Thought & Perception | Philosophy and Cognitive Science

Spring 2018

Course #: AS.150.476 (Phil); AS.200.316 (PBS, Undergrad); AS.200.616 (PBS, Grad)

Meeting Time & Place: Thursday, 1:30pm-3:50pm, Hodson 311

Instructors:

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Course Description

This year's topic: Philosophical, foundational, and methodological issues connected to Bayesian approaches in cognitive science. Bayesian probability theory and Bayesian decision theory aim to lay out how ideal reasoners update their beliefs in the light of new evidence and make decisions based on those beliefs. But what about such apparently non-ideal agents such as ourselves? The past few decades have witnessed a rising tide of Bayesian work on perception, higher cognition, neural coding, etc. This trend has been accompanied by vigorous debate concerning the aims and claims of these approaches. Some see the prospect of a grand unified theory of the mind/brain; others demur. We'll examine these debates and what one can learn from them more generally about approaches to modeling the mind and the nature of rationality.

Welcome!

Welcome to Thought & Perception (aka, Philosophy and Cognitive Science). We've designed this class to focus on topics that we genuinely care about, topics where neither of us yet knows everything we'd like to know, and topics that are of current interest and at the center of debate in our fields. We hope to learn from this class, and we fully expect it to play a role in our current thinking and personal research plans.

So where do you fit in? We don't want mere 'spectators' in this class. Given the broad and cross-disciplinary nature of the subject matter, we think that we will learn more by surrounding ourselves with students from different backgrounds and different levels of experience — students like you. So, our hope is that this class ends up feeling like a really good lab meeting. Ideally, by the end of the semester some of us may walk away with ideas for new writing projects or experiments.

To get there, we need to work hard and rigorously. Some of the readings will be challenging; there might be a lot at times (especially since we only meet once a week); and all of our reading will come from primary sources. So be prepared to work hard, and set aside the time to get the reading done. While the material is challenging, we have no reason to make the course itself challenging. This is a small and very advanced seminar — as far as we're concerned this means that just doing the reading, showing up, and participating thoughtfully should earn you a good grade. But given the limited space, and the personal motivation we have for teaching the class, if you don't do the reading, and you talk (or

don't talk) about reading you didn't do, we'll be especially annoyed, and your grade will reflect that. Attendance at every session is **required**.

Undergraduate Requirements & Grading

A. Participation & a weekly discussion board post (40% total)

Participation will determine a very significant portion of your grade. Participation mainly means: useful contributions to class discussion, required weekly discussion board posts, and leading discussion for at least one session with a presentation on one of the readings. But significant interactions at office hours can contribute as well.

Each week, every student in the class is required to make a "post" to a discussion board that will be set up on Blackboard; your post must appear by Wednesday at 7:00pm (i.e. the evening before class). You're **required** as well to read your fellow students' posts before class, so that we can discuss them in person. These posts should be brief (~50 words is sufficient, though you are free to write more), and should raise a question or try out a point about that week's reading. These are not meant to be polished pieces of writing, but they shouldn't be overly informal either. For example, the following would not be appropriate: "hey dudes, whats this guy talking about – catch ya later. #philospherswtf 😕". However, the following would do just fine: "On p. 10, Jones argues that XYZ. But this doesn't seem consistent with her claim on p. 13 that ABC. Is there a way to understand Jones' position that eliminates this apparent tension?" We will not assign grades to posts, but instead will take the general quality of your effort into account in deciding participation grades at the end of term. If we find your posts wanting early on, we'll let you know and pass on advice on how to improve them.

B. A short commentary (10% total)

The first writing assignment in the course is a short 'Commentary' piece in the style of *Behavioral and Brain Sciences*. BBS is a journal that publishes very long, theoretical articles. In addition, it solicits commentaries from other researchers, and those commentaries are published (with a response from the authors) along with the target article. You will see at least one example a BBS paper in class, since they make for great seminar readings and so are on our syllabus. You must write a 3-page commentary on one of the readings from the first four weeks of class.

Due: **Friday, February 23**, by the stroke of midnight.

