

The Neurobiology of Learning and Memory (PSYC 380) Spring 2007

Professor:

John Green
Dewey Hall 358
E-mail: john.green@uvm.edu
Office hours: By appointment

Meeting Time & Location:

Dewey Hall 238
Tuesdays, 9:30 am-12:15 pm

Course Description

The focus of this course is on a systems level approach to the study of the neurobiology of learning and memory. We will largely (but not completely) avoid discussing the molecular and cellular basis of learning and memory and focus on how entire neural structures and circuits give rise to learned behavior. We will also emphasize “psychological” processes in learning and memory, such as encoding, consolidation, storage, and retrieval, and how they are instantiated at the neural circuit level. I feel strongly that a solid grounding in the neurobiology of learning and memory must start at the behavioral and systems level; after all, learning and remembering are properties of the behavior of entire organisms interacting with their environments, not of individual neurons. Only with an understanding of the behavioral and systems level can one begin to approach the cellular and molecular level of learning and memory. In particular, what an organism can and can’t learn, and how learning and memory “look” at a behavioral level will, I feel, constrain interpretations of the cellular and molecular data.

We will also largely focus on rodent (rats and mice) studies. Thus, we will take a somewhat, but not entirely, reductionist approach in this course. Specifically, we will focus on (relatively) simple forms of learning and memory in (relatively) simple organisms in the (relatively) simple environment of the laboratory and how specific brain structures underlie encoding, consolidation, storage, and retrieval of specific memories. I sometimes think of this as the (relatively) neglected “middle level” between the cognitive neuroscience approach to learning and memory (focusing on the entire brain) and the molecular neuroscience approach to learning and memory (focusing on the role of an individual molecule or gene in a specific brain area).

Course Objectives

In this course, we will study and discuss the basic principles of, and theory behind, the neurobiology of learning and memory. The course is designed in four parts, with the final part providing some integration, expansion, and closure. In part 1 (weeks 1-4), I hope to get you thinking about what learning and memory is at both a behavioral and a neural level. In part 2 (weeks 5-8), we will examine current thinking and data on the role of the key brain structures in four well-studied types of learning and memory: emotional, motor, “declarative”, and habit. The purpose of this section is to show you some of the techniques and approaches used to study the neural basis of learning and memory. In some cases, I’ve chosen recent studies that have significantly advanced the field. In other cases, I’ve chosen studies with more “modest” results

that I feel make an important point. Some of parts 1 and 2 of the course will be a review from the Biobehavioral portion of Professional Seminar. In part 3 (weeks 9-12), we will examine the neurobiology of learning and memory across early and late development, some of things that can interfere with the brain's ability to support learning and memory, and some potential ways to ameliorate these problems.

In the penultimate class, we'll try to integrate, as much as possible, the topics we've discussed. We'll also talk about how to integrate findings in non-human animals with the neurobiology of human learning and memory.

In the final class, each student will give a 10 minute presentation (followed by 5 minute question & answer) on a recent (2004-2007) article (empirical or review) of interest to them related to the neurobiology of learning and memory. This should be in Powerpoint format and should clearly define terminology and concepts that we have not discussed in class. Hopefully, this will give you an opportunity to discuss something of interest to you that we've not covered.

Course Requirements

At the end of each week's meeting, I will present a brief (~15-20 min) Powerpoint presentation providing background material for the next meeting's readings. I will also pass out some thought questions for the next meeting. At the beginning of this next meeting, I will quickly (~5-10 min) recap the presentation from the end of the week before. Then, we will launch into discussion of the readings.

The discussion of each article will be led by a student. First, you should briefly summarize the article. For **empirical articles**, this summary should include a bit of background as to why the study was undertaken, what were the general methods used (just basics, such as what particular methods were designed to accomplish), general results (focus on the big picture, not every single ANOVA), and what the main result(s) mean). For **review or theoretical articles**, this summary should define the topics under discussion and describe the arguments and/or data supporting the topic. You should take no more than 10 minutes for this. The format of summary can involve any or all of the following: verbal description, Powerpoint presentation, handouts, or video). **Second**, you should have prepared at least two questions about the article that will get discussion going. These can be methodological or, ideally, conceptual. You are welcome to expand on my "thought" questions, bring in outside sources, or use your own science background. **Students who do not lead discussion of a particular article should turn in their written comments** regarding either my thought question pertaining to the article, or your own thoughts on the article at the end of class.

For the **final class** (May 1), I'd like to do something not unlike a "data blitz". For this class, I'd like each student to present **up to 3 Powerpoint slides** on something of interest to them related to the neurobiology of learning and memory that was not covered by the assigned readings. You can present something on a technique (behavioral or neuroscientific) with which you have at least some familiarity, some recent data (from an empirical paper from 2004 to the present), or a recent theory. You should be able to explain your topic in 10 minutes and with no more than 3 Powerpoint slides. We'll leave about 5 minutes after each presentation for a question and answer session. This should be a somewhat informal but informative way for you to try to apply what you've learned in the course and expand upon it.

Due in this final class will be a 5 page paper (1" margins, 12 pt font, 1.5 paragraph line spacing) summarizing your article and integrating it with what you've learned in the course.

Grading

Article presentations – 30%
 Class participation – 30%
 Final class presentation – 15%
 Final 5 page paper – 25%

Optional Background Text

Eichenbaum, H. (2002). The Cognitive Neuroscience of Memory. New York: Oxford

Course Outline

NOTE: the articles should be read in the order specified for the optimal learning experience!

Readings will be available by the Psych 1 office.

Part I: Using Biology to Explain Psychology and Psychology to Explain Biology

Jan 16 -- Introduction

Jan 23 – Historical and Conceptual Perspectives on the Neurobiology of Learning and Memory

Cahill, McGaugh, & Weinberger (2001). The neurobiology of learning and memory: Some reminders to remember. Trends in Neurosciences, 24, 578-581 (see also comment, pp. 77-78).

Hebb (1949). The Organization of Behavior. (pp. 60-66; 224-231)

Rosenzweig (1996). Aspects of the search for neural mechanisms of memory. Annual Review of Psychology, 47, 1-32. (read pp. 1-20)

Quinn (1998). Reductionism in learning and memory. Novartis Foundation Symposium, 213, 117-132.

Jan 30 – Behavioral Plasticity and Stability: Learning, Memory, and Remembering

Skinner (1950). Are theories of learning necessary? Psychological Review, 57, 193-216.

Palmer (1991). A behavioral interpretation of memory. In Hayes & Chase (Eds.). Dialogues on Verbal Behavior (pp. 261-279). Reno, NV: Context Press.

Bouton & Moody (2004). Memory processes in classical conditioning. Neuroscience and Biobehavioral Reviews, 28, 663-674.

Shettleworth (1993). Varieties of learning and memory in animals. Journal of Experimental Psychology: Animal Behavior Processes, 19, 5-14.