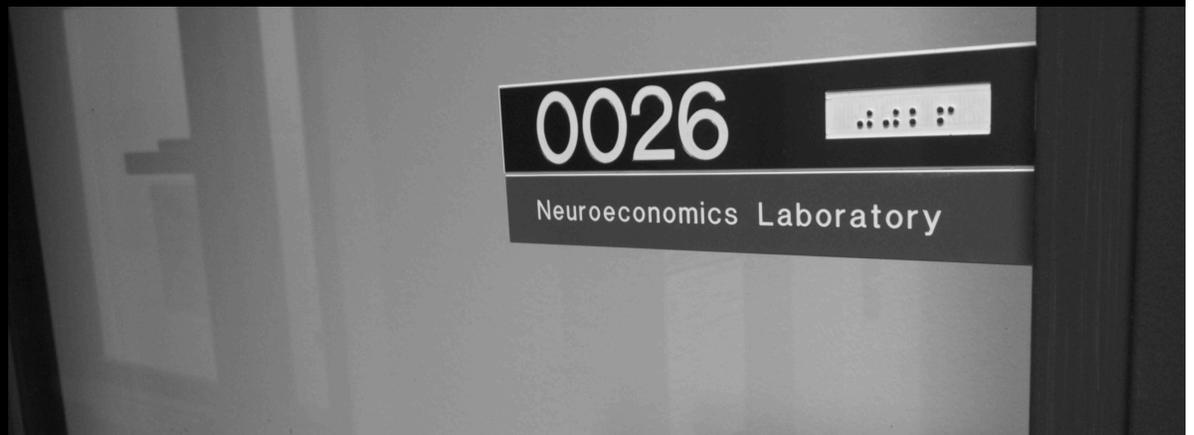


Why We Do The Dumb Things We Do: The Neuroscience of Human Decision Making

Dr. Olav E. Krigolson
University of Victoria





The Neuroeconomics Laboratory at the University of Victoria

[HOME](#) [ABOUT US](#) [ALUMNI](#) [CURRENT RESEARCH](#) [LAB INFORMATION](#) [NEWS](#) [PEOPLE](#) [PUBLICATIONS](#)

Economics

Psychology



Neuroscience

Decision Making



Human's fundamental ability to process multiple alternatives and choose the optimal course of action

Utilitarianism

The creed which accepts as the foundation of morals, Utility, or the Greatest-Happiness Principle, holds that actions are right in proportion as they tend to promote happiness, wrong as they tend to produce the reverse of happiness. By happiness is intended pleasure, and the absence of pain; by unhappiness, pain, and the privation of pleasure.

-Mill

Utility Theory

- People are Risk Averse
- People evaluate decisions in terms of utility, which is defined in terms of net wealth
- Final state of wealth is the only thing that matters
- Losses and Gains only differ by + **and** -
- Assumes Rationality

Consider...



Problem 1: In addition to whatever you own, you have been given \$1000.
You are now asked to choose of these option
50% chance to win \$1000 OR get \$500 for sure.

Problem 2: In addition to whatever you own, you have been
given \$2000.

You are now asked to choose of these option
50% change to lose \$1000 OR lose \$500 for sure.

Kahneman, 2011

Consider...



Problem 1: In addition to whatever you own, you have been
given \$1000.

You are now asked to choose of these option
50% chance to win \$1000 OR get \$500 for sure

Problem 2: In addition to whatever you own, you have been
given \$2000.

You are now asked to choose one of these options:
50% chance to lose \$1000 OR lose \$500 for sure

Kahneman, 2011

Consider...



Problem 1: In addition to whatever you own, you have been
given \$1000.

You are now asked to choose of these option
50% chance to win \$1000 OR get \$500 for sure

Problem 2: In addition to whatever you own, you have been
given \$2000.

You are now asked to choose one of these options:
50% chance to lose \$1000 OR lose \$500 for sure

Kahneman, 2011

Consider...



Problem 1: In addition to whatever you own, you have been given \$1000.

You are now asked to choose of these option
50% change to win \$1000 OR **get \$500 for sure**

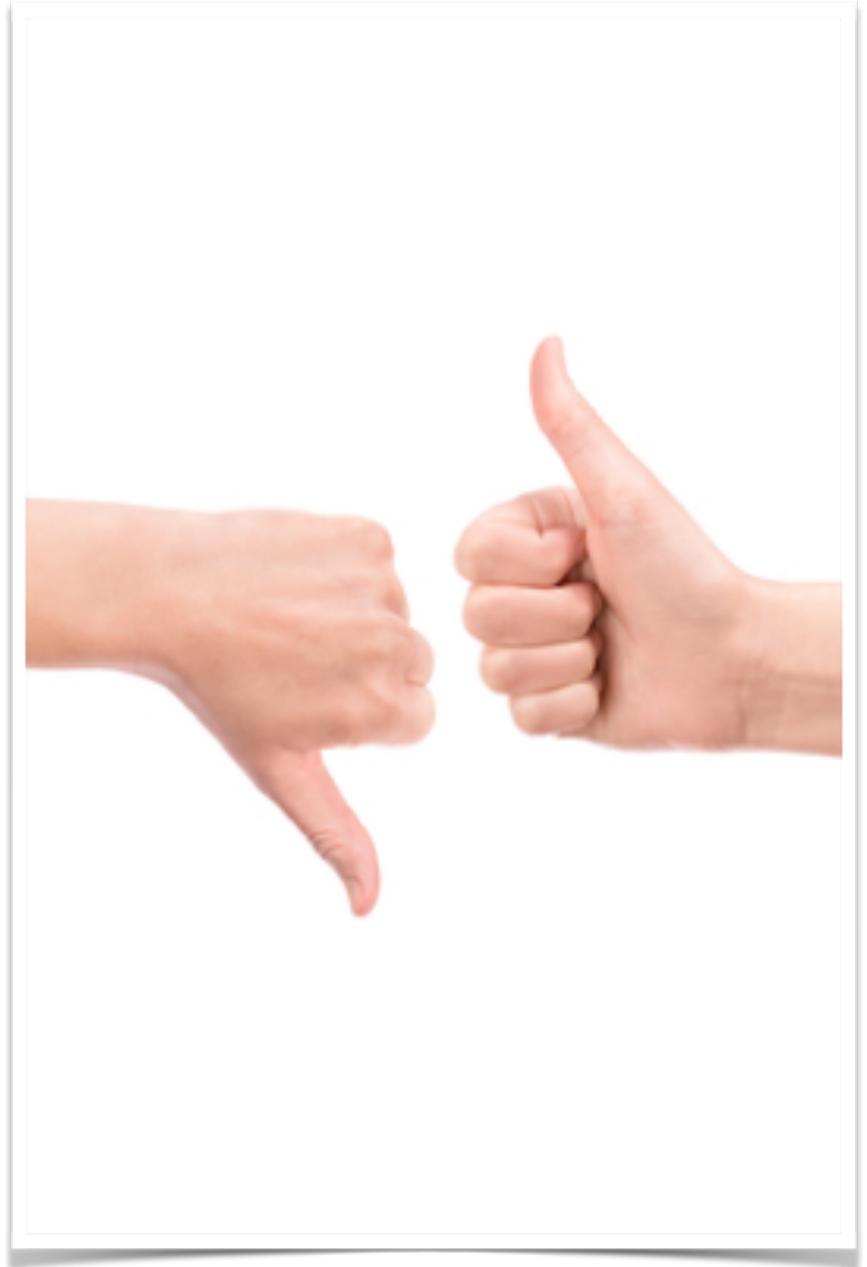
Problem 2: In addition to whatever you own, you have been given \$2000.

You are now asked to choose one of these options:
50% chance to lose \$1000 OR lose \$500 for sure

