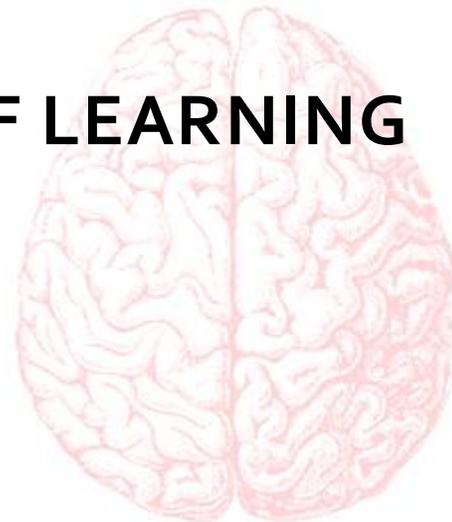


PSYC437: NEUROBIOLOGY OF LEARNING & MEMORY



DEPARTMENT OF PSYCHOLOGY & NEUROSCIENCE

MWF 9:05-9:55AM

PEABODY 218

FALL 2017 COURSE SYLLABUS

Instructor: Marsha Penner, PhD

Office: Davie Hall 237

Office hours: Monday 12:30-1:30pm - Please use the sign up tool on Sakai to reserve time

Email: mpenner@email.unc.edu (please use the messages tool on Sakai rather than my email address)

COURSE DESCRIPTION

This seminar course focuses on the current state of our knowledge about the neurobiological basis of learning and memory. Much of our class time will be devoted to discussing and critically evaluating primary research articles in the field.

Target audience: This course is intended for undergraduates interested in molecular, cellular, computational and systems level analysis of learning and memory from a behavioral and neural perspective.

Prerequisite: PSYC 220 or 315. BIOL 101 is recommended.

OBJECTIVES



Describe, and be able to explain, the major terminology, theories, and research methods used when studying learning and memory.

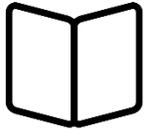


Read, present, discuss, and critically evaluate empirical learning and memory research.



Communicate learning and memory research findings to a lay audience.

COURSE RESOURCES



Textbook: Neurobiology of Learning and Memory by J.W. Rudy. (2nd edition)



Course website: Quizzes, assignments, etc can be found on the course Sakai site: <https://sakai.unc.edu/portal/site/437>

OTHER RESOURCES

The Writing Center is a wonderful resource to use if you need some help with your writing and editing skills, and The Learning Center would love to coach you – they have excellent coaching opportunities for things like time management, study skills, and goal setting. Give them a try!

If you experience difficulty during the semester that interferes with your ability to come to class or complete your work, including difficulty securing food or housing, or stress and mental health issues, I urge you to contact the Office of the Dean of Students (in person or by phone 919-966-4042) or Counseling and Psychological Services (in person or by phone 919-966-3658). If the Dean of Students is consulted, they can notify all of your instructors (for all of your classes) at your request. Their services are confidential – so while they may contact your instructors on your behalf to alert them that you are experiencing difficulty, they do not disclose details. I am also available to walk you over to Counseling and Psychological Services or the Office of the Dean of Students.

If you require an accommodation, please contact the Office of Accessibility and Resources. If you have accommodations to take exams at the Office of Accessibility Resources, please let me know as soon as possible.

WHAT ARE THE COURSE REQUIREMENTS?

Rationale

The quizzes, exams, assignments, and activities that you will complete in this class are carefully designed to optimize your learning. I use an evidence-based approach when designing classes. This means that I use learning approaches based on scientific evidence that demonstrates the effectiveness of these approaches.

Overall, my aim is to help you progress through Bloom's taxonomy of learning such that you are analyzing, evaluating, and creating information. Not only is this a lot more fun than memorizing, but you will also be more likely to retain the information!



