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Subject: E-mail 1.1. Neurobiology of Learning and memory. Short Course Outline.

Psychology/Neuroscience 4740.03F.
(Also Psych./Neuro/ 6071.03. Physiological Psychology.)

Topics in the Neurobiology of Learning and Memory.
(September-December 2023)

Tuesdays 4:05 - 5:55 PM in the Group Testing Room (Psychology second floor)

[NOT in the LSC-Common area, Room C212]

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E-mail 1.1. Neurobiology of Learning and memory. Short Course Outline.

This is the first of 15 or 16 e-mails that you will get. When put together, they will form the complete course outline.

The first class of Psych/Neuro 4740 [Neurobiology of Learning and Memory] is on Tuesday 5 September 2023.

The tentative course outline is given below. This will probably change during the course of the class.

The class is in a seminar format with students giving 3 or 4 presentations and writing a paper. Grades are based on a ChatGPT essay (10), a real essay (50); best 2 presentations (40), and class participation (10). = 110 marks.

Topics in the Neurobiology of Learning and Memory.
Psychology/Neuroscience 4740.03F (2023-2024).

REVISED Tentative Course Outline [Things always change]

Class 1. Tues 5 September 2023. Who was Donald Hebb and what did he do? (1) Course outline, (2) overview of Hebb's life and work, and (3) Revising the Hebb synapse for the 21st century. Presentations by R. Brown.

Read the Foreword, Preface and Introduction to Hebb (1949) The Organization of Behavior by Brown and Milner (2002)

Class 2. 12 Sept. 2023. I WAS ILL. Class cancelled

Class 3. (Class 2)19 Sept. 2023. Papers that stimulated Hebb. Influences on Hebb: Where did Hebb get his ideas?
Read Hebb 1949. Chapters 1, 2, and 3. [Repeated in class 6]

Class 4. (Class 3) 26 Sept. 2023. Hebbian plasticity: Hebb synapses, cell assemblies and phase sequences. Perception of a complex: The phase sequence. Graph theory. Read Hebb 1949. Chapters 4 and 5.

Class 4a. 26 Sept. 2023. LTP and LTD as mechanisms of the Hebbian synapse
Learning-related synaptic plasticity: LTP and LTD

Class 5. (Class 4b) 3 Oct. 2023. The crazy world of Synaptic Plasticity: Hebbian, Non-Hebbian, Anti-Hebbian and Homeostatic, and maybe more. Spike timing-dependent plasticity. Synaptic tagging theory.
[I will be in London this week. Kyle will take the class]

Class 6. 10 Oct. 2023. Where does memory reside: Cell or synapse?

Class 7. 17 Oct. 2023. Hebbian theories of perceptual learning.
Hebb 1949. Chapters 1, 2, and 3.

***Class 8. 24 Oct. 2023. Hebb Chapter 6. Development of the learning capacity. Early and late brain damage**
Hebb 1949. Chapter 6.

Class 9. 31 Oct. 2023. Higher and lower processes related to learning. Intelligence, consciousness and thought, imagery
Hebb 1949. Chapter 7.
Accolades and Critiques of Hebb

Class 10. 7 Nov. 2023. Hebbian theories of motivation and reward, fear and fear learning, pain, etc.
Hebb 1949. Chapters 8, 9 and 10.

12-18 November is the stupid Fall break.

Class 11. 21 Nov. 2023. Hebbian theories of Synapse dysfunction in neurodevelopmental and neurodegenerative disorders
Hebb 1949. Chapter 11.

Class 12. 28 Nov. 2023. Genetic and epigenetic analyses of the Hebb synapse. Hebb synapse genetics, epigenetics and the immune system

Class 13. Hebb synapse, artificial intelligence, engineering and robotics. [There is no class 13, but this stuff is pretty interesting]

Suggested background reading 1. Books on the Neurobiology of Learning and Memory.

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1. Bear, M.F., Connors, B.W. & Paradiso, M.A. 2016. Neuroscience: exploring the brain, 4th edition. Philadelphia: Walters Kluwer. [This is the textbook for Psych./Neuro 2470. You should be familiar with this book. Chapters 24 and 25 are on learning and memory mechanisms.]