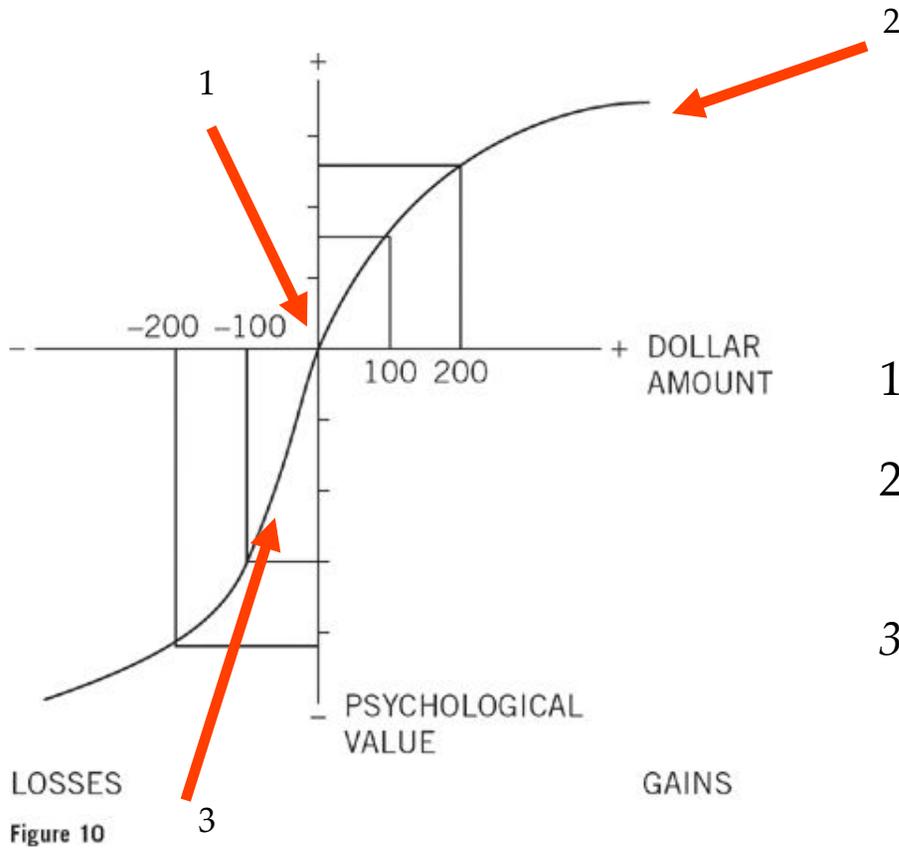
Kahneman, 2011

Prospect Theory

Daniel Kahneman and Amos Tversky



Prospect Theory

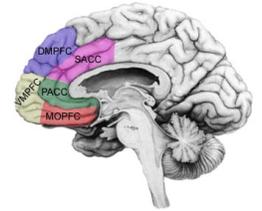


1. Neutral reference point
2. Diminishing sensitivity to gains and losses
3. S is not symmetrical

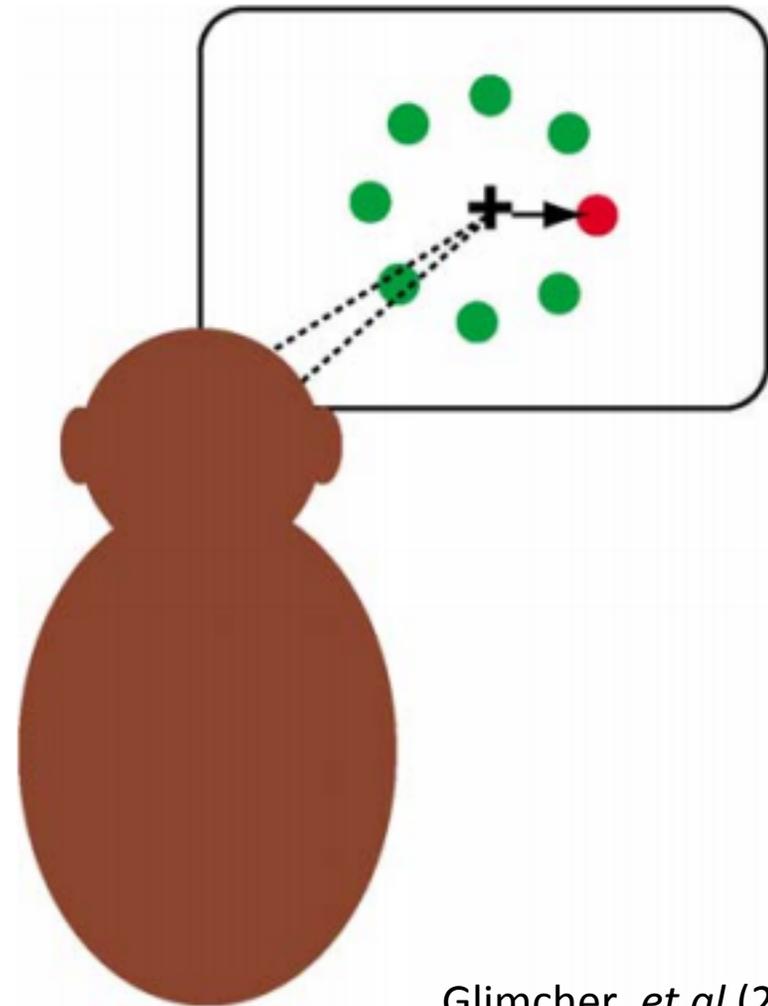
Figure 10

LOSS AVERSION

Hanes & Schall's Odd-ball task



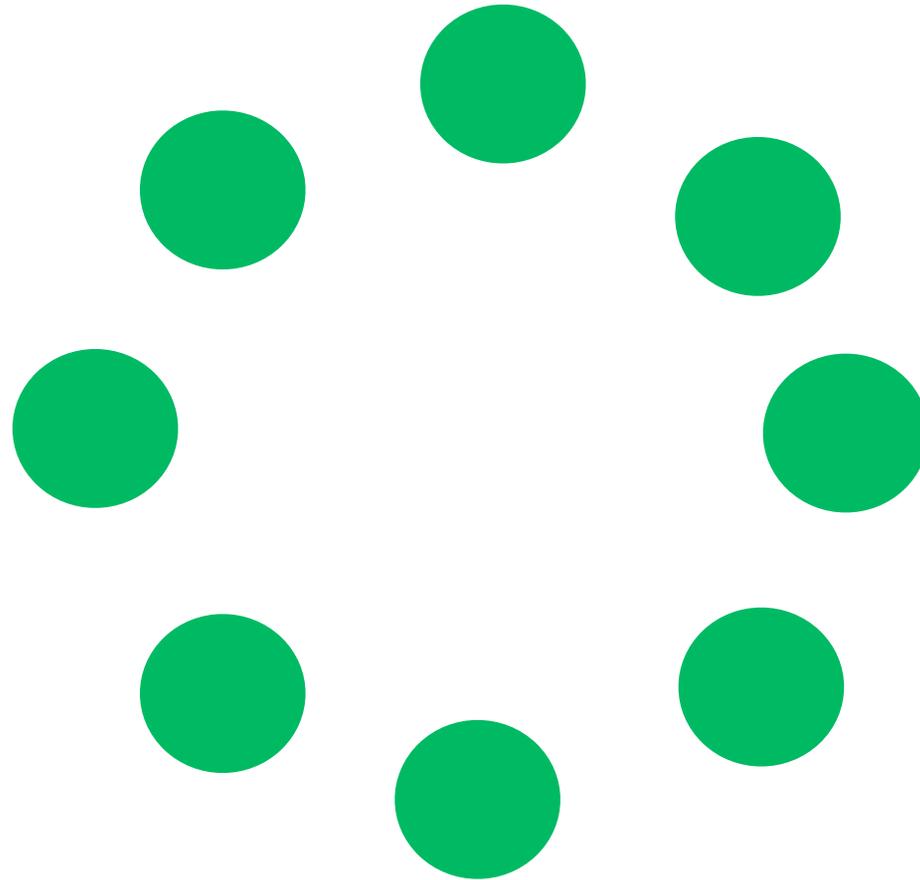
- Monkey is situated in a chair, trained to stare at a blank screen
- Neurons monitored
- Given stimulus
- Looks at circle of dots
- Has to choose the odd dot
- Receives juice



