Topics in Cognitive Neuroscience
BME 69500 / PSY 69200
Fall 2022- Wed 2:30-5:20pm, ME 2053

Instructor
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Office:
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Office hours: By appointment

Prerequisites: There are no formal prerequisites. This course is intended for graduate students interested in mathematical and computational, neural, cognitive, and clinical approaches to understanding cognitive neuroscience, including but not limited to students in biomedical engineering and psychological sciences.

Description and goals: The objective of this course is to master select topics in cognitive neuroscience and introduces students to computational, neural, and behavioral approaches used in the interdisciplinary field of research called cognitive neuroscience. Students will learn about selected computational, neural, and behavioral techniques and approaches to various topics in sensory-motor control, sensation and perception, and higher order cognitive functions such as attention and memory. The main goals are:
(1) a better understanding of diverse approaches, techniques, and issues in cognitive neuroscience
(2) experience in reading, understanding, and identifying issues to discuss in primary literature
(3) ability to create and give an effective oral presentation on current research
(4) experience in generating and leading discussions
(5) exposure to historically relevant and current research in cognitive neuroscience

Course Material:
Assigned readings from the literature (see schedule below).

Format:
Class meetings will consist of a combination of lectures, interactive discussions, and presentations. Assignments will stimulate and encourage higher-level thinking and will include homework and in-class presentations and discussions.

Evaluation:
Class meetings will consist of a combination of lectures, interactive discussions, and presentations. Assignments will stimulate and encourage higher-level thinking and will include homework and in-class presentations and discussions.
(1) Homework (1200 points; 43%): Homework assignments will be assigned once per week to facilitate understanding on each topic. To satisfy this requirement, students will submit discussion questions in response to the assigned reading in advance of the class to facilitate discussion after presentations.
(2) Class Participation/Discussion (1200; 43%): Attendance and active participation in all class discussions is required. Each week, students will discuss their homework assignments and their understandings from the homework about the methodology used and application of the methodology in the assigned reading. Each student will present at least one of their homework discussion questions, teach the methodology used in the paper, and lead a discussion on the application of the methodology.
(3) Presentation (400 points; 14%): Each student will prepare a 25 min talk on their topic of choice (approval needed). They will submit an experimental research paper for the class to read in advance. Each student presenter will be responsible for leading the discussion.

Grades for the course will be based on a straight scale: 89.5% or above = A; 79.5% or above = B; 69.5% or above = C; 59.5% or above = D.

Course Policies:

Course Changes: In the event of a major campus emergency or adverse weather, course requirements and deadlines are subject to change. Announcements will come via your email so please check in regularly.

Missed Classes: Please notify us if you have a planned absence (e.g., University-sponsored activities, religious observances, conference travel). For illness and unanticipated absence, please notify us as soon as possible and we will work with you to determine how to catch up. This is the Grief Absence Policy for Students: www.purdue.edu/odos/services/griefabsencepolicyforstudents.php

Special Accommodations: If you have a physical, psychological, medical, or learning disability that may impact your course work, please make an appointment to speak with your instructor to discuss any adjustments. In addition, it is your responsibility to notify the Disability Resource Center of any impairment/condition that may require accommodations: www.purdue.edu/drc

Academic Integrity: Each student must pursue his or her academic goals honestly and be personally accountable for all submitted work. Representing another person's work as your own is always wrong. Any suspected instance of academic dishonesty (e.g., plagiarism or behavior consistent with cheating) will be reported to the Office of the Dean of Students. The first instance will result in a grade of zero on that exam/assignment, and the second instance will result in an F for the course. For more information on academic integrity, including categories of academic dishonesty, please refer to Purdue's student guide for academic integrity: www.purdue.edu/odos/aboutodos/academicintegrity.php

Behavior: Purdue University is committed to providing a safe and secure campus environment for members of the university community that promotes learning. Faculty are required to report to the Office of Student Rights and Responsibilities any disruptive behavior that interrupts their ability to teach, compromises the safety of the learning environment, or inhibits students' ability to learn.

