# Cognitive and Neural Systems (HPS 2355)
# Prof. E. Machery
# Fall 2021

machery@pitt.edu

**Class Meetings**
Th 10:15am-12:45 pm
https://pitt.zoom.us/j/93854811219

**Office Hours**
By appointment, in person or online.

**Course Description/Goals**
This course will examine the theoretical foundations of neuroscience, with a special focus on systems neuroscience, asking what progress has been made towards a general account of neural processing and discussing obstacles to theoretical unification. Example seminar topics are; the neuron doctrine, information theory and the brain, network science, the Bayesian brain, dynamic representation, understanding intrinsic activity, and cognitive architecture.

**Prerequisites**
Graduate standing or permission of instructor.

**Texts**
Readings will be available on a shared Dropbox folder. You will receive an invitation to join this folder by email. Please **do not drag and drop files** in the shared folder: you would delete them. **Do not annotate these files** either.

**Assignments**
(1) Readings and participation;
(2) A research paper due at the end of the term.

*Research paper*
The research paper may be on any subject of relevance to the seminar. To assist you in commencing work, you should submit a brief essay proposal by ***November 04***. It should contain a short paragraph describing the topic to be investigated and give a brief indication of the sources you intend to use. It may, but need not, be based on the seminar presentation. I advise you to talk to me about possible topics as soon as possible. The paper should have the form and the length of a short journal article (no less than 3500 and no more than ***6500 words***). The deadline is ***December 16*****, 05:00 pm (send it by *e-mail*)**. **I do NOT issue incomplete grades**, save in extraordinary circumstances. In return for the rigidity of the deadline, the seminar will not meet in the final week of term (i.e., *no class April 16*).

**Assessment**

Your seminar grade will be based on the quality of your research paper due at the end of the term and on your participation.

**Class Organization**
This course will be based on the discussion of the readings. I will lead the discussion. Participation in class discussion is expected. Reading the articles is of course mandatory. You are expected to attend every class.

**Special Needs**
If you have a disability for which you are or may be requesting an accommodation, you are encouraged to contact both your instructor and Disability Resources and Services (DRS), 140 William Pitt Union, 412 648 7890, drsrecep@pitt.edu, 412 228 5347 for P3 ASL users, as early as possible in the term. DRS will verify your disability and determine reasonable accommodations for this course.

## COURSE SCHEDULE
## (Subject to revision as the semester proceeds)

**Thursday 09/02**
*Topic: Syllabus*

**Thursday 09/09**
*Topic: Why Representations?*
*Readings*:

Fodor, J. A. (1985). Fodor's guide to mental representation: The intelligent auntie's vade-mecum. *Mind*, *94*, 76-100.
Fodor, J. A. (1986). Why paramecia don't have mental representations. *Midwest studies in philosophy*, *10*, 3-23.
Orlandi, N. (2020). Representing as coordinating with absence. In J. Smortchkova, K. Dołrega, and T. Schlicht (Eds.), *What are Mental Representations?* (p. 101). OUP.
Ramsey, W. (2007). *Representations reconsidered*. CUP. Chapter 1.

*Additional Readings:*

Barack, D. L., & Krakauer, J. W. (2021). Two views on the cognitive brain. *Nature Reviews Neuroscience*, *22*(6), 359-371.
Poldrack, R. A. (2020). The physics of representation. *Synthese*, 1-19.

**Thursday 09/16**
*Topic: Detectors and Information*
*Readings*:

Drestke, D. I. (1981). *Knowledge and the flow of information*. MIT Press. Chapter 3.
Hubel, D. H., & Wiesel, T. N. (1959). Receptive fields of single neurons in the cat's striate cortex. *The Journal of physiology*, *148*(3), 574-591.
Ramsey, W. (2007). *Representations reconsidered*. CUP. Chapter 4.

*Additional Readings:*

Drestke, D. I. (1981). *Knowledge and the flow of information*. MIT Press. Chapters 1-2.

**Thursday 09/23 NO CLASS**

**Thursday 09/30**

*Topic: Teleology*

*Readings*:

Dretske, F. I. (1991). *Explaining behavior: Reasons in a world of causes*. MIT press. Chapter 3.

Millikan, R. G. (1989). Biosemantics. *The journal of philosophy*, *86*(6), 281-297.

Shea, N. (2018). *Representation in cognitive science*. OUP. Chapters 3-4.

*Additional Readings:*

Niv, Y. (2009). Reinforcement learning in the brain. *Journal of Mathematical Psychology, 53*(3), 139-154.

Shea, N., Godfrey-Smith, P., & Cao, R. (2018). Content in simple signalling systems. *The British journal for the philosophy of science*, *69*(4), 1009-1035.

