Non-mnemonic functions of memory systems

GU4435 / Course Syllabus / Fall 2019
4 Points

When / Where
Fridays, 2:10-4pm, Schermerhorn 405

Instructor
Dr. Mariam Aly [ma3631@columbia.edu]
Office hours: Mondays and Fridays, 4-5pm, Schermerhorn 355D
no office hours on Friday, October 4, or on academic or university holidays

Prerequisites
Undergraduate students: UN1010 (Mind, Brain, & Behavior), UN2430 (Cognitive Neuroscience), or equivalent introductory course in neuroscience or cognitive psychology, **and** instructor's permission
Graduate students: Open to Ph.D. students in the Psychology department and graduate students in other related departments, with instructor's permission.

Bulletin description
The past decade has produced an extraordinary amount of evidence that challenges the classic view of a "medial temporal lobe memory system", namely, the idea that the medial temporal lobe plays a necessary role in long-term declarative memory but not other cognitive functions. This course will introduce these challenges to the traditional perspective by exploring functions of the so-called memory system in domains outside of long-term memory.

Detailed description of the course
The goal of the seminar is to arrive at a deeper understanding of how the computations and representations of "memory systems" (like the hippocampus) can enable them to play a broad role in cognition, including in visual perception, short-term memory, imagination, language processing, decision making, and implicit learning.

Each week will be devoted to a different topic. Each student will lead class discussion for one week, by preparing a slide presentation focused on the required readings *in addition to other papers they find on the topic*. The required readings provide only a starting point. A key component of this course is the ability to do research — given a particular topic, find what has been published on it, and be prepared to summarize *and evaluate* the findings to the class. Find contradictory studies if you'd like — it'll make the debate more interesting! You should try to engage the class as much as possible — remember, seminars are meant to be discussions. At the end of each class, we can talk about whether we have sufficient evidence to challenge the dominant memory systems perspective, or what more needs to be done.

Course goals and learning objectives
This course will give you training in reading primary research articles and review papers, the majority of what scientists read. Primary research articles and review papers are a much different reading experience than textbooks, and reading, dissecting, and critically thinking about them is a key skill for the developing scientist. This course will also enable you to engage in constructive scientific conversations and debates, which will broaden and deepen your understanding of cognitive neuroscience research, and teach you about which questions you should be asking as you read and hear

about new results, and how to interpret them in the context of other studies. Furthermore, this course will enable you to learn how to effectively communicate, with both oral presentations and written work. You will learn how to review the literature and find relevant peer-reviewed papers, thus allowing you to keep up to date in any field of science. You will also gain a deep understanding of the links between different areas of episodic memory research, and gain an appreciation of the development of this research over several decades, challenges to this research, and the latest advancements.

Role in the Psychology curriculum

GU4435 is a seminar open to graduate students and advanced undergraduate students. It fulfills the following degree requirements:

- For graduate students, it can partially fulfill the seminar requirement for the M.A. or the elective requirement for the M.Phil.
- For undergraduates pursuing a Psychology major or concentration in the College or GS or the Psychology Postbac certificate, it meets the Group II (Psychobiology and Neuroscience) distribution requirement.
- For Psychology majors and Psychology Postbac students, it fulfills the seminar requirement.
- For undergraduates pursuing the Neuroscience & Behavior major, it fulfills the advanced seminar requirement in the Psychology portion of the major.
- Graduate students in Psychology and junior and senior Neuroscience & Behavior and Psychology majors will have priority for registration. However, for non-majors in the College and in G.S., GU44xx could count as one term of the natural science requirement, provided the student has taken the prerequisite courses and has instructor permission.

