BEHV 4900-5900-711

Behavioral Neuroscience
Credits: 03

Department of Behavior Analysis
The University of North Texas

Spring, 2019

COURSE INSTRUCTORS: Daniele Ortu, PhD
Oanh Luc, Teaching Assistant

INSTRUCTORS CONTACT INFORMATION:

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WEB SITE ADDRESS: https://learn.unt.edu

COURSE TIME: Tuesday and Thursday 3:30 pm to 4:50 pm (Col 047)

COURSE DESCRIPTION & GOALS

The brain plays a fundamental role in allowing organisms to learn and interact effectively with their environment. In this course we will analyze how neural activation and anatomy are shaped - during the lifetime of the individual - by relevant behavioral variables. We will look at different levels of resolution, starting from the individual neuron, its structure and how neurons communicate with each other, to larger structural elements (e.g., the hippocampus), and to the whole organism. In all cases we will take into account how experience continuously modifies structure and activation of neural variables. The course will stress that brain activation in relation to behavioral variables can only be understood by taking a systemic approach in which the role of individual areas is best understood within the context of other brain areas and within the natural environment. We will introduce the methodologies typically used in behavioral neuroscience, with a specific focus on neuroimaging technologies applied to the behaving organism.

COURSE OBJECTIVES

The course has been divided into units. Each unit has specific corresponding reading objectives that will be used as guides for *Interteaching* discussions. The units for the course are listed at the end of the syllabus. The reading objectives are available on the course website.

LEARNING ACTIVITIES & EVALUATION

Interteaching

The course will be run using an *Interteaching* format. Students will be required to complete the Reading Objectives for the corresponding unit. Students should bring their prepared responses to class. Preparation does not necessarily entail complete essay answers to each objective. Instead, verbal prompts that enable a fluent discussion of the material qualifies as preparation for interteaching in class. During the second class of the week (i.e. Thursday), students will divide into pairs to discuss the material from the weekly readings. Approximately one-third of the class time will be spent in these discussion pairs. Each class, students should select new partners. At the end of the *Interteaching* session, students will create a brief powerpoint presentation reviewing the most important/ interesting aspects of the interteaching session.

After each interteach, one or more interteach groups will be selected by the course instructors to present to the rest of the class. All other presentations will be submitted to the instructors via BlackBoard. An interteaching participation grade is based upon a combination of weekly powerpoint presentation submissions, one or more presentations to the entire class, and consistent preparedness/active contributions during time allotted to interteaching. PowerPoints will be worth 15 points each and presentation(s) will be worth 45 points.

Midterm Exam

The class session on March 7th will be spent taking a midterm exam. Material from the beginning of the semester through March 5th will be covered on this exam. The exam will be a combination of True or False Questions, short answer questions, and two short essays from your choice of four essay options (50 points).

Final Exam

The class session on May 2nd will be spent taking a final exam. Material from the beginning of the semester will be covered on this exam. The exam will be a combination of True or False Questions, short answer questions, and two short essays from your choice of four essay options (100 points).

Final Paper

Each student will prepare a literature review or a theoretical paper based on some of the content presented during the course. There is not a page limit for the final paper.

Students are free to organize the paper in the best way that fits their topic and are encouraged to discuss their paper with the instructor at several points throughout the semester.

Final papers are due on May 10th and will be evaluated as if they were undergoing review for publication in a professional, peer-reviewed journal. The final paper will be worth 100 points. Students will receive final grades based on the following mock editorial decisions: No Revisions Necessary (100 pts), Accept with Minor Revisions (90 pts), Accept with Major Revisions (75 pts), Reject with an Invitation to Resubmit (60 pts), or Reject (50 pts).

POINT SUMMARY

Interteaching = 240 total points

Powerpoint Presentations 13 @ 15 points each = 195 points

Presentation(s) = 45 points

Midterm Exam = 50 points

Final Exam = 100 points

Final Paper = 100 points

Total Points Possible = 490 points

GRADE EQUIVALENTS (% of 490 points earned):

A: 90% to 100% B: 80% to 89% C: 70% to 79% F: 69% or less

ACCOMMODATIONS FOR STUDENTS WITH DISABILITIES

The University of North Texas is on record as being committed to both the spirit and letter of federal equal opportunity legislation; reference Public Law 92-112 – The Rehabilitation Act of 1973 as amended. With the passage of new federal legislation entitled Americans with Disabilities Act (ADA), pursuant to section 504 of the Rehabilitation Act, there is renewed focus on providing this population with the same opportunities enjoyed by all citizens.

