeton Neuroscience Institute (I didn't actually grow up *in* the Institute) before joining the faculty at Bard. It was in Princeton that I found my two cats, Mandy and Jerri (sisters from the same litter). They quickly became my inspirations, portable space heaters, and sage meditation teachers. Two more tidbits about me: I have aphantasia and severely deficient autobiographical memory (SDAM)—conditions that are only starting to be explored in neuroscience. Regardless, I have no doubt that we'll find ways to make this semester memorable for everyone!

Tentative Course Schedule

Date (day)	#	Guiding Question of the Week	Readings/Assignments <i>(due class start unless otherwise specified)</i>
1/15 (th)	1	What is neurofeedback? <ul style="list-style-type: none"> ▶ Getting-to-know-you survey: https://forms.gle/X5Mav4Pfbgktn9wn7 ▶ Getting to know your Muse ▶ Group members assigned & team policies discussed ▶ Assign Human Subjects Training (Biomed) https://www.bates.edu/institutional-review-board/training-requirements-for-all-human-subjects-researchers/ (due 1/29) 	
1/22 (th)	2	How does science decide what to trust (replication, measurement, uncertainty)?	<ul style="list-style-type: none"> • Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide • Team Policies Agreement • Have read: <ul style="list-style-type: none"> • Syllabus • deCharms (2008, <i>Nat. Rev. Neurosci.</i>)
1/29 (th)	3	What are we measuring (EEG, ERP, fMRI), and what are we not measuring? <ul style="list-style-type: none"> ▶ Group Checkpoint #1 explained 	<ul style="list-style-type: none"> • Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide • CITI Training Certificate • Have read: <ul style="list-style-type: none"> • Sitaram et al. (2016, <i>Nat. Rev. Neurosci.</i>) • Have watched (links on Lyceum): <ul style="list-style-type: none"> • 2-Minute Neuroscience: Electroencephalography (EEG) • ERP Bootcamp: Event-Related Potentials, Generation, Time-Frequency Analysis, & Fourier • Nancy's Brain Talks: What is fMRI?, MVPA • Optional readings: <ul style="list-style-type: none"> • Enriquez-Geppert et al. (2017, <i>Front. Hum. Neurosci.</i>) • Weiskopf et al. (2007, <i>MRI</i>)

Date (day)	#	Guiding Question of the Week	Readings/Assignments (due class start unless otherwise specified)
2/5 (th)	4	What would it take to convince you neurofeedback works?	<ul style="list-style-type: none"> Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide Have read: <ul style="list-style-type: none"> • Ros et al. (2020, <i>BRAIN</i>)
2/12 (th)	5	Is it learning or just placebo/relaxation?	<ul style="list-style-type: none"> Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide • Group Checkpoint #1: Mini pre-registration Have read: <ul style="list-style-type: none"> • Schabus et al. (2017, <i>BRAIN</i>) • Thibault et al. (2017, <i>BRAIN</i>) • Schabus (2017, <i>BRAIN</i>) Reply
2/19 (th)	--	No Class (February Break)	
2/26 (th)	6	What would neurofeedback success look like outside the training session? ▶ Group Checkpoint #2 explained	<ul style="list-style-type: none"> Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide Have read: <ul style="list-style-type: none"> • deBettencourt et al. (2015, <i>Nature Neuroscience</i>) • Treves et al. (2025, <i>J. Med. Internet Res.</i>)
3/5 (th)	7	How do we design a study we can learn from? ▶ Anonymous course feedback survey	<ul style="list-style-type: none"> Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide Have read: <ul style="list-style-type: none"> • Sorger et al. (2019, <i>NeuroImage</i>) Optional reading: <ul style="list-style-type: none"> • Ramot & Martin (2022, <i>TiCS</i>)
3/12 (th)	8	Why might neurofeedback not work (confounds, artifacts, boundary conditions)? ▶ Group Checkpoint #3 explained	<ul style="list-style-type: none"> Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide • Group Checkpoint #2: Measurement & quality control plan Have read: <ul style="list-style-type: none"> • Kvamme et al. (2022, <i>NeuroImage</i>)
3/19 (th)	--	No Class (March Break)	

Date (day)	#	Guiding Question of the Week	Readings/Assignments <i>(due class start unless otherwise specified)</i>
3/26 (th)	9	If it works sometimes, what mechanisms are plausible (and what's speculation)?	<ul style="list-style-type: none"> • Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide • Have read: <ul style="list-style-type: none"> • Watanabe et al. (2017, <i>TiCS</i>) • Optional reading: <ul style="list-style-type: none"> • Shibata et al. (2011, <i>Science</i>)
4/2 (th)	10	What would count as evidence that neurofeedback changed the brain, not just behavior?	<ul style="list-style-type: none"> • Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide • Group Checkpoint #3: Analysis & interpretation plan • Have read: <ul style="list-style-type: none"> • Sampaio-Baptista et al. (2021, <i>Cell</i>) • Optional reading: <ul style="list-style-type: none"> • Rozengurt et al. (2017, <i>Neurobiol. Learn. Mem.</i>)
4/9 (th)	11	How should neurofeedback be used responsibly (consent, privacy, power)? ▶ Mock ethics boards	<ul style="list-style-type: none"> • Have submitted to Lyceum: <ul style="list-style-type: none"> • Q-Response • Evidence Slide • Have read: <ul style="list-style-type: none"> • Furnari et al., (2024, <i>Philos. Trans. R. Soc. B</i>) • Magee et al. (2024, <i>Neuron</i>) • Optional readings: <ul style="list-style-type: none"> • Nakazawa et al. (2016, <i>AJOB Neuroscience</i>) • UNESCO's Ethics of Neurotechnology (link in Lyceum) • Kalokairinou et al. (2022, <i>Neuroethics</i>)
4/16 (th)	12	So now... what is neurofeedback (and what can we honestly claim)? ▶ Self/peer-assessment forms ▶ Reflection on Learning Experience (ROLE) survey ▶ Final poster prep	<ul style="list-style-type: none"> • Have submitted to Lyceum: <ul style="list-style-type: none"> • Final Reflection • By 11:59pm tomorrow (Friday 4/17) have completed Research Participation or submitted Alternative Assignments (including Extra Credit)

Date (day)	#	Guiding Question of the Week	Readings/Assignments <i>(due class start unless otherwise specified)</i>
4/21 (tu)	13	Final Poster Presentations (in Dana 204) from 8-10am	<ul style="list-style-type: none"> • Have submitted to Lyceum before class: <ul style="list-style-type: none"> • Final Poster (one per group) • Have submitted to Lyceum by 11:59pm today: <ul style="list-style-type: none"> • Group Project Report (one per group)
4/23 (th)	--	No Class (Final Exam Period)	

Schedule is subject to change to improve pacing and/or accommodate unforeseen events (e.g., severe weather, pandemic, alien abduction). Check announcements over email.