Preliminary Course Information for

Psychology G4430

*Learning and the Brain*

Spring 2010

Daphna Shohamy
shohamy@psych.columbia.edu

I. Bulletin description
II. A full description of the content of the course
III. The rationale for giving the course
IV. The reading list and weekly syllabus
V. Course requirements

---

I. Bulletin Description

**PSYC G4430**. Learning and the Brain (seminar).
4 pts. D. Shohamy. R 2:10 – 4 P.M. Room 405 Schermerhorn Hall

Prerequisites: Courses in introductory psychology and/or neuroscience, and the instructor’s permission.

What are the neural mechanisms that support learning, memory, and choices? We will review current theories in the cognitive neuroscience of human learning, discuss how learning and decision making interact, and consider the strengths and weaknesses of two influential methods in the study of human brain and behavior—functional imaging and patient studies.

II. A full description of the content of the course

How does past experience guide behavior? Are there different forms of learning and memory that guide behavior? If so, when do these different forms of learning take place? How do they guide choices and actions? What are the neural mechanisms that support learning, memory, and choices? These are the questions we will focus on in this seminar. We will review current theories in the cognitive neuroscience of human learning, with a particular eye towards understanding how learning and decision making – typically studied separately from each other – interact. We will review these fields with a focus on two heavily influential methods in the study of brain and behavior in humans: 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.

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 empirical journal 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 relates to other questions discussed in the course.

The course will begin with an introductory lecture on how we study the brain bases of learning, surveying the broad questions that will be addressed in the seminar, and introducing the basic principles of studying brain bases of cognition in humans.

In the first half of the seminar, we will discuss what may be considered the “dogma” in the cognitive neuroscience of learning: that there are different “learning systems”, that are dependent upon distinct brain regions. We will particularly focus on the distinction between explicit and implicit learning. Explicit learning is thought to be dependent on the medial temporal lobes, and to support learning of facts and events. Implicit learning is thought to depend on other parts of the brain, particularly the basal ganglia, and to support the learning of skills, or habits. We will discuss some of the seminal papers that have provided evidence for this view, as well as some recent scientific findings which raise questions and pose challenges for this view.

In the second half of the seminar, we will discuss some important variables that impact learning and the brain mechanisms supporting it, including motivation, social context, reinforcement and reward, and neurochemicals (with implications for drug addiction).

III. The rationale for giving the course

Learning is central to human behavior. It allows actions and decisions to be guided by past experience, enabling us to improve our ability to obtain goals. There has been a recent surge in interest in how the brain supports learning, with important implications for education, mental health, and decision making. Thus, it is a topic that crosses disciplines while offering an opportunity for students to learn about the important emerging field of cognitive neuroscience.
PSYC G4430 will fulfill the following degree requirements:

- For Psychology Graduate Students, PSYC G4430 will apply toward the “two seriously graded seminars” requirement of the Master’s degree.

- For the Psychology major or concentration in the College and in G. S., for the Psychology minor in Engineering, and for the Psychology Post-bac, PSYC G4430 will meet the Group II (Psychobiology and Neuroscience) distribution requirement.

- For the Neuroscience and Behavior joint major, G4430 will fulfill the 5th Psychology requirement: “one advanced psychology seminar from a list approved by the Psychology Department advisor to the program.”

- For the Psychology post-bac certificate, PSYC G4430 will fulfill the 7th (advanced seminar) requirement

- For the science requirements of the College and GS, G4430 will fulfill one term of the requirement, provided that students have completed the prerequisite and obtain the necessary permission. Students who are majoring in Psychology or in Neuroscience and Behavior will have priority over students who are taking the course for the science requirement, and we anticipate that the course will rarely be used for the latter.

- For the Barnard Psychology major, PSYC G4430 will fulfill the senior seminar requirement

IV. The reading list and weekly syllabus

Readings will consist of empirical and review articles. All papers are available as downloadable pdfs by searching the PubMed archive at: http://www.ncbi.nlm.nih.gov/entrez/query.fcgi. The following are a sample, subject to revision to represent recent publications.

Course Schedule

Week 1: General Introduction

Week 2: Do different kinds of learning depend on different brain mechanisms?


Week 3: How do we remember what we did this morning? Declarative memory and the hippocampus


Week 4: How do we learn how to ride a bike? Habit learning and the basal ganglia


Week 5: Do different kinds of memory interact?


Week 6: How do we learn to predict reward? Dopamine and reward in reinforcement learning


Week 7: How does feedback drive learning? Dopamine, the striatum, and feedback


Week 8: How do aging and disease impact reward-driven learning?


Week 9: How does novelty impact learning?


Week 10: Do both “learning systems” contribute to both kinds of memory?


Week 11: How do we learn about aversive events? The amygdala, striatum, and fear conditioning


Week 12: Does learning by experience differ from learning by observation? Social and cognitive perspectives


Week 13: Class presentation of term paper research – I

Week 14: Class presentation of term paper research - II
V. Course requirements and grading

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**:
  
  o **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 learning and the brain. Students are encouraged to think about these questions broadly in terms of general interest, and to not build on prior knowledge of the literature.

  o **Opinion/Critical Reviews**: During the semester, each student will write two critical reviews. Each review will focus on a topic that was discussed in class. The review will be no longer than one page, and will briefly describe your opinion on the paper we discussed: Did you like it, or not? Why not? What is your opinion on the theory, approach, findings, or conclusion?

  o **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. During the last two classes, each student will present their topic to the class in the form of a brief (15-20 min) oral presentation.

Grading:

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