INTRODUCTION TO COGNITIVE SCIENCE: FALL 2020

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GRADUATE STUDENT INSTRUCTORS (GSIs):
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OFFICE HOURS: Monday 10:30AM-11:30AM (PST) & Thursday 10:00AM – 11:00AM (PST) **|**
GSI Office Hours by appointment only

REQUIRED TEXTBOOK: Jose Luis Bermudez. Cognitive Science: An introduction to the Science of the Mind. Cambridge University Press. Third Edition (2020).

WEEKLY REQUIRED JOURNAL ARTICLE READINGS
(retrieve weekly articles from internet if open access OR retrieve from UC Berkeley library resources)

EVALUATION:

1. Written Assignment: 1-page paper. Completion Only (10 %)
2. Group Presentation: Group presentation – Groups of 5 students per group (20 %)
3. Midterm Paper: 4-page paper (30 %)
4. Thoughtful Reflections: 4 Reflections on the presentation of the week: Completion Only (20 %)
5. Online Final Exam Multiple Choice Questions (20 %)

GRADING: This class follows a standard percentage to grade conversion: 97%-100% (A+), 93%-96% (A), 90%-92% (A-), 87%-89% (B+), 83%-86% (B) and so forth.

NOTES:

- Assignment and midterm paper must be submitted by the due date on BCourses (not emailed)
- No late assignments will be accepted (exceptions: accommodation letter, medical reasons)
- All other: Students are required to inform the Professor or GSI at least 24 hours in advance if they cannot submit an assignment on time
- Discussion section attendance is required and an integral part of this course
- In compliance with University Policy, all DSP allowances will be honored

COURSE DESCRIPTION

Cognitive Science aims to create a scientific framework for how the human mind operates, motivated by the extraordinary challenge of explaining arguably the most complex and sophisticated entity we have access to in our physical universe. This study of the mind is heavily multidisciplinary and draws on learnings from component fields including psychology, biology,

neuroscience, computer science, artificial intelligence, vision science, linguistics, and philosophy. The course covers the development of theories explaining key cognitive subsystems, such as emotion, memory, attention, and decision-making, among others. Throughout the lectures, we will examine key theories, tools, and applications utilized in each component discipline as well as the main critiques of the paradigms. For instance, the lectures on neuroscience will cover both structural and functional methods and their corresponding strengths, limitations, and applications. We will see that recent advances in neuroscience and artificial intelligence (AI) are providing a bottoms-up understanding of cognitive subsystems that were previously explained via phenomenological theories and behavioral approaches. Indeed, we learn that recent advances in AI were inspired by Cognitive Science research spanning over the last half century. Finally, this course will also cover the most prevalent of brain-based diseases and how cognitive science directly explains central nervous system disorders.

COURSE OBJECTIVES

The objectives of the course are to introduce the fundamental concepts, hypotheses, models, methods, issues, and debates in cognitive science. Because cognitive science lies at the intersection of multiple disciplines, students will gain an understanding of the contributions of each discipline to advancing the study of the human mind. In addition to primary syllabus content, this course will expose students to the various experimental approaches to cognitive science. Lectures, required reading, written assignments, and discussion sections encourage students to apply critical analytical skills to methods, assumptions, and models to reinforce the material and provide a foundation preparing students for more advanced studies in cognitive science. These objectives are met by direct student engagement and participation. Therefore, completion of all weekly laboratory assignments is essential to both mastering course content and gaining applied skills.

WRITTEN ASSIGNMENT & MIDTERM PAPER

Written assignments are a required part of this course. The objective of these assignments is for students to master the material and provide me with feedback to gauge students' understanding of lecture content and to address any questions. The content of written assignments will be drawn from the following: written responses to factual questions on the lecture, reflection/essay responses, journal article analyses, quizzes, or applied problem sets.

Week	Lecture Description	Required Readings
Week 1	**Introduction to Cognitive Science** History & Foundations of Cognitive Science Overview of component fields: psychology, neuroscience, Computer science, linguistics, philosophy Evolution of Human Cognition	Bermudez, Introduction: The Challenge of Cognitive Science, Pages 3-11.

