## **Attention!**

## This is a *representative* syllabus.

The syllabus for the course when you enroll may be *different*.

Use the syllabus provided by *your* instructor for the most up-to-date information. Please refer to your instructor for more information for the specific requirements for a given semester.

Feel free to contact the Psychology Advising Office for any questions regarding psychology courses either by email (<u>psychadvising@osu.edu</u>) or phone (614.292.5750).

Thank you!

## Syllabus for Psych 5612

# Introduction to Cognitive Science

## SPRING 2022

## (subject to change)

Course:Psych 5612 (#16470 & #16471; cross-listed as Phil 5830, #23807 & #23808)Prerequisites:A total of 12 credit hours from any of the following areas: CSE, Ling, Phil, or Psych, or<br/>Grad standing, or permission of instructor.<br/>Jan 10 – April 25, 2022

Course web: <u>https://carmen.osu.edu</u>

Textbook:José Luis Bermúdez (2020). Cognitive Science: An Introduction to the Science of the<br/>Mind (3<sup>rd</sup> edition). Cambridge University Press. ISBN-13 978-1108440349 (paperback).

Office hours: In-person or zoom by appointment Course Assistant (CA): TBA

#### **COURSE OVERVIEW**

This course introduces you to the exciting interdisciplinary field of cognitive science devoted to the study of human intelligence and intelligent systems. Researchers in philosophy, neuroscience, psychology, artificial intelligence, and linguistics realized that they were asking many of the same questions about the nature of the human mind/brain, that they had developed complementary and synergistic methods of investigation, and that the evidence led them to compatible answers to their questions. This course introduces cognitive science through a representative sample of such questions, methods, and answers.

It is not a special-topic course for students who seek detailed knowledge in a specific area of cognitive science, but as a broad survey of different approaches within the field of cognitive science. We will try not to lose sight of the forest for the trees but we will take a closer look at a few trees too because science is in the details. Along the way, we will introduce the constituent disciplines and their respective contributions to the study of cognition. We will discuss the foundational concepts of *computation* and *information processing* from multiple points of view. Two unifying themes are emphasized throughout: (1) Information processing: The mind/brain is viewed as a complex system that receives, stores, retrieves, transforms, and transmits information. (2) Neuroscience grounding: Explicit effort is made to show how mental phenomena emerge from the interactions of networks of neurons in the brain.

## **Intended Audience & Prerequisites**

This course is cross-listed in the Departments of Psychology and Philosophy. It is intended for graduate and advanced undergraduate students in these departments. Interested students from related areas (notably

neuroscience) are welcome too. The formal prerequisites for taking the course are: graduate standing in any of these departments **or** permission of the instructor **or** at least 12 undergraduate-level credit hours from any of the four disciplines. The informal prerequisites are: willingness to step outside the confines of one's area of specialization, willingness to read the professional literature (as opposed to textbooks) with help from the instructor and one's peers, willingness to participate in open discussions, and the ability to write clearly and concisely about topics outside one's area of specialization.

All students must be officially enrolled in the course by the end of the second full week of the semester. No requests to add the course will be approved after that time. Enrolling officially and on time is solely the responsibility of the student.

## **Course Objectives**

Upon successful completion of the course, the undergraduate students will:

- Appreciate the interdisciplinary nature of cognitive science, the diversity of viewpoints, the controversies and the areas of nascent consensus.
- Be exposed to the contribution of each of the five constituent disciplines and be familiar with its methods, key concepts, and focus of investigation.
- Be proficient in the *lingua franca* of cognitive science—the language of information processing.
- Have basic familiarity with brain anatomy and physiology.
- Master multiple definitions of the foundational concepts of *computation* and *information processing* and be able to discuss them from multiple points of view.

## **Textbook & Readings**

The textbook is *Cognitive Science: An Introduction to the Science of the Mind* (Bermúdez, 2020, 3<sup>rd</sup> edition, Cambridge University Press. ISBN-13: 978-1108440349). We will supplement the textbook with additional readings listed in the bibliography below. All required readings (except the textbook itself) are posted in PDF on the Carmen website <u>https://carmen.osu.edu/</u>.

## Attendance

You are expected and required to attend ALL lectures delivered in-person at the scheduled class times, i.e., T & R at 9:35 - 10:55 am. If you are not in attendance when important announcements are made, it is your responsibility to find out about them (e.g., by asking classmates.)