Course schedule

September 6: Introduction
September 13: Attention
September 20: Perception
September 27: Working memory
October 4: Implicit memory
October 11: Statistical learning
October 18: Prediction
October 25: Imagination
November 1: Decision making
November 8: Language
November 15: Problem solving
November 22: Creativity
No class November 29 – Thanksgiving
December 6: Social spaces

Grading

Seminars are meant to be engaging discussions. To participate in these discussions, you must carefully read the relevant papers *before* class, and contribute to the conversation. Grading will be based on whether you have shown that you have read the papers, thought deeply about them, can write about them, and your contribution to class discussions. Grading will be as follows:

30%: attendance and participation
35%: class presentation, including mandatory meeting with the instructor
35%: final paper (research proposal; due by 11:59pm on **Dec 2**), including 1-paragraph overview (due by 11:59pm on **Nov 4**)

Attendance and Participation
Everyone is expected to attend and participate in *every* class. Attendance will be taken prior to each class, and each student should contribute at least once (but preferably more!) to each class discussion. If participating in class is difficult for you, please see me and we can discuss other ways that you can contribute. Absences may be excused if they are accompanied by a note from your advising dean. **Attendance and participation are worth 30% of your grade.**

Class Presentation
Each student is also expected to present for one class period: choose at least three papers (at least 1 from the required reading *and 2 or more from research you do on your own*) and make a slide presentation to lead the class through the papers. **You cannot present all empirical papers or all review papers, and you must present at least 2 empirical papers**. A good approach might be 1-2 review papers and at least 2 empirical papers. If it is an empirical paper, describe the main question, the method, the results, the conclusions, and then bring up points for discussion. Don't get bogged down by details in the methods, especially for neuroimaging studies: convey the critical parts of the method that we need to understand the paper. If it is a review paper, describe the big question it attempts to answer, the different theories it brings up, the evidence for each, the conclusions reached, and then bring up points for discussion. Often, papers are much too comprehensive to go over in detail in a short presentation; you therefore must decide what the main points are, and communicate those. If some sections in a paper are tangential to the main topic, feel free to skip them in your presentation. And remember: presentations are meant to be engaging, and you should try to involve your classmates as much as possible (e.g., by posing questions or asking for opinions regularly). Do your best to understand the background, main findings / arguments, and conclusions of each paper — but it's okay if you don't understand everything. You can also bring up challenging aspects of the paper(s) in class, and we can discuss them together. But try your best to figure things out on your own first.

This presentation is **not** meant to be just a series of article summaries. It must include discussion of the articles you selected, but this discussion should be in the service of putting together a coherent presentation around the topic for that week. Do not just jump from paper to paper. Make sure that there is a *narrative* in your presentation. Think about how to transition from paper to paper to help lead the class through the 'story' you want to tell. That means you must make sure to set up the big question for each paper, why that research is important, what the results mean and their bigger implications.

Each student is required to meet with me before their presentation so that they can receive feedback and have time to incorporate edits before their class presentation. Doing so can substantially improve your grade, and not doing so will result in an automatic 5 point deduction from your presentation. This meeting will also give me a chance to look at the additional papers you chose for your presentation, and make sure they are ok (i.e., peer-reviewed in reputable journals, on a suitable topic).

Each student is also required to e-mail me the additional papers they will present, so I can post them on Courseworks for the class to read before the presentation.

Your class presentation is worth 35% of your grade, and is graded out of 50 points. Describing the questions of each paper is worth 5 points, describing the method (empirical paper) and/or theories discussed (review paper) is worth 10 points, describing the results (empirical paper) and/or evidence for each theory (review paper) is worth 10 points, describing the conclusions reached is worth 5 points, and

bringing up points for discussion is worth 10 points. Clarity of presentation (speaking and slides) is worth an additional 10 points.

