

## Course Syllabus for Neuroeconomics

Class Time: Thu 10:10 am – 12:10 pm

Fall term, 2009

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Course Description: This is a topics course on neuroeconomics. From wiki, “neuroeconomics combines neuroscience, economics, and psychology to study how people make decisions. It looks at the role of the brain when we evaluate decisions, categorize risks and rewards, and interact with each other.” Together we will read a set of papers which would serve as an introduction to some of the fun themes in the field.

My goal is that each of us will get a rough feel about what is going on in the field and be able to ask an interesting research question. Since it is a topics course, I would hope students won’t hesitate to speak up. Understanding a paper is the first step. Being able to criticize scientifically may be the next. The third big step is to become so motivated to start your own research. That is where you get the most fun, but unfortunately, you may have to go through the previous two steps of laboring before arriving there.

Each week we will be discussing a particular topic. For that topic, there will be one paper which we will focus on. A student will make a presentation about that paper. Students not presenting that week will read the paper in advance and hand in a report including a short summary (within one page) and (at least) a question by emailing my course assistant Yu-Ping before 9:00 am that Thursday. During the presentation, each one not presenting will raise at least one question. You can raise the question you have prepared in the report. However, if some other student has raised the same question before, you will have to come up with a question on spot. The presenting student will try to answer all the questions. Yu-Ping and myself will help whenever we can.

After the class, Yu-Ping will forward all the emails to the presenting student. The presenting student now will have to 1) grade the reports handed in by the non-

presenting students according to the quality of the summary and the quality of the question, and 2) write down the answers to all the questions asked. The presenting student will email the grades, the answers together with the ppt file of presentation to Yu-Ping within one week after the presentation. Yu-Ping will then post the answers and the ppt to the course web site so we can all take a look at them.

The presenting student will have to talk to me or Yu-Ping at least one week before the presentation about the plan of presentation. In your presentation you should discuss clearly the research question asked, the experiment design (and the model if there is one), the result, whether you are happy with the interpretation of the result in the paper, whether you will run the experiment differently and whatever interests, excites or confuses you when you read the paper. Please be aware that some papers are very short, but they could have a very long supporting material. You need to read the supporting materials carefully too, in order to have a solid understanding.

Your final grade will depend on your class presentation (50%) and the 10 grades you get from the presenting student each week (50%). I will give you bonus points if you participate well in the discussions.

I have reserved a useful textbook, Paul Glimcher, Colin Camerer, Ernst Fehr, and Russ Poldrack. *Neuroeconomics: Decision Making and the Brain*, Academic Press, 2008 (shorthand as GCFP), at the library of Econ department. It summarizes many important topics in the field and could serve as a good starting point when you want to know more about a topic.

## Reading List

**Sep 17 Introduction:** I will talk about an fMRI study of the beauty contest game and try to get you interested (or confused) in: levels of players as in level-k theory, knowledge or beliefs of different orders in a game. Are they similar or different?

\* Coricellia, G. and Nagel, R. "Neural correlates of depth of strategic reasoning in medial prefrontal cortex," PNAS 2009, vol. 106, no. 23, pp. 9163–9168.

Bhatt, M. and Camerer, C. "Self-Referential Thinking and Equilibrium as States of Mind in Games: Fmri Evidence," Games and Economic Behavior, 2005, 52(2), pp. 424-59.

Chen, C.-T., Huang, C.-Y., and Wang J. T.-Y. "A Window of Cognition: Eyetracking the Reasoning Process in Spatial Beauty Contest Games," working paper, 2009. (available at Joseph Tao-yi Wang's web page)

Hampton, A., Bossaerts, P., and O'Doherty, J. "Neural correlates of mentalizing-related computations during strategic interactions in humans," PNAS 2008, vol. 105, pp. 6741-6746.

**Sep 24 Value:** I will talk about a paper on menu invariance of the orbitofrontal cortex. This addresses the issue of cardinality or ordinality. You should be aware though that there is another paper which suggests otherwise. Moreover, value modulation in parietal cortex seems to be relative, not absolute.