C. Two major essays (50% total)

The largest portion of your grade will be determined by two longer and more substantive essays, each of about 1,500-2,000 words (6-8 pages) and each worth 25%. One essay should be 'theoretical', and one should be 'empirical'. Each essay can be on any topic of your choosing, related broadly to the concerns of the class.

The 'theoretical' essay should not include experimental proposals in any detail. Instead, it should attempt to make a theoretical or philosophical contribution to the subject area. It should be written in a style exemplified by the philosophy papers we read, or as an 'Opinion' piece for a journal such as *Trends in Cognitive Sciences*.

The 'empirical' essay must focus on empirical issues, either by reviewing an experimental literature in detail (i.e. addressing the methods, analyses, and data in that literature), or proposing a new set of experiments to answer a question.

Timeline for handing in essays

You may choose to write these two essays in either order you prefer. Each essay will involve a process of proposing a topic, submitting an abstract/summary of the essay, submitting a rough draft, conferencing with one us about your draft, and then submitting a final manuscript. Prof. Gross will work with you on and then grade all the theoretical papers, and Prof. Firestone will work with you on and then grade all the empirical papers. The following calendar identifies all the relevant deadlines and procedures for submitting your essays. Remember, you may do them in either order.

Requirement	**Due Date**	**Contribution to Final Grade**
Paper 1: Propose a topic by email (this email can be just a few sentences)	2 March 2018	0
Submit a 1-page abstract / summary (email)	9 March 2018	0
Submit a rough daft (email)	16 March 2018	5%, graded pass/fail for completing this requirement and the two above.
One-on-one conference with either Firestone or Gross	To be scheduled	0
Final draft paper 1 (submit by email)	**30 March 2018**	20%
Paper 2: Propose a topic by email (this email can be just a few sentences)	6 April 2018	0
Submit a 1-page abstract / summary	13 April 2018	0
Submit a rough daft	20 April 2018	5%, graded pass/fail for completing this requirement and the two above.
One-on-one conference with either Firestone or Gross	To be scheduled	0
Final draft paper 2	**4 May 2018**	20%

Overall grading breakdown:

40% Participation (including board posts)
10% Short commentary paper
25% Long paper 1
25% Long paper 2
100% total

Graduate Requirements & Grading

One seminar-length paper—topic to be determined in consultation with the instructors—and participation, including posts.

Webpage

There is a Blackboard page for this course. The syllabus and other course documents (for example, any powerpoint slides or hand-outs) will be posted there. The discussion board for posts is also there. To get to the course Blackboard page, go to http://blackboard.jhu.edu.

Policy on Electronica

- **Laptop use is not allowed in class** (excepting accommodations). They must be stowed away out of sight, unless you are using your laptop to give a presentation.
    - In the past, this course has allowed laptop use, but we received complaints from students about other students who surfed the net, answered emails, etc. during class. We realize that the vast majority of students would never do that. But students found the few who did to be highly distracting and disrespectful.
    - Also, evidence has been building up that students who take notes on laptops tend not to learn material as well as those who take notes by hand. Distraction of course is the major factor. (Several studies have even found a significant difference between laptop note-takers with wifi off and other sources of distraction removed vs. those who take notes by hand. The explanation is uncertain, but one hypothesis is that the former tend to try to create a word-for-word record, whereas the latter tend to try to create a conceptual record—e.g., turning the lecture into an outline.)

- **Phones must remain out of sight with the ringer off**.
    - Do not text or check to see who called. If you have trouble avoiding temptation, put your phone in your knapsack or somewhere else where it won't distract you.
    - Phone norms might differ across individuals. We're letting you know ours: don't take it out when we're talking to you (in class, office hours, etc.).

Policy on Lateness

Late papers are assessed a one-third-grade penalty per day (a B+ will become a B, a B will become a B-, etc.). In extreme circumstances (e.g., death of a family member), a student may request, *prior* to the due date, an extension.

Reading Schedule

All readings are either available via the web (in some cases, through the library's e-subscriptions) or will be made electronically available to you by us. It's possible we'll change some readings in light of the direction of class discussion, students' interests, etc. Any changes will be announced in class.