Quizzes

Online, multiple choice, timed quizzes will be used as a study tool and to assess your learning. These quizzes will help you keep abreast of your reading for the class, and will help you determine if you took away key concepts from the reading. As you read your textbook, take

notes in your own words. To assist you in targeting important concepts, selected study questions are provided (on Sakai in the 'Resources' folder). Be sure to use these tools to prepare for the quizzes. Quizzes are due prior to the relevant class, closing 1 hour before class begins. Quizzes will include 5-10 multiple choice or fill-in-the-blank questions. Your lowest 2 quiz scores will be dropped so that you need not worry if you forget to take a quiz, your computer crashes, you get sick, or you lose a wifi signal. *Because you can drop your 2 lowest scores, make up quizzes will not be administered.*

Reading questions

Over the course of the semester, you will read a number of primary research papers. To facilitate your understanding of these papers, you'll submit answers to a set of reading questions. Out of the 16 papers we read this semester, you should submit reading question responses to a minimum of 9 papers. I encourage you to submit responses early in the semester – waiting until the end is not a good strategy to do your best work. You should write your answers in complete sentences, and in YOUR OWN WORDS. In addition to summarizing key aspects of the paper, you are also practicing good writing skills, so please pay attention to spelling, grammar, and sentence structure. Your responses should be relatively short – in many cases a couple of sentences is all that's needed. Answers to these reading questions should be submitted via Sakai by no later than 10pm the night before we discuss the primary paper. Late submissions will not be accepted. These questions should address the following (1 point for each; additional instructions are found on Sakai):

- i. What is the hypothesis?
- ii. What predictions are tested?
- iii. What kinds of techniques and methods are used to test the predictions?
- iv. What are the main findings of the research?
- v. Why are these findings important for everyday life?



Class Assignments

For some classes, we will work together in small groups. Your work will be handed in at the end of class, and a random sample of your work will contribute to this component of your grade. We may also use PollEverywhere (<https://pollev.com/neurons>) during class time. For the first two weeks of class, a response to the in-class Poll will earn one point, and after that, a correct response to the Poll will continue to earn one point, and an incorrect response will earn half a point. Please remember to register for PollEverywhere, as unregistered responses cannot earn points!

Discussion is an important part of this class and will contribute significantly to your learning experience. Contributing to discussions involves developing a particular skill set. Therefore, you should expect to improve at discussion over time just like you would in other skills like reading, writing, or learning another language. Focus on improving your skills. This is an active learning process! I am more interested in your willingness to explore ideas - out loud - than "getting it right". The lowest 10% of your class assignment grade will be dropped. This makes it unnecessary to contact me when you miss an in-class assignment.

EXAMS

There will be 4 exams in total over the course of the semester, 3 will take place in class, and one will take place during the final examination period. Your best 3 test scores will go toward your final grade (i.e. you will be able to drop your lowest test score). Exams can be a combination of multiple choice, short answer, fill-in-the-blank and essay type questions. Note that study questions are available on Sakai under 'resources' and are exactly the kinds of questions that will appear on your exams. We are required to have our final exam on Saturday, December 9th at 8am. If you have two exams at the same time or three exams within 24 hours and you want to reschedule, see an academic advisor for an exam excuse form. Please give me the pink copy of your exam excuse form on or before our last lecture meeting. The alternate exam date for this class is: Tuesday, December 12th at noon.

Talking about science

For each of the primary papers we will read in class, 2 students will lead a discussion period on the assigned primary paper. You should: 1) use interesting visual aids, 2) do additional research on your own to enrich the discussion (What came before this work? After? Why should we care?), 3) summarize the work in YOUR OWN WORDS, and 4) bring several pre-prepared questions to facilitate discussion (please avoid superficial questions that really get a discussion going). **You will post these questions on Sakai, in the resources folder "Discussion questions" 48 hours before your discussion.** I encourage you to start working on your discussions early so that you have sufficient time to meet with me with your questions. Meeting with me is not required, but I encourage you to do so if anything is unclear to you, or if you just want to talk about how awesome your paper is! I think I'm also pretty good at giving tips for being successful – so please use me a resource! This assignment constitutes a large proportion of your grade for the semester – you should expect to put in significant effort. I often have to read a paper MANY times before I really have a good understanding of what is going on. Keep that in mind when you are managing your time. You will be graded on:

