The Brain & Memory

UN3445 / Course Syllabus / Fall 2022
4 points

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

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

Prerequisites
UN1010 (Mind, Brain, & Behavior), UN2430 (Cognitive Neuroscience), or equivalent introductory course in neuroscience or cognitive psychology, **and** instructor's permission

Bulletin description
This seminar will give a comprehensive overview of episodic memory research: what neuroimaging studies, patient studies, and animal models have taught us about how the brain creates, stores, and retrieves memories.

Detailed description of the course
In the first part of the class, we will examine the neural underpinnings of basic memory phenomena, such as encoding, storage, and retrieval. We will then delve into theories of memory and current debates in the field. Finally, we will discuss challenges to the traditional views of "memory systems" in the brain. The readings comprise empirical papers (which report new experiments and their results) and review papers (which summarize and synthesize a large body of research). Our goal is to arrive at a deeper understanding of what we know about memory and what we are still struggling to understand.

Each week will be devoted to a different topic. Class will begin with a brief overview (by the instructor) of the topic for that week. Most of the class will comprise student presentations and discussion. Each student is responsible for one presentation on the topic of their choice. Each student must e-mail the instructor (as soon as possible after the first class) with their top three choices, and every effort will be made to give each student one of their preferences. Each student can either thoroughly present one paper or briefly present two papers. The papers can be from the required or supplementary readings (see comprehensive reading guide).

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

PSYC UN3445 is a seminar designed particularly for undergraduates majoring in Psychology or Neuroscience & Behavior and for students participating in the Psychology Post-Baccalaureate Certificate program. It fulfills the following degree requirements:

- For the Psychology major or concentration in Columbia College and in the School of General Studies, for the Psychology minor in Engineering, and for the Psychology Post-Baccalaureate Certificate program, this class will meet the Group II (Psychobiology & Neuroscience) distribution requirement.
- For the Neuroscience and Behavior joint major, it will fulfill the fifth Psychology requirement for "one advanced psychology seminar from a list approved by the Psychology Department advisor to the program."
- For Psychology Post-Baccalaureate students and for Psychology majors who entered Columbia in Fall 2013 or later, it will fulfill the seminar requirement.
- For the Barnard Psychology major, this class will fulfill the senior seminar requirement.

Course schedule

September 12: Introduction (no thought piece due)

Part 1: Discovering the neural underpinnings of memory

September 19: Patient studies of episodic memory
September 26: Neuroimaging studies of episodic memory
October 3: Do animals have episodic memory?
October 10: Place cells: building blocks of memory?

Part 2: Formulating theories and debates

October 17: Divisions of episodic memory
October 24: Computations of the hippocampus
October 31: Is the hippocampus fundamentally "spatial"?
No class November 7 – Academic Holiday
November 14: Organizing memories in time

Part 3: Challenges to the "memory systems" view

November 21: The role of memory systems in perception
November 28: The role of the hippocampus in imagination
December 5: How the hippocampus influences, and is influenced by, attention
December 12: Implicit memory in "declarative memory" systems

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.

Overview
25%: attendance and participation
25%: thought pieces *(due 10pm the evening before each class)*
25%: class presentation, including mandatory meeting with the instructor
25%: final paper, including 1-paragraph proposal (*1-paragraph proposal due by 11:59pm **Nov 14**; final paper due by 11:59pm **Dec 12***)

Attendance and Participation
Every student has something valuable to share, and I would love to hear your voice. Everyone is encouraged and expected to attend and participate in every class. Attendance will be taken at the beginning of 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. **Attendance and participation are worth 25% of your grade.**

<u>If you believe you may have COVID or have been in contact with someone who has tested positive, you should stay home! There will not be an attendance penalty.</u> Just let me know. Please also see ***COVID-19 Policies***, below, for more information.

If you are sick for another (not COVID) reason and have to miss class, you must provide me with a doctor's note confirming that you have seen a physician either the day you missed class or shortly (1-2 days) before. I will understand if you have not been able to see a physician due to COVID restrictions on hospital visits. If you have to miss class for another reason that you believe should be excused, you must e-mail me in advance of class to explain your situation.

