BEHV 5250.011
BRAIN PLASTICITY AND BEHAVIORAL DYNAMICS
Fall 2019

Instructor:
Dr. April Becker

Office Hours:
12:00 – 2:00 pm Tuesdays
AND by appointment
Room 360G Chilton Hall
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Course Meeting Information:
Thurs 6:00PM - 8:50PM
Audb 212

COURSE DESCRIPTION:
In the first part of this course, students will be introduced to underlying problems and strategies for cross-level analytical science, and to behavioral science as the organizing framework for this class's material. Under this organizing framework, they will then be introduced to the general architecture of the brain, to the known functions of important areas, and to the behavioral and environmental processes that contribute to building this anatomy. The second part of the course will focus on the mechanisms by which brains and behavior change, the mechanisms of neural plasticity and their relationship to the environment, to the physiological mediation of environment-behavior relations, to the network structures related to brain and behavioral plasticity, and to the role of biological complexity, systems organization, and integration in behavioral processes. Although it is not required, students will be best prepared for this course if they have already taken one at least one of the following: BEHV4900-711 (Behavioral Neuroscience), BIOL 4751/BIOL 5751 (Cells and Circuits), and BEHV 2700, 2300, 3150, or 5100 (Introduction to Behavior Analysis).

COURSE OBJECTIVES:
Students use a behavioral organizing framework to:

1. Discuss common philosophical problems involved with the study of intersectional fields between levels of analysis and incorporate their practical implications into the design of experiments, interpretation, and epistemology.
2. Identify sound approaches to connecting the fields of behavior analysis and neuroscience.
3. Recall and discuss basic principles of behavior analysis including the three term contingency, respondent conditioning, operant conditioning, and stimulus control.
4. Recall and discuss basic principles of neuroscience including the structures and functions of the neuron and glia, action potentials, synaptic transmission, and circuits.
5. Recall basic neuroanatomy, basic brain functions, the structure of important circuits, and the mechanisms of global brain states.
6. Apply the difference between selections and essentialist approaches to behavior and brain sciences with regard to various topics.
7. Identify developmental influences on neuroanatomy and dynamics.
8. Identify cellular, synaptic, systems, functional, and structural, mechanisms of brain plasticity.
9. Classify developmental, experience-based, and homeostatic plasticity and identify their underlying functions.
10. Describe the modulation of brain plasticity by neuromodulatory systems and feedback circuits

ACCOMMODATIONS

The Department of Behavior Analysis, in cooperation with The Office of Disability Accommodation, complies with the Americans with Disabilities Act. Additionally, **I consider all students to be need an accommodation of some kind** since you are all unique and diverse individuals with complex histories and current situations. **I request that you all submit** a description of your accommodations using the attachment to this syllabus. **If your accommodations need to go through ODA as well, please include ODA paperwork and make sure to get it to me by the 3rd week**.

POLICIES ON CHILDREN

Respecting parenting status is part of my overall commitment to respecting the wonderful diversity of our UNT classrooms. All exclusively breastfeeding babies are welcome in class as often as necessary. While it is not meant to be a long-term childcare solution, bringing an older child to class in response to unforeseen disruptions to life is also perfectly acceptable. I ask that other students work to reasonably create a welcoming environment for such children. If you do bring your child to class I ask that you sit near the door so that if your little one needs special attention or starts behaving in a way that is disruptive to the learning of other students, you may step outside until their needs have been met. Please use good judgement where this is concerned.

TEXTBOOKS:

- Materials for this class will be posted on Canvas.

COURSE EXPECTATIONS:

Students are expected to:

- Complete all readings before each class period
- Turn in all assignments including weekly topics documents on time
- Participate actively in class discussions and activities in order to maximize their learning experience
- Regularly monitor their UNT e-mail and blackboard and to respond accordingly to messages pertaining to schedule changes, clarifications, or other course-relevant announcements and requests

Students will be evaluated in part on preparedness and in-class activities.