- i. How well you summarize the main findings of the paper. You should be able to see both the forest and the trees. An incomplete understanding of the paper usually results in summaries with unnecessary details and very little depth (5 points)
- ii. Your visual aids – don't just load a bunch of slides with text! Use graphics, figures, diagrams, flow charts, photographs, etc (3 points)
- iii. Your own research that goes beyond the paper you are discussing. You should talk about at least 2 additional papers that are related to the one you are presenting (3 points)
- iv. Your discussion questions. These will be uploaded to Sakai 48 hours before your presentation. Look for the folder 'Discussion Questions' in resources (3 points)
- v. How well you convey why the research is important in everyday life, or how/why it's applicable to you, your grandma, your neighbor... (4 points)
- vi. Your ability to work well with your partner, as assessed by a peer evaluation (2 point)

Students who are not leading the discussion should look at the discussion questions posted on Sakai by the discussion leaders and be prepared to discuss them in class. For discussion classes, you will spend the first 15 minutes of the class working in small groups going over the paper together. **Bring a copy of the paper, your reading questions, and the discussion questions with you to class to make notes on. Even if you did not submit reading questions for any given paper: I DO expect you to be able to discuss the paper in class.** I may

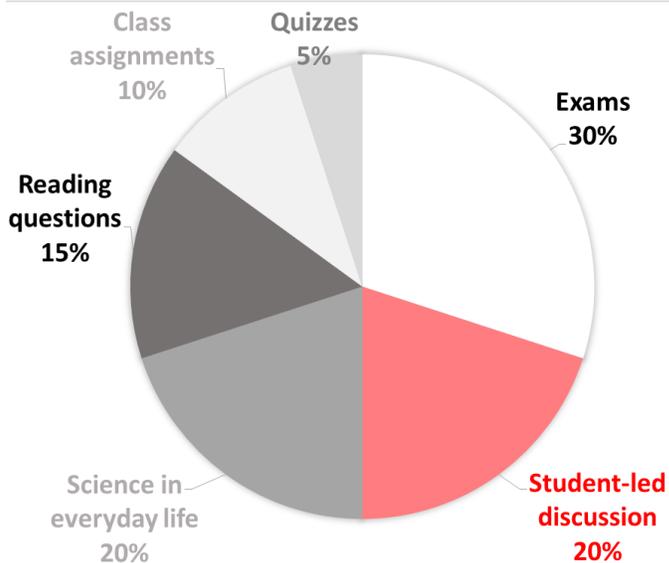
also provide you with additional activities to complete in your groups. The remainder of the class will be spent discussing the paper as a class, with the discussion leaders facilitating.

Science in Everyday Life

You are going to work on summarizing and interpreting one of the primary papers we discussed in class (it can be the paper you worked on for the class discussion, or another paper). These projects will be a hybrid between a short formal review of the paper, and an infographic. You can use the Adobe software you have access to via UNC (e.g., Illustrator) or something like Piktochart (<https://piktochart.com/>), or other software programs you are comfortable with. The overall goal of this project is to summarize the primary paper for someone who has not read the primary paper, and tell them how the main findings apply to everyday life. At a MINIMUM your project should include the following:

- 1) A concise statement of the problem(s) that the paper addresses (1.5 points)
- 2) Some background and context to help a naive reader understand why the study was done and/or what was known, previously. (3.0 points)
- 3) A summary of the **main** findings and conclusions (3.0 points)
- 4) Interpretation and discussion of the findings, including why the findings are important in everyday life (i.e., to the lay person) (5.0 points)
- 5) **Original** figures and infographics that highlight the main findings, ideas, themes, and/or interpretations of the work contained within the paper. These should enhance your ability to explain the paper to a naive audience (5.0 points)
- 6) Reference materials used to prepare the paper should be listed at the end. (0.5 point)
- 7) Clarity of the paper as a whole – the paper is well edited, language is clear and concise, and is free of unnecessary jargon. (2 point)

YOUR GRADE



Rather than having your grade ride on just a few high stakes exams and/or assignments, your grade in this course will be composed of a number of components that have been used to facilitate your learning.

Letter Grade Assignments

A = 94-100

A- = 90-93

B+ = 87-89

B = 84-86

B- = 80-83

C+ = 77-79

C = 74-76

C- = 70-73

D+ = 67-69

D = 60-66

F = 0-59

* Final grades are rounded (.4 down and .5 up). For example 89.4 = 89/B+; 89.5 = 90/A-.

COURSE EXPECTATIONS

We are going to use a lot of class time engaging in active-learning activities (e.g. problem-solving, discussion). Using this approach means that you will need to make a significant effort to be an active learner. Rather than passively listening to me lecture, important concepts will be introduced via the pre-assigned readings and assignments. During class time, everyone will be required to contribute to discussions. Besides being fun, you will have many opportunities in class to work through concepts that are giving you trouble - reading primary literature can be a challenge – but it is such an important skill to develop! What does all of this mean?



I expect that you will come to class prepared to work!

You can prepare for class by following these steps:

1. Complete the assigned readings before class.
2. Do the reading questions, making sure you answer the questions in your own words. Bring your responses with you to class to work on them further with your peers.
3. Do the timed online quizzes to assess your reading comprehension.
4. Identify the concepts that you are having difficulty with so that you can work through these concepts with me and/or your peers. Please remember that I am here to make sure that you succeed in this class! We are working as a team, and it is ok to not know something. However, I expect that you will put in your best effort, always. If you are having trouble, please see me for help. And the sooner the better!



I expect that you will respect our learning environment and each other!

You may need to use a digital device during class time. Please be respectful of your classmates and restrict your use to course content. Hopefully it will never come to this, but if I have to, I will ask you to put your device away for the rest of the class, and you will forfeit your class assignment points for that day. Remember that you affect other students around you. It's likely that there will be times in class when you have completed your work, but your classmates have not – use this time to review your notes or ask questions before we move on. Even better: help your classmates! We are all working as a learning team in class, and we're only as awesome as our weakest link!



I expect that you will show integrity and academic honesty, respecting the Honor Code, always!

As in all Carolina courses, the Honor Code is in effect. The work you submit in this class will be your own work. Observing the Honor Code also means that during exams, you should not look at another person's exam; talk to anyone, either in person or by cell phone or email; or use the Internet, or any other text or notes. Please report any violations that you observe.

Please review the UNC's academic code: (http://integrity.unc.edu/hc_handout.html). If you plagiarize any material, it will result in an 'F' grade on the assignment. There are no second chances. Please note that I am REQUIRED by the University to report all suspected cases of academic misconduct, and this absolutely includes plagiarism of any kind. In this class, you are expressly forbidden to quote directly from your sources. That means that you will need to work on your annotating and paraphrasing skills. If you are not sure how to do this, please ask for help, or contact the Writing Center for guidance. I have also uploaded a document under 'resources' on the Sakai course site that you should consult to avoid plagiarism. When in doubt, ask!

Finally, please do not post materials (notes, videos, slides, etc) from this class elsewhere without my permission.



A note from Dr. Penner...

I want you to succeed in this class! You belong here and deserve to be here. In addition to meeting about course content, I am also happy to talk to you about graduate school and research opportunities, or you can just pop in to talk about neuroscience! My favorite topic!