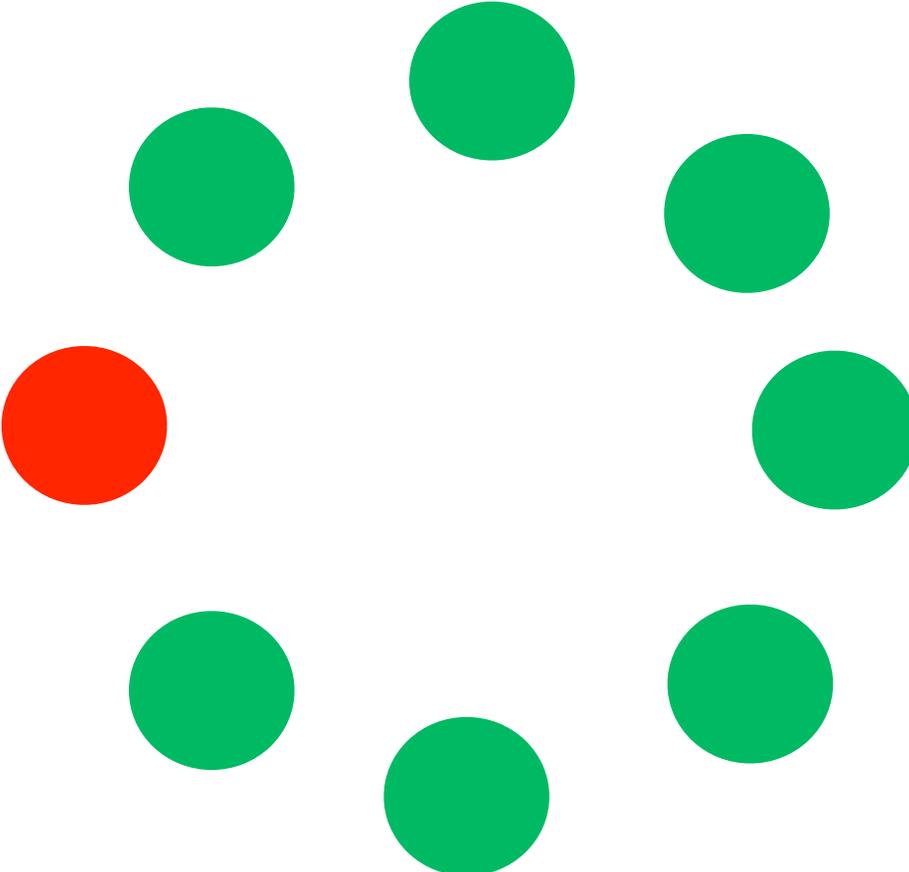
Stare at the Center



Ring of Circles Appear

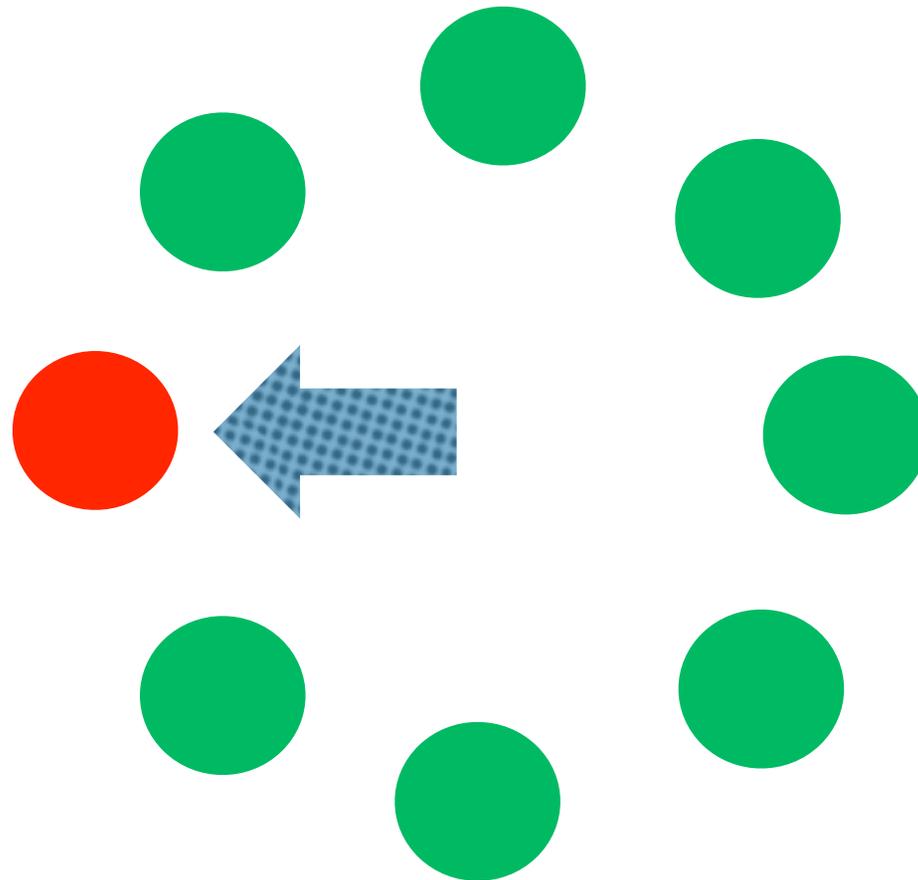


Red Dot Appears



Look at Red Dot

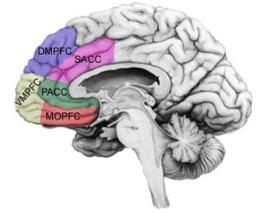
Eye tracking
equipment
is used



Receive Juice

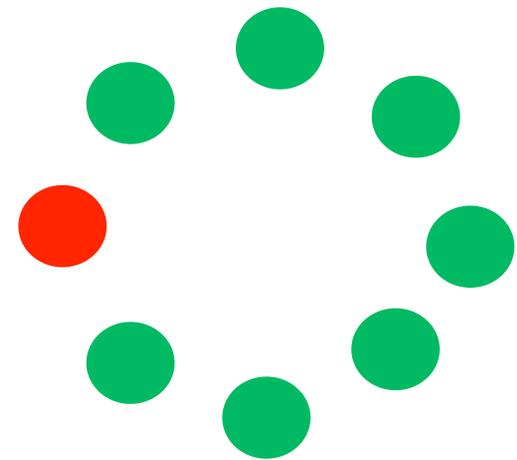


The key finding of this study (Hanes & Schall, 1996)



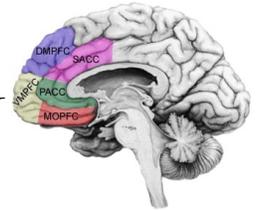
Individual neurons were measured at the visual cortex

- all neurons activate upon viewing of the stimulus
- Action potential rate continued only in areas representing the red stimuli

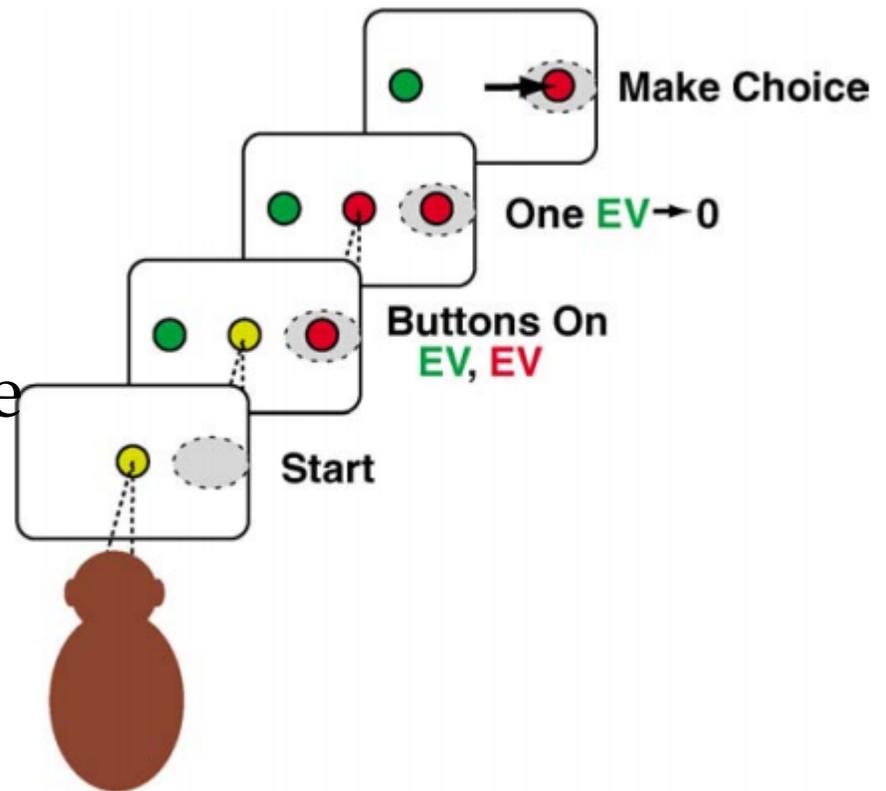


Once a threshold is reached, there exists a kind of “winner take all” scenario at the neuronal level

Platt and Glimcher's Two-Choice Cued Lottery



- Thirsty monkey strapped to chair
- Neurons monitored
- Monkey makes choice
- One choice results in more juice than the other
- A basic utility function emerges

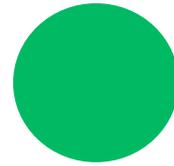
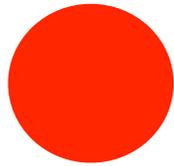


$$\frac{\text{LeftReward}}{\text{LeftReward} + \text{RightReward}} = \text{FiringRate.}$$

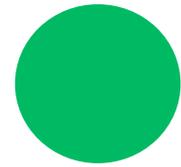
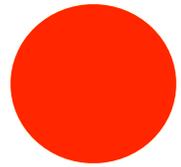
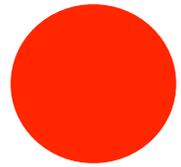
Stare at the Center



Choices Appear



Some Conditions had a Cue



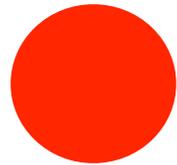
Some Conditions had a Cue



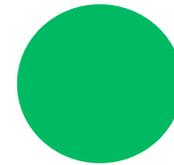
Make choice , receive juice



Other Conditions Allowed Learned Preference of Choice

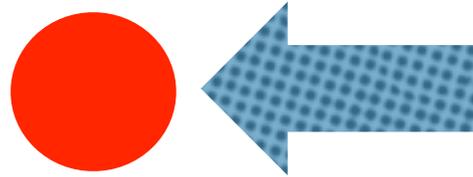


0.8 ml juice

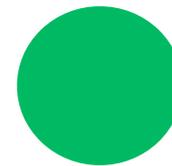


0.2 ml juice

Other Conditions Allowed Learned Preference of Choice



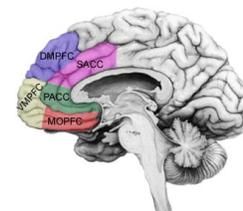
0.8 ml juice



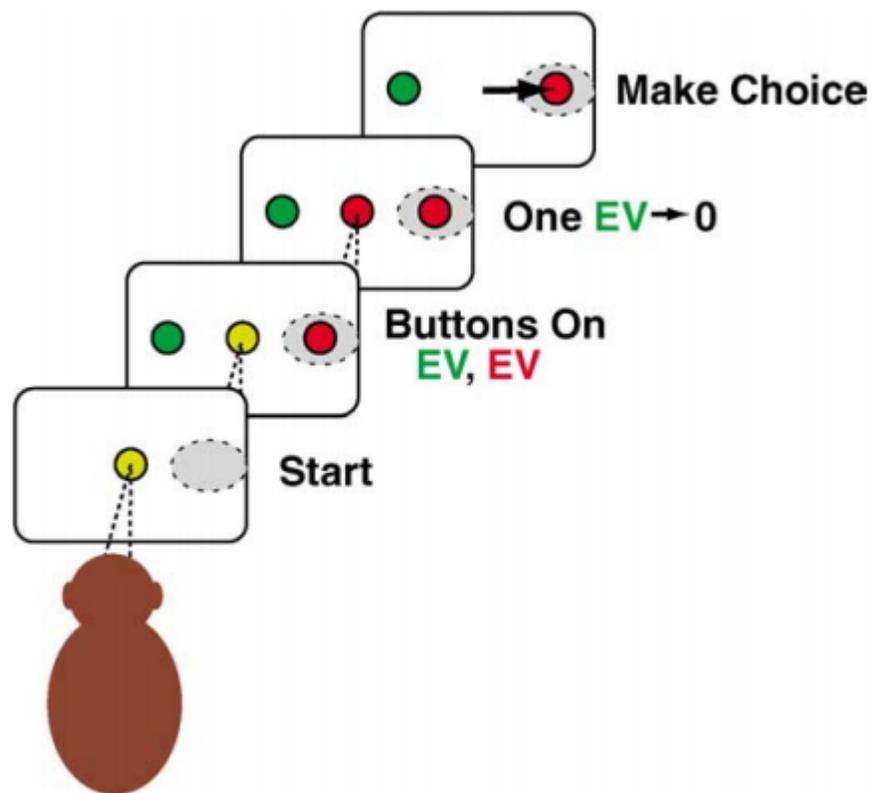
0.2 ml juice



Platt and Glimcher's Two-Choice Cued Lottery

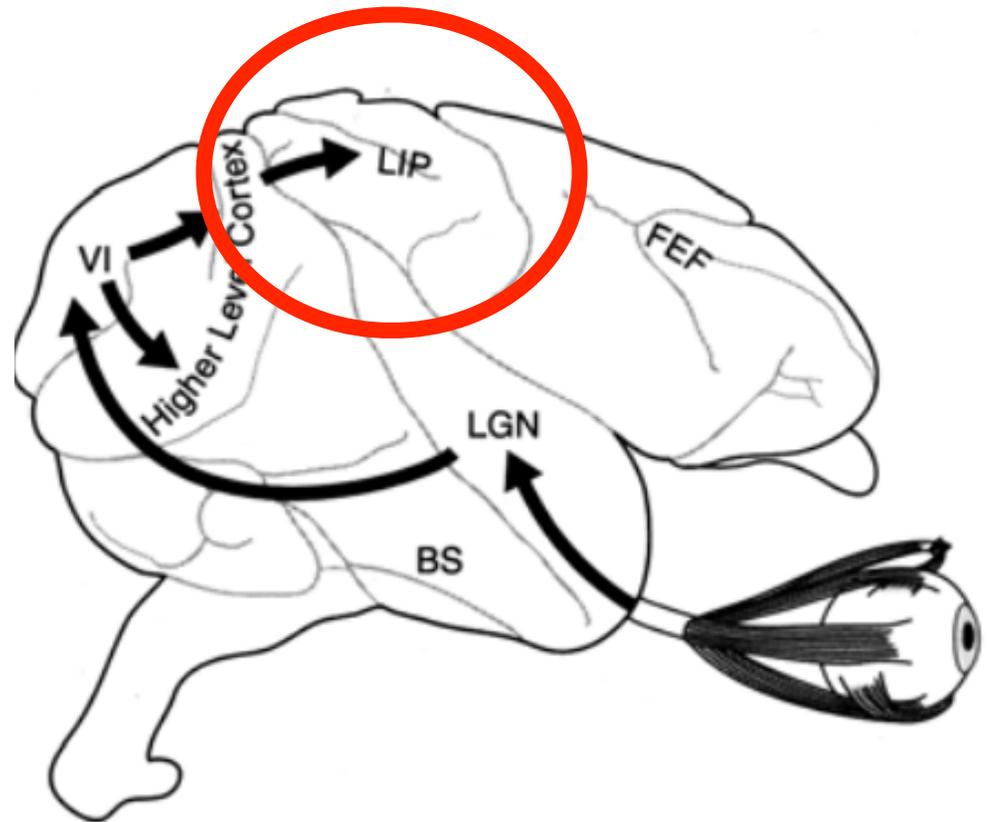


- Thirsty monkey strapped to chair
- Neurons monitored
- Monkey makes choice
- One choice results in more juice than the other
- A basic utility function emerges