\* Padoa-Schioppa, C. and Assad, J. "The representation of economic value in the orbitofrontal cortex is invariant for changes of menu," Nature Neuroscience 2008, vol. 11, no. 1, pp. 95-102.

Tremblay, L. and Schultz, W. "Relative reward preference in primate orbitofrontal cortex," Nature 1999, vol. 398, pp. 704-708.

Padoa-Schioppa, C. and Assad, J. "Neurons in orbitofrontal cortex encode economic value," Nature 2006, vol. 441, pp. 223-226.

GCFP Chapter 29.

**Oct 1 guest speaker on introduction to fMRI and preprocessing**

**Oct 8 guest speaker on data analysis and how to read the result**

**Oct 15 Marginal utility:** Do we observe diminishing marginal utility neurally?  
(student presentation)

\* Pine, A., Seymour, B., Roiser, J., Bossaerts, P., Friston, K., Curran, H. V., and Dolan, R. "Encoding of marginal utility across time in the human brain," *Journal of Neuroscience* 2009, 29 (30), pp. 9575-9581.

Tobler, P., Fletcher, P., Bullmore, E., and Schultz, W. "Learning-related human brain activations reflecting individual finances," *Neuron* 2007, 54, pp. 167-175.

Wallis, J. "Orbitofrontal cortex and its contribution to decision-making," *Ann. Rev. Neurosci* 2007, 30, pp. 31-56. (What does figure 3 mean?)

**Oct 22 Reward value:** Let us understand a bit about probability and prediction error.  
(student presentation)

\* Tobler, P., Fiorillo, C., and Schultz, W. "Adaptive coding of reward value by dopamine neurons," *Science* 2005, vol. 307, pp. 1642-1645.

Fiorillo, C., Tobler, P., and Schultz, W. "Discrete coding of reward probability and uncertainty by dopamine neurons," *Science* 2003, vol. 299, pp. 1898-1902.

GCFP Chapters 21, 22.

**Oct 29 Reward, risk, ambiguity in human:** Do we encode third moment, fourth moment? How do we feel a probability distribution? (student presentation)

\* Preuschoff, K., Bossaerts, P. and Quartz, S. "Neural differentiation of expected reward and risk in human subcortical structures," *Neuron* 2006, 51, pp. 381-390.

Hsu, M., Bhatt, M., Adolphs, R., Tranel, D., Camerer, C. "Neural systems responding to degrees of uncertainty in human decision making," *Science* 2005, vol. 310, pp. 1680-1683.

Preuschoff, K., Quartz, S. and Bossaerts, P. "Human insula activation reflects risk prediction errors as well as risk," *Journal of Neuroscience* 2008, 28, pp. 2745-2752.  
GCFP Chapter 23.

**Nov 5 Prospect theory and motor lottery** (student presentation)

\* Tom, S., Fox, C., Trepel, C., and Poldrack, R. "The neural basis of loss aversion in decision-making under risk," *Science* 2007, vol. 315, pp. 515-518.

Wu, S.-W., Delgado, M., and Maloney, L. "Economic decision-making compared with an equivalent motor task," *PNAS* 2009, vol. 106, no. 15, pp. 6088-6093.

GCFP Chapter 11.

**Nov 12 Midterm week:** A field trip to the scanner or a week off? To be decided.

**Nov 19 guest speaker on MRI physics**

To prepare you for this class, instead of handing in a report as usual, you are asked to hand in a one sentence explanation for each of the following terms. You can either google on line or check out any reference. A good reference is the book *Functional Magnetic Resonance Imaging* by Scott Huettel, Allen Song, and Gregory McCarthy (shorthanded as HSM) which is on reserve in the Econ library as well.

fMRI, BOLD, EPI (echo planar imaging), voxel, volume, TR, TE, FOV, matrix size, flip angle, slice thickness, slice number, phase encoding direction, T1 contrast, T2 contrast.