**Thursday 10/07**

*Topic: Structural Representations*

*Readings:*

Gładziejewski, P., & Miłkowski, M. (2017). Structural representations: Causally relevant and different from detectors. *Biology & philosophy*, *32*(3), 337-355.

O'Brien, G., & Opie, J. (2004). Notes toward a structuralist theory of mental representation. In *Representation in mind* (pp. 1-20). Elsevier.

Tolman, E. C. (1948). Cognitive maps in rats and men. *Psychological review*, *55*(4), 189.

*Additional Readings:*

Moser, E. I., Kropff, E., & Moser, M. B. (2008). Place cells, grid cells, and the brain's spatial representation system. *Annual Review of Neuroscience*, *31*, 69-89.

Shagrir, O. (2012). Structural representations and the brain. *The British Journal for the Philosophy of Science*, *63*(3), 519-545.

Shea, N. (2018). *Representation in cognitive science*. OUP. Chapter 5.

**Thursday 10/14**

*Topic: Digital and Analog Representations*

*Readings:*

Beck, J. (2015). Analogue magnitude representations: A philosophical introduction. *The British Journal for the Philosophy of Science*, *66*(4), 829-855.

Dietrich, E., & Markman, A. B. (2003). Discrete thoughts: Why cognition must use discrete representations. *Mind & Language*, *18*(1), 95-119.

Maley, C. J. (2011). Analog and digital, continuous and discrete. *Philosophical Studies*, *155*(1), 117-131.

Schneider, S. (2019). The language of thought. In *The Routledge Companion to Philosophy of Psychology* (pp. 280-295). Routledge.

*Additional Readings:*

Haugeland, J. (1981). Analog and analog. *Philosophical Topics*, *12*(1), 213-225.

Maley, C. (in press). Analog computation and representation. *British Journal for the Philosophy of Science*.

Frankland, S. M., & Greene, J. D. (2020). Concepts and compositionality: in search of the brain's language of thought. *Annual review of psychology*, *71*, 273-303.

**Thursday 10/21**

*Topic: Identifying Representations in Neuroscience*

*Readings*:

Haxby, J. V., Connolly, A. C., & Guntupalli, J. S. (2014). Decoding neural representational spaces using multivariate pattern analysis. *Annual review of neuroscience*, *37*, 435-456.

Kriegeskorte, N., Mur, M., & Bandettini, P. A. (2008). Representational similarity analysis-connecting the branches of systems neuroscience. *Frontiers in systems neuroscience*, *2*, 4.

Ritchie, J. B., Kaplan, D. M., & Klein, C. (2019). Decoding the brain: Neural representation and the limits of multivariate pattern analysis in cognitive neuroscience. *The British journal for the philosophy of science*, *70*(2), 581-607.

Roskies, A. L. (2021). Representational similarity analysis in neuroimaging: proxy vehicles and provisional representations. *Synthese*, 1-19.

*Additional Readings:*

Kourtzi, Z., & Grill-Spector, K. (2005). fMRI adaptation: a tool for studying visual representations. *Fitting the mind to the world: Adaptation and after-effects in high-level vision*, 173-188.

Gessell, B., Geib, B., & De Brigard, F. in press. Multivariate pattern analysis and the search for neural representations. *Synthese*.

**Thursday 10/28**

*Topic: Against Representations*

*Readings*:

Egan, F. (2020). A deflationary account of mental representation. In J. Smortchkova, K. Dołęga, & T. Schlicht (Eds.), *What are mental representations?* (pp. 26–53). Oxford University Press.

Favela, L. H. (2020). The dynamical renaissance in neuroscience. *Synthese*, 1-25.

Hutto, D. D., & Myin, E. (2012). *Radicalizing enactivism: Basic minds without content*. MIT press. Chapter 4.

*Additional Readings:*

Chemero, A. (2009). *Radical embodied cognitive science*. MIT Press. Chapter 4.

Piccinini, G. (2020). *Neurocognitive mechanisms*. OUP. Chapter 12.

Sprevak, M. (2013). Fictionalism about neural representations. *The Monist*, 96(4), 539-560.

Favela, L. & Machery, E. ms. The untenable status quo: The concept of representation in the cognitive and neural sciences.

**Thursday 11/04 (possibly online)**
*Topic: Information and the Neural Code*
*Readings*:

Brette, R. (2019). Is coding a relevant metaphor for the brain? *Behavioral and Brain Sciences*, 42.

Cao, R. (2012). A teleosemantic approach to information in the brain. *Biology & Philosophy*, *27*(1), 49-71.

Rathkopf, C. (2017). Neural information and the problem of objectivity. *Biology & Philosophy*, *32*(3), 321-336.

Maley, C. J. (2020). Continuous Neural Spikes and Information Theory. *Review of Philosophy and Psychology*, *11*(3), 647-667.

*Additional Readings:*

Stanley, G. B. (2013). Reading and writing the neural code. *Nature neuroscience, 16*, 259-263.