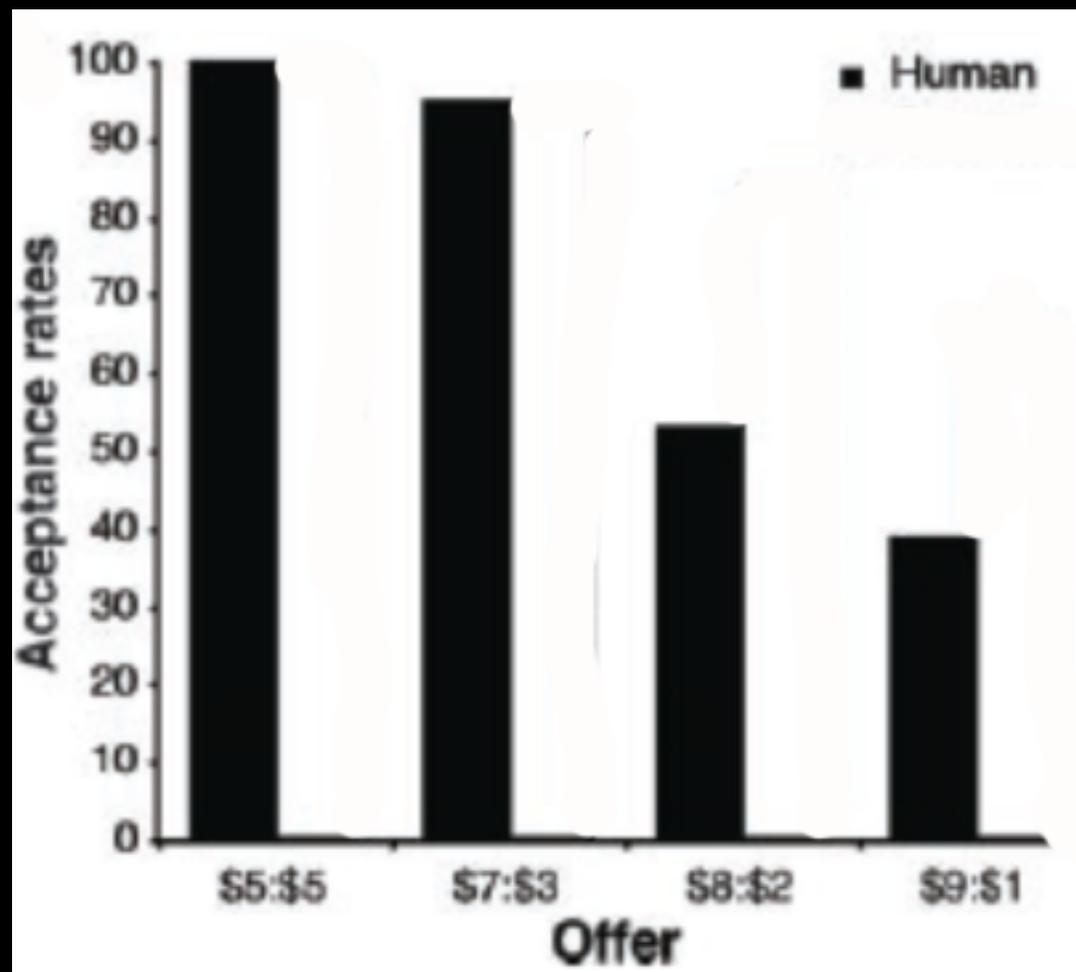


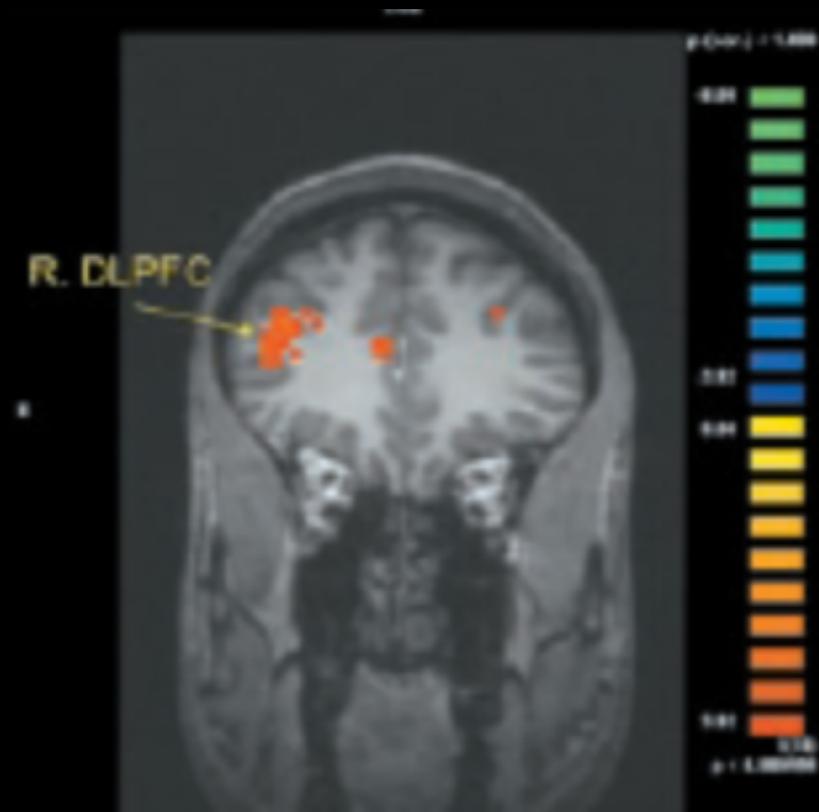
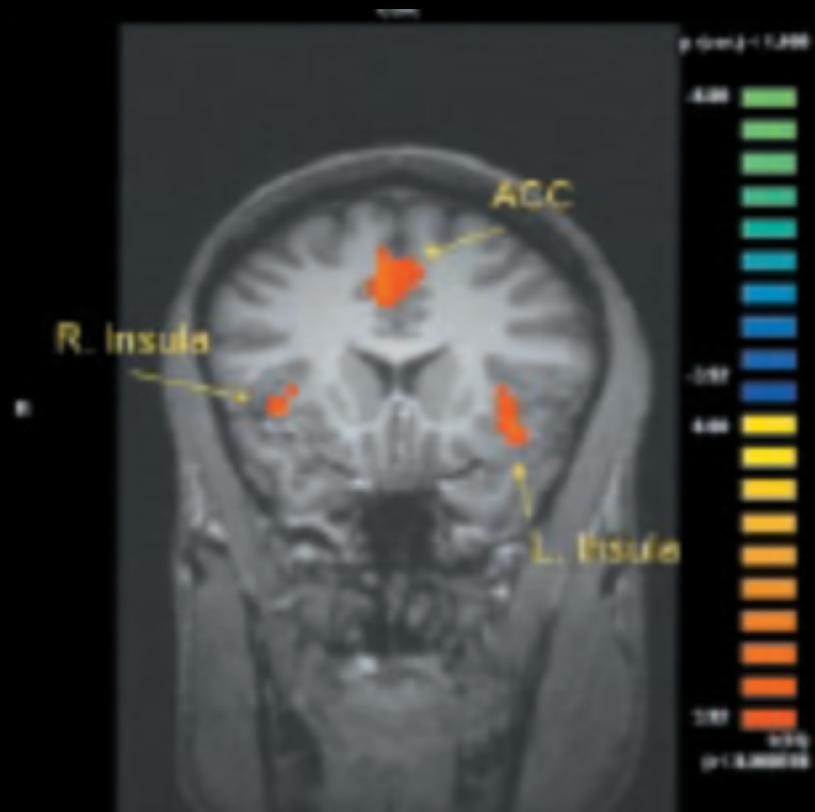
$$\frac{\text{LeftReward}}{\text{LeftReward} + \text{RightReward}} = \text{FiringRate}.$$

