

Methods and Issues in Cognitive Neuroscience: Memory and Decision Making

Psychology 4415
Thursday 2:10-4:00
Room 405 Schermerhorn Hall

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Course Description

How are decisions shaped by past experience? Are there different forms of memory and experience that guide decisions? If so, when are decisions guided by explicit knowledge, and when by implicitly learned associations or biases? What are the neural mechanisms that support memory, decisions, and their interaction?

These are the questions we will focus on in this seminar. We will review current theories in the cognitive neuroscience of decision making and memory, with a particular eye towards understanding how these two cognitive processes – typically studied separately from each other - interact. We will review these fields with a focus on two heavily influential methods in cognitive neuroscience: functional imaging and patient studies. We will debate the strengths and weaknesses of each approach, and will discuss how methodological trends and limitations have shaped our view of cognitive function.

Course Structure

The seminar will survey recent literature on the cognitive neuroscience of learning, memory and decision making. Each weekly meeting will address a question in the field. We will begin each meeting by discussing the background and importance of that week's topic, followed by a student presentation of a recent data article that bears on this question. Finally, we will together consider how the data presented inform our understanding of that week's topic, and how it related to other questions discussed in the course.

Course Requirements

- Class participation: Prior to each class, students are expected to read the assigned papers. Students are encouraged to seek out additional research or theoretical papers that are relevant to the topic and to bring these up during the class discussion. All class participants are expected to actively contribute to the discussion.
- Class presentation: Each student will be responsible for presenting at least once during the semester. Weekly presentations will be assigned during the first class. Presentations should be relatively brief (30-40

minutes), concise, and critical. The presentation should focus on providing a clear presentation of (a) Question – what is the main question the paper addresses, (b) Methods - how did the researchers address this question (c) Results and (d) Critique and Conclusions.

- Written assignments:

- **Questions.** What would you like to learn about in this class? Before the second week students are required to email me a list of 5 questions that they are curious about on the topic of memory and decision making. I encourage you to think about these questions broadly in terms of general interest, and to *not* build on prior knowledge of the literature.
- **Opinion/Critical Reviews:** During the semester, each student will select two topics they are particularly interested in for which to submit a briefly written critical review. The review will be no longer than one page, and will briefly describe your opinion on the paper: did you like it, or not? Why not? What is your opinion on the theory, approach, findings, or conclusion?
- **Term Paper:** Term papers addressing a question discussed during the seminar can be written either as research proposals, or as review papers. The final paper will be 8-10 pages long, and will be submitted by the last class.

Course Evaluation

- Class participation will count towards 25% of the final grade.
- Class presentation will count towards 25% of the final grade.
- Written assignments will count towards 50% of the final grade, as follows:
 - Question assignment - 5%
 - Critical reviews – 20% (10% each)
 - Term paper – 25%

Articles

Readings will consist of empirical and review articles. Most papers are available as downloadable pdfs by searching the PubMed archive at:

<http://www.ncbi.nlm.nih.gov/entrez/query.fcgi>. The exceptions (marked as *** below) are available on the site for this class.

Adcock, R. A., A. Thangavel, et al. (2006). "Reward-motivated learning: mesolimbic activation precedes memory formation." Neuron **50**(3): 507-17.

Addis, D. R., A. T. Wong, et al. (2007). "Remembering the past and imagining the future: Common and distinct neural substrates during event construction and elaboration." Neuropsychologia **45**(7): 1363-77.

Buckner, R. L. and D. C. Carroll (2007). "Self-projection and the brain." Trends Cogn Sci **11**(2): 49-57.