I teach several classes each semester, and often have several hundred students in any given semester. I encourage you to use the sign up tool on the course Sakai site to ensure you get some face time when you need it. I tend to get a lot of email, and

I try my best to respond within 24 hours (M-F), but I am not always successful. If you send me a message (please use the 'Message' tool in Sakai) and I do not respond, please politely send it again to remind me. I am looking forward to getting to know you and talking neuroscience with you!

See you in class!

PSYC 437 Neurobiology of Learning and Memory
 Department of Psychology & Neuroscience
 MWF 9:05-9:55

SCHEDULE

Changes to the Schedule: If a change to the schedule becomes necessary, I will announce this in class or by email.

Bolded dates indicate quizzes are due before class

Date	Topic	Reading
08-23	Introduction to class	
08-25 Quiz 1	Fundamental Concepts and Historical Foundations	Chapter 1
08-28	Neuroanatomy review (in-class quiz)	LECTURE SLIDES
08-30	Neurophysiology review (in-class quiz)	LECTURE SLIDES
09-01	Experimental design (in-class assignment)	Reading on Sakai
09-04	Labor day - No classes	
09-06	Anatomy of an empirical paper; using search engines effectively (e.g., Pubmed)	LECTURE SLIDES
09-08 Quiz 2	Mechanisms of Synaptic Plasticity	Chapter 2
09-11 Quiz 3	Modifying Synapses: Central Concepts	Chapter 3
09-13 Quiz 4	Making Memories: Conceptual Issues and Methods	Chapter 9
09-15	Making Memories: Conceptual Issues and Methods	Chapter 9 and lecture slides
09-18	EXAM 1	
09-20	Memory Formation: Early Stages	Chapter 10

Quiz 5		
09-25 Quiz 6	Memory Consolidation	Chapter 11
09-22 *Reading questions due	Practice Discussion: Kitamura T, Ogawa SK, Roy DS, Okuyama T, Morrissey MD, Smith LM, Redondo RL, Tonegawa S. (2017) Engrams and circuits crucial for systems consolidation of a memory. Science 356:73-78. *NOTE: Everyone is required to submit reading questions for this discussion so that I can provide you with feedback	
09-27 Reading questions due	<u>Discussion 1:</u> Borota D, Murray E, Keceli G, Chang A, Watabe JM, Ly M, Toscano JP, Yassa MA. (2014) Post-study caffeine administration enhances memory consolidation in humans. Nat Neurosci: 201-203.	
09-29 Quiz 7	Memory Maintenance and Forgetting	Chapter 12
10-02 Reading questions due	<u>Discussion 2:</u> Lee AM, Kanter BR, Wang D, Lim JP, Zou ME, Qiu C, McMahon T, Dadgar J, Fischbach-Weiss SC, Messing RO (2013). Prkcz null mice show normal learning and memory. Nature. 493: 416-419.	
10-04 Quiz 8	Memory Modulation Systems	Chapter 13
10-06 Quiz 9	The Fate of Retrieved Memories	Chapter 14
10-09 Reading questions due	<u>Discussion 3:</u> Takeuchi T, et al. (2016) Locus coeruleus and dopaminergic consolidation of everyday memory. Nature 537: 357-362	
10-11 Reading questions due	<u>Discussion 4:</u> Schwabe L, Nader K, Wolf OT, Beaudry T, Pruessner JC (2012) Neural signature of reconsolidation impairments by propranolol in humans. Biol Psychiatry 71:380-386.	
10-13 Reading questions due	<u>Discussion 5:</u> Lopez J, Gamache K, Schneider R, Nader K. (2015) Memory Retrieval Requires Ongoing Protein Synthesis and NMDA Receptor Activity-Mediated AMPA Receptor Trafficking. J Neurosci. 35:2465-75.	
10-16	EXAM 2	
10-18	Memory Systems and the Hippocampus	Chapter 15