## TARGET ARTICLES

The following is a list of ten target articles from the course readings on which you write and submit **EIGHT** "reaction papers", one paper per target article:

<u>Target Article #1</u>: Koenderink, J. (2011). Vision as a user interface. In B. E. Rogowitz (ed.), *Human Vision and Electronic Imaging XVI, Proceedings of SPIE-ES&T Electronic Imaging, SPIE Vol. 7865, 786504-1/13.* 

Target Article #2: Sacks, O. (2003). The mind's eye. The New Yorker (July 28), 48-59.

Target Article #3: Somers, J. (2021). Head space. The New Yorker (December 6), 30-35.

Target Article #4: Brooks, R. A. (1991). Intelligence without representation. *Artificial Intelligence*, 47, 139-159.

Target Article #5: Bostrom, N. (2003). Are we living in a computer simulation? *The Philosophical Quarterly*, *53*(211), 243-255.

Target Article #6: Dennett, D. C. (1978). Where am I? In *Brainstorms: Philosophical Essays on Mind and Psychology*. Bradford Books.

Target Article #7: Rothman, J. (2018). As real as it gets. The New Yorker (April 2), 30 – 36.

Target Article #8: Dehaene, S., Lau, H., & Kouider, S. (2017). What is consciousness, and could machines have it? *Science, 358 (27 October 2017),* 486-492.

Target Article #9: Nicolelis, M. A. L. & Chapin, J. K. (2004). Controlling robots with the mind. *Scientific American (October 2002)*, 46-53.

Target Article #10: Blanke, O. & Metzinger, T. (2009). Full-body illusions and minimal phenomenal selfhood. *Trends in Cognitive Sciences, 13*, 7-13.

Note that you are NOT necessarily writing ten reaction papers, and instead may opt to write just EIGHT reaction papers of your choosing. See below for further details.

## **EVALUATION**

Your final course grade will be based on the following components:

•	Eight reaction papers (submit 8 out of 10 possible, 15 points each)		120
•	Midterm Exam #1 (Thursday 2/10, 9:35 – 10:55)		60
•	Midterm Exam #2 (Tuesday 3/29, 9:35 – 10:55)		60
•	Final Exam ( <mark>Thursday 4/21</mark> , 9:35 – 10:55)		60
	Tot	<u>al:</u>	<u>300</u>

Final course grades are based on the following cutoffs: A (465 - 500), A- (450 - 464.99), B+ (433 - 449.99), B (416 - 432.99), B- (400 - 415.99), C+ (383 - 399.99), C (366 - 382.99), C- (350 - 365.99), D+ (325 - 349.99), D (300 - 324.99), and E (0 - 299.99).

<u>Important note:</u> Your final course grade will NOT be based on the percentage value or total points shown on the Carmen. Instead, at the end of the semester, I will "manually & off Carmen" calculate your total points and final grade, according to the scheme described above.

**Reaction papers:** Each reaction paper must be 450–550 words long and must be single-spaced, properly formatted, and proofread. No separate title page is required. On the upper-left corner of the first page, write the title of the target article, your name, submission date, the number of words, and the file name (e.g., **SmithJ\_Paper\_1.doc**), in that order. An example reaction paper will be given. Additional guidelines are as follows:

- 1. Your reaction paper should begin with an introductory paragraph that states the purpose and/or goal of the target article.
- 2. The paper should summarize two major issues or problems that are discussed or investigated in the target article. If there are more than two issues, then pick the two that you think are most relevant and important.
- 3. The paper must represent your own synthesis of information.
- 4. The paper should include your own critical reactions to the target article. For example, you may disagree with the author(s) in certain issues/points, or may have alternative viewpoints and/or new suggestions.