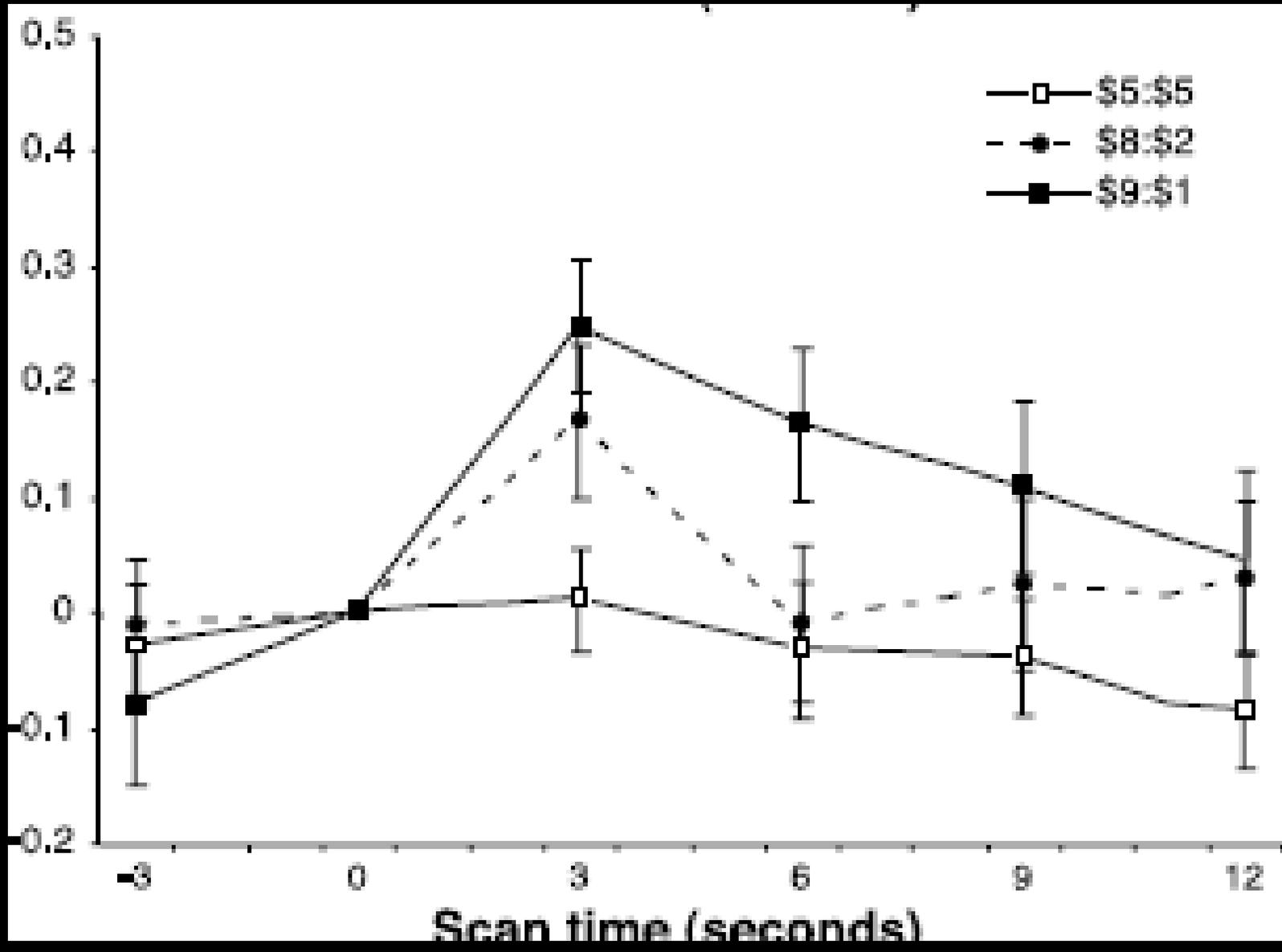
- This study found that the lateral intraparietal cortex (LIP) in monkeys is where (a form of) expected utility calculation takes place



The Ultimatum Game









Huygens, 1657

Expected Value = Value x Probability

The Problem with Value...



Expected Value = Value x Probability

The Problem with Probability...



1 in 13.3 million

chance of **contracting Ebola in America** this year
(based on a model of 12 imported cases of Ebola
in the course of a year)



1 in 11 million

chance of **dying in a plane crash**
for an American this year



1 in 9.6 million

chance of **dying from a lightning strike**
for an American this year



1 in 5.2 million

chance of **dying from a bee sting**
for an American this year



1 in 3.7 million

chance of being **killed by a shark**
in your lifetime (worldwide)



1 in 9100

chance of being **killed in a car accident**
in America this year

The Problem with Hagens

Exploration versus Exploitation

Another problem with Huygens...



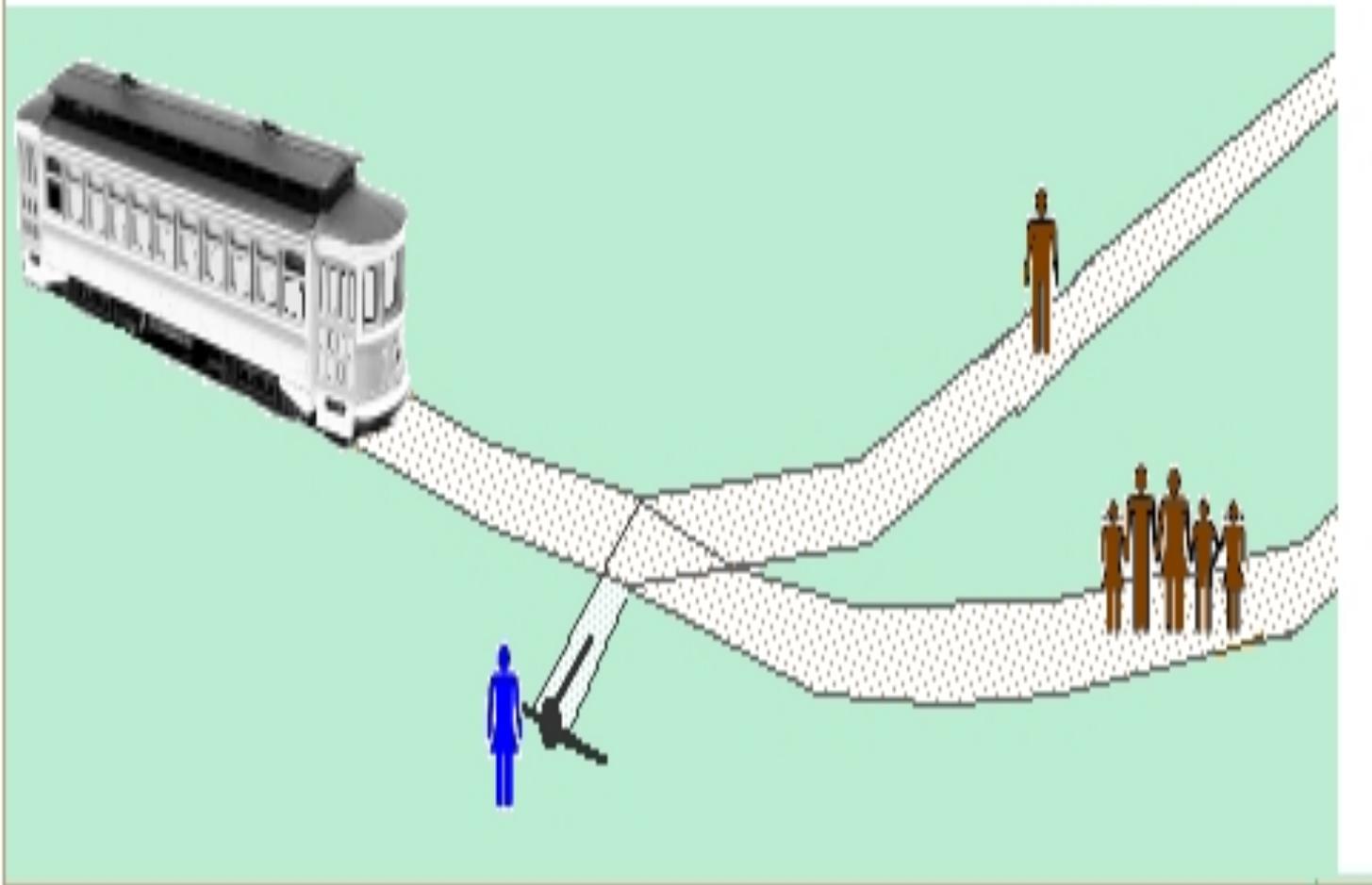


In law a man is guilty when he violates the rights of others. In ethics he is guilty if he only thinks of doing so.

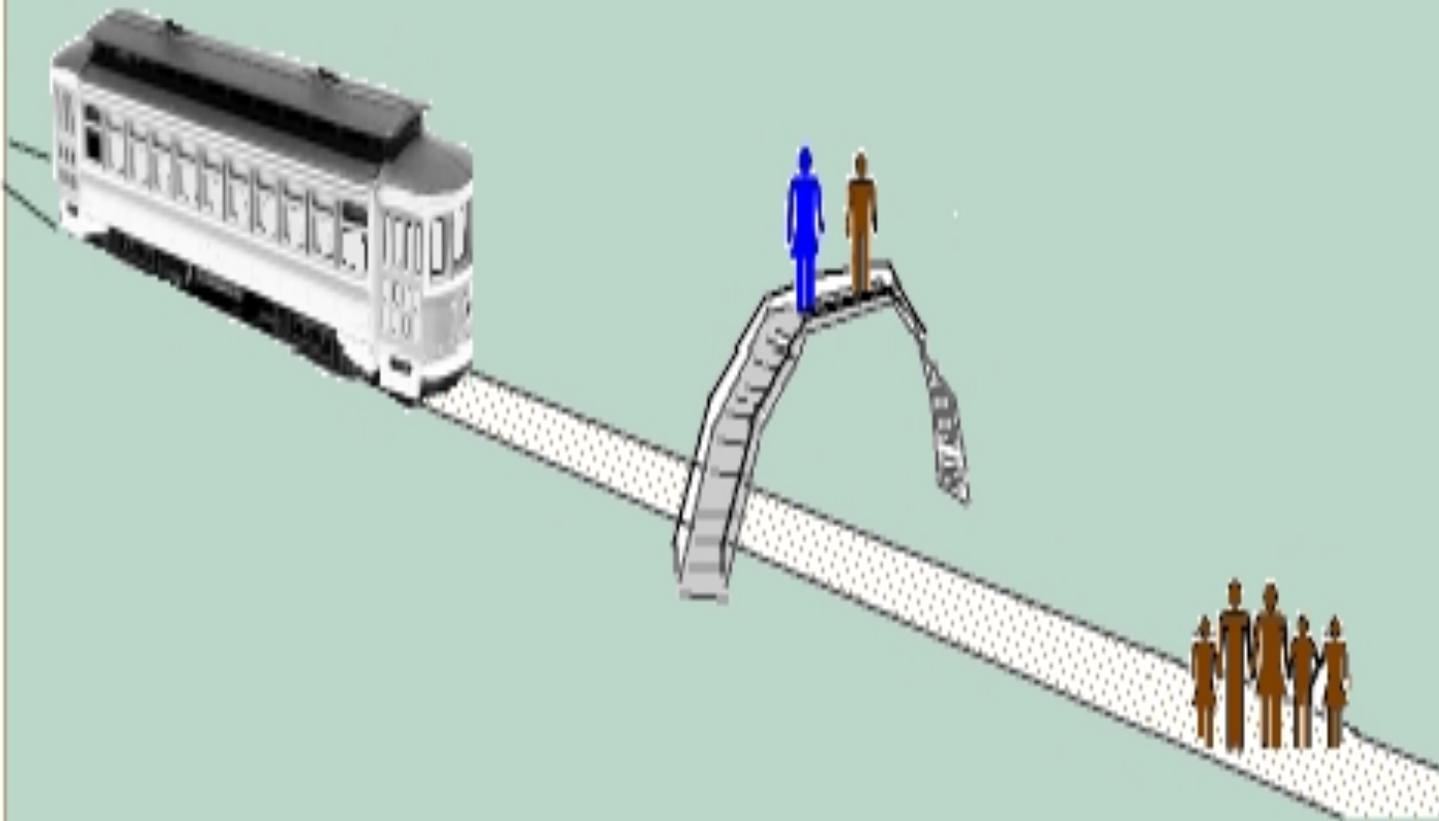
(Immanuel Kant)