CLASS ACTIVITIES & REQUIREMENTS

Activity	Description	Points
Weekly Topics Document	Each student will produce a document about the week's readings and seminar discussion, including: 1. A bulleted outline covering the main and important topics from the readings (please be as brief as possible but complete), with subtopic summaries of points discussed in the day's seminar 2. A section about how the readings and seminar form a big picture and what that picture is The readings section of this doc should be completed before coming to class. Seminar notes will be added during or after class. This document will serve as a learning tool, but also as a reference in the future. You should write your summaries with your future self in mind. These should be complete in the sense that large concepts are all included, but your focus should also be perhaps even more on parsimony. It is easy to make an outline complete and easy to make it parsimonious, but to balance both will contribute to your clear thinking. Your goal is to produce the simplest document that still accounts for all vital concepts. Tools to achieve brevity include bulleting and visual rather than verbal conveyance (feel free to make a drawing or figure!). When we have readings that cover a great deal of simple route information, please copy/paste or page#/reference these important points into an appendix on your doc rather than re-stating or re-summarizing. Again, this is a learning tool and a reference – do not engage in work that serves neither purpose.	30
Seminar Leadership	Each week, one student will utilize their topics document to lead a seminar on the readings. Other students may also use the concepts in their document to participate in the discussions. The role of the leader will be to: 1. Make sure the conversation is complete (covers all aspects of the week's material). This means you may need to redirect or keep us on topic. Use your best judgement when redirecting interesting diversions. 2. Prompt participation in quiet people, guide participation with talkative people. Play devil's advocate if ideas are going unchallenged.	20
Intraverbal & Route Facts Tests	There will be at least two tests throughout the semester that will provide an opportunity to practice promptless recall of route, anatomical, or intraverbal principles covered in the class. Students will design their own tests/testing materials based on their individual learning goals. Four small tests will be worth 5 points each and a final, long test will be worth 10.	30
Term Paper	Each student will write a paper synthesizing some portion of the class with a topic of their personal interest. Please vet your topics before you begin writing. The topic should be profound enough to justify at least 4-5 pages, but there is no maximum page limit. Papers should be as simple as possible yet complete.	20
TOTAL POINTS		**100**

A= 100-90, B=89-80, C=79-70, F=69 or below

COURSE SCHEDULE FALL 2019

	DATE	TOPICS	SCHEDULE/ DUE	OPTIONAL ANATOMY SEQUENCE
Approach	26-Aug	Syllabus, Overview, Individual Learning Choices, Topics Introduction		
	5-Sep	Before we can connect the dots: Levels of Analysis & Reductionism	**TOPICS DOC (NEXT DAY) ANATOMY GROUP (9 – 9:20)**	Cerebrum 1 (chapters 1-6)
	12-Sep	Connecting Behavior Analysis and Neuroscience	**TOPICS DOC (NEXT DAY)**	Cerebrum 2 (chapters 7-14)
Structures/Functions	19-Sep	Components Week (Background Specific)	**TOPICS DOC (NEXT DAY) ANATOMY GROUP (9 – 9:20) TESTING MATERIALS**	Cerebrum 3 (chapters 15-22)
	26-Sep	Brain Anatomy and Function Overview: Input-Output Flow & the 3 Term Contingency	**TEST 1 (FIRST 20 MIN) TOPICS DOC (NEXT DAY)**	Basal Nuclei & Cerebellum
	3-Oct	Developmental and Dynamical Determinants of Brain Structure and Function: Selection vs. Essentialism	**TOPICS DOC (NEXT DAY) ANATOMY GROUP (9 – 9:20) TESTING MATERIALS**	Diancephalon
	10-Oct	Selection-based Approaches to Behavioral and Brain Dynamics	**TEST 2 (FIRST 20 MIN) TOPICS DOC (NEXT DAY)**	Brainstem 1 (chapters 43 - 50)
Plasticity	17-Oct	Brain Plasticity: Overview, Mechanisms, Timing-Dependent Plasticity	**TOPICS DOC (NEXT DAY) ANATOMY GROUP (9 – 9:20)**	Brainstem 2 (chapters 51-59)
	24-Oct	Plasticity in Systems	**TOPICS DOC (NEXT DAY)**	Spinal Cord 1 (chapters 60-67)
	31-Oct	Developmental, Homeostatic, and Meta Plasticity	**TEST 3 (FIRST 20 MIN) TOPICS DOC (NEXT DAY) ANATOMY GROUP (9 – 9:20)**	
Plasticity Control	7-Nov	Plasticity-Controlling Systems: Neuromodulators	**TOPICS DOC (NEXT DAY) TESTING MATERIALS**	
	14-Nov	Feedback/Feedforward Circuits part 1 – Basal Ganglia	**TEST 4 (FIRST 20 MIN) TOPICS DOC (NEXT DAY)**	
	21-Nov	Feedback/Feedforward Circuits part 2 – Hippocampus & Cerebellum	**TOPICS DOC (NEXT DAY)**	
	28-Nov	NO CLASS - THANKSGIVING	**TOPICS DOC (NEXT DAY)**	
Integration	5-Dec	Selection meets Emergence: Systems, Self-Organization, Degeneracy, Complexity, and Integration	**TOPICS DOC (NEXT DAY) TESTING MATERIALS**	
	12-Dec	Final Test & Paper Topics	**FINAL TEST (1.5 HOUR) PAPER TOPIC DISCUSSIONS**	

