

Psychology 512. The Science of Decision- Making



Instructor: Mauricio Delgado

Course Information: Smith 371A, Wed: 9:00-11:50

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Course Description: An introduction to behavioral, psychological and neural mechanisms underlying decision-making and decision theory. The class is organized into four basic sections covering the integration of ideas from psychology, neuroscience and economics that inspire research in the new disciplines of neuroeconomics and social neuroscience.

Part I – Value in the brain: How does the brain compute value? How do we develop preferences?

Part II – Decision-making theory and representation in the brain: What theories drive new interdisciplinary research in the field of neuroeconomics? (e.g., are we susceptible to the “framing” of particular decisions?)

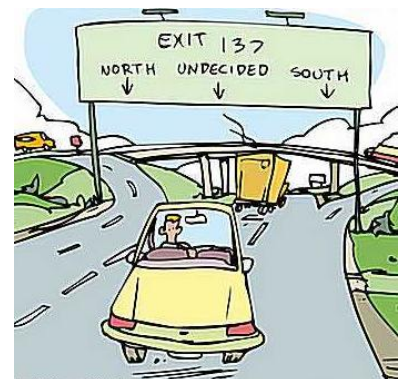
Part III – Social influences on decision-making: How are reputations acquired and trusting bonds formed? Does the perception of unfairness lead to aggressive decisions (e.g., revenge)?

Part IV – When decision-making goes awry: How is value computed in the face of potentially harmful situations (e.g., addiction)? Why are adolescents more inclined to behave in a risky manner?

Course Requirements (TBD):

Special Note for Ph.D. students from Rutgers Business School:

This syllabus is from a version of this course offered to psychology and neuroscience students in 2008. It is an example of the general structure of the course objectives. The syllabus for 2011 will feature more decision theory and focus on psychological (e.g., emotional, social) influences on decision-making. Neural information will be used to complement the psychological theories and evidence presented, particularly when neural data is influential in informing decision-making (e.g., Somatic Marker Hypothesis posited by Antonio Damasio). Finally, we will discuss how (or if) psychology/neuroscience can inform economic theory and the future of this interdisciplinary venture.



Course Schedule:

I- Value in the Brain

23 Jan – Introduction

30 Jan – Organization of the Nervous System/Reward Systems

A- Background

- Chapters 2 & 3 - Gazzaniga, et al. (2002). *Cognitive neuroscience: the biology of the mind*.

B- Neuroscience of reward systems

- Delgado, M.R. (*in press*). Positive emotions and reward: Human reward systems. In Squire, L., Ed., *New Encyclopedia of Neuroscience*, Elsevier.
- Murray, E.A., O'Doherty, J.P. & Schoenbaum, G. What we know and do not know about the functions of the orbitofrontal cortex after 20 years of cross-species studies. *J Neurosci* 27, 8166-8169 (2007).
- Balleine, B.W., Delgado, M.R. & Hikosaka, O. The role of the dorsal striatum in reward and decision-making. *J Neurosci* 27, 8161-8165 (2007).
- Wickens, J.R., Horvitz, J.C., Costa, R.M. & Killcross, S. Dopaminergic mechanisms in actions and habits. *J Neurosci* 27, 8181-8183 (2007).
- Lee, D., Rushworth, M.F., Walton, M.E., Watanabe, M. & Sakagami, M. Functional specialization of the primate frontal cortex during decision making. *J Neurosci* 27, 8170-8173 (2007).

6 Feb –Rewards, learning and choice behavior

A- Rewards

- Delgado, M.R., Nystrom, L.E., Fissell, C., Noll, D.C. & Fiez, J.A. Tracking the hemodynamic responses to reward and punishment in the striatum. *J Neurophysiol* 84, 3072-3077 (2000).
- Knutson, B., Taylor, J., Kaufman, M., Peterson, R. & Glover, G. Distributed neural representation of expected value. *J Neurosci* 25, 4806-4812 (2005).
- O'Doherty, J.P. Reward representations and reward-related learning in the human brain: insights from neuroimaging. *Curr Opin Neurobiol* 14, 769-776 (2004).

B- Rewards & Learning

- Montague, Dayan, Schultz (1997). A neural substrate of prediction and reward. *Science*. 275:1593-9
- O'Doherty, J., *et al.* Dissociable roles of ventral and dorsal striatum in instrumental conditioning. *Science* 304, 452-454 (2004).
- Niv & Schoenbaum (draft) Dialogues on prediction errors.

