

Neuroeconomics

- ▶ *Neuroeconomics* is the study of economic decision-making through its biological foundations in the brain
- ▶ What are these biological foundations?
- ▶ How do we study these foundations?

Neuroeconomics

Multiple Systems Hypothesis

- ▶ One possible neuroeconomic way to study behavior is the *multiple systems model*
- ▶ The model:
 - ▶ Brain is built up from many independent systems
 - ▶ Each system has a physical locus in the brain, and is specialized for a certain task or activity
 - ▶ Given a stimulus, each system produces a (potentially different) response
 - ▶ The brain integrates these multiple signals to decide on a final course of action
- ▶ Example: do you want a cookie right now?

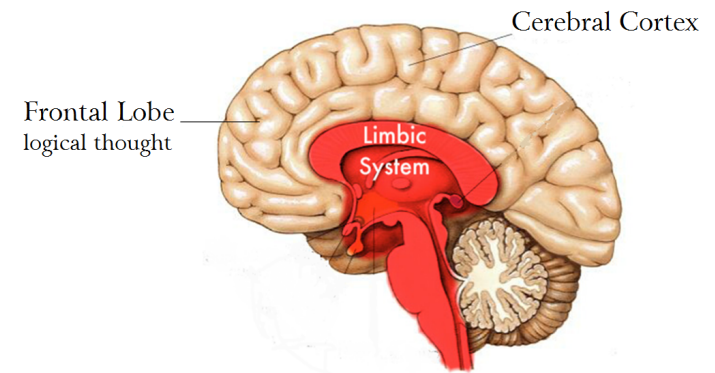
Connection to System 1 and 2

- ▶ The multiple systems model sounds a lot like Kahneman's System 1 and System 2
 - ▶ However, system 1 and system 2 is just one example of a multiple systems hypothesis
 - ▶ Other examples?
- ▶ Note that there can be more than two systems interacting in general

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An Over-Simplified Model of the Brain

- ▶ Prefrontal cortex (PFC): the center higher reasoning, logic, self control
- ▶ Limbic system: releases dopamine in response to rewards like food and sex



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Relation to Time Preferences and Self-Control

- ▶ Hypothesis: the PFC is patient but the limbic system is impatient
- ▶ Preferences are derived from adding up the outputs of the two systems
- ▶ For example, consider how the two systems evaluate the prospect of getting a small reward each period:

Period	1	2	3	4
PFC contribution	1	1	1	1
Limbic contribution	1	0	0	0
Average signal	1	$\frac{1}{2}$	$\frac{1}{2}$	$\frac{1}{2}$

- ▶ What do total decision weights look like?

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Testing the Hypothesis

- ▶ How do we test this hypothesis?
- ▶ How can we easily implement this?

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Cognitive Load

- ▶ Shiv and Fedorikhin (1999) ask people to remember a number
- ▶ While holding the number in their head, they are asked if they want cake or fruit
- ▶ Two treatments:
 - ▶ High cognitive load: 7 digit number
 - ▶ Low cognitive load: 2 digit number
- ▶ Results:
 - ▶ High cognitive load: % choose cake
 - ▶ Low cognitive load: % choose cake
- ▶ Two systems explanation?
- ▶ Any alternate explanations?

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Discount Rates

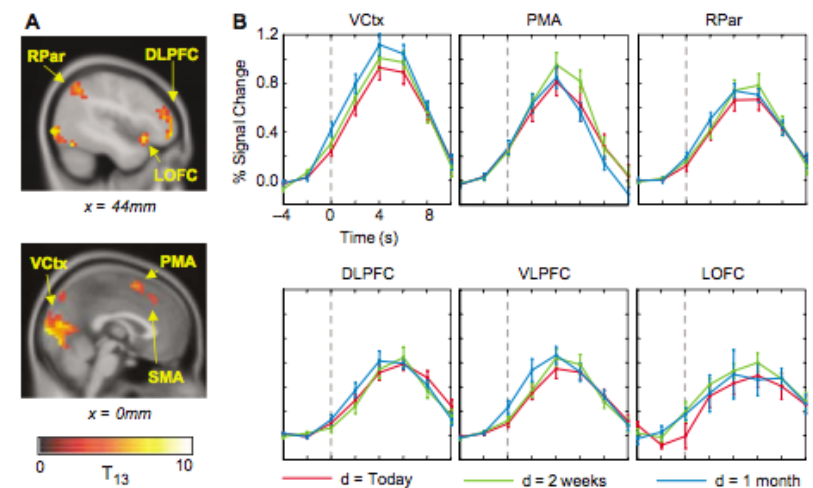
- ▶ Hinson, Jameson, and Whitney (2003) seek to measure time preferences directly using price list methodology we saw earlier in course
- ▶ Subjects choose between smaller, sooner reward and later, larger reward
- ▶ Vary the cognitive load in a similar way:
 - ▶ Control: no cognitive load
 - ▶ Treatment: hold a 5-digit number in memory
- ▶ Estimated one-month discount rate:
 - ▶ Control:
 - ▶ Treatment:

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Measuring Brain Activity Directly

- ▶ McClure, Laibson, Loewenstein, and Cohen (2004) take a more direct approach
- ▶ Attempt to measure the signal coming from each of the two systems
- ▶ Task: Subjects make binary decisions between a smaller sooner reward and a larger later reward
 - ▶ Sooner period: $d = 0, 2$, or 4 weeks
 - ▶ Later period: 2 weeks later
- ▶ Predictions of which tasks brain areas will send signal?
 - ▶ PFC:
 - ▶ Limbic system:

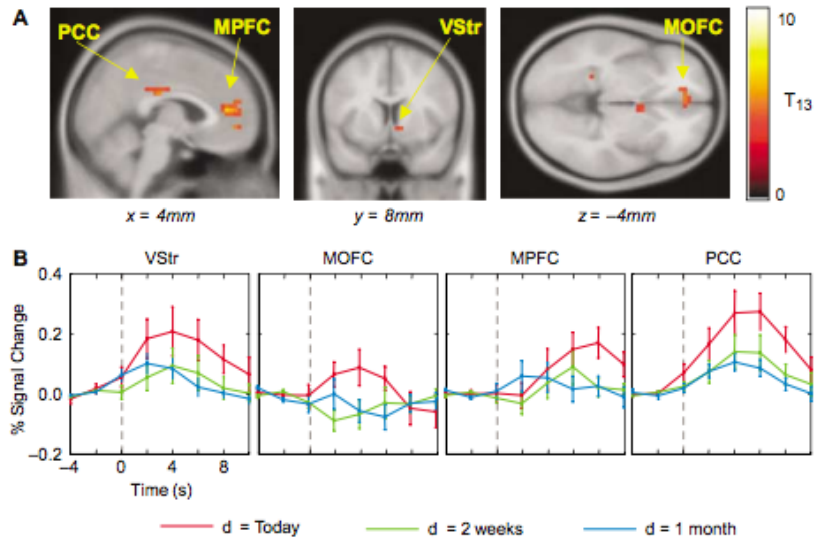
δ Areas Activate for All Options



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β Areas Activate Only for Options with Immediate Rewards



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Emotion

Emotion in Economics

- ▶ We tend to avoid directly studying emotion as either an input or output to the decision process
- ▶ Why is emotion hard to study directly?
- ▶ However, emotion is clearly a major factor in the kinds of decisions we study in this class
- ▶ Examples?

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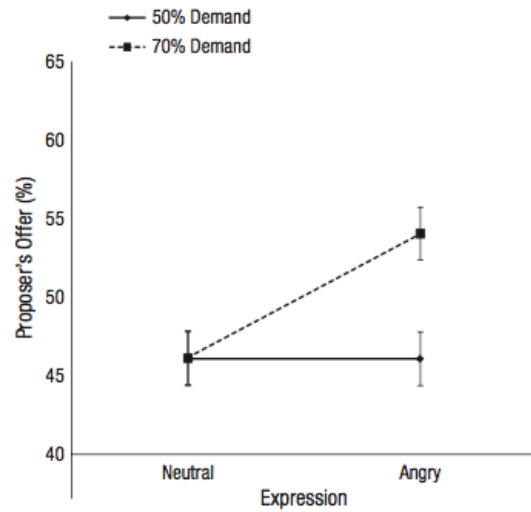
Facial Expressions in the Ultimatum Game

- ▶ Reed, DeScioli, and Pinker (2014) examine behavior of proposers in a standard ultimatum game
- ▶ Shown short video of a "typical responder" in this game
 - ▶ Responder's facial expression was either neutral or angry
- ▶ Video was accompanied by a demand for either 50% or 70% of the pie
- ▶ 2-by-2 design:

Neutral/50%	Neutral/70%
Angry/50%	Angry/70%

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Results



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Regression Model for 2x2 Design

- ▶ We can interpret result using regression model:

$$\text{Offer} = \beta_0 + \beta_1 \text{Angry} + \beta_2 \text{Demand70} + \beta_3 \text{Angry} \cdot \text{Demand70} + \varepsilon$$

- ▶ Based on graphs what is (approximate) value of

- ▶ β_0 ?

- ▶ β_1 ?

- ▶ β_2 ?

- ▶ β_3 ?

- ▶ Putting predicted offer for each treatment in table can help:

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Explanations for Results

- ▶ What can explain these results?

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