Thought Pieces
To ensure that everyone reads the material, each student must submit a short (1 paragraph, ~250-400 words, not a hard word limit) 'thought piece' via Courseworks **the evening before each class** (**no later than 10pm**). Thought pieces must also be handed in the week that you present – these will be much easier for you! The thought piece should describe something you found interesting in the readings (and *why* it was so interesting), or raise substantive questions about something you found confusing (and *why* it was so hard to understand). Specifically, you should briefly summarize a point from the readings (e.g., a specific result, a theoretical viewpoint, an analysis technique; this is worth 2 points), raise a question or an observation about it (this is worth 2 points), describe what led you to that question or observation (this is worth 2 points), and what new evidence could be useful for answering the question or supporting/contradicting the observation (this is worth 2 points). This allows me to make sure everyone is on track, and get a better handle on what might be challenging in the readings. Grading will be based on your ability to follow the instructions for the thought piece (as noted above), as well as the clarity of writing (2 points). **Thought pieces are worth 25% of your grade** (each thought piece is graded out of 10, as noted above).

Class Presentation
Each student is also expected to present for one class period: choose <u>at least</u> one paper assigned that week (more than one is encouraged; you can choose any listed papers, whether required reading or not) and make a slide presentation to lead the class through the paper(s). Depending on class size, there may have to be more than one presenter in any given week. If this happens, the instructor will contact the individuals presenting on the same day, and they should coordinate to make sure they present different papers. **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.

For empirical papers, describe the question (this is worth 5 points), the method (this is worth 10 points), the results (this is worth 10 points), the conclusions (this is worth 5 points), and then bring up points for discussion (this is worth 10 points). 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.

For review papers, describe the big question they attempt to answer (this is worth 5 points), the different theories they bring up (this is worth 10 points), the evidence for each theory (this is worth 10 points), the conclusions reached (this is worth 5 points), and then bring up points for discussion (this is worth 10 points).

Clarity of presentation (speaking and slides) is worth an additional 10 points.

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. You can present one paper thoroughly, or two or more papers more briefly. You can bring in additional material as well (this is highly encouraged!). 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 intermittently 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 see me in office hours to discuss difficult points before your presentation. 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 (you can always Google things you don't know). **Your class presentation is worth 25% of your grade** (presentations are graded out of 50 points, as noted above).

Note that this presentation is **not** meant to be just a series of summaries, or a step through each figure in a paper. You must discuss the article(s) you selected, of course, 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 figure to figure or from paper to paper. Make sure that there is a *narrative* in your presentation. Think about how to transition from topic to topic to help lead the class through the 'story' you want to tell. That means you must make sure to set up the big questions, why that research or that finding is important, what the results mean, and their bigger implications.

With respect to discussion questions in your presentation: go for questions aimed at getting students' thoughts, opinions, criticisms, concerns, or interpretation of specific issues discussed in the papers. What *doesn't* work well is just putting up a figure and asking the class if someone can explain it; that is *your* job as a presenter. The goal of class discussion is to get other students' thoughts, feelings, criticisms, and so on, *not* to ask them to present basic concepts. In other words, it is *your job* to explain the basic concepts in order to set up discussion questions for the class, and the goal of the discussion questions is to gather opinions, criticisms, and so on. Also, more targeted questions are better at eliciting answers than more vague ones. For example, "*What aspect of episodic memory do you think is the hardest to find evidence for in animals? Why?*" is better than "*Does anyone have any questions*?"

Final Paper

At the end of the course, each student must submit a final paper (10-12 pages, 8.5" by 11" paper, 1" margins, 11- or 12-point font, double-spaced, excluding references) summarizing the topic that was of most interest to them in the class and raising new questions — making sure to talk about the brain as well as behavior. What do we know now, and what do you think we still need to understand? You should feel free to bridge across topics discussed in different weeks. **You cannot write a paper that is essentially your presentation in a written format. You <u>must</u> go beyond the content of your presentation.**

In your paper, you should be able to describe some findings that interested you (describing them in enough detail for a person to understand if they did not read the article you are talking about; this is worth 10 points), discuss the implications of those findings (this is worth 10 points), and raise problems with those findings and/or outstanding questions for future research (this is worth 10 points). You should then discuss ways of answering those outstanding questions, or specific experiments that could be conducted to test problematic aspects of prior work (this is worth 10 points). To do a good job on this, <u>you must do research beyond the papers discussed in class</u>: find new peer-reviewed articles that touch on the same topic (if you're stuck, a good place to look is in the references of articles that you read, or use Google Scholar to find articles that cited your article). Because this paper is about a whole area of research, you should read several articles carefully, and make sure to cite them: the expectation is to read and cite at least 10 articles, at least 5 of which must be articles that were **<u>not</u>** on the syllabus. Clarity of writing is worth an additional 5 points, and reading/citing enough articles (at least 5 new ones) will be worth 5 points. **Your final paper is worth 25% of your grade** (papers are graded out of 50 points, as noted above). Your final paper is due on **Monday, December 12** (**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 at least three new references relevant for your paper, which <u>cannot</u> be from the class readings. This must be handed in no later than Monday, November 14 (by 11:59pm). Not handing this in will result in an automatic 5-point deduction from your final paper.