	Brain basics: anatomy, neurotransmitters, action potentials	
Week 2	**Philosophy of Mind** Philosophical theories of Mind: Cartesian dualist theory, Putnam's Functionalism Continental tradition: Kant, Hegel, Heidegger, Sartre Phenomenology: Edmund Husserl Epistemology: Benedict de Spinoza, Bertrand Russell Consciousness: Daniel Dennett	A Priori and A Posteriori Knowledge, Immanuel Kant (article available on bcourses)
Week 3	**Logic, Reasoning, Judgement & Decision Making** Neural basis of judgement and decision-making Theoretical Foundations: Tversky and Kahneman Bounded Rationality Framework (Simon) Inductive and Deductive Reasoning, Inferences Closed vs. Open Loop System of Decision-Making	Amos Tversky and Daniel Kahneman (1974). Judgment under uncertainty: Heuristics and biases. Science, 185, 1124–1131.
Week 4	**Information Processing** Theoretical Foundations (George Miller, 1956) Models: Serial-Sequential, Parallel, Cascade Types: vertical or horizontal Centralized or Decentralized (distributed)	Bermudez, Chapter 1: Information Processing models Pages 28-34 Bermudez, Chapter 5: Neural Networks and Distributed Information Processing Pages 123-143.
Week 5	**Linguistics** Neural Basis Evolution of Language: Learned vs. Innate Competing Theories: N. Chomsky, B.F. Skinner, S. Pinker Physical Symbol Hypothesis Syntax, Semantics, discourse, conceptual systems Language and developmental lifespan	Bermudez, Chapter Chapter 1: Pages 25-26 Bermudez, Chapter 10: Models of Language Learning: Pages 259-280
Week 6	**Attention** Theories: Descartes, Berkeley, James, Locke, Broadbent Neural structures and connectivity Process of attention (alerting, awareness, sensory input, affect, arousal) Automaticity vs. control (Consciousness) Models: Selective Attention (Broadbent & Treisman) Attentional Bias/Blink Rapid Series Visual Presentation, Perceptual Load Feature Integration and binding	Bermudez, Chapter 9: Strategies for Brain Mapping: Networks for Attention: Pages 246-253 Vossel, S., Geng, J.J., & Fink, G. (2014). Dorsal and Ventral Attention Systems: Distinct Neural Circuits but Collaborative Roles. Neuroscientist. 2014 20(2): 150–159.
Week 7	**Memory** Neural Structures (Hippocampus) Physiology (Long-Term Potentiation) Phonological loop, Serial position curve, chunking Frameworks: Craik & Lockhart, Baddeley & Hitch Process: Encoding, learning, retrieval Types of Memory & Memory as a Storage System	Bermudez, Chapter 3: Studying Memory for Visual Events, Pages 84-89 Larry R. Squire. (2004). Memory systems of the brain: A brief history and current perspective. Neurobiology of Learning and Memory, 82, 171–177.

	Decay and Types of Interference (Ebbinghaus)	
Week 8	**Learning** Theories of Learning: Behaviorism, Cognitivism, Constructivism (Guthrie, Thorndike, Tolman) Classical Conditioning (Pavlov) Operant Conditioning (Skinner) Social/Observational Learning (Bandura)	Davies, J. (2015). What is Learning? A Definition for Cognitive Science. Pages 271-276.
Week 9	**Vision & Perception** Neuroanatomy and Function Spatial (where) Object Recognition (what) Complex Perceptual Processes (Scenes) Mirror Neurons Vision in relation to other systems	Bermudez, Chapter 2: The Discipline Matures: Three Milestones Pages 53-61 Pylyshyn, Z. (1999). Vision and cognition: How do they connect? Behavioral and Brain Sciences, 22(3), 401-414.
Week 10-11	**Cognition & Emotion** Neural basis of Cognition and Emotion (fronto-limbic coupling) Network Theories of Human Emotion Action-readiness theory, core-affect theory, communicative theory Impact of Emotion on Cognitive Processes: attention, memory, decision-making, higher order (executive) functions **Guest Lecturer Yasi: Neurobiology of Stress**	Oatley, K. & Johnson-Laird, P.N. (2014). Cognitive approaches to emotions. Trends in Cognitive Sciences, 18 (3), Pages 134-140. Tyng, C.M., Amin, H.U., Saad, M.N.M., & Aamir S. Malik. (2017). The Influences of Emotion on Learning and Memory. Frontiers in Psychology, 8, 1454.
Week 12	**Neuroscience (Part 1: Structural Imaging)** Introduction: Molecules, Neurons, Circuits, Functional Networks Structural Methods & Applications Magnetic Resonance Imaging Diffusion Tensor Imaging (DTI) Voxel-Based Morphometry (VBM) Structural Imaging of the developing brain	Bermudez, Chapter 3: The Turn to the Brain, Pages 90-92 Turner, R. (2016). Uses, misuses, new uses and fundamental limitations of magnetic resonance imaging in cognitive science. Philosophical Transactions of the Royal Society, 371 (1705),1-11.
Week 13	**Neuroscience (Part 2: Functional Imaging)** Functional Methods, Applications, Neuroplasticity Functional Magnetic Resonance Imaging (fMRI) Resting State Functional Magnetic Resonance Imaging (rs-fMRI) Neurophysiology (EEG), Neurostimulation Positron Emission Tomography (PET) Mapping the Brain & Statistics: Analyses (correlation vs. causation) Additional Methods for brain function: Neuropsychology & Psychometrics	Bandettini, P.A. (2012). Twenty years of functional MRI: The science and the stories. NeuroImage, 62 (2), 575-588.
Week 14	**Data Science & Artificial Intelligence: Dheeraj/Prakhar**	Bermudez, Part 3, Chapter 12, Pages Pages 307-334

	Machine Learning overview and components Supervised v/s unsupervised Learning Feature Engineering Linear Regression Decision Trees Neurons/Action Potential Neural Networks Deep Learning CNNs and Pattern Recognition Reinforcement Learning	Forbus, K.D. (2010). AI and Cognitive Science: The Past and Next 30 Years. Topics in Cognitive Science, 2(3), 345-356.
Week 15	**Review & Integration** Summary of Course Material Integration of Component Disciplines Reciprocity among Brain-Mind Cognition-Behavior-Emotion Cognitive Science: state of the art field Future Directions & Contemplations	Davelaar, E.J. (2010). Cognitive science – future challenges of an interdisciplinary field. Frontiers in Psychology, 1, (7), 1-2.