The Brain & Memory

UN3445 / Course Syllabus / Fall 2017
4 points

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

Instructor
Dr. Mariam Aly [ma3631@columbia.edu]
Office hours: TBD, Schermerhorn Hall 355D

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

Course 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 will comprise empirical papers (which report new experiments and their results) and review papers (which summarize and synthesize a large body of research). The goal of the seminar 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 rationale
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 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.

Course schedule

Part 1: Discovering the neural underpinnings of memory

Week 2: Patient studies of episodic memory
Week 3: fMRI studies of episodic memory
Week 4: Do animals have episodic memory?
Week 5: Place cells: building blocks of memory?

Part 2: Formulating theories and debates

Week 6: Divisions of episodic memory
Week 7: Computations of the hippocampus
Week 8: Is the hippocampus fundamentally "spatial"?
Week 9: Organizing memories in time

Part 3: Challenges to the "memory systems" view

Week 10: The role of memory systems in perception
Week 11: The role of the hippocampus in imagination
Week 12: How the hippocampus influences, and is influenced by, attention
Week 13: 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
25%: class presentation, including mandatory meeting with the instructor
25%: final paper, including 1-paragraph overview 1 month prior to paper submission

Attendance and Participation

Everyone is 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.**

Thought Pieces

To ensure that everyone reads the material, each student must submit a short (1 paragraph) 'thought piece' via Courseworks the evening before each class (no later than 6pm; thought pieces must also be handed in on 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 at least one paper assigned that week (from any listed, whether required 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.**

If it is an empirical paper, 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.

If it is a review paper, describe the big question it attempts to answer (this is worth 5 points), the different theories it brings up (this is worth 10 points), the evidence for each (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 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).

Final Paper

At the end of the course, each student must submit a final paper (10-15 pages, double-spaced, excluding references) summarizing the topic that was of most interest to them in the class and raising new questions. 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. 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, you must do research beyond the papers discussed in class: 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, no more than 5 of which can be articles from the course reading list. 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 11** (**by 11:59pm).**

To make sure you are on track, each student is required to submit one paragraph describing what they intend to write about and including some references. This must be handed in no later than Thursday, November 9, to allow me enough time to give everyone feedback before the final paper is due. 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. 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).

Weekly Topics and Readings

Readings come in different forms: some are required, some you get to choose from, and others are optional. I have listed many fewer papers than needed to truly understand a topic, but the supplementary readings are there to help you pursue your interests should any topic intrigue you. Assuming we all read slightly different sets of papers, we can have a very rich discussion in class! The last few pages of the syllabus are the comprehensive reading guide.

Week 1: Introduction (and how to find papers online)

Required background reading that will help during the class (no 'thought piece' required)

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.

Week 2: 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

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, 2629-2634.

Baldo JV, Shimamura AP. (2002). Frontal lobes and Memory. In Baddeley A, Wilson B, Kopelman M (Eds), Handbook of Memory Disorders, 2nd Edition, John Wiley & Co: London. p363-379.

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.

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

Clark IA, Maguire EA. (2016). Remembering preservation in hippocampal amnesia. Annual Review of Psychology, 67, 51-82.

<u>Week 3: fMRI studies of episodic memory</u>

Required

Mitchel 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.

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

Choose **one** of

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.

Rissman J, Greely HT, Wagner AD. (2010). Detecting individual memories through the neural decoding of memory states and past experience.

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

Aly M, Turk-Browne NB. (2016). Attention promotes episodic encoding by stabilizing hippocampal representations. Proceedings of the National Academy of Sciences, 113, E420-E429.

Carr VA, Rissman J, Wagner AD. (2010). Imaging the human medial temporal lobe with high-resolution fMRI. Neuron, 65, 298-308.

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

Week 4: Do animals have episodic memory?

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.

Templer VL, Hampton RR. (2016). Episodic memory in nonhuman animals Current Biology, 23, R801-R806.

Choose **one** of

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

Ergorul C, Eichenbaum H. (2004). The hippocampus and memory for "what", "where", and "when". Learning & Memory, 11, 397-405.

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.

Optional

McKenzie S, Keene CS, Farovik A, Bladon J, Place R, Komorowski R, Eichenbaum H. (2016). Representation of memories in the cortical-hippocampal system: Results from the application of population similarity analyses. Neurobiology of Learning & Memory, 134, 178-191.

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.

Week 5: Place cells: building blocks of memory?

Required

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

Moser EI, Paulsen O. (2001). New excitement in cognitive space: Between place cells and spatial memory. Current Opinion in Neurobiology, 11, 745-751.

Choose **one** of

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

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, 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.

Zucker HR, Ranganath C. (2015). Navigating the human hippocampus without a GPS. Hippocampus, 25, 697-703.

