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# An Introduction to Learning

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<http://smash.psych.nyu.edu/>

Fridays 12:30pm-2:30pm, Rm 469

## Overview:

Learning is a critical component of adaptive behavior in animals and humans. This course will expose students to key concepts, theories, and experimental paradigms for studying human learning. The goal is to provide an integrative view of the area that crosses both classic approaches (e.g., classical conditioning, instrumental learning) as well as modern issues (e.g., cognitive neuroscience of learning, language learning, social learning, computational approaches). Special attention will be given to exploring what is known about the neural substrates of learning and memory, as well as computational and mathematical theories. In addition, the class is oriented toward a understanding of the evolution of ideas about learning in the field. Students will leave the course as sophisticated consumers of learning research and be able to apply learning concepts directly to their own research. This course fulfills part of the introductory “core” cognition requirements for the NYU psychology program. As such there will be a series of exams throughout the semester that assess mastery of the key concepts.

## Grading:

Active class participation (15%) and homeworks and assignments based on readings (15%), two exams (each worth 35%).

## Course Website:

Bookmark and check back often for announcements and links to the readings:

<http://smash.psych.nyu.edu/courses/fall10/learning>

## Textbook:

*Learning and Memory: From Brain to Behavior* by Gluck, Mercado, and Myers (should be available at the NYU Bookstore). The Gluck text is geared at a slightly introductory level but provides a useful “frame” within which to structure our dialog this semester. As fulfilling the core course requirement, there are basic issues that not all students in our program may have been exposed to (e.g., many have not had a undergrad course in neuroscience let alone psychology). The text will help fill those gaps when they arise. In addition to the readings from the text (which provide a broad, modern overview of various topics), there will be a number of supplementary readings from other texts and original research articles. Going back and forth between both the textbook readings and the original research articles will hopefully give students insight into the deeper issues as well as helping to contextualize the work in ways the original authors of were unable to do. Early in the course we will read classic papers, but later will see how these ideas have continued to resonate in modern

learning research (e.g., statistical learning, structure learning, reinforcement learning, etc...).  
*Note:* At various point there are a lot of readings for this course. It is a core course and so is reading-intensive. If you aren't reading 20-30 hours a week you aren't reading enough in grad school. This should help increase your average.

**Tentative Class Schedule (readings for the following week will be places online immediately after class):**

Date	Summary
<b>Sept 14</b>	<p><b>1. Introduction/Overview</b> - What is learning? Historical ideas and the birth of the modern science of learning. Additional topics include learning/performance, innate behaviors versus adaptation (nature/nurture), critical periods, models and mechanisms, and levels of analysis</p> <p>Textbook reading: Gluck, Ch. 1 - <i>The psychology of learning and memory</i></p> <p>Watson, J.B. (1994) "Psychology as the Behaviorist Views It" <i>Psychological Review</i>, 101(2), 248-253.</p> <p>Hull, C.L. (1937) "Mind, Mechanism, and Adaptive Behavior" <i>Psychological Review</i>, 44 (1), 1-32.</p> <p>Pinker, S. (2004) "Why nature &amp; nurture won't go away" <i>Daedalus</i>, 133(4), 5-17.</p> <p>Optional Readings (discussed in lecture): Phattanasri, P., Chiel, H.J., and Beer, R.D. (2007) "The Dynamics of Associative Learning in Evolved Model Circuits" <i>Adaptive Behavior</i>, 15(4), 377-396.</p> <p>Skinner, B.R. (1950) "Are Theories of Learning Necessary?" <i>Psychological Review</i>, 57 (4), 193-216.</p>

Date	Summary
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**Sept 21**    **2. Basic concepts in neuroscience of learning and memory** - In the following weeks we will explore a number of basic phenomena of learning. However, it is helpful to begin by casting these ideas against the backdrop of contemporary neuroscience. Today's lecture will be a basic whirl-wind tour of the neural processes thought to underly learning and memory. We'll talk about the function of neurons, the specialization of function in the brain, basic learning mechanisms (hebbian learning, LTP), and modern techniques for studying learning and memory (fMRI, EEG, etc...)