C-Learning & Simple Choices

- Delgado, M.R., Miller, M.M., Inati, S. & Phelps, E.A. An fMRI study of reward-related probability learning. *Neuroimage* 24, 862-873 (2005)
- Haruno, M. & Kawato, M. Different neural correlates of reward expectation and reward expectation error in the putamen and caudate nucleus during stimulus-action-reward association learning. *J Neurophysiol* 95, 948-959 (2006).
- Schonberg, T., Daw, N.D., Joel, D. & O'Doherty, J.P. Reinforcement learning signals in the human striatum distinguish learners from nonlearners during reward-based decision making. *J Neurosci* 27, 12860-12867 (2007).

13 Feb –Beyond simple choices: Preferences & Discounting

A-Preferences

- Tremblay & Schultz (1999). *Nature*; 398 (6729): 704-708

- Erk et al. (2002). Cultural objects modulate reward circuitry. *Neuroreport*, 13(18):2499-503
- Chapter 7 - Montague, P.R. (2006). *Why choose this book?* (pages 198-218)
- "BrainScam" editorial *Nature Neuroscience*

B- Preference & choice

- Knutson, B., Rick, S., Wimmer, G.E., Prelec, D. & Loewenstein, G. Neural predictors of purchases. *Neuron* 53, 147-156 (2007).
- Plassmann, H., O'Doherty, J. & Rangel, A. Orbitofrontal cortex encodes willingness to pay in everyday economic transactions. *J Neurosci* 27, 9984-9988 (2007).

C-Discounting

- McClure, S.M., Laibson, D.I., Loewenstein, G. & Cohen, J.D. Separate neural systems value immediate and delayed monetary rewards. *Science* 306, 503-507 (2004).
- McClure, S.M., Ericson, K.M., Laibson, D.I., Loewenstein, G. & Cohen, J.D. Time discounting for primary rewards. *J Neurosci* 27, 5796-5804 (2007).
- Kable, J.W. & Glimcher, P.W. The neural correlates of subjective value during intertemporal choice. *Nat Neurosci* 10, 1625-1633 (2007).

II- Decision-Making Theory & Representation in the Brain

20 Feb –Somatic markers

A- Pro:

- Bechara, A., Damasio, H., Tranel, D. & Damasio, A.R. Deciding advantageously before knowing the advantageous strategy. *Science* 275, 1293-1295 (1997).
- Bechara, A., Damasio, H., Damasio, A.R. & Lee, G.P. Different contributions of the human amygdala and ventromedial prefrontal cortex to decision-making. *J Neurosci* 19, 5473-5481 (1999).
- Bechara, A., Damasio, H., Tranel, D. & Damasio, A.R. The Iowa Gambling Task and the somatic marker hypothesis: some questions and answers. *Trends Cogn Sci* 9, 159-162; discussion 162-154 (2005).

B- Con:

- Maia, T.V. & McClelland, J.L. A reexamination of the evidence for the somatic marker hypothesis: what participants really know in the Iowa gambling task. *Proc Natl Acad Sci U S A* 101, 16075-16080 (2004).
- Tomb, I., Hauser, M., Deldin, P. & Caramazza, A. Do somatic markers mediate decisions on the gambling task? *Nat Neurosci* 5, 1103-1104; author reply 1104 (2002).
- Dunn, B.D., Dalgleish, T. & Lawrence, A.D. The somatic marker hypothesis: a critical evaluation. *Neurosci Biobehav Rev* 30, 239-271 (2006).

27 Feb – Rational Choice Theory, Prospect Theory & Framing of Decisions

A- Theory

- Chapter 1 - Kahneman & Tversky (2000). *Choices, values and frames*.
- Chapter 8 - Kahneman & Tversky (2000). *Choices, values and frames*.
- Chapter 12- Kahneman & Tversky (2000). *Choices, values and frames*.
- Chapter 9 - Plous, S. (1993). *The Psychology of Judgment and Decision-Making* (pages 94-105)

B- Neural correlates

- De Martino, B., Kumaran, D., Seymour, B. & Dolan, R.J. Frames, biases, and rational decision-making in the human brain. *Science* 313, 684-687 (2006).

5 Mar – Aversions, fear and the brain

A- Loss aversion, ambiguity and uncertainty

- Tom, S.M., Fox, C.R., Trepel, C. & Poldrack, R.A. The neural basis of loss aversion in decision-making under risk. *Science* 315, 515-518 (2007).

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

B- Fear

- Delgado, M.R., Olsson, A. & Phelps, E.A. Extending animal models of fear conditioning to humans. *Biol Psychol* 73, 39-48 (2006).