Quiz 10		
10-20	Enjoy Fall Break! No classes	
10-23 Quiz 11	The Hippocampus Index and Episodic Memory	Chapter 16
10-25 Reading questions due	<u>Discussion 6</u> : Bakker A, Kirwan CB, Miller M, Stark CE. (2008) Pattern separation in the human hippocampal CA3 and dentate gyrus. Science. 319:1640-2.	
10-27 Reading questions due	<u>Discussion 7</u> : Wimmer GE, Shohamy D (2012) Preference by association: how memory mechanisms in the hippocampus bias decisions. Science 338:270-273.	
10-30 Quiz 12	The MTH System: Episodic Memory, Semantic Memory, and Ribot's Law	Chapter 17
11-01 Reading questions due	<u>Discussion 8</u> : Wang SH, Teixeira CM, Wheeler AL, Frankland PW. (2009) The precision of remote context memories does not require the hippocampus. Nat Neurosci. 12:253-5.	
11-03	EXAM 3	
11-06 Quiz 13	Action, Habits, and the Cortico-Striatal System	Chapter 18 – to the end of p 365
11-08 Quiz 14	Action, Habits, and the Cortico-Striatal System	Chapter 18 – remainder of the chapter
11-10 Reading questions due	<u>Discussion 9</u> : Smith KS, Virkud A, Deisseroth K, Graybiel AM. (2012) Reversible online control of habitual behavior by optogenetic perturbation of medial prefrontal cortex. Proc Natl Acad Sci U S A. 109:18932-7.	
11-13 Reading questions due	<u>Discussion 10</u> : Flagel SB, Clark JJ, Robinson TE, Mayo L, Czuj A, Willuhn I, Akers CA, Clinton SM, Phillips PE, Akil H. (2011) A selective role for dopamine in stimulus-reward learning. Nature. 469:53-7.	
11-15 Reading questions due	<u>Discussion 11</u> : Nasrallah NA, Clark JJ, Collins AL, Akers CA, Phillips PE, Bernstein IL. (2011) Risk preference following adolescent alcohol use is associated with corrupted encoding of costs but not rewards by mesolimbic dopamine. Proc Natl Acad Sci U S A. 108:5466-71.	

11-17 Quiz 15	Learning about Danger: The Neurobiology of Fear Memories	Chapter 19
11-20 Reading questions due	<u>Discussion 12</u> : Banerjee SB, Gutzeit VA, Baman J, Aoued HS, Doshi NK, Liu RC, Ressler KJ. (2017) Perineuronal Nets in the Adult Sensory Cortex Are Necessary for Fear Learning. Neuron 95:169-179.	
11-22	Happy Thanksgiving! No classes	
11-24	Happy Thanksgiving! No classes	
11-27 Reading questions due	<u>Discussion 13</u> : Hauner KK, Howard JD, Zelano C, Gottfried JA (2013) Stimulus-specific enhancement of fear extinction during slow-wave sleep. Nat Neurosci 16:1553-5.	
11-29 Quiz 16 Science in everyday life assignment due	The Role of Replay and Sleep in Learning and Memory: Diekelmann S, Born J (2010) The memory function of sleep. Nat Rev Neurosci 11:114-126.	
12-01 Reading questions due	<u>Discussion 14</u> : Rolls A, Colas D, Adamantidis A, Carter M, Lanre-Amos T, Heller HC, de Lecea L (2011) Optogenetic disruption of sleep continuity impairs memory consolidation. Proc Natl Acad Sci U S A 108:13305-13310.	
12-04 Reading questions due	<u>Discussion 15</u> : Oyarzún JP, Morís J, Luque D, de Diego-Balaguer R, Fuentemilla L (2017) Targeted Memory Reactivation during Sleep Adaptively Promotes the Strengthening or Weakening of Overlapping Memories. J Neurosci. 37:7748-7758	
12-06	Review and course evaluations	

Final Exam: Saturday, December 9th at 8am