

PSYC 473: NEUROECONOMICS
Spring 2011
Tuesdays & Thursdays 1:30-3:00, Solomon B-50

Instructor: Joe Kable (kable@psych.upenn.edu), office hours by appointment, Solomon C-5

Course Description: This seminar will review recent research that combines psychological, economic, and neuroscientific approaches to study human and animal decision-making. The course will focus on our current state of knowledge regarding the neuroscience of decision-making, and how evidence concerning the neural processes associated with choices might be used to constrain or advance economic and psychological theories of decision-making. Topics covered will include decisions involving risk and uncertainty, decisions that involve learning from experience, decisions in strategic interactions and games, and social preferences. Prerequisite: Psychology 149, 153, or 165, or permission of the instructor.

Readings: There is one required text for the course, “Neuroeconomics: Decision making and the brain,” edited by Glimcher, Camerer, Fehr and Poldrack, 2008, Elsevier Academic Press (henceforth GCFP). There are also a number of additional readings, mostly primary scientific articles, which will be posted on Blackboard or available through the library.

Format: Generally, classes will alternate between a lecture format in which I introduce new topics and concepts, and a discussion format, in which we discuss primary research articles as a group, with the discussion of each article led by one of the students.

Course requirements: Evaluations will be based on class participation (20%), leading the discussion for one primary article (20%), one paper (20%), and one final small-group project (40%).

- For all of the assigned readings, students will be required to post on Blackboard one discussion question per reading by noon on the day of class. Submission of questions will be considered as part of your participation grade. These questions will also help steer the discussion of the readings during class.
- The discussion of each primary article will be led by one of the students. This can begin with a summary presentation by the lead student using PowerPoint slides. However, this presentation must be limited to 10 minutes. The remainder of the time allotted to that paper should consist of a discussion involving the whole class. Slides of the figures may be put up for the discussion to reference during this time, but otherwise should not be used. I strongly encourage you to talk with me about the paper you will be presenting as you’re preparing.
- The paper (4 p, ~1000 words) will be a critical media review of a recent media report related to neuroeconomics. The media can be any format—print, television, internet, etc.—the only requirement is that I also have access to the report in some way. I will provide some examples to get you thinking, but part of the assignment will be to first

find an appropriate and interesting media report. Your task will be to critique how the popular press has reported the scientific findings. What did they get right? What did they oversimplify? How might you have conveyed the same research more accurately? How might you have made the same research more interesting to non-scientists?

- The final project will be done in groups, and will involve putting together a research proposal to address an interesting unanswered question in the field. Creativity is strongly encouraged. You will write a paper outlining your proposal (10 p, ~2500 words, one paper per group), and also give a short presentation (20 min) of your proposal to the class.
- **Additional requirements for graduate students:** In addition to the above requirements, graduate students will also be required to write a “news and views”-style paper (4 p, ~1000 words) concerning a research article related to neuroeconomics. The research article must be one we did not discuss in class. Many journals publish “news and views,” or something similar, to highlight specific articles in that issue of the journal. This short piece summarizes the central findings of the article, and explains the innovation as well as the limitations of the research. I’ll hand out a list of potential target articles, as well as some example “news and views.” You can also choose your own article to write about, as long as the article you choose did not already have an accompanying piece when it was published. In calculating your grade, each of the two papers will count equally (so the percentages cited above will decrease accordingly). Graduate students are also particularly encouraged to read the “of interest” chapters, in addition to the assigned reading.

Free Lunch: Take your professor to lunch! See <http://www.business-services.upenn.edu/universityclub/events.shtml>. “Reservations” are made via email to universityclub@pobox.upenn.edu, at least three days in advance. Contact me for availability.

Course Outline

1/13: Introduction: What is neuroeconomics?!?

Assigned Reading: GCFP 1 (Glimcher, Camerer, Fehr, Poldrack)

Of Interest: GCFP 2 (Smith), GCFP 33 (Kahneman)

1/18: Neuroscience Review (Neurophysiology)

1/20: Neuroscience Review (Methods)

The following reading provides a background overview for the first half of the class.

Kable JW and Glimcher PW (2009). The neurobiology of decision: consensus and controversy. *Neuron*, **63**: 733-745. (See also GCFP 32, Glimcher)

1/25: Could neuroscience inform economics? (Discussion)

Clithero JA, Tankersley D, Huettel SA (2008). Foundations of neuroeconomics: from philosophy to practice. *PLoS Biology*, **6**, e298.