Optional

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

Week 6: Divisions of episodic memory

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

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

Bowles B, Crupi C, Mirsattari SM, Pigott SE, Parrent AG, Pruessner JC, Yonelinas AP, Kohler S. (2007). Impaired familiarity with preserved recollection after anterior temporal-lobe resection that spares the hippocampus. Proceedings of the National Academy of Sciences, 104, 16382-16387.

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

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

Quamme JR, Weiss DJ, Norman KA. (2010). Listening for recollection: A multi-voxel pattern analysis of recognition memory retrieval strategies. Frontiers in Human Neuroscience, Volume 4, Article 61, 1-17.

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.

Week 7: Computations of the hippocampus

Required

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

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.

Kirwan CB, Hartshorn A, Stark SM, Goodrich-Hunsaker NJ, Hopkins RO, Stark CEL. (2012). Pattern separation deficits following damage to the hippocampus. Neuropsychologia, 50, 2408-2414.

LaRocque KF, Smith ME, Carr VA, Witthoft N, Grill-Spector K, Wagner AD. (2013). Global similarity and pattern separation in the human medial temporal lobe predict subsequent memory. Journal of Neuroscience, 33, 5466-5474.

Optional

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.

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

Week 8: 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.

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

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

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.

Optional

Bird CM & Burgess N. (2008). The hippocampus and memory: Insights from spatial processing. Nature Reviews Neuroscience, 9, 182-194.

Week 9: Organizing memories in time

Required

Davachi L, DuBrow S. (2015). How the hippocampus preserves order: The role of prediction and context. Trends in Cognitive Sciences, 19, 92-99.

Eichenbaum HB. (2013). Memory on time. Trends in Cognitive Sciences, 17, 83-90.

Choose **one** of

Barnett AJ, O'Neil EB, Watson HC, Lee ACH. (2014). The human hippocampus is sensitive to durations of events and intervals within a sequence. Neuropsychologia, 64, 1-12.

DuBrow S, Davachi L. (2014). Temporal memory is shaped by encoding stability and intervening item reactivation. Journal of Neuroscience, 34, 13998-14005.

Hsieh L-T, Gruber MJ, Jenkins LJ, Ranganath C. (2014). Hippocampal activity patterns carry information about objects in temporal context. Neuron, 81, 1165-1178.

Jenkins LJ, Ranganath C. (2010). Prefrontal and medial temporal lobe activity at encoding predicts temporal context memory. Journal of Neuroscience, 30, 15558, 15565.

Palombo DJ, Keane MM, Verfaellie M. (2016). Does the hippocampus keep track of time? Hippocampus, 26, 372-379.

Ranganath C, Hsieh L-T. (2016). The hippocampus: A special place for time. Annals of the New York Academy of Sciences, 1369, 93-110.

Optional

Eichenbaum HB. (2014). Time cells in the hippocampus: A new dimension for mapping memories. Nature Reviews Neuroscience, 15, 732-744.

Sakon JJ, Naya Y, Wirth S, Suzuki WA. (2014). Context-dependent incremental timing cells in the primate hippocampus. Proceedings of the National Academy of Sciences, 51, 18351-18356.

Week 10: The role of memory systems in perception

Required

Baxter M. (2009). Involvement of medial temporal lobe structures in memory and perception. Neuron, 61, 667-677.

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

Choose **one** of

Aly M, Ranganath C, Yonelinas AP. (2013). Detecting changes in scenes: The hippocampus is critical for strength-based perception. Neuron, 78, 1127-37.

Barense MD, Groen IIA, Lee ACH, Yeung L-K, Brady SM, Gregori M, Kapur N, Bussey TJ, Saksida LM, Henson RNA. (2012). Intact memory for irrelevant information impairs perception in amnesia. Neuron, 75, 157-167.

Bussey TJ, Saksida LM. (2005). Object memory and perception in the medial temporal lobe: An alternative approach. Current Opinion in Neurobiology, 15, 730-737.

Graham KS, Barense MD, Lee ACH. (2010). Going beyond LTM in the MTL: A synthesis of neuropsychological and neuroimaging findings on the role of the medial temporal lobe in memory and perception. Neuropsychologia, 48, 831-853.

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

Mullally SL, Intraub H, Maguire EA. (2012). Attenuated boundary extension produces a paradoxical memory advantage in amnesic patients. Current Biology, 22, 261-268.

Zeidman P, Mullally SL, Maguire EA. (2015). Constructing, perceiving, and maintaining scenes: Hippocampal activity and connectivity. Cerebral Corex, 25, 3836-3855.

Optional

Nadel L, Peterson MA. (2013). The hippocampus: Part of an interactive posterior representational system spanning perceptual and memorial systems. Journal of Experimental Psychology: General, 142, 1242-1254.

Olsen RK, Moses SN, Riggs L, Ryan JD. (2012). The hippocampus supports multiple cognitive processes through relational binding and comparison. Frontiers in Human Neuroscience, Volume 6, Article 146, 1-13.

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

Week 11: The role of the hippocampus in imagination

Required

Addis DR, Schacter DL. (2012). The hippocampus and imagining the future: Where do we stand? Frontiers in Human Neuroscience, Volume 5, Article 173, 1-15.