**Thursday 11/11 NO CLASS (PSA - TBC)**

**Thursday 11/18**
*Topics: The Neuron Doctrine and Probabilistic Representation*
*Readings:*

Barlow, H. B. (1972). Single units and sensation: a neuron doctrine for perceptual psychology?. *Perception*, *1*(4), 371-394.

Saxena, S., & Cunningham, J. P. (2019). Towards the neural population doctrine. *Current opinion in neurobiology*, *55*, 103-111.

Pouget, A., Beck, J. M., Ma, W. J., & Latham, P. E. (2013). Probabilistic brains: knowns and unknowns. *Nature neuroscience*, *16*(9), 1170-1178.

*Additional Readings:*

Darlington, T. R., Beck, J. M., & Lisberger, S. G. (2018). Neural implementation of Bayesian inference in a sensorimotor behavior. *Nature neuroscience*, *21*(10), 1442-1451.

Rahnev, D. (2017). The case against full probability distributions in perceptual decision making. *bioRxiv*, 108944.

**Thursday 11/25**
*Topic: The Bayesian Program in Cognitive Science and Neuroscience*
*Readings*:

Chater, N., Tenenbaum, J. B., & Yuille, A. (2006). Probabilistic models of cognition: Conceptual foundations. *Trends in cognitive sciences*, *10*(7), 287-291.

Eberhardt, F., & Danks, D. (2011). Confirmation in the cognitive sciences: The problematic case of Bayesian models. *Minds and Machines*, *21*(3), 389-410.

Xu, F., & Tenenbaum, J. B. (2007). Word learning as Bayesian inference. *Psychological review*, *114*(2), 245.

Weiss, Y., Simoncelli, E. P., & Adelson, E. H. (2002). Motion illusions as optimal percepts. *Nature neuroscience*, *5*(6), 598-604.

*Additional Readings:*

Zednik, C., & Jäkel, F. (2016). Bayesian reverse-engineering considered as a research strategy for cognitive science. *Synthese*, *193*(12), 3951-3985.
Lieder, F., & Griffiths, T. L. (2020). Resource-rational analysis: Understanding human cognition as the optimal use of limited computational resources. *Behavioral and Brain Sciences*, *43*.

**Thursday 11/25 NO CLASS (Fall Break)**

**Thursday 12/02**
*Topic: Bayesian Just So Stories*
*Readings*:

Bowers, J. S., & Davis, C. J. (2012). Bayesian just-so stories in psychology and neuroscience. *Psychological bulletin*, *138*(3), 389.
Colombo, M., & Seriès, P. (2012). Bayes in the brain—on Bayesian modelling in neuroscience. *The British journal for the philosophy of science*, *63*(3), 697-723.
Griffiths, T. L., Chater, N., Norris, D., & Pouget, A. (2012). How the Bayesians got their beliefs (and what those beliefs actually are): comment on Bowers and Davis (2012). *Psychological Bulletin, 138*(3), 415–422.
Jones, M., & Love, B. C. (2011). Bayesian fundamentalism or enlightenment? On the explanatory status and theoretical contributions of Bayesian models of cognition. *Behavioral and brain sciences*, *34*(4), 169.

*Additional Readings:*

Marcus, G. F., & Davis, E. (2013). How robust are probabilistic models of higher-level cognition?. *Psychological science*, *24*(12), 2351-2360.
Goodman, N. D., Frank, M. C., Griffiths, T. L., Tenenbaum, J. B., Battaglia, P. W., & Hamrick, J. B. (2015). Relevant and robust: A response to Marcus and Davis (2013). *Psychological science*, *26*(4), 539-541.

**Thursday 12/09**
*Topic: Empirical Challenges*
*Readings*:

Mandelbaum, E. (2019). Troubles with Bayesianism: An introduction to the psychological immune system. *Mind & Language*, *34*(2), 141-157.
Morales, J., Solovey, G., Maniscalco, B., Rahnev, D., de Lange, F. P., & Lau, H. (2015). Low attention impairs optimal incorporation of prior knowledge in perceptual decisions. *Attention, Perception, & Psychophysics*, *77*(6), 2021-2036.
Rahnev, D., & Denison, R. N. (2018). Suboptimality in perceptual decision making. *Behavioral and Brain Sciences*, *41*.

*Additional Readings:*

Block, N. (2018). If perception is probabilistic, why does it not seem probabilistic?. *Philosophical Transactions of the Royal Society B: Biological Sciences*, *373*(1755), 20170341.
Tanrıkulu, Ö. D., Chetverikov, A., Hansmann-Roth, S., & Kristjansson, A. (2019). What kind of empirical evidence is needed for probabilistic mental representations? An example from visual perception.

**Thursday 11/16 No Class—Deadline for the term paper (5:00pm)**