SCHOLARLY EXPECTATIONS

- Students are expected to use correct spelling, grammar and clarity in any written material submitted for class credit. If you need assistance in fulfilling this expectation, please refer to the writing lab (listed below), where you will find teachers ready to help you acquire these skills.
- In keeping with the norms of higher education, any student found guilty of academic dishonesty may receive a failing grade for the course and be reported to their college dean. Refer to your student handbook for complete provisions of the policies and procedures set forth by UNT.
- Religious Holidays: Please let me know within the first 15 days of the semester if you require provision for religious holidays. In accordance with state law, students absent due to the observance of a religious holiday may take examinations or complete assignments scheduled for the day missed within a reasonable time after the absence if the student has notified the instructor of each class of the date of the absence within the first 15 days of the semester. Notification must be in writing, either personally delivered with receipt of the notification acknowledged and dated by the instructor, or by certified mail, return receipt requested.

ROUTE TESTS SAFMEDS GUIDE

STUDENT PERCEPTIONS OF TEACHING (SPOT)

Student feedback is important and an essential part of participation in this course. The student evaluation of instruction is a requirement for all organized classes at UNT. The short SPOT survey will be made available to you with an opportunity to evaluate how this course is taught. You will receive an email from "UNT SPOT Course Evaluations via *IASystem* Notification" (no-reply@iasystem.org) with the survey link. Please look for the email in your UNT email inbox.

ABSENCES

If you must be absent for any reason, you should arrange to submit the written assignments early. If absent unexpectedly for unavoidable reasons, you may submit the day's assignments electronically. 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.

STUDENT RESOURCES

Office of Disability Accommodation - http://disability.unt.edu/
Learning Center - http://learningcenter.unt.edu/ UNT
Writing Lab - http://writinglab.unt.edu/

WEEKLY READINGS

Reading guidance: Page numbers for each reading precede the reference, and approximate weekly totals antecede the header to help you with your study/time management. "Quick read" means skim all material that is not new to you and do a moderate-speed read only of those parts that are of particular novelty or interest. "Moderate Read" means read all material once but don't worry about digesting every detail or re-reading parts that confuse you. "Deep Read" means read fully for complete understanding. "Lay read" means that this paper was taken from a popular source and should therefore be a faster read. "Optional read" is what it sounds like.

This class will involve a lot of new material for any given background. You will have to learn to be a strategic reader in order to avoid getting lost, panicking, or creating disruptive holes in your learning process. We will discuss strategies to this end on the first day, which include: 1. knowing when to skim, when to skip, and when to focus, 2. scheduling lay reads for bedtime or times when you're not fresh/need to relax, difficult reads for your best, most focused "on" times, and multiple reading windows (subdivided by sections/headings) for long/complex reads.

Before we can connect the dots: Levels of analysis & Reductionism 65

12 Bechtel, W. (2005). The challenge of characterizing operations in the mechanisms underlying behavior. *Journal of the experimental analysis of behavior*, *84*(3), 313-325. Deep read

53 Bechtel, W., & Hamilton, A. (2007). Reduction, integration, and the unity of science: Natural, behavioral, and social sciences and the humanities. In *General Philosophy of Science* (pp. 377-430). North-Holland. Moderate read

Connecting Behavior Analysis and Neuroscience 50

19 Donahoe, J. W. (2017). Behavior analysis and neuroscience: Complementary disciplines. *Journal of the experimental analysis of behavior*, *107*(3), 301-320. Deep read

5 Schlinger, H. D. (2015). Behavior analysis and behavioral neuroscience. *Frontiers in human neuroscience*, *9*, 210. WITH COMMENTARY Moderate read

10 Krakauer, J. W., Ghazanfar, A. A., Gomez-Marin, A., MacIver, M. A., & Poeppel, D. (2017). Neuroscience needs behavior: correcting a reductionist bias. *Neuron*, *93*(3), 480-490. Moderate read

16 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. Moderate read

Components Week (Background Specific) 129 / 107

If you are new to Neuroscience:

125 Bear, M. F., Barry W. Connors, M. Paradiso, M. F. Bear, B. W. Connors, and M. A. Neuroscience. "Exploring the brain." *Neuroscience* (2009). p. 28-44, 46-48, 59-166. Quick read. Do not read extra boxes in this text. Skim any topics you're already familiar with. This is to give you an overview. Don't' fret about remembering disconnected details – concentrate instead on the picture that the details paint.