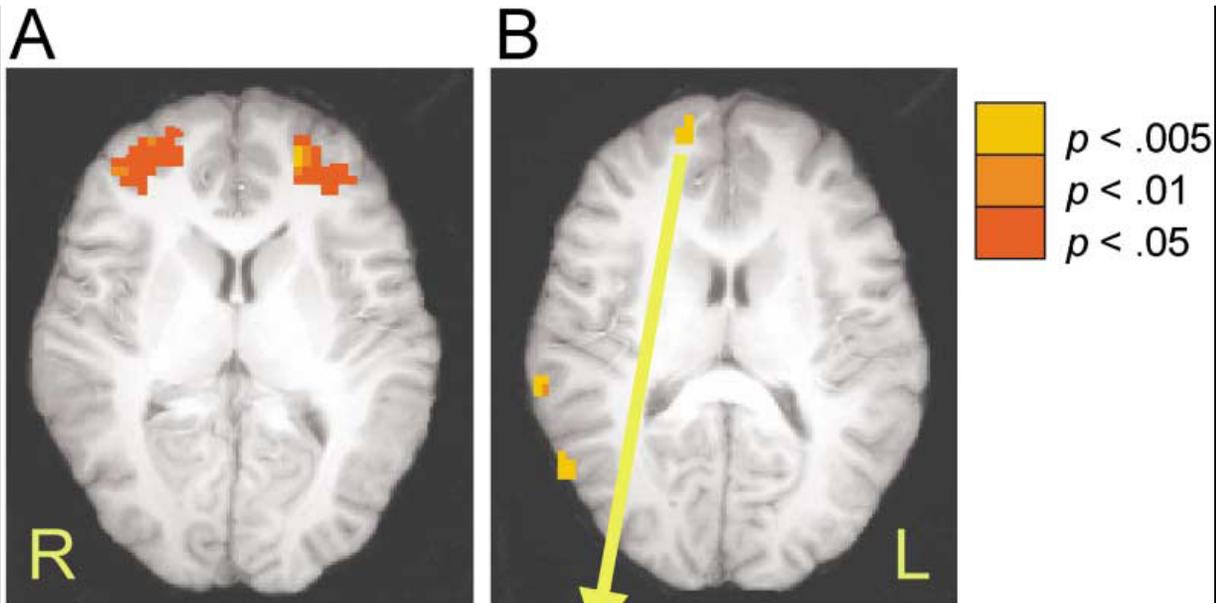
izquotes.com

The Trolley Dilemma

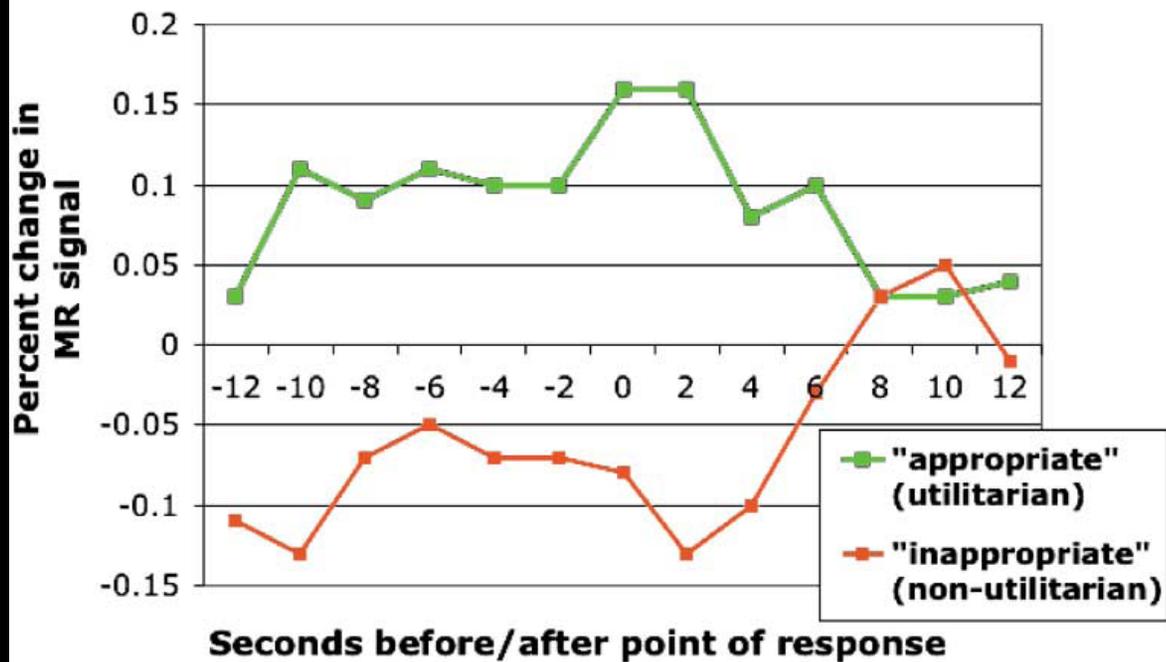


The Footbridge Dilemma





C **Right anterior DLPFC:**
Utilitarian vs. non-utilitarian moral judgment



You and your childhood friend have the dream job. Hard work and persistence has you both in positions of management. For whatever reason, your friend's attitude takes a turn for the worse and he makes a very questionable decision, putting five other people's jobs in jeopardy. Your boss does not suspect your friend is to blame. His mistake will cost five people their jobs if you don't step forward with what the truth. Either...

A) Explain to your boss the truth, and save the five people's jobs or...



B) Remain silent and let the five innocent coworkers take the blame but your friend's job remains safe.



Another view on decision making

System I
"Fast"

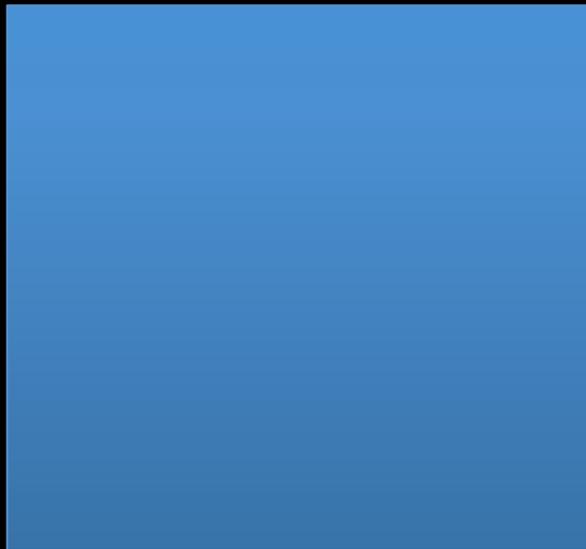


System II
"Slow"

Kahneman (2011)

$$2 + 2 =$$

“bread and ...”

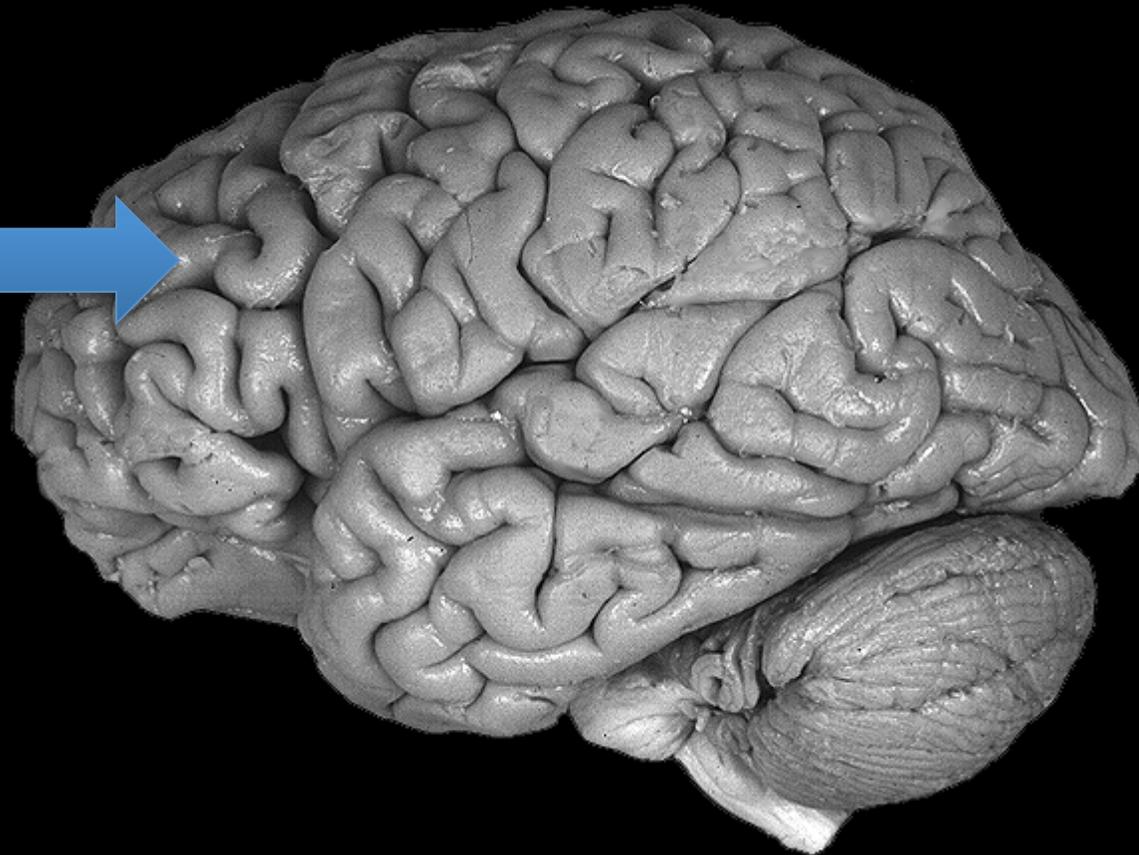


$$13678 / 13 =$$

“the third highest mountain in BC is ...”