Since this is primarily a introduction/review for students who have no prior exposure to neuroscience, we will default primarily to the book for neuroscience background, then turn to the paper readings for the evolution of a view of the organization of learning and memory in the brain.

Textbook Reading: Ch. 2 - *The neuroscience of Learning and Memory*

Foundational Work:

Lashley, K.S. (1950) "In Search of the Engram" *Society of Experimental Biology Symposium*, 4, 454-482.

Scoville, W.B. and Milner, B. (1957) "Loss of Recent Memory After Bilateral Hippocampal Lesions" *Journal of Neurology, Neurosurgery and Psychiatry*, 20, 11-21.

Posner, MI, Petersen, S.E., Fox, PT, Raichle, ME (1988) "Localization of cognitive operations in the human brain" *Science*, 240 (4859), 1627-1631.

Squire, L.R. (1992) "Declarative and Nondeclarative Memory: Multiple Brain Systems Supporting Learning and Memory" *Journal of Cognitive Neuroscience*, 4 (3), 232-243

Date	Summary
Sept 28	<p><b>3. Non-associative/Perceptual forms of Learning</b> - This lecture will cover basic, non-associative forms of learning including unsupervised learning, perceptual learning, habituation/sensitization (incl. habituation as a empirical technique for studying learning in non-linguistic animals), latent learning, feature learning, imprinting, priming, repetition suppression, etc.... We will talk about both psychological, neural, and computational properties of these forms of learning.</p> <p>Textbook reading: Gluck, Ch. 6 - Non-associative learning</p> <p>Foundational: Tolman, E.C. (1948) "Cognitive Maps in Rats and Men" <i>Psychological Review</i>, 55(4), 189-208.</p> <p>Contemporary Work: Goldstone, R.L. (1998) "Perceptual Learning" <i>Annual Review of Psychology</i>, 49, 585-612.</p> <p>Grill-Spector, K., Henson, R. and Martin, A. (2006) "Repetition and the brain: neural models of stimulus-specific effects" <i>Trends in Cognitive Sciences</i>, 10(1), 14-23.</p> <p>Barlow, H.B. (1989) "Unsupervised Learning" <i>Neural Computation</i>, 1, 295-311.</p> <p>Optional (if you have an interest in the study of non-verbal primates): Jeffrey, W.E. and Cohen, L.B. (1971) "Habituation in the Human Infant" in Reese, H. (Ed.) <u>Advances in child development and behavior: Vol 6</u>. pp. 63-97. New York: Academic Press.</p>

Date	Summary
Oct 5	<p><b>4. Classical Conditioning I</b> - Pavlov, basic procedure, phenomena and terms (CS/US, etc...), basic findings, blocking and overshadowing, etc..., Rescorla-Wagner model, Pearce-Hall model and the role of attention/associability in classical conditioning, basic neural substrates of classical conditioning, interactions with other learning systems (e.g., role of hippocampus in trace conditioning)</p> <p>Textbook reading: Gluck, Ch 7 - Classical Conditioning</p> <p>Rescorla, R.A. "Pavlovian Conditioning: It's not what you think it is" <i>American Psychologist</i>, 43(4), 151-160.</p> <p>Rescorla, R.A. and Wagner, A.R. "A Theory of Pavlovian Conditioning: Variations in the Effectiveness of Reinforcement and Non-reinforcement" in Black, A.H. &amp; Prokasy, W.F. (eds.), <i>Classical conditioning II: Current research and theory</i> (pp. 64-99). New York: Appleton-Century-Crofts.</p> <p>Clark, R.E. and Squire, L.R. (1998) "Classical Conditioning and Brain System: The Role of Awareness" <i>Science</i>, 280, 77-81.</p> <p>Dayan, P., Kakade, S. and Montague, P.R. (2000) "Learning and selective attention" <i>Nature Neuroscience</i>, 3, 1218-1223.</p> <p>Pearce, J.M. and Hall, G. (1980) "A Model for Pavlovian Learning: Variations in the Effectiveness of Conditioned by Not of Unconditioned Stimuli" <i>Psychological Review</i>, 87, 532-552</p>
Oct 12	<p><b>5. Classical Conditioning II</b> - modern theories including causal interpretations of classical conditioning, context-dependent learning, second-order condition (temporal-difference model and relationship to Rescorla-Wagner), neural basis of prediction errors</p> <p>Niv, Y. and Schoenbaum, G. (2008) "Dialogues on prediction errors" <i>Trends in Cognitive Science</i>, 12(7), 265-72.</p> <p>Schultz, W., Dayan, P. &amp; Montague, P.R. (1997) "A neural substrate of prediction and reward" <i>Science</i>, 275, 1593.</p> <p>Courville, A.C., Daw, N.D., Gordon, G.J., and Touretzky, D.S. (2003) "Model Uncertainty in Classical Conditioning" <i>Neural Information Processing Systems</i>, 16, 977-984.</p> <p>Gershman, S.J., and Blei, D. and Niv, Y. (2009) "Context, learning, and extinction" <i>Psychological Review</i>, 117(1), 197-209.</p>