4 Purves D, Augustine GJ, Fitzpatrick D, et al., editors. Neural Circuts. In Neuroscience. 2nd edition. Sunderland (MA): Sinauer Associates; 2001. Neural Circuits. Available from:https://www.ncbi.nlm.nih.gov/books/NBK11154/ Quick read

If you are new to Behavior Analysis:

13 Ryle, G. (1949). Descartes' myth. In Ryle, G. (2009). *The concept of mind*. Routledge. p. 1-13. Deep read

8 A system of behavior. In Skinner, B. F. (1938). The behavior of organisms: An experimental analysis (pp. 3-8). Englewood Cliffs, NJ: Prentice-Hall. Moderate read

8 Harzem, P. (1986). The language trap and the study of pattern in human action. *Analysis and integration of behavioral units*, 45-53. Quick read

20 Skinner, B. F. (1935). The generic nature of the concepts of stimulus and response. *The Journal of General Psychology*, *12*(1), 40-65. Sort of moderate read, however this will be difficult even at moderate level. It may take multiple readings to get a moderate-read outcome. Do not read when you're tired. Act like the page count is twice as long.

58 Reflexes and Conditioned Reflexes, Operant Behavior, and The Controlling Environment. In Skinner, B. F. (1953). *Science and human behavior* (No. 92904). Simon and Schuster. Lay read

Brain Anatomy and Function Overview: Input-Output Flow & the 3 Term Contingency 75

32 Neuroanatomy overview and basic definitions. In Blumenfeld, H. (2002). Neuroanatomy through clinical cases. p. 14-46. Moderate read

18 Keijzer, F., Van Duijn, M., & Lyon, P. (2013). What nervous systems do: early evolution, input–output, and the skin brain thesis. *Adaptive Behavior*, *21*(2), 67-85. Moderate read

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

23 Bickel, W. K., & Etzel, B. C. (1985). The quantal nature of controlling stimulus-responses relations as measured in tests of stimulus generalization. *Journal of the Experimental Analysis of Behavior*, 44(2), 245-270. Deep read

Developmental and Dynamical Determinants of Brain Structure and Function: Selection vs. Essentialism 85

14 Palmer, D. C., & Donahoe, J. W. (1992). Essentialism and selectionism in cognitive science and behavior analysis. *American Psychologist*, *47*(11), 1344. Deep read

14 Pelaez, M., Gewirtz, J. L., & Wong, S. E. (2008). A critique of stage theories of human development. *Comprehensive handbook of social work and social welfare*, *2*. Moderate read

13 Bran Basics: Some Revelations of Developmental Neuroscience. In Moore, D. S. (2003). *The Dependent Gene: The Fallacy of" nature Vs. Nurture"*. Macmillan. p. 90-103. Lay read

35 Price, D., Jarman, A. P., & Mason, J. O. J. (2011). Experience-Dependent Development. In *Building brains: An introduction to neural development*. Retrieved from https://ebookcentral.proquest.com Quick read – for cellular/molecular just do a run through to catch what you can – we'll come back to that topic

9 Diversity and Overlapping Connectivity in Neural Structures & Critical Challenges to Instructionist and Information Processing Models. In Edelman, G. M. (1987). Neural Darwinism: The theory of neuronal group selection. Basic books. p. 33-42. Quick read

Selection-based Approaches to Behavioral and Brain Dynamics 46 - 63

23 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. Quick Read

7 Glenn, S. S., Ellis, J., & Greenspoon, J. (1992). On the revolutionary nature of the operant as a unit of behavioral selection. *American Psychologist*, *47*(11), 1329. Deep Read

10 Edelman, G. M. (1993). Neural Darwinism: selection and reentrant signaling in higher brain function. *Neuron*, *10*(2), 115-125. Moderate read

6 Takahashi, H., Yokota, R., & Kanzaki, R. (2013). Response variance in functional maps: neural darwinism revisited. *PloS one*, *8*(7), e68705. Moderate read

17 Fernando, C. T., Szathmary, E., & Husbands, P. (2012). Selectionist and evolutionary approaches to brain function: a critical appraisal. *Frontiers in computational neuroscience*, *6*, 24. Optional read

Brain Plasticity: Overview, Mechanisms, Timing-Dependent Plasticity 34 - 42

For this week: Non-bio folks DO NOT STRUGGLE, just absorb what you can. We will clarify in class.