Note that **this is not a freeform paper** where you can write about anything related to the brain and/or cognition. You **cannot** just choose a new topic that we have not discussed in class and review that topic. You **must** show me that you've learned something in this class, thought about it, and can raise new observations or questions. You **cannot** re-format your presentation as a paper; your paper must be sufficiently distinct from your presentation. Be sure to follow the rubric laid out above.

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 accommodation, meet me before the first class to discuss your needs. You must also contact Disability Services before the first class to register for specific accommodations (https://health.columbia.edu/disability-services).

COVID-19 policies
To do well in class, you are highly encouraged to do all the readings and assignments, attend all classes, and participate. That said, I recognize that these are not normal times, and all of us are facing challenges that have not been a part of our lives before. For this reason, I will aim to be as helpful and accommodating as possible to your unique situations. If you require accommodations because of COVID-19-related challenges, please e-mail me as soon as you know you need accommodations and explain to me what your needs are so that you can do well.

**** Reading list for the class begins on the next page****

September 12 (no thought piece due)
Introduction (and how to find papers online)
Required background reading that will help during the class

Primer on hippocampal anatomy and function

Knierim JJ. (2015). The hippocampus. Current Biology, 25, R1107-R1125.

Understanding fMRI multivoxel pattern analysis / decoding / classification techniques:

Norman KA, Polyn SM, Detre GJ, Haxby JV. (2006). Beyond mind-reading: Multi-voxel pattern analysis of fMRI data. Trends in Cognitive Sciences, 10, 424-430.

Overview of the cognitive neuroscience of episodic memory (and more):

Moscovitch M, Cabeza R, Winocur G, Nadel L. (2016). Episodic memory and beyond: The hippocampus and neocortex in transformation. Annual Review of Psychology, 67, 105-134.

Anatomy of the medial temporal lobes (see especially Figures 2 & 3)

Lavenex P, Amaral DG. (2000). Hippocampal-neocortical interaction: A hierarchy of associativity. Hippocampus, 10, 420-430.

weekly readings and topics continue on the next page

September 19

Patient studies of episodic memory

Required

Moscovitch M, Nadel L, Winocur G, Gilboa A, Rosenbaum RS. (2006). The cognitive neuroscience of remote episodic, semantic, and spatial memory. Current Opinion in Neurobiology, 16, 179-190.

Squire LR, Wixted JT. (2011). The cognitive neuroscience of human memory since H.M. Annual Review of Neuroscience, 34, 259-288.

Choose **one** of

Barry DN, Maguire EA. (2019). Remote memory and the hippocampus: A constructive critique. Trends in Cognitive Sciences, 23, 128-142.

McCormick C, Ciaramelli E, De Luca F, Maguire EA. (2017). Comparing and contrasting the cognitive effects of hippocampal and ventromedial prefrontal cortex damage: A review of human lesion studies. Neuropsychologia, 374, 295-318.

Robin J, Moscovitch M. (2017). Details, gist, and schema: Hippocampal-neocortical interactions underlying recent and remote episodic and spatial memory. Current Opinion in Behavioral Sciences, 17, 114-123.

Simons JS, Peers PV, Mazuz YS, Berryhill ME, Olson IR. (2010). Dissociation between memory accuracy and memory confidence following bilateral parietal lesions. Cerebral Cortex, 20, 479-485.

St. Laurent M, Moscovitch M, Jadd R, McAndrews MP. (2014). The perceptual richness of complex memory episodes is compromised by medial temporal lobe damage. Hippocampus, 24, 560-576.

Sutherland RJ, Lee JQ, McDonald RJ, Lehmann H. (2019). Has multiple trace theory been refuted? Hippocampus, 30, 842-850.

Vargha-Khadem F, Gadian DG, Watkins KE, Connelly A, Van Paesschen W, Mishkin M. (1997). Differential effects of early hippocampal pathology on episodic and semantic memory. Science, 277, 376-380.

Optional

Vargha-Khadem F, Isaacs E, Mishkin M. (1994). Agnosia, alexia, and a remarkable form of amnesia in an adolescent boy. Brain, 117, 683-703.