- 5. While you may discuss your thoughts & ideas about this assignment with other students, your papers must be your own original work written in your own words. TURNITIN will be used on all reaction papers.
- 6. Regarding the TURNITIN
  - a. TURNITIN will be used on all reaction papers. You can check the TURNITIN score and its report for your paper immediately after submission.
  - b. TURNITIN is a plagiarism detecting and prevention tool.
  - c. TURNITIN checks your paper for inappropriate copying by comparing the paper to text and content in its massive databases.
  - d. TURNITIN generates a similarity score ranging 0% to 100%.
  - e. In general, a similarity score of 25% or higher may indicate possible plagiarism.
  - f. For your reaction papers for this class, you should try to have the similarity score of 24% or lower, preferably below 10%.
  - g. For a paper with similarity scores greater 24%, the following penalty points may be deducted from your total: (a) up to 3 points for 25% 30%; (b) up to 6 points for 31% or higher. The instance may also be forwarded to COAM.
  - h. Finally, here is an OSU website on TURNITIN you might find useful: https://teaching.resources.osu.edu/toolsets/carmencanvas/guides/turnitin.
- 7. Multiple submission attempts are allowed within the window of submission time. In such case, only the latest and most recent version will be graded.
- 8. Late submissions will not be accepted.
- 9. The paper will be graded as a weighted sum of scores on the following four criteria:
  - a. 50%: Thoughtfulness, thoroughness, and correctness of the summary
  - b. 25%: Ability to critically examine the target article in your own term
  - c. 25%: Format, word count, organization, quality, and clarity of the writing
- 10. This is not a writing course, so paper comments are not provided.
- 11. Each reaction paper must be submitted in electronic form on the Carmen website (<u>https://carmen.osu.edu/</u>) under the tab 'Assignments'. Acceptable file types are .doc, .docx, .pdf, and .txt. The only way to submit a paper is to upload it to the Carmen. Files sent by email, slipped under a door, and so on will not be accepted without prior arrangement.
- 12. There are a total of ten reaction papers to write, each worth 15 points, posted throughout the semester.
- 13. <u>Only the EIGHT best scores</u> of the ten papers will count toward your final grade, i.e., up to a total of 120 points max. Or alternatively, you may decide to write just eight reaction papers.
- 14. Finally, missed reaction papers cannot be made up; no excuses of any sort will be accepted.

**Exams:** Two Midterm Exams (2/10 & 3/29) and Final Exam (4/21) are closed-book & closed-note, conducted during the scheduled class times. Each exam comprises a combination of T-F, multiple-choice questions, and short assay questions. The exams are not cumulative, except that the topics covered in later periods of the course depend on concepts and facts introduced in the earlier periods. A missed exam cannot be made up without a legitimate, documented excuse in which case the instructor may arrange a make-up oral (read next paragraph)

<u>No make-up exams will be given</u>, except in the case of documented medical emergency of your own or death of a family member. In the event of a last-minute emergency, you should send an email message to Dr. Myung on the same day as the exam, preferably before the exam begins. Acceptable excuses for missing an exam are a death in your family and personal illness. Please obtain documented proof of these events should they occur. If you are late for an exam, you will be allowed to take it but you will have to

submit your answers by the closing time like everybody else. All make-up exams will be administered orally in-person or via Zoom by instructor. Also note that your <u>make-up oral exam</u> questions will not be the same as the ones in the written exam.