Camerer C (2007). Neuroeconomics: using neuroscience to make economic predictions. *Economic Journal*, **117**, C26-C42.

Bernheim, BD (2008). Neuroeconomics: a sober (but hopeful) appraisal. *AEJ: Microeconomics*.

Of Interest: GCFP 9 (Bernheim), GCFP 27 (Gallistel), GCFP 32 (Glimcher)

1/27: Choice

Assigned Readings: GCFP 28 (Rangel)

Of Interest: GCFP 31 (Lee and Wang), GCFP 4 (Rustichini)

2/1: Special guest lecture I: Nicole Senecal & Joe McGuire, Kable Lab, Behavioral studies of discounting and impatience

2/3: Choice (Discussion)

Gold JI & Shadlen MN (2000). Representation of a perceptual decision in developing oculomotor commands. *Nature*, **404**:390-394.

Krajbich I, Armel C, Rangel A (2010). Visual fixations and comparison of value in simple choice. *Nature Neuroscience*, **13**:1292-1298.

2/8: Valuation I: Decision-making under risk and uncertainty

Assigned Reading: GCFP 11 (Fox and Poldrack)

Of Interest: GCFP 7 (Santos and Chen), GCFP 10 (Weber and Johnson), GCFP 23 (Bossaerts, Preuschoff and Hsu), GCFP 8 (Trommershauser, Maloney and Landy)

2/10: Valuation I: Decision making under risk and uncertainty (Discussion)

Platt ML and Glimcher PW (1999). Neural correlates of decision variables in parietal cortex. *Nature*, **400**, 233-238.

Tom S, Fox CR, Trepel C and Poldrack RA (2007). The neural basis of loss aversion in decision making under risk. *Science*, **315**, 515-8.

2/15: Valuation II: Goods values and action values

Assigned Reading: GCFP 29 (Platt and Padoa-Schioppa)

Of Interest: GCFP 26 (Doya and Kimura)

2/17: Valuation II: Goods values and action values

Rudebeck PH, Behrens TE, Kennerley SW, Baxter MG, Buckley MJ, Walton ME, Rushworth MF (2008). Frontal cortex subregions play distinct roles in choices between actions and stimuli. *Journal of Neuroscience*, **28**: 13775-85.

*Fellows LK and Farah MJ (2007). The role of ventromedial prefrontal cortex in decision making: judgment under uncertainty or judgment per se? *Cerebral Cortex*, **17**, 2669-74.

*Wunderlich K, Rangel A, O'Doherty JP (2009). Neural computations underlying action-based decision making in the human brain. *Proceedings of the National Academy of Sciences*, **106**:17199-17204.

2/22: Value learning I: Dopamine

Assigned Reading: GCFP 22 (Niv and Montague)

Of Interest: GCFP 21 (Schultz), GCFP 25 (Knutson, Delgado and Phillips), GCFP 23 (Bossaerts, Preuschoff and Hsu), GCFP 26 (Doya and Kimura), GCFP 3 (Caplin and Dean), GCFP 30 (Corrado, Sugrue, Brown, and Newsome)

2/24: Value learning I: Dopamine (Discussion)

Schultz W, Dayan P, and Montague PR (1997). A neural substrate of prediction and reward. *Science*, **275**, 1593-1599.

Pessiglione M, Seymour B, Flandin G, Dolan R and Frith C (2006). Dopamine-dependent prediction errors underpin reward-seeking behaviour in humans. *Nature*, **442**,1042-1045.

3/1: Value learning II: Multiple learning systems

Assigned Reading: GCFP 24 (Balleine, Daw, O'Doherty)

Of Interest: GCFP 12 (Dayan and Seymour), GCFP 30 (Corrado, Sugrue, Brown, and Newsome)

3/3: Special guest lecture II: Brad Lega, Kahana Lab, Human subthalamic nucleus encodes decision conflict

MEDIA REPORTS FOR PAPER MUST BE IDENTIFIED BY THE START OF CLASS, 3/3 (DUE VIA EMAIL)

3/8 & 3/10—SPRING BREAK

Note: This reading provides a background overview for the second half of the class.

Fehr E and Camerer CF (2007). Social neuroeconomics: the neural circuitry of social preferences. *Trends in Cognitive Sciences*, **11**, 419-427.