Discrimination is prohibited against any member of the University community on the basis of race, religion, color, sex, age, national origin, genetic information, marital status, parental status, sexual orientation, gender identify and expression, disability, or status as a veteran. If you believe you have been discriminated against, you may submit an anonymous complaint to the Office of Institutional Equity: www.purdue.edu/report-hate

Course Schedule: Tentative Class Schedule & Readings

Week 1: Class organization, sign up and finalization of topics.

Week 2: Cortical representation of shape and space, and computational modeling of spatial attention
Readings:
—Sereno AB, and Maunsell JHR. Shape selectivities in primate lateral intraparietal cortex. *Nature*. 395:500-503, 1998. article [pdf]
—Sereno AB, Lehky SR, Patel S, Peng X. *A neurophysiological correlate and model of reflexive spatial attention*. In N. Srinivasan, Bhoomika R. Kar, and J. Pandey (eds.), Advances in Cognitive Science: Volume 2: 104-131, 2010. article [pdf]
—Patel SS, Peng X, Sereno AB. Shape effects on reflexive spatial selective attention and a plausible neurophysiological model. *Vision Research*, 50: 1235-1248, 2010. article [pdf]

[Labor Day]

Week 3: Computational modeling of memory
—Patel SS, Red S, Lin E, Sereno AB. Single Canonical Model of Reflexive Memory and Spatial Attention, *Scientific Reports, 5, 15604,* 2015. Oct 23;5:15604. doi: 10.1038/srep15604. article [link]

Week 4: Perceptual grouping & some basics of the human visual system
Readings:
—Palmer, S. E. (2002). Perceptual organization in vision. In H. Pashler (Ed.), Stevens' Handbook of Experimental Psychology: 1. Sensation and Perception (3rd ed.). (pp. 177–234). New York, NY: Wiley.
—Selection (pp. 24-43) from Palmer, S. E. (1999). Vision Science: Photons To Phenomenology. Cambridge, MA: MIT Press.

Week 5: Adaptive resonance theory (ART) models, bipole circuits, and emergent segmentation
Readings: Selections from
—Grossberg, S., & Mingolla, E. (1985). Neural dynamics of perceptual group- ing: Textures, boundaries, and emergent segmentations. Perception & Psychophysics, 38, 141–171.
—Grossberg, S., & Raizada, R. D. S. (2000). Contrast-sensitive perceptual grouping and object-based attention in the laminar circuits of primary visual cortex. Vision Research, 40, 1413–1432.
—Grossberg, S. (2021). Conscious Mind, Resonant Brain: How Each Brain Makes a Mind. New York: Oxford University Press.

Week 6: Computational modeling of perceptual grouping (A new bipole circuit, dynamic emergent segmentation, and an account of perceptual grouping)
Reading:
—Kon, M., & Francis, G. (2022). Cortical circuits for top-down control of perceptual grouping. Neural Networks, 151, 190–210.

[October Break]

Week 7: Computational modeling of the entorhinal-hippocampal system
— Whittington, Muller, Mar, Barry Burgess, Behrens (2020). The Tolman-Eichenbaum Machine: Unifying

Space and Relational Memory through Generalization in the Hippocampal Formation. Cell, 183, 1249-1263. article [link]

Week 8: Computational logic and neural substrates of successor representation
— Gershman, S.J. (2018). The Successor Representation: Its Computational Logic and Neural Substrates. Journal of Neuroscience, 38, 7193-7200. article [link]

Week 9: Computational modeling of the prefrontal cortex
— Parr, T, Rikhye, RV, Halassa, MM, and Friston, KJ. (2020). Prefrontal Computation as Active Inference. Cerebral Cortex, 30, 682-695. article [link]

Weeks 10-14: To be finalized with class input

Week 10: ____

Week 11: (SFN/Psychon)

Week 12: ____

Week 13: ____

Week 14: ____