- Daw, N. D., Y. Niv, et al. (2005). "Uncertainty-based competition between prefrontal and dorsolateral striatal systems for behavioral control." Nat Neurosci **8**(12): 1704-11.
- Delgado, M. R., R. H. Frank, et al. (2005). "Perceptions of moral character modulate the neural systems of reward during the trust game." Nat Neurosci **8**(11): 1611-8.
- Foerde, K., B. J. Knowlton, et al. (2006). "Modulation of competing memory systems by distraction." Proc Natl Acad Sci U S A **103**(31): 11778-83.
- Frank, M. J., L. C. Seeberger, et al. (2004). "By carrot or by stick: cognitive reinforcement learning in parkinsonism." Science **306**(5703): 1940-3.
- Gabrieli, J. D. (1998). "Cognitive neuroscience of human memory." Annu Rev Psychol **49**: 87-115.
- Hassabis, D., D. Kumaran, et al. (2007). "Patients with hippocampal amnesia cannot imagine new experiences." Proc Natl Acad Sci U S A **104**(5): 1726-31.
- Kahn, I., Y. Yeshurun, et al. (2002). "The role of the amygdala in signaling prospective outcome of choice." Neuron **33**(6): 983-94.
- Knowlton, B. J., J. A. Mangels, et al. (1996). "A neostriatal habit learning system in humans." Science **273**(5280): 1399-402.
- Lisman, J. E. and A. A. Grace (2005). "The hippocampal-VTA loop: controlling the entry of information into long-term memory." Neuron **46**(5): 703-13.
- O'Doherty, J. P. (2004). "Reward representations and reward-related learning in the human brain: insights from neuroimaging." Curr Opin Neurobiol **14**(6): 769-76.
- O'Doherty, J. P., P. Dayan, et al. (2003). "Temporal difference models and reward-related learning in the human brain." Neuron **38**(2): 329-37.
- Paller, K. A. and A. D. Wagner (2002). "Observing the transformation of experience into memory." Trends Cogn Sci **6**(2): 93-102.
- Poldrack, R. A., J. Clark, et al. (2001). "Interactive memory systems in the human brain." Nature **414**(6863): 546-50.
- Poldrack, R. A. and M. G. Packard (2003). "Competition among multiple memory systems: converging evidence from animal and human brain studies." Neuropsychologia **41**(3): 245-51.
- Schott, B. H., R. N. Henson, et al. (2005). "Redefining implicit and explicit memory: the functional neuroanatomy of priming, remembering, and control of retrieval." Proc Natl Acad Sci U S A **102**(4): 1257-62.
- Schultz, W. (2006). "Behavioral theories and the neurophysiology of reward." Annu Rev Psychol **57**: 87-115.
- Shohamy, D., C. E. Myers, et al. (2006). "L-dopa impairs learning, but spares generalization, in Parkinson's disease." Neuropsychologia **44**(5): 774-84.
- Shohamy, D., C. E. Myers, et al. (2004). "Cortico-striatal contributions to feedback-based learning: converging data from neuroimaging and neuropsychology." Brain **127**(Pt 4): 851-9.
- Staresina, B. P. and L. Davachi (2006). "Differential encoding mechanisms for subsequent associative recognition and free recall." J Neurosci **26**(36): 9162-72.

- Tom, S. M., C. R. Fox, et al. (2007). "The neural basis of loss aversion in decision-making under risk." *Science* **315**(5811): 515-8.
- Valentin, V. V., A. Dickinson, et al. (2007). "Determining the neural substrates of goal-directed learning in the human brain." *J Neurosci* **27**(15): 4019-26.
- Yin, H. H. and B. J. Knowlton (2006). "The role of the basal ganglia in habit formation." *Nat Rev Neurosci* **7**(6): 464-76.

Course Schedule

Date	Topic	Readings
Sept 6	General Introduction	
Sept 13	Do different kinds of memory depend on different brain mechanisms?	Gabrieli, 1998 <i>Schott et al., 2005</i>
Sept 20	How do we remember what we did this morning? Declarative memory and the hippocampus	Paller & Wagner, 2002 <i>Staresina et al., 2006</i>
Sept 27	How do we remember how to ride a bike? Habit learning and the basal ganglia	Yin & Knowlton, 2006 <i>Knowlton, Mangels, Squire, 1996</i>
Oct 4	Do different kinds of memory interact?	Poldrack & Packard, 2003 <i>Shohamy et al., 2007</i> <i>Foerde et al., 2006</i>
Oct 11	How do we learn to predict reward? Dopamine and reward in reinforcement learning	Schultz, 2006, or O'Doherty 2004 <i>O'Doherty et al., 2003</i>
Oct 18	How does feedback drive learning? Dopamine, the striatum, and feedback	Poldrack et al., 2001 <i>Shohamy et al., 2004;</i> <i>Frank et al., 2004</i>
Oct 23	Do dopamine and reward also enhance declarative memory?	Lisman & Grace, 2005 <i>Adcock et al., 2006</i>
Oct 30	How do we learn to avoid loss?	Kahn et al., 2002 <i>Tom & Podrack, 2007</i>
Nov 1	Are there different decision-making systems in the brain?	Daw et al., 2005 <i>Valentin et al., 2007</i>
Nov 8	How do emotions and social context impact memory and decisions?	Phelps, 2004 <i>Delgado, 2005</i>
Nov 15	How do emotions impact declarative/hippocampal memory?	<i>Sharot et al., 2007</i>
Nov 22	"Memories" of the future? The	Buckner and Carrol, 2007

Nov 30
Dec 6

hippocampus and planning of
future events
THANKSGIVING no class
Term Papers due;
Summary and discussion of
term paper topics

Addis et al., 2006
Hassabis et al., 2007