System II



System I ?

My Laboratory



1st dorsal

2-

3-

4-

5-

6-

7-

DR. **HOUSE** M.D.

A Universal Model of Diagnostic Reasoning

Pat Croskerry, MD, PhD

Abstract

Clinical judgment is a critical aspect of physician performance in medicine. It is essential in the formulation of a diagnosis and key to the effective and safe management of patients. Yet, the overall diagnostic error rate remains unacceptably high. In more than four decades of research, a variety of approaches have been taken, but a consensus approach toward diagnostic decision making has not emerged.

In the last 20 years, important gains have been made in psychological research on

human judgment. Dual-process theory has emerged as the predominant approach, positing two systems of decision making, System 1 (heuristic, intuitive) and System 2 (systematic, analytical). The author proposes a schematic model that uses the theory to develop a universal approach toward clinical decision making. Properties of the model explain many of the observed characteristics of physicians' performance. Yet the author cautions that not all medical reasoning and decision making falls neatly into one or

the other of the model's systems, even though they provide a basic framework incorporating the recognized diverse approaches. He also emphasizes the complexity of decision making in actual clinical situations and the urgent need for more research to help clinicians gain additional insight and understanding regarding their decision making.

Acad Med. 2009; 84:1022–1028.



READ (80s)

A 38 yr old man, dx 18 yrs ago with ulcerative colitis is referred to your clinic with itching & abnormal liver enzymes.

Medical Hx: Non-smoker. Drinks 1-2 beers/d. No hx of blood transfusions. No IV drug use or high risk sexual behavior. No psych illness. No family hx of liver disease. Has had 3 courses of prednisone for ulcerative colitis flares which happen approximately every 6 yrs.

Recent Hx: Completed course of corticosteroids (prednisone) 6 months ago. Complains of mild, generalized itching for past 3 months. No skin rash noted. Taking Asacol (mesalamine) 3g/d for ulcerative colitis maintenance.

Assessment: No diabetes, joint pains or lung disease.

Physical exam normal. Normal BMI. Has 1 soft non-bloody BM/d.

Eating well. No abdominal pain. Ultrasound reveals normal gallbladder with no biliary dilatation.

ALT 45 (7-40)	AST 32 (5-35)	Alk Phos 536 (30-145)	GGT 540 (20-35)	INR 1.0 (0.9-1.1)
Total Bili 12 (5-22)	Hgb 155 (140-180)	WBC 9.1 (3.5-12)	PLT 180 (150-400)	

MCQ (20s)

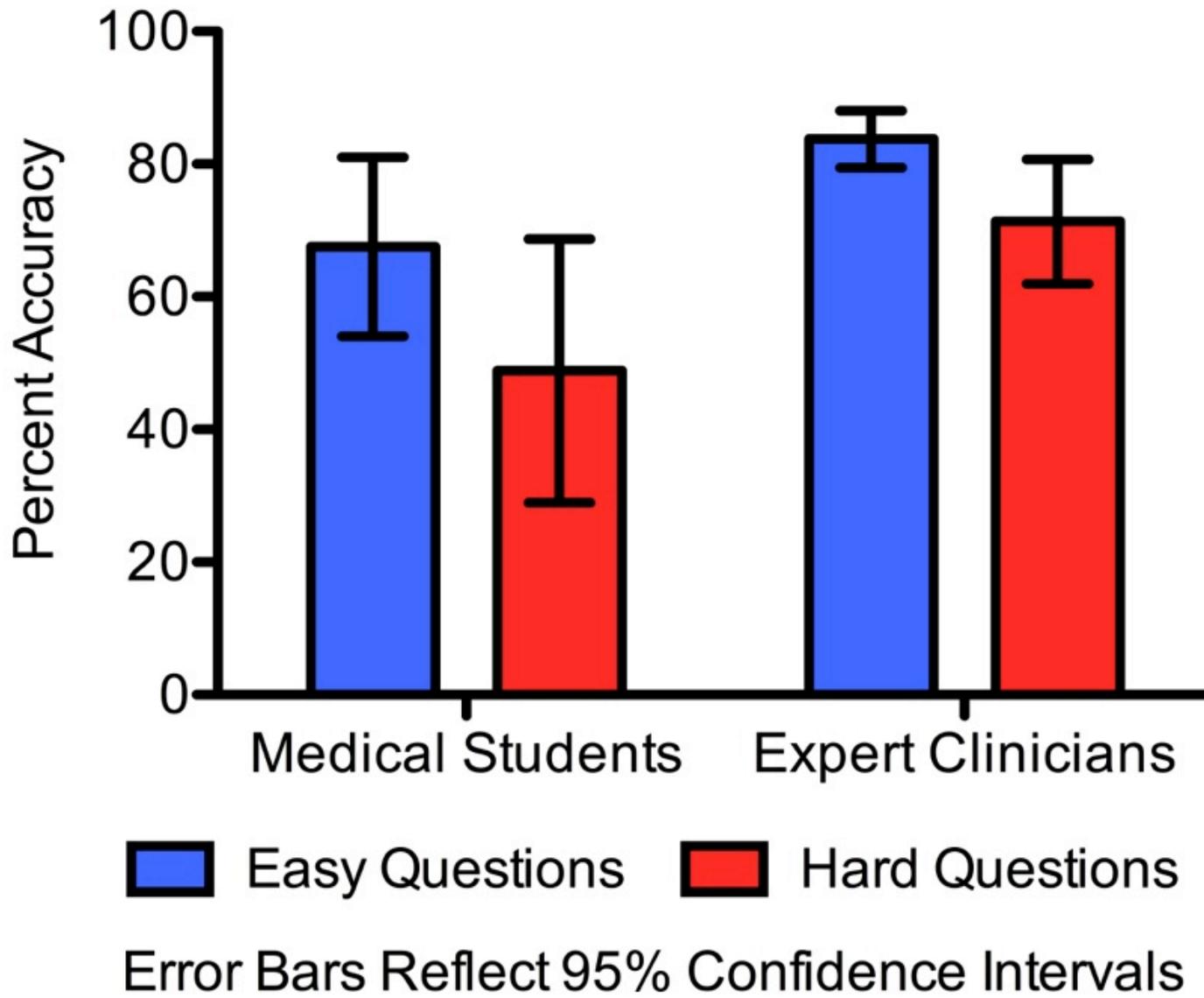
What is the most likely diagnosis?

- A. Primary biliary cirrhosis
- B. Viral Hepatitis B
- C. Cholelithiasis
- D. Primary sclerosing cholangitis

Feedback (20s)

What is the most likely diagnosis?

- A. Primary biliary cirrhosis
- B. Viral Hepatitis B
- C. Cholelithiasis
- D. Primary sclerosing cholangitis



READ (80s)

A 38 yr old man, dx 18 yrs ago with ulcerative colitis is referred to your clinic with itching & abnormal liver enzymes.

Medical Hx: Non-smoker. Drinks 1-2 beers/d. No hx of blood transfusions. No IV drug use or high risk sexual behavior. No psych illness. No family hx of liver disease. Has had 3 courses of prednisone for ulcerative colitis flares which happen approximately every 6 yrs.

Recent Hx: Completed course of corticosteroids (prednisone) 6 months ago. Complains of mild, generalized itching for past 3 months. No skin rash noted. Taking Asacol (mesalamine) 3g/d for ulcerative colitis maintenance.

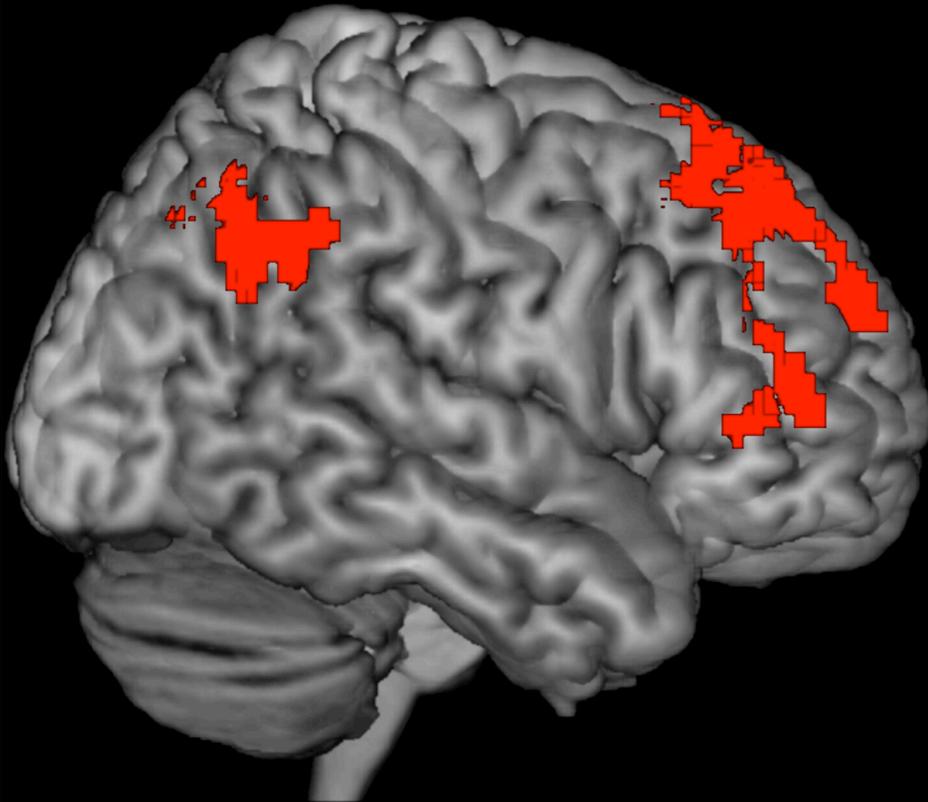
Assessment: No diabetes, joint pains or lung disease.

Physical exam normal. Normal BMI. Has 1 soft non-bloody BM/d.

Eating well. No abdominal pain. Ultrasound reveals normal gallbladder with no biliary dilatation.