- Thielscher, A. & Pessoa, L. Neural correlates of perceptual choice and decision making during fear-disgust discrimination. *J Neurosci* 27, 2908-2917 (2007).

III- Social Influences on Decision-Making

12 Mar – Moral Decision Making

- Greene, J.D., Nystrom, L.E., Engell, A.D., Darley, J.M. & Cohen, J.D. The neural bases of cognitive conflict and control in moral judgment. *Neuron* 44, 389-400 (2004).

- Tankersley, D., Stowe, C.J. & Huettel, S.A. Altruism is associated with an increased neural response to agency. *Nat Neurosci* 10, 150-151 (2007).

- Looking for the lie – NYTimes Magazine

- The brain on the stand – NYTimes Magazine

19 Mar – Spring Break: Choose your actions carefully...

26 Mar – Midterm

2 April – Social/Group Influences on Decision-making

A- Love & attractiveness

- Aron, A., *et al.* Reward, motivation, and emotion systems associated with early-stage intense romantic love. *J Neurophysiol* 94, 327-337 (2005).

- Shepherd, S.V., Deaner, R.O. & Platt, M.L. Social status gates social attention in monkeys. *Curr Biol* 16, R119-120 (2006).

- Hayden, B.Y., Parikh, P.C., Deaner, R.O. & Platt, M.L. Economic principles motivating social attention in humans. *Proc Biol Sci* 274, 1751-1756 (2007).

- Greg Berns – *Satisfaction*

B- Social comparisons

- Fliessbach, K., *et al.* Social comparison affects reward-related brain activity in the human ventral striatum. *Science* 318, 1305-1308 (2007).

- Chen, M. K. & Santos, L. R. (2006). Some thoughts on the adaptive function of inequity aversion: An alternative to Brosnan's social hypothesis. *Social Justice Research*, 19(2). 201-207.

9 April – Trust, Fairness & Consequences

A- Trust

- Tomlin, D., *et al.* Agent-specific responses in the cingulate cortex during economic exchanges. *Science* 312, 1047-1050 (2006).

- King-Casas, B., *et al.* Getting to know you: reputation and trust in a two-person economic exchange. *Science* 308, 78-83 (2005).

- Delgado, M.R., Frank, R.H. & Phelps, E.A. Perceptions of moral character modulate the neural systems of reward during the trust game. *Nat Neurosci* 8, 1611-1618 (2005).

- Fehr, E. Oxytocin & trust & moral decisions (*in press*).

B- Fairness & Consequences

- Sanfey, A.G., Rilling, J.K., Aronson, J.A., Nystrom, L.E. & Cohen, J.D. The neural basis of economic decision-making in the Ultimatum Game. *Science* 300, 1755-1758 (2003).

- Knoch, D., *et al.* Studying the Neurobiology of Social Interaction with Transcranial Direct Current Stimulation The Example of Punishing Unfairness. *Cereb Cortex* (2007).
- de Quervain, D.J., *et al.* The neural basis of altruistic punishment. *Science* 305, 1254-1258 (2004).

IV- When Decision-Making Goes Awry

16 April –Addiction

- Naqvi, N.H., Rudrauf, D., Damasio, H. & Bechara, A. Damage to the insula disrupts addiction to cigarette smoking. *Science* 315, 531-534 (2007).
- Redish, A.D. Addiction as a computational process gone awry. *Science* 306, 1944-1947 (2004).
- Everitt, B.J. & Robbins, T.W. Neural systems of reinforcement for drug addiction: from actions to habits to compulsion. *Nat Neurosci* 8, 1481-1489 (2005).

23 April – Risky decision-making and development

- Steinberg, L. (2007). Risk-taking in adolescence: New perspectives from brain and behavioral science. *Current Directions in Psychological Science*, 16, 55-59.
- Ernst, M., Pine, D.S. & Hardin, M. Triadic model of the neurobiology of motivated behavior in adolescence. *Psychol Med* 36, 299-312 (2006).
- Galvan, A., Hare, T., Voss, H., Glover, G. & Casey, B.J. Risk-taking and the adolescent brain: who is at risk? *Dev Sci* 10, F8-F14 (2007).
- Crone, E.A., Bunge, S.A., Latenstein, H. & van der Molen, M.W. Characterization of children's decision making: sensitivity to punishment frequency, not task complexity. *Child Neuropsychol* 11, 245-263 (2005).

30 April – Presentation Day

7 May – Final Paper Due