3/15: Special guest lecture III: Long Ding, Gold Lab, Value, choice and learning signals in caudate

3/17: Value learning II: Multiple learning systems (Discussion)

Glascher J, Daw ND, Dayan P, O'Doherty JP (2010). States vs. rewards: dissociable neural prediction error signals underlying model-based and model-free reinforcement learning. *Neuron*, **66**: 585-595.

*Yin HH, Knowlton BJ and Balleine BW (2004). Lesions of dorsolateral striatum preserve outcome expectancy but disrupt habit formation in instrumental learning. *European Journal of Neuroscience*, **19**, 181-189.

*Yin HH, Ostlund SB, Knowlton BJ and Balleine BW (2005). The role of the dorsomedial striatum in instrumental conditioning. *European Journal of Neuroscience*, **25**, 513-523.

3/22: Game theory and behavioral game theory

Assigned Reading: GCFP 5 (Houser and McCabe), GCFP 13 (Camerer)

Of Interest: GCFP 6 (Sanfey and Dorris), GCFP 31 (Lee and Wang), GCFP 17 (Singer)

3/24: Stochastic decision making in mixed strategy games (Discussion)

Hampton AN, Bossaerts P, and O'Doherty JP (2008). Neural correlates of mentalizing-related computations during strategic interactions in humans. *Proceedings of the National Academy of Sciences*, **105**, 6741-6746.

Seo H, Barraclough DJ, Lee D (2007). Dynamic signals related to choices and outcomes in the dorsolateral prefrontal cortex. *Cerebral Cortex*, **17**: i110-i117.

3/29: Trust, fairness & punishment

Assigned Reading: GCFP 15 (Fehr)

Of Interest: GCFP 6 (Sanfey and Dorris), GCFP 19 (Brosnan), GCFP 14 (Damasio), GCFP 16 (Phelps)

3/31: Trust, fairness & punishment (Discussion)

Kosfeld M, Heinrichs M, Zak P, Fischbacher U and Fehr E (2005). Oxytocin increases trust in humans. *Nature*, **435**, 673-676.

*Knoch D, Pascual-Leone A, Meyer K, Treyer V and Fehr E (2006). Diminishing reciprocal fairness by disrupting the right prefrontal cortex. *Science*, **314**, 912-915.

*Knoch D, Nitsche MA, Fischbacher U, Eisenegger C, Pascual-Leone A and Fehr E (2008). Studying the neurobiology of social interaction with transcranial direct current stimulation—the example of punishing unfairness. *Cerebral Cortex*, **18**, 1987-1990.

MEDIA CRITIQUE PAPERS ARE DUE BY THE BEGINNING OF CLASS, 3/31

4/5: Other-regarding preferences

Assigned Reading: GCFP 18 (Silk), GCFP 20 (Mayr, Harbaugh, Tankersley)

Of Interest: GCFP 17 (Singer), GCFP 19 (Brosnan), GCFP 7 (Santos and Chen)

4/7: Other-regarding preferences (Discussion)

*Silk JB, Brosnan SF, Vonk J, Henrich J, Povinelli DJ, Richardson AF, Lambeth SP, Mascaró J, Schapiro SJ (2005). Chimpanzees are indifferent to the welfare of other group members. *Nature*, **435**, 1357-1359.

*Lakshminarayanan V & Santos LR (2008). Capuchin monkeys are sensitive to others' welfare. *Current Biology*, **18**, R999-R1000.

Harbaugh W, Mayr U, Burghart D (2007). Neural responses to taxation and voluntary giving reveal motives for charitable donations. *Science*, **316**, 1622-1625.

4/12: Neuromarketing & social effects on preferences

Ariely D & Berns GS (2010). Neuromarketing: the hope and hype of neuroimaging in business. *Nature Reviews Neuroscience*, **11**, 284-292.

4/14: Neuromarketing & social effects on preferences (Discussion)

Plassmann H, O'Doherty J, Shiv B, Rangel A (2008). Marketing actions can modulate neural representations of experienced pleasantness. *Proceedings of the National Academy of Sciences*, **22**, 1050-4.

Falk EB, Berkman ET, Mann T, Harrison B, Lieberman MD (2010). Predicting persuasion-induced behavior change from the brain. *Journal of Neuroscience*, **30**, 8421-8424.

4/19: Student presentations, part 1

4/21: Student presentations, part 2

4/26: Student presentations, part 3 & Whither Neuroeconomics?

FINAL PROJECT PAPERS ARE DUE BY THE BEGINNING OF CLASS, 4/26

“NEWS & VIEWS” PAPERS ARE DUE BY MIDNIGHT ON 5/1