Buckner RL. (2010). The role of the hippocampus in prediction and imagination. Annual Review of Psychology, 61, 27-48.

Choose **one** of

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.

Addis DR, Wong AT, Schacter DL. (2007). Remembering the past and imaging the future: Common and distinct neural substrates during event construction and elaboration. Neuropsychologia, 45, 1363-1377.

Zeidman P, Maguire EA. (2016). Anterior hippocampus: The anatomy of perception, imagination, and episodic memory. Nature Reviews Neuroscience, 17, 173-182.

Optional

Rosenbaum RS, Gilboa A, Levine B, Winocur G, Moscovitch M. (2009). Amnesia as an impairment of detail generation and binding: Evidence from personal, fictional and semantic narratives in K.C. Neuropsychologia, 47, 2181-2187.

Week 12: How the hippocampus influences, and is influenced by, attention

Required

Aly M, Turk-Browne NB. (in press). 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.

Muzzio IA, Kentros C, Kandel E. (2009). What is remembered? Role of attention on the encoding and retrieval of hippocampal representations. The Journal of Physiology, 587, 2837-2854.

Choose **one** of

Aly M, Turk-Browne NB. (2016). Attention stabilizes representations in the human hippocampus. Cerebral Cortex, 26, 783-796.

Cosman JD, Vecera SP. (2013). Learned control over distraction is disrupted in amnesia. Psychological Science, 24, 1585-1590.

Kentros CG, Agnihotri NT, Streater S, Hawkins RD, Kandel ER. (2004). Increased attention to spatial context increases both place field stability and spatial memory. Neuron, 42, 283–295.

Muzzio IA, Levita L, Kulkarni J, Monaco J, Kentros C, Stead M, Abbott LF, Kandel ER. (2009). Attention enhances the retrieval and stability of visuospatial and olfactory representations in the dorsal hippocampus. PLoS Biology, Volume 7, e1000140. 1–20.

Rowland DC, Kentros CG. (2008). Potential anatomical basis for attentional modulation of hippocampal neurons, Annals of the New York Academy of Sciences, 1129, 213-224.

Stokes MG, Atherton K, Patai EZ, Nobre AC. (2012). Long-term memory prepares neural activity for perception. Proceedings of the National Academy of Sciences, 109, E260-E367.

Summerfield JJ, Lepsien J, Gitelman DR, Mesulam MM, Nobre AC. (2006). Orienting attention based on long-term memory experience. Neuron, 49, 905-916.

Optional

Fenton AA, Lytton WW, Barry JM, Lenck-Santini PP, Zinyuk LE, Kubík S, Bureš J, Poucet B, Muller RU, Olypher AV. (2010). Attention-like modulation of hippocampus place cell discharge. Journal of Neuroscience, 30, 4613–4625.

Hutchinson JB, Turk-Browne NB. (2012). Memory-guided attention: Control from multiple memory systems. Trends in Cognitive Sciences, 16, 576-579.

Kelemen E, Fenton AA. (2010). Dynamic grouping of hippocampal neural activity during cognitive control of two spatial frames. PLoS Biology, Volume 8, e1000403, 1–14.

<u>Week 13: Implicit memory in “declarative memory” systems</u>

Required

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.

Choose **one** of

Chun MM, Phelps EA. (1999). Memory deficits for implicit contextual information in amnesic subjects with hippocampal damage. Nature Neuroscience, 2, 844-847.

Hannula DE, Ranganath C. (2009). The eyes have it: Hippocampal activity predicts expression of memory in eye movements. Neuron 63, 592-599.

Hannula DE, Ryan JD, Tranel D, Cohen NJ. (2007). Rapid onset relational memory effects are evident in eye movement behavior, but not in hippocampal amnesia. Journal of Cognitive Neuroscience, 19, 1690-1705.

Ryan JD, Althoff RR, Whitlow S, Cohen NJ. (2000). Amnesia is a deficit in relational memory. Psychological Science, 11, 454-461.

Ryals AJ, Wang JX, Polnaszek KL, Voss JL. (2015). Hippocampal contribution to implicit configuration memory expressed via eye movements during scene exploration. Hippocampus, 25, 1028-1041.

Schapiro AC, Gregory E, Landau B, McCloskey M, Turk-Browne NB. (2014). The necessity of the medial temporal lobe for statistical learning. Journal of Cognitive Neuroscience, 26, 1736-1747.

Turk-Browne NB, Scholl BJ, Johnson MK, Chun MM. (2010). Implicit perceptual anticipation triggered by statistical learning. Journal of Neuroscience, 30, 11177-11187.

Optional

Giesbrecht B, Sy JL, Guerin SA. (2013). Both memory and attention systems contribute to visual search for targets cued by implicitly learned context. Vision Research, 85, 80-89.

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.

** These readings are subject to revision. Revisions will be noted in class and on the website **