## **COURSE SCHEDULE**

## (subject to change)

### Part I: Five Foundations of Cognitive Science

- T & R 1/11 & 1/13 Introduction. Course organization, exam dates, etc. Motivation: Newell's big question. Constituent disciplines. Interdisciplinary approach. <u>Required readings: Textbook</u> <u>Chap. 0; Rapaport (2000)</u>. [Optional reading: Newell & Simon (1976).]
- T & R 1/18 & 1/20 Neuroscience: Brain anatomy. Hierarchical functional organization. Neuronal computation. <u>Required reading: Textbook Chap. 3. [Optional reading: Wikiversity</u> (2018).]
- 3. W 1/26 11:59 pm Reaction Paper #1 due on Carmen
- T & R 1/25 & 1/27 Neural Computation: Neuron doctrine. Single neuron computation. Prepost-synaptic potentials. <u>Required readings: Textbook Sec. 5.1 & 5.2. [Optional reading:</u> <u>Economist (2017); Service (2014).]</u>
- T & R 2/1 & 2/3 Artificial Intelligence. Weak versus strong AI. Subfields, applications, and recent trends in AI. Turing Test. Universal Turing machine. Chinese Room. <u>Required readings:</u> <u>Textbook Sec.1.2</u>; McCarthy (2004). [Optional reading: Turing (1950).]
- 6. W 2/2 11:59 pm Reaction Paper #2 due on Carmen
- 7. T 2/8 Artificial Intelligence (continued)
- 8. R 2/10 Midterm Exam #1 (9:35 10:55)
- 9. T 2/15 Computing with DNA. <u>Required reading: Adleman (1998)</u>. [Optional reading: Lee et al (2004).]
- 10. W 2/16 11:59 pm Reaction Paper #3 due on Carmen
- 11. R & T 2/17 & 2/22 Cognitive Psychology. Memory systems. Associative learning & Hebbian rule. Executive control. Working and recognition memory models. Causality learning. Conditioning experiments. Hippocampal neurocomputational hypotheses. <u>Required readings:</u> <u>Textbook Sec. 1.1 & 1.4</u>; Loftus & Pickrell (1995); Loftus (2003). [Optional readings: Milton & Everitt (2012); Ramirez et al (2013)].
- 12. W 2/23 11:59 pm Reaction Paper #4 due on Carmen
- R & T 2/24 & 3/1 Language. Phonetics, Syntax, semantics. Generative grammars. Language of thought. Physiological foundations. <u>Required readings: Textbook Sec 1.3</u>; Whitney (1998).
- 14. W 3/2 11:59 pm Reaction Paper #5 due on Carmen
- 15. R & T 3/3 & 3/8 Philosophy of Mind & Mind-body Problem. The ship of Theseus. Unchanging essences and forms. Mind-body problem. Cartesian dualism. Descartes' epistemological argument. <u>Required readings: Bechtel (1988, Chap. 5 -7); Nagel (1974); Bostrom (2003)</u>

### 16. W 3/9 11:59 pm - Reaction Paper #6 due to Carmen

#### Part II: Computational Cognitive Science

- 17. **R 3/10 Auditory Computation.** Neurophysiological foundations of audition. Elements of auditory signal processing. Sound localization. <u>Required reading: Konish (1993).</u>
- 18. W 3/23 11:59 pm Reaction Paper #7 due on Carmen
- T & R 3/22 & 3/24 Visual Computation. Neurophysiological foundations of vision. Signal processing and feature detecting cells in visual cortex. Synchronized oscillation. <u>Required reading:</u> <u>Gazzaniga et al (1998, Chap. 4). [Optional reading: Singer et al (1997).]</u>
- 20. T 3/29 Midterm Exam #2 (9:35 10:55)
- 21. W 3/30 11:59 pm Reaction Paper #8 due on Carmen
- 22. R, T & R 3/31, 4/5 & 4/7 Neural Networks & Distributed Information Processing. Multiple realizability. Marr's tri-level hypothesis. Brain-style computation. Computational cognitive neuroscience. Integrate-and-fire neurons. Point neuron approximation. Simulated (linear) neuron. *Emergent* simulator. <u>Required readings: Textbook Chap. 5 & 12; McClelland et al (1986).</u>
- 23. W 4/6 11:59 pm Reaction Paper #9 due on Carmen
- 24. T & R 4/12 & 4/14 Behavior-based Robotics. Critique of the standard representational approach. SHAKEY the robot. Perception-action cycle. Change blindness. Intelligence without representation? Subsumption architecture and behavior-based robotics. Rodney Brooks demos. Decorticate animals revisited. Dynamic system approach. State spaces. <u>Required readings:</u> <u>Textbook Chap. 16; Brooks (1991).</u>
- 25. W 4/13 11:59 pm Reaction Paper #10 due on Carmen

#### Part III: New Trends & Issues: In-class Discussions

26. **T 4/19 - Consciousness/self-awareness &Wrap up.** In-class discussion of full-body illusion, Rubber-hand illusion, and phantom pains. <u>Required readings: Textbook Chap. 15; Blanke & Metzinger (2009).</u>

27. R 4/21 - Final Exam (9:35 – 10:55)

The above calendar is subject to change at the discretion of the instructor, depending on the rate of progress through the material, student interest in alternative topics, and/or scheduling constraints.

## HEALTH AND SAFETY REQUIREMENTS

All students, faculty and staff are required to comply with and stay up to date on all university safety and health guidance (https://safeandhealthy.osu.edu), which includes wearing a face mask in any indoor space and maintaining a safe physical distance at all times. Non-compliance will result in a warning first, and disciplinary actions will be taken for repeated offense.