9 Holtmaat, A., & Svoboda, K. (2009). Experience-dependent structural synaptic plasticity in the mammalian brain. *Nature Reviews Neuroscience*, *10*(9), 647. Note: mechanisms of structural, not functional plasticity. Moderate read

14 Caporale, N., & Dan, Y. (2008). Spike timing–dependent plasticity: a Hebbian learning rule. *Annu. Rev. Neurosci.*, *31*, 25-46. Note: mechanisms of functional, not structural plasticity. Quick/Moderate read.

11 Shouval, H. Z., Wang, S. S. H., & Wittenberg, G. M. (2010). Spike timing dependent plasticity: a consequence of more fundamental learning rules. *Frontiers in Computational Neuroscience*, *4*, 19. Quick/Moderate read.

8 Shepherd, J. D., & Huganir, R. L. (2007). The cell biology of synaptic plasticity: AMPA receptor trafficking. *Annu. Rev. Cell Dev. Biol.*, *23*, 613-643. Note: mechanisms of functional, not structural plasticity. Optional Moderate read.

Plasticity in Systems 60

37 Buonomano, D. V., & Merzenich, M. M. (1998). Cortical plasticity: from synapses to maps. *Annual review of neuroscience*, *21*(1), 149-186. Moderate read

12 Polley, D. B., Steinberg, E. E., & Merzenich, M. M. (2006). Perceptual learning directs auditory cortical map reorganization through top-down influences. *Journal of neuroscience*, *26*(18), 4970-4982. Moderate/Quick read – feel free to skip parts. Just get the take-home of the experiment

10 Reed, A., Riley, J., Carraway, R., Carrasco, A., Perez, C., Jakkamsetti, V., & Kilgard, M. P. (2011). Cortical map plasticity improves learning but is not necessary for improved performance. *Neuron*, *70*(1), 121-131. Moderate read

1 Ohl, F. W., & Scheich, H. (2004). Fallacies in behavioural interpretation of auditory cortex plasticity. *Nature Reviews Neuroscience*, *5*(12), 972. Moderate read

Developmental Homeostatic, and Meta Plasticity 50

14 Merzenich, M. M. (2001). Cortical plasticity contributing to child development. In *Mechanisms of cognitive development*. Psychology Press. Moderate read

15 Kleim, J. A., & Jones, T. A. (2008). Principles of experience-dependent neural plasticity: implications for rehabilitation after brain damage. *Journal of speech, language, and hearing research*. Quick read

5 Vitureira, N., Letellier, M., & Goda, Y. (2012). Homeostatic synaptic plasticity: from single synapses to neural circuits. *Current opinion in neurobiology*, *22*(3), 516-521. Moderate read

6 Li, J., Park, E., Zhong, L. R., & Chen, L. (2019). Homeostatic synaptic plasticity as a metaplasticity mechanism—a molecular and cellular perspective. *Current opinion in neurobiology*, *54*, 44-53. Moderate read

4 Abraham, W. C., & Bear, M. F. (1996). Metaplasticity: the plasticity of synaptic plasticity. *Trends in neurosciences*, *19*(4), 126-130. Moderate read

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

Plasticity-Controlling Systems: Neuromodulators 45 - 72

11 Pawlak, V., Wickens, J. R., Kirkwood, A., & Kerr, J. N. (2010). Timing is not everything: neuromodulation opens the STDP gate. *Frontiers in synaptic neuroscience*, *2*, 146. Quick read

17 Carcea, I, Froemke, R. C. (2013). Cortical Plasticity, Excitatory-Inhibitory Balance, and Sensory Perception. In Merzenich, M., Nahum, M., & van Vleet, T. *Changing brains: applying brain plasticity to advance and recover human ability* (Vol. 207). Elsevier. Moderate read

15 Avery, M. C., & Krichmar, J. L. (2017). Neuromodulatory systems and their interactions: a review of models, theories, and experiments. *Frontiers in neural circuits*, *11*, 108. Moderate read

2 Ortu, D. (2015). How do we remember traumatic events? Exploring the role of neuromodulation. *Behavioral and Brain Sciences*, *38*. Moderate read

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

2 Kilgard, M. (2003). Cholinergic modulation of skill learning and plasticity. *Neuron*, *38*(5), 678-680. Optional read

11 Miyazaki, K., Miyazaki, K. W., & Doya, K. (2012). The role of serotonin in the regulation of patience and impulsivity. *Molecular neurobiology*, *45*(2), 213-224. Optional read