Final Paper

At the end of the course, each student must submit a research proposal on any of the topics discussed in class. The goal of the research proposal is for you to think about how you would conduct an experiment to test any of the questions we addressed in class. If you had access to fMRI, patients, or animal models, what experiment would you run, why, what do you expect to find, and how does it address open questions in the field? The research proposal should be prefaced with a short abstract (~300 words) summarizing the background, your proposed experiment, your anticipated results, and the conclusion. **Not including an abstract will result in a 5 point deduction**. The research proposal will consist of the background to the problem (i.e., a literature review and introduction of the topic; this is worth 10 points), methods for your proposed experiment (don't worry about complex details of fMRI data collection or analysis; this is worth 10 points), anticipated results (this section is worth 10 points; **a figure must be included; not having a figure will result in a 5 point deduction**), and discussion (this is worth 10 points). Remember to write about why your experiment is important (why run it at all?) and what it would mean for the field if you found (or didn't find) your anticipated results; these should be key parts of the introduction and discussion. Your research proposal must be **10-12 pages double-spaced**, including figures but excluding the abstract and references. You should aim to read and cite at least 12 papers, no more than half of which can be articles from the course reading list. Clarity of writing and number / suitability of references is worth an additional 10 points. **Your research proposal is worth 35% of your grade**, graded out of 50 points as mentioned above. It is due on **Monday, December 2** (**by 11:59pm).**

To make sure you are on track, you are required to submit one paragraph (~300 words) on Courseworks), describing what you intend to write about, and include some new references relevant for your paper that are not in the class readings. This must be handed in no later than Monday, November 4 (by 11:59pm). Not handing this in will result in an automatic 5 point deduction from your final paper.

Additional course notes

Academic integrity

As a member of the academic community, one of your responsibilities is to uphold principles of honesty and integrity. This means that you can only present your own work on assignments and presentations — plagiarism is strictly prohibited, as is presenting work as your own when it was done by someone else. Doing so compromises your academic integrity and potentially your academic standing. This should go without saying, but **all of your work, including your oral presentation, must be in your own words. You cannot copy and paste text from articles or book chapters into your presentation or your written assignments. You cannot read from assigned papers for your presentation. Everything you present or write must be in your own words.**

If you are falling behind, don't understand the material, or are not confident about your writing or presentation, talk to me as soon as possible instead of taking measures that go against principles of academic integrity. [Columbia's Honor Code in Columbia's Guide to Academic Integrity (http://www.college.columbia.edu/academics/academicintegrity)].

Students with disabilities

If you are a student with special needs and require any type of accommodation, make an appointment with me before the first class to discuss your needs. You should also contact the office of Disability Services (https://health.columbia.edu/disability-services) before the first class to register for specific accommodations.

Schedule and required readings

September 6: Introduction, and how to find papers online (no presentations)

Schiller D, Eichenbaum H, Buffalo EA, Davachi L, Foster DJ, Leutgeb S, Ranganath C. (2015). Memory and space: Towards an understanding of the cognitive map. Journal of Neuroscience, 35, 13904-13911.

Verfaellie M, Keane MM. (2017). Neuropsychological investigations of human amnesia: Insights into the role of the medial temporal lobes in cognition. Journal of the International Neuropsychological Society, 23, 732-740.

September 13: Attention

Aly M, Turk-Browne NB. (2017). How hippocampal memory shapes, and is shaped by, attention. In *The Hippocampus from Cells to Systems: Structure, Connectivity, and Functional Contributions to Memory and Flexible Cognition.* (Eds. Deborah E. Hannula and Melissa C. Duff). Springer. p369-403.

Mack ML, Love BC, Preston AR. (2016). Dynamic updating of hippocampal object representations reflects new conceptual knowledge. PNAS, 113, 13203-13208.

September 20: Perception

Lee ACH, Yeung LK, Barense MD. (2012). The hippocampus and visual perception. Frontiers in Human Neuroscience, 6, article 91, 1-17.

Suzuki WA. (2009). Perception and the medial temporal lobe: Evaluating the current evidence. Neuron, 61, 657-666.

September 27: Working memory

Hannula DE, Tranel D, Cohen NJ. (2006). The long and short of it: Relational memory impairments in amnesia, even at short lags. Journal of Neuroscience, 26, 8352-8359.

Yonelinas AP. (2013). The hippocampus supports high-resolution binding in the service of perception, working memory, and long-term memory. Behavioural Brain Research, 254, 34-44.