## **OHIO STATE'S ACADEMIC INTEGRITY POLICY**

Academic integrity is essential to maintaining an environment that fosters excellence in teaching, research, and other educational and scholarly activities. Thus, The Ohio State University and the Committee on Academic Misconduct (COAM) expect that all students have read and understand the university's Code of Student Conduct (studentconduct.osu.edu), and that all students will complete all academic and scholarly assignments with fairness and honesty. Students must recognize that failure to follow the rules and guidelines established in the university's Code of Student Conduct and this syllabus may constitute "Academic Misconduct."

The Ohio State University's Code of Student Conduct (Section 3335-23-04) defines academic misconduct as: "Any activity that tends to compromise the academic integrity of the university or subvert the educational process." Examples of academic misconduct include plagiarism, unauthorized collaboration on a graded assignment, copying the work of another student, and possession of unauthorized materials during an examination. Ignorance of the university's Code of Student Conduct is never considered an excuse for academic misconduct, so I recommend that you review the Code of Student Conduct and, specifically, the sections dealing with academic misconduct.

If I suspect that a student has committed academic misconduct in this course, I am obligated by university rules to report my suspicions to the Committee on Academic Misconduct. If you have any questions about the above policy or what constitutes academic misconduct in this course, please contact me.

It is the responsibility of the Committee on Academic Misconduct (COAM) to investigate or establish procedures for the investigation of all reported cases of student academic misconduct. The term "academic misconduct" includes all forms of student academic misconduct wherever committed; illustrated by, but not limited to, cases of plagiarism and dishonest practices in connection with examinations. Instructors shall report all instances of alleged academic misconduct to the committee (Faculty Rule 3335-5-487). For additional information, see the Code of Student Conduct at http://studentconduct.osu.edu.

#### SEXUAL MISCONDUCT/RELATIONSHIP VIOLENCE

Title IX makes it clear that violence and harassment based on sex and gender are Civil Rights offenses subject to the same kinds of accountability and the same kinds of support applied to offenses against other protected categories (e.g., race). If you or someone you know has been sexually harassed or assaulted, you may find the appropriate resources at http://titleix.osu.edu or by contacting the Ohio State Title IX Coordinator, Kellie Brennan, at titleix@osu.edu.

## **DISABILITY SERVICES**

The university strives to make all learning experiences as accessible as possible. In light of the current pandemic, students seeking to request COVID-related accommodations may do so through the university's request process, managed by Student Life Disability Services. If you anticipate or experience academic barriers based on your disability (including mental health, chronic, or temporary medical conditions), please let me know immediately so that we can privately discuss options. To establish reasonable accommodations, I may request that you register with Student Life Disability Services. After registration, make arrangements with me as soon as possible to discuss your accommodations so that they may be implemented in a timely fashion. SLDS contact information: slds@osu.edu; 614-292-3307; slds.osu.edu; 098 Baker Hall, 113 W. 12th Avenue.

#### READINGS

In addition to Bermúdez' (2020) textbook, which is the main text for this course, the following readings supplement and amplify some topics of particular importance. All of the following items are available on Carmen in PDF format, except for some web versions. The list of readings is subject to change at the discretion of the instructor.