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.

weekly readings and topics continue on the next page

September 26

Neuroimaging studies of episodic memory

Required

Davachi L. (2006). Item, context, and relational episodic encoding in humans. Current Opinion in Neurobiology, 16, 693-700.

Paller KA, Wagner AD. (2002). Observing the transformation of experience into memory. Trends in Cognitive Sciences, 6, 93-102.

Choose **one** of

Buckner RL, Wheeler ME. (2001). The cognitive neuroscience of remembering. Nature Reviews Neuroscience, 2, 624-634.

Gilmore AW, Quach A, Kalinowski SE, González-Araya EI, Gotts SJ, Schacter DL, Martin A. (2021). Evidence supporting a time-limited hippocampal role in retrieving autobiographical memories. Proceedings of the National Academy of Sciences, 118, e2023069118

Mitchell KJ, Johnson MK. (2009). Source monitoring 15 years later: What have we learned from fMRI about the neural mechanisms of source memory? Psychological Bulletin, 135, 638-677.

Polyn SM, Natu VS, Cohen JD, Norman KA. (2005). Category-specific cortical activity precedes retrieval during memory search. Science, 310, 1963-1966.

Rissman J, Greely HT, Wagner AD. (2010). Detecting individual memories through the neural decoding of memory states and past experience. Proceedings of the National Academy of Sciences, 107, 9849-9854.

Rissman J, Wagner AD. (2012). Distributed representations in memory: Insights from functional brain imaging. Annual Review of Psychology, 63, 101-128.

Ritchey M, Cooper RA. (2020). Deconstructing the posterior medial episodic network. Trends in Cognitive Sciences, 24, 451-465.

Simons JS, Spiers HJ. (2003). Prefrontal and medial temporal lobe interactions in long-term memory. Nature Reviews Neuroscience, 4, 637-648.

Wagner AD, Shannon BJ, Kahn I, Buckner RL. (2005). Parietal lobe contributions to episodic memory retrieval. Trends in Cognitive Sciences, 9, 445-453.

Optional

Fell J, Axmacher N. (2011). The role of phase synchronization in memory processes. Nature Reviews Neuroscience, 12, 105-118. *[EEG, intracranial EEG, and MEG studies of memory]*

Lee H, Chun MM, Kuhl BA. (2016). Lower parietal encoding activation is associated with sharper information and better memory. Cerebral Cortex, 27, 2486-2499.

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October 3
<u>Do animals have episodic memory?</u>
Required

Clayton NS, Griffiths DP, Emery NJ, Dickinson A. (2001). Elements of episodic-like memory in animals. Philosophical Transactions of the Royal Society B, 356, 1483-1491.

Crystal JD. (2010). Episodic-like memory in animals. Behavioural Brain Research, 215, 235-243.

Wilkins C, Clayton N. (2019). Reflections on the spoon test. Neuropsychologia, 134, 107221.

Choose **one** of

Allen TA, Fortin NJ. (2013). The evolution of episodic memory. Proceedings of the National Academy of Sciences, 110, 10379-10386.

Babb SJ, Crystal JD. (2006). Episodic-like memory in the rat. Current Biology, 16, 1317-1321.

Fugazza C, Pogány Á, Miklósi Á. (2016). Recall of others' actions after incidental encoding reveals episodic-like memory in dogs. Current Biology, 26, 3209-3213.

Fortin NJ, Wright SP, Eichenbaum H. (2004). Recollection-like memory retrieval in rats is dependent on the hippocampus. Nature, 431, 188-191.

Lewis A, Berntsen D, Call J. (2019). Long-term memory of past events in great apes. Current Directions in Psychological Science, 28, 117-123.

Millin PM, Riccio DC. (2019). False memory in nonhuman animals. Learning & Memory, 26, 381-386.

Suddendorf T, Corballis MC. (2010). Behavioural evidence for mental time travel in nonhuman animals. Behavioural Brain Research, 215, 292-298.

Templer VL, Hampton RR. (2013). Episodic memory in nonhuman animals. Current Biology, 23, R801-R806.

Optional

Jelbert SA, Clayton NS. (2017). Comparing the non-linguistic hallmarks of episodic memory systems in corvids and children. Current Opinion in Behavioral Sciences, 17, 99-106.

Morris RGM. (2001). Episodic-like memory in animals: Psychological criteria, neural mechanisms, and the value of episodic-like tasks to investigate animal models of neurodegenerative disease. Philosophical Transactions of the Royal Society B, 356, 1453-1465.