As a faculty member, I am required by law to provide "reasonable accommodations" to students with disabilities, so as not to discriminate on the basis of that disability. Student responsibility primarily rests with informing faculty of their need for accommodation and in providing authorized documentation through designated administrative channels. Information regarding specific diagnostic criteria and policies for obtaining academic accommodations can be found at http://www.unt.edu/oda/apply/index.html. Also, you may visit the Office of Disability Accommodation in the Sage Hall (room 167) or call them at (940) 565-4323.

POLICIES

No individual exceptions can be made to the syllabus.

Re-grades: If a student believes an error has been made in grading, a written request for reconsideration of the item(s) in question may be submitted within 1 week of receipt

of the graded material. The written request should specify the item(s) in question, and the reason the student believes the answer given was correct, citing relevant sources (e.g., page number from readings on which the answer was based).

Absences: If a student must be absent for any reason, s/he should arrange to submit the applicable written assignment early, as no assignments turned in after the due date can be accepted. Students are responsible for making their own arrangements to obtain information from any missed class period. There will be no additional make-up opportunities for missed examinations.

Student Conduct: Each student automatically certifies that any material submitted for grading is his/her own independent work. UNT policies require reporting of plagiarism or any suspected violations that constitute possible academic misconduct. Students are responsible for being familiar with the Code of Student Conduct.

Group work is encouraged; however, in the past there have been situations in which group work could have been considered cheating or plagiarism. "Legitimate" group work takes advantage of consultation with your peers, provides you with ideas, suggestions, corrections, etc., which you take into consideration in the development of your unique and individual product. Examples include reading the text and writing answers to the study guide items, then working closely with other students to compare study guide answers, and to attempt to resolve different understandings. Failing to do the reading, and memorizing answers that another student has written for the study guide is not legitimate group work; it is cheating. Drafting the assignments, then comparing specific aspects of your product to others' is appropriate. Copying someone else's work products (or making your work available to another student to copy) is not legitimate; it is cheating. Always, if you are unsure about boundaries of legitimate group work, please (1) ask for clarification from the instructor, and (2) make full disclosure so that there is no question about your intentions. We are very happy to talk about these boundaries and work with you to maximize your learning and maintain individual accountability.

Assistance: Students are encouraged to contact the instructor (by email or during office hours) or teaching assistant any time clarification or additional help in understanding the material is needed. Any questions that will aid you in mastering the material are welcomed.

Diversity Statement: It is the policy of the University of North Texas (and this instructor) not to discriminate on the basis of race, color, religion, sex, age, national origin, disability (where reasonable accommodations can be made), disabled veteran status or veteran of the Vietnam era status in its educational programs, activities, admissions or employment policies. In addition to complying with federal and state equal opportunity laws and regulations, the university through its diversity policy declares harassment based on individual differences (including sexual orientation) inconsistent with its mission and educational goals. Direct questions or concerns to the equal opportunity office, (940) 565-2456, or the dean of students, (940) 565-2648. TTY

access is available through Relay Texas: (800) 735-2989.

Unit 1: Course Introduction & Syllabus – Week of January 15th-17th

Unit 2: Is a Radical Behaviorist Approach to Neuroscience Possible?
January 22nd-January 24th
Subtopics: Antecedent stimuli, Responses and Reinforcement. Lobe Differentiation. Sensory Responses and the Occipital, Temporal and Parietal Lobes. Motor Responses and the Frontal Lobe. Subcortical Nuclei and Reinforcement. Reductionism. Neuropsychology vs. Behavior Analytic Neuroscience.

Readings:

Ortu, D., & Vaidya, M. (2016). The challenges of integrating behavioral and neural data: bridging and breaking boundaries across levels of analysis. The Behavior Analyst, 1-16.

Wickens, Chapter 1, (p. 36-52) From 'Introduction to the Central Nervous System' to 'Monoamine Pathways in the Brain'

Donahoe, J. W., Burgos, J. E., & Palmer, D. C. (1993). A selectionist approach to reinforcement. Journal of the Experimental Analysis of Behavior, 60(1), 17-40.

Unit 3: The Neuron and the Synapse - February 29th-31st

Subtopics: The Cell Body, Dendrites and Axons. The Sodium-Potassium Pump. Action Potentials. Postsynaptic Potentials. Levels of Analysis and Definitions of Behavior.