October 4: Implicit memory

Hannula DE, Greene AJ. (2012). The hippocampus re-evaluated in unconscious learning and memory: At a tipping point? Frontiers in Human Neuroscience, Volume 6, Article 80, 1-20.

Henke K. (2010). A model for memory systems based on processing modes rather than consciousness. Nature Reviews Neuroscience, 11, 523-532.

October 11: Statistical learning

Covington NV, Brown-Schmidt S, Duff MC. (2018). The necessity of the hippocampus for statistical learning. Journal of Cognitive Neuroscience, 30, 680-697.

Schapiro AC, Kustner LV, Turk-Browne NB. (2012). Shaping of object representations in the human medial temporal lobe based on temporal regularities, Current Biology, 22, 1622-1627.

October 18: Prediction

Brown TI, Carr VA, LaRocque KF, Favila SE, Gordon AM, Bowles B, Bailenson JN, Wagner AD. (2016). Prospective representation of navigational goals in the human hippocampus. Science, 352, 1323-1327.

Buckner RL. (2010). The role of the hippocampus in prediction and imagination. Annual Review of Psychology, 61, 27-48. ** useful for both weeks 7 & 8 **

Pfeiffer BE, Foster DJ. (2013). Hippocampal place-cell sequences depict future paths to remembered goals. Nature, 497, 74-81.

October 25: Imagination

Schacter DL, Addis DR, Szpunar KK. (2017). Escaping the past: Contributions of the hippocampus to future thinking and imagination. In *The Hippocampus from Cells to Systems: Structure, Connectivity, and Functional Contributions to Memory and Flexible Cognition.* (Eds. Deborah E. Hannula and Melissa C. Duff). Springer. p439-465.

Buckner RL. (2010). The role of the hippocampus in prediction and imagination. Annual Review of Psychology, 61, 27-48. ** useful for both weeks 7 & 8 **

Hassabis D, Kumaran D, Vann SD, Maguire EA. (2007). Patients with hippocampal amnesia cannot imagine new experiences. Proceedings of the National Academy of Sciences, 104, 1726-1731.

November 1: Decision making

Shohamy D, Daw ND. (2015). Integrating memories to guide decisions. Current Opinion in Behavioral Sciences, 5, 85-90.

Yu JY, Frank LM. (2015). Hippocampal-cortical interaction in decision making. Neurobiology of Learning & Memory, 117, 34-41.

November 8: Language

Duff MC, Brown-Schmidt S. (2012). The hippocampus and the flexible use and processing of language. Frontiers in Human Neuroscience, Volume 6, Article 69, 1-11.

Piai V, Anderson KL, Lin JJ, Dewar C, Parvizi J, Dronkers NF, Knight RT. (2016). Direct brain recordings reveal hippocampal rhythm underpinnings of language processing. Proceedings of the National Academy of Sciences, 113, 11366-11371.

November 15: Problem solving

Sheldon S, McAndrews MP, Moscovitch, M. (2011). Episodic memory processes mediated by the medial temporal lobes contribute to open-ended problem solving. Neuropsychologia, 49, 2439-2447.

Sheldon S, Vandermorris S, Al-Haj M, Cohen S, Winocur G, Moscovitch M. (2015). Ill-defined problem solving in amnestic mild cognitive impairment: Linking episodic memory to effective solution generation. Neuropsychologia, 68, 168-175.

November 22: Creativity

Duff MC, Kurczek J, Rubin R, Cohen NJ, Tranel D. (2013). Hippocampal amnesia disrupts creative thinking. Hippocampus, 23, 1143-1149.

Rubin RD, Watson PD, Duff MC, Cohen NJ. (2014). The role of the hippocampus in flexible cognition and social behavior. Frontiers in Human Neuroscience, 8, 742, 1-15.

December 6: Social Spaces

Omer DB, Maimon SR, Las L, Ulanovsky N. (2018). Social place-cells in the bat hippocampus. Science, 359, 218-224.

Schafer M, Schiller D. (2018). Navigating social space. Neuron, 100, 476-489.