2/1. Introduction to the course and to Bayesian modeling in the mind-brain sciences

- Tenenbaum, J. B., Kemp, C., Griffiths, T. L., & Goodman, N. D. (2011). How to grow a mind: Statistics, structure, and abstraction. *Science*, 331, 1279–1285.
- Feldman, J. "Bayesian models of perception: A tutorial introduction," in Wagemans (ed.), *Handbook of Perceptual Organization*, Oxford, 2015.
- Papineau, D. *Philosophical Devices*, part III, "The Nature and Uses of Probability," OUP 2012 – especially chapters 7 & 8.

2/8. Perception

- Kersten, D., Mamassian, P., & Yuille, A. (2004). Object perception as Bayesian inference. *Annual Review of Psychology*, 55, 271–304.
- Rescorla, M. "Bayesian Perceptual Psychology," in Matthen (ed.), *The Oxford Handbook of the Philosophy of Perception*, Oxford 2015.
- Weiss, Y., Simoncelli, E. P., & Adelson, E. H. (2002). Motion illusions as optimal percepts. *Nature Neuroscience*, *5*, 598–604.

2/15. Higher-level Cognition

- Griffiths, T. L., & Tenenbaum, J. B. (2006). Optimal predictions in everyday cognition. *Psychological Science*, 17, 767–773.
- Frank, M. C., & Goodman, N. D. (2012). Predicting pragmatic reasoning in language games. *Science*, 336, 998.
- Nichols, S., & Samuels, R. (2017). Bayesian psychology and human rationality. In Hung & Lane (eds.), *Rationality: Constraints and Contexts*. Elsevier.

2/22. Development

- Gopnik, A., & Wellman, H. M. (2012). Reconstructing constructivism: Causal models, Bayesian learning mechanisms, and the theory theory. *Psychological Bulletin*, *138*, 1085–1108.
- Gweon, H., & Schulz, L. E. (2011). 16-month-olds rationally infer causes of failed actions. *Science*, *332*, 1524.

3/1. Universal Bayesianism

- Clark, A. (2013). Whatever next? Predictive brains, situated agents, and the future of cognitive science. *Behavioral and Brain Sciences*, 36, 181–204.
- Orlandi, N. & Lee, G. (forthcoming). How radical is predictive processing?
- Take another look at Tenenbaum, J. B., Kemp, C., Griffiths, T. L., & Goodman, N. D. (2011). How to grow a mind: Statistics, structure, and abstraction. *Science*, 331, 1279–1285.

3/8. Critiques from Psychology

- Bowers, J. S., & Davis, C. J. (2012). Bayesian just-so stories in psychology and neuroscience. Psychological Bulletin, 138, 389–414.
    - Reply: Griffiths, T., Chater, N., Norris, D., & Pouget, A. (2012). How the Bayesians got their beliefs (and what those beliefs actually are). Psychological Bulletin, 138, 415-22. (Also Bowers & Davis' rejoinder.)
- Marcus, G. F., & Davis, E. (2013). How robust are probabilistic models of higher-level cognition? Psychological Science, 24, 2351–2360.
    - Reply: Goodman, N. D., Frank, M. C., Griffiths, T. L., Tenenbaum, J. B., Battaglia, P. W., & Hamrick, J. B. (2015). Relevant and Robust. Psychological Science, 26, 539–541.

3/15. Critiques from Philosophy

- Mandelbaum, E. (manuscript). Troubles with Bayesianism: An introduction to the psychological immune system.
- Glymour, C. 2007. Bayesian Ptolemaic psychology. In Harper & Wheeler (eds.), *Probability and inference: Essays in Honor of Henry E. Kyburg, Jr.*, pp. 123 – 41. Kings College Publishers.

3/22. NO CLASS (Spring Break!)