Readings:

Wickens, Chapter 1, (p. 10-29) From 'The Discovery of the Nerve Cell' to 'Chemical Events in the Postsynaptic Neuron'.

Stein, L., Xue, B. G., & Belluzzi, J. D. (1994). In vitro reinforcement of hippocampal bursting: a search for Skinner's atoms of behavior. *Journal of the Experimental Analysis of Behavior*, *61*(2), 155-168.

Houweling, A. R., & Brecht, M. (2008). Behavioural report of single neuron stimulation in somatosensory cortex. *Nature*, *451*(7174), 65.

Unit 4: Antecedents and Sensory Brain Areas – Week of 5th-7th

Subtopics: Discriminative Stimuli. Anatomy of the Visual System. Hierarchical Organization of the Visual System. The Three Term Vs. The Two Term Contingency.

Readings:

Donahoe, J. W., Palmer, D. C., & Burgos, J. E. (1997). The S-R issue: Its status in behavior analysis and in Donahoe and Palmer's Learning and Complex Behavior. Journal of the experimental analysis of behavior, 67(2), 193-211.

Shull, R. L. (1995). Interpreting cognitive phenomena: Review of Donahoe and Palmer's Learning and Complex Behavior. Journal of the Experimental Analysis of Behavior, 63, 347–358.

Daw, N. W., & Daw, N. W. (2006). *Visual development* (Vol. 9). New York: Springer. Chapter 2: Functional Organization of the Visual System.

Unit 5: From Individual Movements to Sequences: Organization of Motor Areas – Week of February 12th-14th

Subtopics: Primary Motor Cortex and Single Movements. Premotor Cortex, Supplementary Motor Cortex and Complex Behavioral Sequences, Molar Vs. MOlecular Analyses, Multiscaled Analyses, Natural Lines Of Fracture.

Readings:

Fuster, J. M. (2004). Upper processing stages of the perception–action cycle. *Trends in cognitive sciences*, *8*(4), 143-145.

Hineline, P. N. (2001). Beyond the molar– molecular distinction: We need multiscaled analyses. Journal of the Experimental Analysis of Behavior, 75, 342–347.

Diedrichsen, J., & Kornysheva, K. (2015). Motor skill learning between selection and execution. *Trends in cognitive sciences*, *19*(4), 227-233.

Unit 6: Reinforcement of Sensory-Motor Relations Part 1 -
Week of February 19th- February 21st

Subtopics: Subcortical Nuclei and Phasic Brain Responses to Reinforcing Environmental Stimuli. The Dopaminergic and the Noradrenergic Systems.

Schultz, W. (2007). Behavioral dopamine signals. *Trends in neurosciences*, *30*(5),

203-210.

Sara, S. J. (2009). The locus coeruleus and noradrenergic modulation of cognition. *Nature reviews neuroscience*, *10*(3), 211-223.

Schultz, W. (2016). Dopamine reward prediction-error signalling: a two-component response. *Nature Reviews Neuroscience*, *17*(3), 183.

Unit 7: Reinforcement of Sensory-Motor Relations Part 2 -
Week of February 26th-28thth
Subtopics: Neuromodulation. Dopaminergic Input to the Basal Ganglia and Reinforcement of Sensory-Motor Relations.

Packard, M. G., & Knowlton, B. J. (2002). Learning and memory functions of the basal ganglia. *Annual review of neuroscience*, *25*(1), 563-593.

Hélie, S., Ell, S. W., & Ashby, F. G. (2015). Learning robust cortico-cortical associations with the basal ganglia: An integrative review. *Cortex*, *64*, 123-135.

Unit 8: Midterm Week March 5th- March 7th.
Tuesday --- Summary Lecture and Preparation for Midterm Exam.
Thursday --- Midterm exam.

Unit 9: Learning Complex Environmental Configurations: The Hippocampus.
Week of March 19th- March 21th.
Subtopics: Reinforcement, Dopaminergic Input to the Hippocampus and Acquisition of Complex Environmental Configurations.

Readings:
Ortu, D., Skavhaug, I. M., & Vaidya, M. (2013). Timescales of learning in the basal ganglia and the hippocampus. *Frontiers in behavioral neuroscience*, *7*, 98.

Bussey, T. J., & Saksida, L. M. (2007). Memory, perception, and the ventral visual-perirhinal-hippocampal stream: Thinking outside of the boxes. Hippocampus, 17(9), 898-908.