Date	Summary
<p><b>Oct 19</b></p>	<p><b>6. Instrumental Conditioning I</b> - law of effect, role of reinforcement, stimulus control, choice behavior, matching law, concurrent schedules, self control/impulsivity - Assign Homework I</p> <p>Textbook reading: Gluck, Ch 8 - Instrumental Conditioning, up to pg. 318</p> <p>Dickinson, A. (1994) "Instrumental Conditioning" in <i>Animal Learning and Cognition</i>, pg. 45-79.</p> <p>Herrnstein, R.J. (1970) "On the law of effect" <i>Journal of the Experimental Analysis of Behavior</i>, 13, 243-266.</p> <p>Skinner, B.F. (1948) "Superstition in the Pigeon" <i>Journal of Experimental Psychology</i>, 38, 168-172.</p> <p>Dickinson, A. (1985) "Actions and habits: The development of behavioral autonomy" <i>Philosophical Transactions of the Royal Society of London, Series B, Biological</i>, 38, 168-172.</p>
<p><b>Oct 26</b></p>	<p><b>7. Instrumental Conditioning II</b> - motivation for behavior, premack's principle, extinction, spontaneous recovery, neural substrates of associative learning, role of striatum in associative learning - Exam I</p> <p>Textbook reading: Gluck, Ch 8 - Instrumental Conditioning, pg. 318 till end</p> <p>Balleine, B.W., Daw, N.D., and O'Doherty, J.P. (2008) "Multiple Forms of Value Learning and the Function of Dopamine" <i>Neuroeconomics: Decision Making and the Brain</i> (Ed. Glimcher, P.W., Camerer, C.F., Fehr, E., and Poldrack, R.A., Chapter 24, 367-38.</p> <p>Niv, Y., Daw, N.D., Joel, D., Dayan, P. (2006) "Tonic dopamine: Opportunity costs and the control of response vigor" <i>Psychopharmacology</i>, 191(1), 507-520.</p> <p>Sugrue, L.P. (2004) "Matching behavior and the representation of value in the parietal cortex" <i>Science</i>, 304, 1782.</p> <p>Herrnstein, R.J. and Prelec, D. (1991) "Melioration: A Theory of Distributed Choice" <i>The Journal of Economic Perspectives</i>, 5(3), pg 137-156.</p>