Paxton R, Hampton RR. (2009). Tests of planning and the Bischof-Köhler hypothesis in rhesus monkeys (*Macaca mulatta)*. Behav Processes, 80, 238-246.

weekly readings and topics continue on the next page

October 10

Place cells: building blocks of memory?

Required

Buffalo EA. (2015). Bridging the gap between spatial and mnemonic views of the hippocampal formation. Hippocampus, 25, 713-718.

Moser M-B, Rowland DC, Moser EI. (2015). Place cells, grid cells, and memory. Cold Spring Harbor Perspectives in Biology, 7; a021808, 1-16. doi: 10.1101/cshperspect.a021808

Choose **one** of

Eichenbaum H, Dudchenko P, Wood E, Shapiro M, Tanila H. (1999). The hippocampus, memory and, place cells: Is it spatial memory or a memory space? Neuron, 23, 209-226.

Knierim JJ. (2015). From the GPS to HM: Place cells, grid cells, and memory. Hippocampus, 25, 719-725.

Knierim JJ, Lee I, Hargreaves EL. (2006). Hippocampal place cells: Parallel input streams, subregional processing, and implications for episodic memory. Hippocampus, 16, 755-764.

Milivojevic B, Doeller CF. (2013). Mnemonic networks in the hippocampal formation: From spatial maps to temporal and conceptual codes. Journal of Experimental Psychology: General, 142, 1231-1241.

Miller JF et al. (2013). Neural activity in human hippocampal formation reveals the spatial context of retrieved memories. Science, 342, 1111-1114.

Rolls ET, Wirth S. (2018). Spatial representations in the primate hippocampus, and their functions in memory and navigation. Progress in Neurobiology, 171, 90-113.

Optional

Horner AJ, Bisby JA, Zotow E, Bush D, Burgess N. (2016). Grid-like processing of imagined navigation. Current Biology, 26, 842-847.

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

Payne HL, Lynch GF, Aronov D. (2021). Neural representations of space in the hippocampus of a food-caching bird. Science, 373, 343-348.

Plitt MH, Giocomo LM (2021). Spatial memory: Place cell activity is causally related to behavior. Current Biology, 31, R335-R337.

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October 17
<u>Divisions of episodic memory</u>
Required

Eichenbaum H, Yonelinas AP, Ranganath C. (2007). The medial temporal lobe and recognition memory. Annual Review of Neuroscience, 30, 123-152.

Wixted JT, Squire LR. (2011). The medial temporal lobe and the attributes of memory. Trends in Cognitive Sciences, 15, 210-217.

Choose **one** of

Bastin C, Besson G, Simon J, Delhaye E, Geurten M, Willems S, Salmon E. (2019). An integrative memory model of recollection and familiarity to understand memory deficits. Behavioral and Brain Sciences, 42, e281, 1-60.

Bird CM. (2017). The role of the hippocampus in recognition memory. Cortex, 93, 155-165.

Bird CM, Shallice T, Cipolotti L. (2007). Fractionation of memory in medial temporal lobe amnesia. Neuropsychologia, 45, 1160-1171.

Brown MW, Warburton EC, Aggleton JP. (2010). Recognition memory: Material, processes, and substrates. Hippocampus, 20, 1228-1244.

Kohler S, Martin CB. (2020). Familiarity impairments after anterior temporal-lobe resection with hippocampal sparing: Lessons learned from case NB. Neuropsychologia, 138, 107339.

Mayes A, Montaldi D, Migo E. (2007). Associative memory and the medial temporal lobes. Trends in Cognitive Sciences, 11, 126-135.

Ranganath C. (2010). A unified framework for the functional organization of the medial temporal lobes and the phenomenology of episodic memory. Hippocampus, 20, 1263-1290.

Yonelinas AP, Aly M, Wang W-C, Koen JD. (2010). Recollection and familiarity: Examining controversial assumptions and new directions. Hippocampus, 20, 1178-1194.

Optional

Cowell RA, Barense MD, Sadil PS. (2019). A roadmap for understanding memory: Decomposing cognitive processes into operations and representations. eNeuro. DOI: <u>https://doi.org/10.1523/ENEURO.0122-19.2019</u>

Quamme JR, Yonelinas AP, Norman KA. (2007). Effect of unitization on associative recognition n amnesia. Hippocampus, 17, 192-200.

Sauvage MM, Fortin NJ, Owens CB, Yonelinas AP, Eichenbaum H. (2007). Recognition memory: Opposite effects of hippocampal damage on recollection and familiarity. Nature Neuroscience, 11, 16-18.