Rolls, E. T. (2016). Pattern separation, completion, and categorisation in the hippocampus and neocortex. *Neurobiology of learning and memory*, *129*, 4-28.

Unit 10: Complex Environmental Configurations and Complex Behavioral Sequences. Week of March 26th- 28th.
Subtopics: The Organism Behaving in a Natural Environment, Hippocampal Responses and the Basal Ganglia. Artificial Intelligence and Reinforcement Learning

Readings:
Ortu, D., & Vaidya, M. (2013). A neurobiology of learning beyond the declarative non-declarative distinction. *Frontiers in behavioral neuroscience*, *7*.

Silver, D., Hubert, T., Schrittwieser, J., Antonoglou, I., Lai, M., Guez, A., ... & Lillicrap, T. (2018). A general reinforcement learning algorithm that masters chess, shogi, and Go through self-play. *Science*, *362*(6419), 1140-1144.

Unit 11: Response Competition and the Basal Ganglia. Week of April 2nd - 4th.
Subtopics: Response Competition. The Basal Ganglia and Fast Inhibition of Competing Motor Programs. The Thalamo-cortical Loop. Palmer's Concept of the Repertoire.

Readings:
Palmer, D. C. (2009). Response strength and the concept of the repertoire. *European Journal of Behavior Analysis*, *10*(1), 49-60.

Redgrave, P., Prescott, T. J., & Gurney, K. (1999). The basal ganglia: a vertebrate solution to the selection problem? Neuroscience, 89(4), 1009-1023.

Jahanshahi, M., Obeso, I., Rothwell, J. C., & Obeso, J. A. (2015). A fronto–striato–subthalamic–pallidal network for goal-directed and habitual inhibition. *Nature Reviews Neuroscience*, *16*(12), 719.

Unit 12: Neuroimaging: Real Time Measures of Brain Responses and Applications, Part 1. Week of April 9th-11th.
Subtopics: fMRI and the BOLD Response. EEG and Postsynaptic Potentials. Event Related Potentials.

Readings:
Ortu, D. (2012). Neuroscientific measures of covert behavior. *The Behavior Analyst*, *35*(1), 75.

Schlund, M. W., & Ortu, D. (2010). Experience-dependent changes in human brain activation during contingency learning. *Neuroscience*, *165*(1), 151-158.

Unit 13: Neuroimaging: Real Time Measures of Brain Responses and Applications, Part 2. Week of April 16th-18th.
Subtopics: Brain Responses and Reinforcement. Computer-Brain Interfaces. Neural Behavioral Topographies and the Paralyzed Patient.

Readings:
Sepulveda, F. (2011). *Brain-actuated Control of Robot Navigation*. INTECH Open Access Publisher.

Carmena, J. M., Lebedev, M. A., Crist, R. E., O'Doherty, J. E., Santucci, D. M., Dimitrov, D. F., ... & Nicolelis, M. A. (2003). Learning to control a brain–machine interface for reaching and grasping by primates. *PLoS biol*, *1*(2), e42.

Unit 14: Neuroplasticity: The Brain as an Adaptive Organ.
Week of April 23rd-25th.
Subtopics: Brain plasticity in early critical periods. Brain plasticity in adulthood. Neurogenesis and learning.

Readings:
Kilgard, M. P. (2012). Harnessing plasticity to understand learning and treat disease. *Trends in neurosciences*, *35*(12), 715-722.

Merzenich, M. M., Nelson, R. J., Stryker, M. P., Cynader, M. S., Schoppmann, A., & Zook, J. M. (1984). Somatosensory cortical map changes following digit amputation in adult monkeys. *Journal of comparative neurology*, *224*(4), 591-605.

Unit 15: Theoretical Frameworks: Selectionism, Essentialism in Neuroscience and

Behavior Analysis. Week of April 30th, May 2nd.
Subtopics: Neuroplasticity and Selectionism; Neuropsychology and Essentialism. Behavior Analysis and Selectionism; Cognitive Science and Essentialism.

Readings:
Palmer, D. C., & Donahoe, J. W. (1992). Essentialism and selectionism in cognitive science and behavior analysis. American Psychologist, 47(11), 1344-1358.

Gaffan, D. (2002). Against memory systems. Philos. Trans. R. Soc. Lond. BBiol. Sci. 357, 1111–1121.