HSM Chapters 1, 2, 3, 4, 5, 6, 7

**Nov 26 Efficiency, equity and fairness** (student presentation)

\* Hsu, M., Anen, C., and Quartz, S. "The right and the good: distributive justice and neural encoding of equity and efficiency," *Science* 2008, vol. 320, pp. 1092-1095.

Spitzer, M., Fischbacher, U., Herrnberger, B., Gron, G., and Fehr, E. "The neural signature of social norm compliance," *Neuron* 2007, 56, pp. 185-196.

Brosnan, S., and De Waal, F. "Monkeys reject unequal pay," Nature 2003, vol. 425, no. 6955, pp. 297-299.

GCFP Chapter 15.

### **Dec 3 guest speaker on MRI physics**

In this class, we will go into more details. Try your best to understand what those terms listed above mean so that when you get the protocol from others, you roughly know what is going on.

HSM Chapters 1, 2, 3, 4, 5, 6, 7

### **Dec 10 Charitable giving** (student presentation)

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

Moll, J., Krueger, F., Zahn, R., Pardini, M., De Oliveira-Souza, R., and Grafman, J. "Human fronto-mesolimbic networks guide decisions about charitable donations," PNAS 2006, vol. 103, no. 42, pp. 15623-15628.

GCFP Chapter 20.

### **Dec 17 Morality** (student presentation)

\* Greene, J. and Paxton, J. "Patterns of neural activity associated with honest and dishonest moral decisions," PNAS 2009, vol. 106, no. 30, pp. 12501-12511.

Greene, J., Sommerville, B., Nystrom, L., Darley, J., and Cohen, J. "An fMRI investigation of emotional engagement in moral judgment," Science 2001, vol. 293, pp. 2105-2108.

Koenigs, M., Young, L., Adolphs, R., Tranel, D., Cushman, F., Hauser, M., and Damasio, A. "Damage to the prefrontal cortex increases utilitarian moral judgements," Nature 2007, vol. 446, pp. 908-911.

### **Dec 24 Trust** (student presentation)

\* King-Casas, B., Tomlin, D., Anen, C., Camerer, C., Quartz, S., and Montague, R. "Getting to know you: reputation and trust in a two-person economic exchange," Science 2005, vol. 308, pp. 78-83.

Delgado, M., Frank, R., and Phelps, E. "Perceptions of moral character modulate the neural systems of reward during the trust game," Nature Neuroscience 2005, vol. 8, no. 11, pp. 1611-1618.

Kosfeld, M., Heinrichs, M., Zak, P., Fischbacher, U. and Fehr, E. "Oxytocin increases trust in humans," Nature 2005, vol. 435, pp. 673-676.

### **Dec 31 Intertemporal choice** (student presentation)

\* Kable, J. and Glimcher, P. "The neural correlates of subjective value during intertemporal choice," Nature Neuroscience 2007, vol. 10, no. 12, pp. 1625-1633.

McClure, S., Laibson, D., Loewenstein, G., and Cohen, J. "Separate neural systems value immediate and delayed monetary rewards," Science 2004, vol. 306, pp. 503-507.

### **Jan 7 Culture/Race** (student presentation)

\* Golby, A., Gabrieli, J., Chiao, J., and Eberhardt, J. "Differential responses in the fusiform region to same-race and other-race faces," Nature Neuroscience 2001, vol 4, no. 8, pp. 845-850.

Phelps, E., O'Connor, K., Cunningham, W., Funayama, S., Gatenby, C., Gore, J., and Banaji, M. "Performance on indirect measures of race evaluation predicts amygdala activation," Journal of Cognitive Neuroscience 2000, 12:5, pp. 729-738.

Lieberman, M., Hariri, A., Jarcho, J., Eisenberger, N., and Bookheimer, S. "An fMRI investigation of race-related amygdala activity in African-American and Caucasian-American individuals," Nature Neuroscience 2005, vol. 8, no. 6, pp.720-722.

### **Jan 14 Final week:** free discussion