2. Squire, L.R. & Kandel, E.R. 1999. Memory: From mind to molecules. Scientific American Library. [This is an easy to read book on the neurobiology of learning and memory.]

3. Martinez, J. & Kesner, R. (Eds.) Neurobiology of Learning and Memory. 1998. Academic Press, New York. [This has some useful chapters in it.]

4. Schwartz, B., Wasserman, E.A., & Robbins, S.J. 2001. Psychology of Learning and Behavior, 5th Edition. New York: Norton. [This is the textbook for the Animal Learning course (Psych 2140) and you should be familiar with basic learning theory.]

5. Eichenbaum, H. 2002. The Cognitive Neuroscience of Memory: An Introduction. Oxford University Press.

6. Sweatt, J.D. 2003. Mechanisms of Memory. Elsevier/Academic Press.

Background readings on the Neurobiology of Learning and Memory 2: Twelve journal articles which cover a range of topics relevant to the class.

Spatz, H.C. 1996. Hebb's concept of synaptic plasticity and neuronal cell assemblies. Behavioral Brain Research, 78, 3-7. **[This a short over-view of Hebb's theory.]**

Milner, B., Squire, L., & Kandel, E.R. 1998. Cognitive neuroscience and the study of memory. Neuron, 20, 445-468. **[This paper covers the whole of the class, so acts as an outline for the class, even if it is 24 years old]**

Poo MM, Pignatelli M, Ryan TJ, Tonegawa S, et al. 2016. What is memory? The present state of the engram. BMC Biology, 14:40. doi: 10.1186/s12915-016-0261-6. **[These are the big boys of rock and roll. They all got together to discuss the problems in the neurobiology of memory that need to be solved.]**

Aggleton JP and Morris RGM. 2018. Memory: Looking back and looking forward. Brain and Neuroscience Advances, 2: 1–9. DOI: 10.1177/2398212818794830 **[This is a newish overview of the neurobiology of learning and memory]**

Lisman J, Cooper K, Sehgal M, Silva AJ. 2018. Memory formation depends on both synapse-specific modifications of synaptic strength and cell-specific increases in excitability. Nat Neurosci. 21(3):309-314. doi: 10.1038/s41593-018-0076-6. **[I believe that these guys are on the right track--they think like we do]**

Langille, JJ. and Brown, RE. 2018.The synaptic theory of memory: A historical survey and reconciliation of recent opposition. **Frontiers in Systems Neuroscience** 12: 52. doi: 10.3389/fnsys.2018. **[I wrote this paper so it must be right.]**

Ferbinteanu J. 2019. Memory systems 2018 - Towards a new paradigm. Neurobiol Learn Mem. 157:61-78. doi: 10.1016/j.nlm.2018.11.005**. [How should we think about multiple memory systems?]**

Yavas E, Gonzalez S, Fanselow MS. 2019. Interactions between the hippocampus, prefrontal cortex, and amygdala support complex learning and memory. F1000 Res. 8: (F1000 Faculty Rev) 1292. doi: 10.12688/f1000research.19317.1 **[How do different brain areas interact in memory formation?]**

Smolen P, Baxter DA, Byrne JH. 2019. How can memories last for days, years, or a lifetime? Proposed mechanisms for maintaining synaptic potentiation and memory. Learn Mem. 26(5):133-150. doi: 10.1101/lm.049395.119. **[How can memories last so long?]**

Josselyn SA & Tonegawa S. 2020. Memory engrams: Recalling the past and imagining the future. Science 367, 39, 3 January 2020, 15 pages. **[This is the latest paper from the world of engrams.]**

Rivi V, Benatti C, Rigillo G, Blom JMC. 2023. Invertebrates as models of learning and memory: investigating neural and molecular mechanisms. J Exp Biol. 226(3):jeb244844. doi: 10.1242/jeb.244844. **[Sometimes we forget that invertebrates learn and remember too.]**

Posner MI, Rothbart MK. 2023. Fifty years integrating neurobiology and psychology to study attention. Biol Psychol. 180:108574. doi: 10.1016/j.biopsycho.2023.108574. **[How do attention and memory networks function together?]**