Date	Summary
Nov 2	<p><b>8. Generalization and Discrimination</b> - Pearce (configural) vs. R-W (elemental), stimulus generalization, attention learning, context dependent learning</p> <p>Textbook reading: Gluck, Ch 9 - Generalization, Discrimination, and the Representation of Similarity</p> <p>Mitchell, T.M. (1980). The need for biases in learning generalizations (Report CBM-TR-5-110). New Brunswick, NJ: Rutgers University, Department of Computer Science.</p> <p>Shepard, R.N. (1987) "Toward a universal law of generalization for psychological science" <i>Science</i>, 237(4820), 1317-1323.</p> <p>Tenenbaum, J.B. and Griffiths, T.L. (2001) "Generalization, similarity, and Bayesian inference.", <i>Behavioral and Brain Sciences</i>, 24, 629-641.</p>
Nov 9	<p><b>No class - traveling for grant panel</b></p>
Nov 16	<p><b>9. Cognitive forms of learning</b> - more complex forms of generalization: category and concept learning, multiple system views in the categorization literature and their relation to multiple systems of conditioning</p> <p>Textbook reading: Gluck, Ch. 4 - Skill Memory</p> <p>Slovan, S.A. (1996) "The empirical case for two systems of reasoning" <i>Psychological Bulletin &amp; Review</i>, 119(1), 3-22.</p> <p>Maddow, W.T. and Ashby, F.G. (2004) "Dissociating explicit and procedural-learning based systems of perceptual category learning" <i>Behavioral Processes</i>, 66, 309-332.</p> <p>Johansen, M.K. and Palmeri, T.J. (2002) "Are there representational shifts during category learning?" <i>Cognitive Psychology</i>, 45, 482-553.</p>
Nov 23	<p><b>10. Cognitive forms of learning II</b> - hypothesis testing, learning with rule or associations causal learning, learning by analogy to previous examples</p> <p>Erickson, M.A. and Kruschke, J.K. (1998) "Rules and Exemplars in Category Learning" <i>Journal of Experimental Psychology: General</i>, 127(2), 107-140.</p> <p>Gopnik, A., Glymour, C., Sobel, D.M., Schultz, L.E., Kushnir, T. and Danks, D. (2004). A Theory of Causal Learning in Children: Causal Maps and Bayes Networks. <i>Psychological Review</i>, 111(1), 3-32.</p> <p>Gentner, D. (1998) "The mechanisms of Analogical Learning" in <i>Similarity and Analogical Reasoning</i> (Ed. Vosnaidou, S. and Ortony, A.).</p>

Date	Summary
Nov 30	<p><b>11. Learning and language</b> - Are languages learned? Statistical learning, grammar learning, word learning</p> <p>Textbook reading: Gluck, Ch 13 - Language Learning</p> <p>Saffran, J.R., Aslin, R.N. and Newport, E.L. (1996) "Statistical Learning by 8-month-old Infants" <i>Science</i>, 274, 1926-1928.</p> <p>Marcus, G.F., Vijayan, S., Rao, S.B., Vishton, P.M. (1996) "Rule Learning by Seven-Month-Old Infants" <i>Science</i>, 283, 77-80.</p> <p>Xu, F. and Tenenbaum, J.B. (2007) "Word Learning as Bayesian Inference" <i>Psychological Review</i>, 114 (2), 245-272.</p> <p>Optional: Gomez, R.L. (2002) "Variability and the detection of invariant structure" <i>Psychological Science</i>, 13 (5), 431-436.</p>
Dec 7	<p><b>12. Observational Learning</b> - Learning from other people, pedagogical reasoning, copying, imitation, mirror neuron systems, observational learning</p> <p>Textbook reading: Gluck, Ch 11 - Observational Learning</p> <p>Bandura, A. (1965) "Vicarious Processes: A Case of No-Trial Learning" <i>Advances in Experimental Social Psychology</i>, 2, 1-55.</p> <p>Laland, K. (2004) "Social Learning Strategies" <i>Learning &amp; Behavior</i>, 32(1), 4-14.</p> <p>Dinstein, I., Thomas, C., Behrmann, M., Heeger, D.J. (2008) "A Mirror Up to Nature" <i>Current Biology</i>, 18(1), R13-R18.</p>
Dec 14	<p><b>13. Final Day - Various topics</b> - Developmental, aging, and effects of brain damage on learning and memory</p> <p>Textbook reading: Gluck, Ch 12 - Learning and memory across the lifespan - Exam II</p>

\*\* This course is a synthesis of a couple courses I took as a student and from colleagues both at NYU and other places. Special thanks to Yael Niv, Nathaniel Daw, Rob Goldstone, and Brad Love for inadvertent contributions.