Feedback/Feedforward Circuits 1 – Basal Ganglia 66

19 Thomas Jessell, Siegelbaum, S., & Hudspeth, A. J. (2000). The Basal Ganglia. In *Principles of neural science* (Vol. 4, pp. 1227-1246). E. R. Kandel, J. H. Schwartz, & T. M. Jessell (Eds.). New York: McGraw-hill. Quick/Moderate read (depending on prev. knowledge)

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

7 Jin, X., & Costa, R. M. (2015). Shaping action sequences in basal ganglia circuits. *Current opinion in neurobiology*, *33*, 188-196. Deep read

6 Donahoe, J. W. (2014). Evocation of behavioral change by the reinforcer is the critical event in both the classical and operant procedures. *International Journal of Comparative Psychology*, *27*(4). Deep read

4 Mink, J. W. (2018). Basal ganglia mechanisms in action selection, plasticity, and dystonia. *European Journal of Paediatric Neurology*, *22*(2), 225-229. Moderate read

Feedback/Feedforward Circuits 2 – Hippocampus & Cerebellum 78 - 98

7 Gyorgy Buzsaki (2011) Hippocampus. Scholarpedia, 6(1):1468. Moderate read

1 Neural Circuits of the hippocampus. Neural Circuits and Memory Lab Website, https://sites.lsa.umich.edu/diba-lab/neural-circuits-of-the-hippocampus/ Take a glance

10 Rudy, J. W. (2008). The neurobiology of learning and memory. *Psychology*, *4032*, 5032. p. 254 – 264 Moderate read

~5 Hudgins, Caleb. (2016). A unified theory of hippocampal function. Deep read

15 Ortu, D., & Cihon, T. M. (2018). A Neuro-Operant Analysis of Mnemonic Recognition. *Perspectives on Behavior Science*, 1-15. Moderate read

9 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. Optional read

11 Ortu, D., & Vaidya, M. (2013). A neurobiology of learning beyond the declarative non-declarative distinction. *Frontiers in Behavioral Neuroscience*, *7*, 161. Optional read

19 Thomas Jessell, Siegelbaum, S., & Hudspeth, A. J. (2000). The Cerebellum. In *Principles of neural science* (Vol. 4, pp. 1227-1246). E. R. Kandel, J. H. Schwartz, & T. M. Jessell (Eds.). New York: McGraw-hill. Quick/Moderate read (depending on prev. knowledge)

2 Ito, M. (1993). Movement and thought: identical control mechanisms by the cerebellum. *Trends in neurosciences*, *16*(11), 448-450. Moderate read

7 Nixon, P. D. (2003). The role of the cerebellum in preparing responses to predictable sensory events. *The Cerebellum*, *2*(2), 114. Moderate read

12 Bostan, A. C., & Strick, P. L. (2018). The basal ganglia and the cerebellum: nodes in an integrated network. *Nature Reviews Neuroscience*, *19*(6), 338. Quick read

Selection meets Emergence: Systems, Self-Organization, Degeneracy, Complexity, and Integration 86

9 Camazine, S., Deneubourg, J. L., Franks, N. R., Sneyd, J., Bonabeau, E., & Theraula, G. (2003). What is Self-Organiziation? & How Self-Organization Works. In *Self-organization in biological systems*. Princeton university press. p. 5-14. Moderate read

12 Corning, P. A. (2002). The re-emergence of “emergence”: A venerable concept in search of a theory. *Complexity*, *7*(6), 18-30. Moderate read

24 Bechtel, W., & Richardson, R. C. (2010). Integrated Mechanisms. In *Discovering complexity: Decomposition and localization as strategies in scientific research*. MIT press. Quick read

5 Edelman, G. M., & Gally, J. A. (2001). Degeneracy and complexity in biological systems. *Proceedings of the National Academy of Sciences*, *98*(24), 13763-13768. Moderate read

4 Edelman, G. M., & Gally, J. A. (2013). Reentry: a key mechanism for integration of brain function. *Frontiers in integrative neuroscience*, *7*, 63. Quick read

32 Buzsaki, G. (2006). Structure Defines Function. In *Rhythms of the Brain*. Oxford University Press. Moderate read

ACCOMMODATIONS DESCRIPTIONS:

Please describe any points of your unique life that will or may weigh on the logistical implementation of this class. For each, please tell me if it's just something I should be aware of or if there is a particular point of reasonable accommodation or flexibility that can be provided.