- 1. Adleman, L. (1998). Computing with DNA. Scientific American (Aug 1998), 54-61.
- Bechtel, W. (1988). The mind-body problem: Dualism and philosophical behaviorism (Chapter 5); The mind-body problem: Versions of materialism (Chapter 6).; Functionalism (Chapter 7). In *Philosophy of Mind: An Overview for Cognitive Science* (pp. 79-141). Hillsdale, NJ: Lawrence Erlbaum Associates.
- 3. Bostrom, N. (2003). Are we living in a computer simulation? *The Philosophical Quarterly*, *53(211)*, 243-255.
- 4. Brooks, R. A. (1991). Intelligence without representation. Artificial Intelligence, 47, 139-159.
- 5. Blanke, O. & Metzinger, T. (2009). Full-body illusions and minimal phenomenal selfhood. *Trends in Cognitive Sciences*, 13, 7-13.
- 6. Dehaene, S., Lau, H., & Kouider, S. (2017). What is consciousness, and could machines have it? *Science, 358 (27 October 2017),* 486-492.
- 7. Dennett, D. C. (1978). Where am I? In *Brainstorms: Philosophical Essays on Mind and Psychology*. Bradford Books.
- 8. Economist (2017). Tests suggest the methods of neuroscience are left wanting. *The Economist, Jan* 21<sup>st</sup>, 2017.
- 9. Gazzaniga, M. S., Ivry, R. B. & Mangun, G. R. (1998). Perception and Encoding (Chapter 4). In *Cognitive Neuroscience: The Biology of Mind* (pp. 121-161). W.W. Norton & Company.
- 10. Grosz, B. J. (2012) What question would Turing pose today? *AI Magazine (Winter 2012)*, 73-81. Association for the Advancement of Artificial Intelligence (AAAI).
- Koenderink, J. (2011). Vision as a user interface. In B. E. Rogowitz (ed.), Human Vision and Electronic Imaging XVI, Proceedings of SPIE-ES&T Electronic Imaging, SPIE Vol. 7865, 786504-1/13.
- 12. Konish, M. (1993). Listening with two ears. Scientific American, 2681, 66-73.
- 13. Lee, J. Y., Shin, S-Y, Park, T. H., & Zhang, B-T. (2004). Solving traveling salesman problem with DNA molecules encoding numerical values. *Biosystems*, *78*, 39-47.
- 14. Loftus, E. F., & Pickrell, J. E. (1995). The formation of false memories. *Psychiatric Annals, 25*, 720-725.
- 15. Loftus, E. F. (2003). Make-Believe Memories. American Psychologist (November), 867-873.
- 16. McCarthy, J. (2004). What is artificial intelligence? (Archived file.)
- McClelland, J. L., Rumelhart, D. E., & Hinton, G. E. (1986). The appeal of Parallel Distributed Processing. In D. E. Rumelhart, J. L. McClelland, and the PDP Research Group (Eds.), *Parallel Distributed Processing: Explorations in the Microstructure of Cognition, Vol. I: Foundations* (pp. 3-44).
- 18. Milton, A. L. & Everitt, B. J. (2012). Wiping drug memories. Science, 336 (13 April 2012), 167-168.
- 19. Nagel, T. (1974). What is it like to be a bat? Philosophical Review, 83 (4: October), 435-450.
- 20. Nicolelis, M. A. L. & Chapin, J. K. (2004). Controlling robots with the mind. *Scientific American* (October 2002), 46-53.
- 21. Ramirez, S., Liu, X., ... & Tonegawa, S. (2013). Creating a false memory in the hippocampus. Science, 341 (26 July 2013), 387-391.

- 22. Rapaport, William J. (2000). Cognitive Science. In Anthony Ralston, Edwin D. Reilly, & David Hemmendinger (eds.), *Encyclopedia of Computer Science, 4th edition* (pp. 227-233). New York: Grove's Dictionaries.
- 23. Rothman, J. (2018). As real as it gets. The New Yorker (April 2), 30-36.
- 24. Sacks, O. (2003). The mind's eye. The New Yorker (July 28), 48-59.
- 25. Sejnowski, T. J. & Rosenberg, C. R. (1986). NETtalk: A parallel network that learns to read aloud. *Johns Hopkins University Electrical Engineering and Computer Science Technical Report* JHU/EECS-86/01.
- 26. Service, R. F. (2014). The brain chip. Science, 345 (8 August 2014), 614-616.
- 27. Singer, W., Engel, A. K., Kreiter, A. K. & et al. (1997). Neuronal assemblies: Necessity, signature and detectability. *Trends in Cognitive Sciences*, 1(7), 252-260.
- 28. Somers, J. (2021). Head space. The New Yorker (December 6), 30-35.
- 29. Turing, Alan M. (1950). Computing machinery and intelligence. *Mind*, 59, 433-460. [Available on-line <u>http://loebner.net/Prizef/TuringArticle.html]</u>
- 30. Whitney, P. (1998). What language users must know (pp. 31-71). Chapter 2 in *The Psychology of Language*. Boston, MA: Houghton Mifflin Co.
- 31. Wikiversity (2018). Fundamentals of neuroscience. Web site: https://en.wikiversity.org/wiki/Fundamentals\_of\_Neuroscience.