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October 24

<u>Computations of the hippocampus</u>

Required

Deuker L, Doeller CF, Fell J, Axmacher N. (2014). Human neuroimaging studies on hippocampal CA3 region — integrating evidence for pattern separation and completion. Frontiers in Cellular Neuroscience, Volume 8, Article 64, 1-9.

Yassa MA, Stark CEL. (2011). Pattern separation in the hippocampus. Trends in Neurosciences, 34, 515-525.

Choose **one** of

Bakker A, Kirwan CB, Miller M, Stark CEL. (2008). Pattern separation in the human hippocampal CA3 and dentate gyrus. Science, 319, 1640-1642.

Berron D, Schutze H, Maass A, Cardenas-Blanco A, Kuijf HJ, Kumaran D, Duzel E. (2016). Strong evidence for pattern separation in human dentate gyrus. Journal of Neuroscience, 36, 7579-7579.

Duncan K, Ketz N, Inati SJ, Davachi L. (2012). Evidence for area CA1 as a match/mismatch detector: A high-resolution fMRI study of the human hippocampus. Hippocampus, 22, 389-398.

Grande X, Berron D, Horner AJ, Bisby JA, Düzel E, Burgess N. (2019). Holistic recollection via pattern completion involves hippocampal subfield CA3. Journal of Neuroscience, 39, 8100-8111.

Baker S, Vieweg P, Gao F, Gilboa A, Wolbers T, Black SE, Rosenbaum RS. (2016). The human dentate gyrus plays a necessary role in discriminating new memories. Current Biology, 26, 2629-34.

Knierim JJ, Neunuebel JP. (2016). Tracking the flow of hippocampal computation: Pattern separation, pattern completion, and attractor dynamics. Neurobiology of Learning and Memory, 129, 38-49.

Leal SL, Yassa MA. (2018). Integrating new findings and examining clinical applications of pattern separation. Nature Neuroscience. 21:163-73.

Lee H, GoodSmith D, Knierim J. (2020). Parallel processing streams in the hippocampus. Current Opinion in Neurobiology, 64, 1-8.

Optional

Guzowski JF, Knierim JJ, Moser EI. (2004). Ensemble dynamics of hippocampal regions CA3 and CA1. Neuron, 44, 581-584.

Kent BA, Hvoslef-Eide M, Saksida LM, Bussey TJ. (2016). The representational-hierarchical view of pattern separation: Not just hippocampus, not just space, not just memory? Neurobiology of Learning and Memory, 129, 99-106.

weekly readings and topics continue on the next page

October 31

Is the hippocampus fundamentally “spatial”?

Required

Eichenbaum H, Cohen NJ. (2014). Can we reconcile the declarative memory and spatial navigation views on hippocampal function? Neuron, 83, 764-770.

Maguire EA, Mullally SL. (2013). The hippocampus: A manifesto for change. Journal of Experimental Psychology: General, 4, 1180-1189.

Choose **one** of

Bird CM, Capponi C, King JA, Doeller CF, Burgess N. (2010). Establishing the boundaries: The hippocampal contribution to imagining scenes. Journal of Neuroscience, 30, 11688-11695.

Clark IA, Kim M, Maguire EA. (2018). Verbal paired associates and the hippocampus: The role of scenes. Journal of Cognitive Neuroscience, 30, 1821-1845.

Eichenbaum H. (2016). What versus where: Non-spatial aspects of memory representation by the hippocampus. Current Topics in Behavioral Neurosciences, 450, 1-17.

Ekstrom AD, Ranganath C. (2018). Space, time, and episodic memory: The hippocampus is all over the cognitive map. Hippocampus, 28, 680-687.

Nadel L. (1991). The hippocampus and space revisited. Hippocampus, 1, 221-229.

Robin J. (2018). Spatial scaffold effects in event memory and imagination. WIREs Cognitive Science, 23, e1462, 1-15.

Rueckemann JW, Buffalo EA. (2017). Spatial responses, immediate experience, and memory in the monkey hippocampus. Current Opinion in Behavioral Sciences, 17, 155-160.

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November 14

<u>Organizing memories in time</u>

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November 21

<u>The role of memory systems in perception</u>

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November 28

<u>The role of the hippocampus in imagination</u>

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December 5
<u>How the hippocampus influences, and is influenced by, attention</u>
Required

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December 12

Implicit memory in "declarative memory" systems

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Reading for when the class is over and you miss it

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