3/29. Levels of explanation, rational analysis, psychological reality

- Marr, D. 1982. *Vision*, MIT Press, Sec 1.2.
- Griffiths, T. L., Lieder, F., & Goodman, N. D. (2015). Rational use of cognitive resources: Levels of analysis between the computational and the algorithmic. *Topics in Cognitive Science*, *7*, 217–229.
- Icard, T., forthcoming. Bayes, bounds, and rational analysis. *Philosophy of Science.*

4/5. Sampling

- Bonawitz, E., Denison, S., Griffiths, T. L., & Gopnik, A. (2014). Probabilistic models, learning algorithms, and response variability: sampling in cognitive development. Trends in Cognitive Sciences, 18, 497–500.
- Sanborn, A. N., & Chater, N. (2016) Bayesian brains without probabilities. Trends in Cognitive Sciences, 12, 883-893.
- Griffiths, T. L., Vul, E., & Sanborn, A. N. (2012). Bridging levels of analysis for probabilistic models of cognition. *Current Directions in Psychological Science*, *21*, 263–268.
- Vul, E., & Pashler, H. (2008). Measuring the Crowd Within: Probabilistic Representations Within Individuals. *Psychological Science*, *19*, 645–647.

4/12. Empirical critiques: 'anti-Bayesian' phenomena as case-study

- Brayanov, J. B., & Smith, M. A. (2010). Bayesian and "anti-Bayesian" biases in sensory integration for action and perception in the size–weight illusion. Journal of Neurophysiology
- Peters, M. A. K., Ma, W. J., & Shams, L. (2016). The size-weight illusion is not anti-Bayesian after all: A unifying Bayesian account. PeerJ, 4, e2124. [and supplementary material which raises objection to previous]

4/19. Empirical critiques continued

- Perhaps something by Firestone & Gross!
- Burr, D., & Ross, J. 2008. A Visual Sense of Number. Current Biology 18, pp. 1-4.

4/26. Yet more on empirical critiques

- Wei, X.-X., & Stocker, A. A. (2015). A Bayesian observer model constrained by efficient coding can explain "anti-Bayesian" percepts. *Nature Neuroscience*, *18*, 1509–1517.
- Webster, M. A. (2015). Visual adaptation. *Annual Review of Vision Science*, *1*, 547–567.
- Kemp, C., Perfors, A., & Tenenbaum, J. 2007. Learning overhypotheses with hierarchical Bayesian models. *Developmental Science, 10*, 307–321.

Extra resources that might be helpful or give context (not required reading)

- Griffiths, T. L., Kemp, C., & Tenenbaum, J. B. (2008). Bayesian models of cognition. In R. Sun (Ed.), Cambridge handbook of computational cognitive modeling.
- Griffiths, T. L., & Yuille, A. (2008). Technical introduction: A primer on probabilistic inference. In M. Oaksford & N. Chater (Eds.), The probabilistic mind: Prospects for rational models of cognition.
- A. Gopnik & E. Bonawitz (2015). Bayesian models of child development. *Wiley Interdisciplinary Reviews (WIRES) Cognitive Science*, 6:75-86.
- Perfors, Tenenbaum, Griffiths, and Xu, "A Tutorial Introduction to Bayesian Models of Cognitive Development," Cognition 2011
- Rahnev, D., & Denison, R. (2016). Suboptimality in perception. bioRxiv.
- Mamassian, Landy, and Maloney, "Bayesian Modelling of Visual Perception," in Rao, Olshausen, and Lewicki (eds.) Probabilistic Models of the Brain: Perception and Neural Function, 2002
- Doya and Ishii, "A Probability Primer," in Doya, Ishii, Pouget, and Rao (eds.) Bayesian Brain: Probabilistic Approaches to Neural Coding, 2007
- Gallistel and King, Memory and the Computational Brain, chap. 2, 2009
- Chater and Oaksford, "Ten years of the rational analysis of cognition," Trends Cogn Sci.1999 Feb;3(2):57-65.
- Icard, T. 2016. Subjective probability as sampling propensity. Review of Philosophy and Psychology 7, pp. 863-903.
- TICS, 10.7, 2006 (special issue)
- In general, the open-access *Stanford Encyclopedia of Philosophy* is a top-notch resource for anything philosophical.