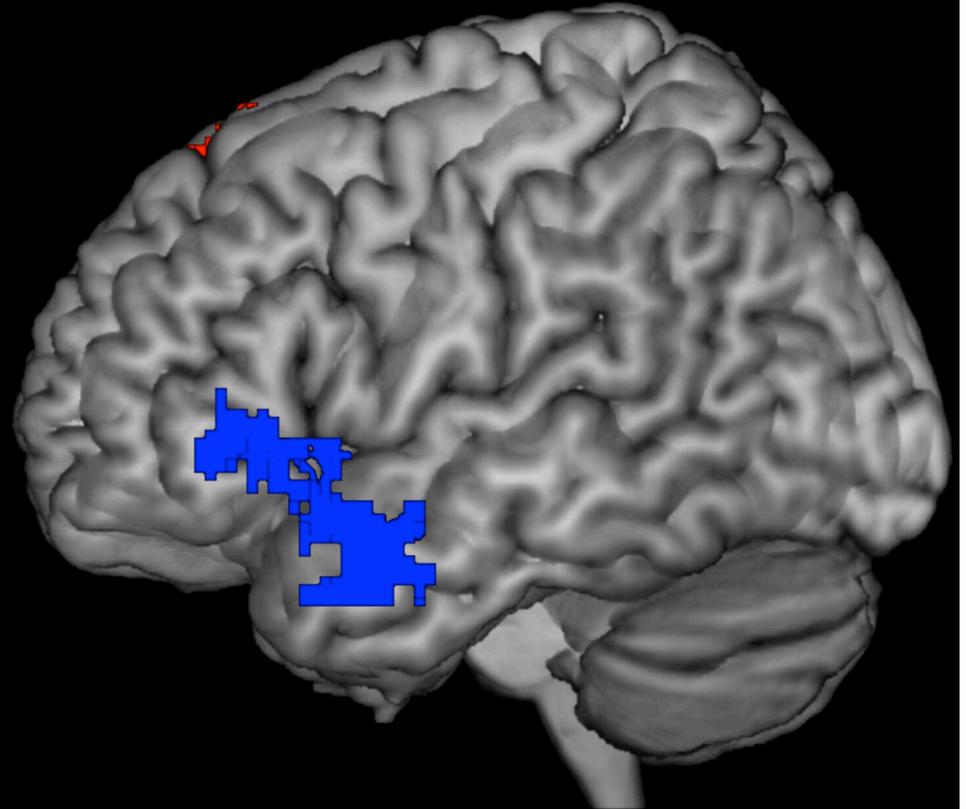
ALT 45 (7-40)	AST 32 (5-35)	Alk Phos 536 (30-145)	GGT 540 (20-35)	INR 1.0 (0.9-1.1)
Total Bili 12 (5-22)	Hgb 155 (140-180)	WBC 9.1 (3.5-12)	PLT 180 (150-400)	

Right



Experts
Holistic, Experience Based Imagery

Left

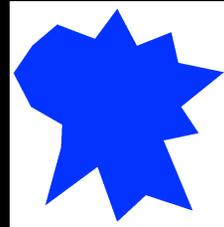
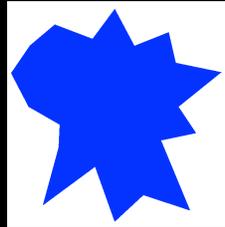


Novices
Analytic, Book Based Knowledge

Electroencephalographic Evidence for System I and System II

Trial Order

+



+

"Correct"

C

400-600ms

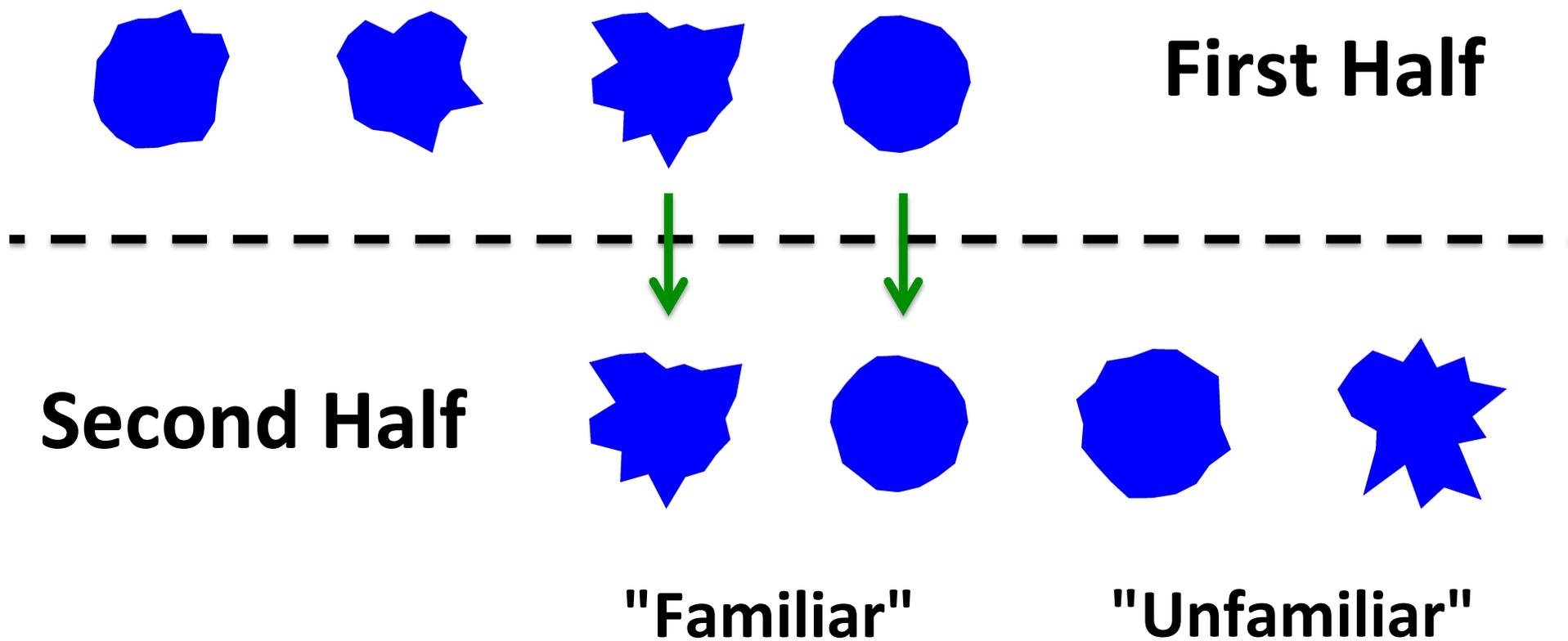
800-1200ms

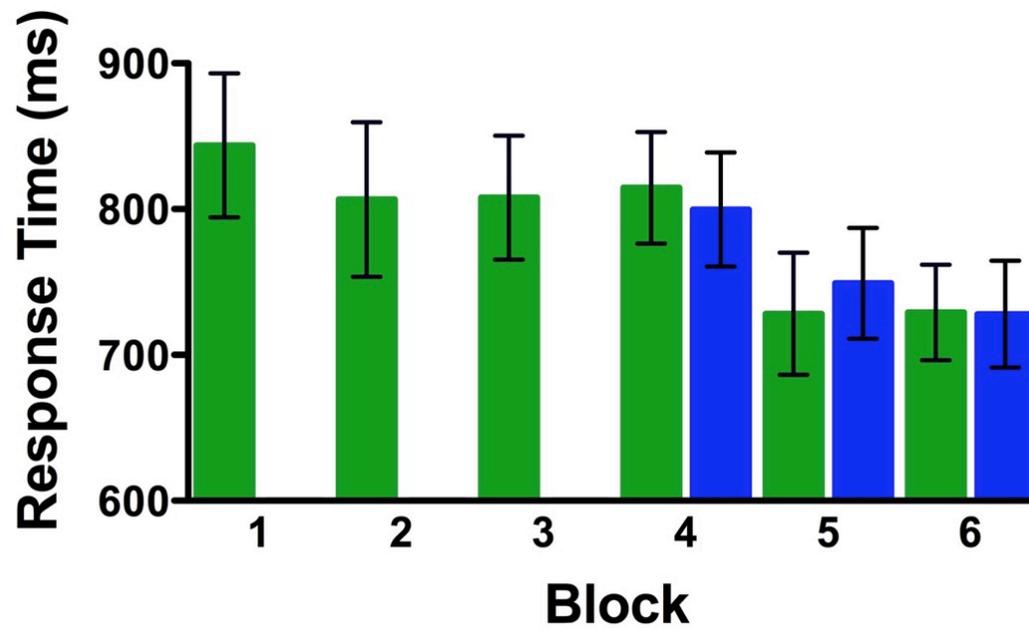
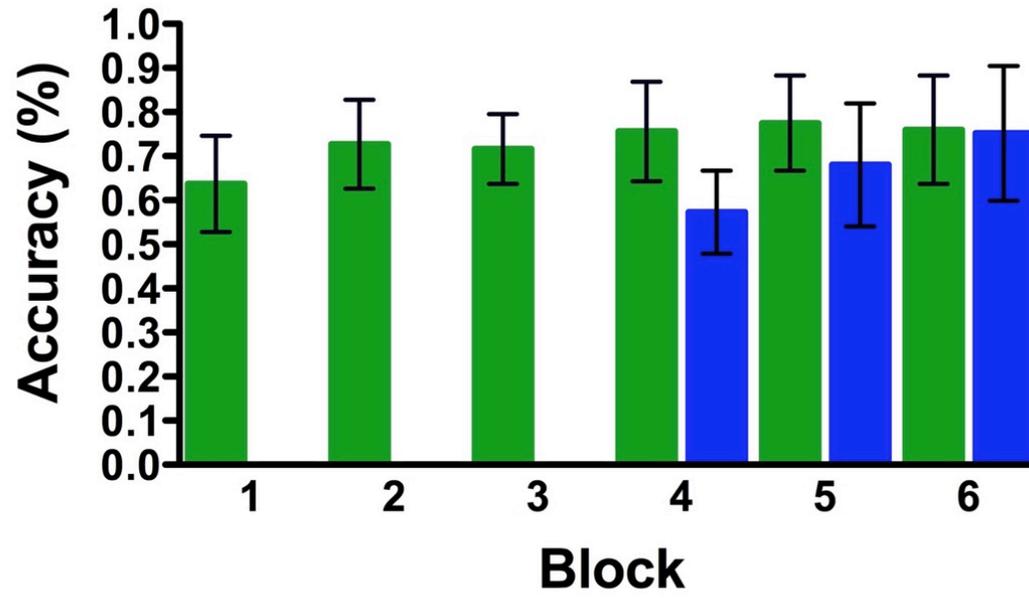
700-1000ms

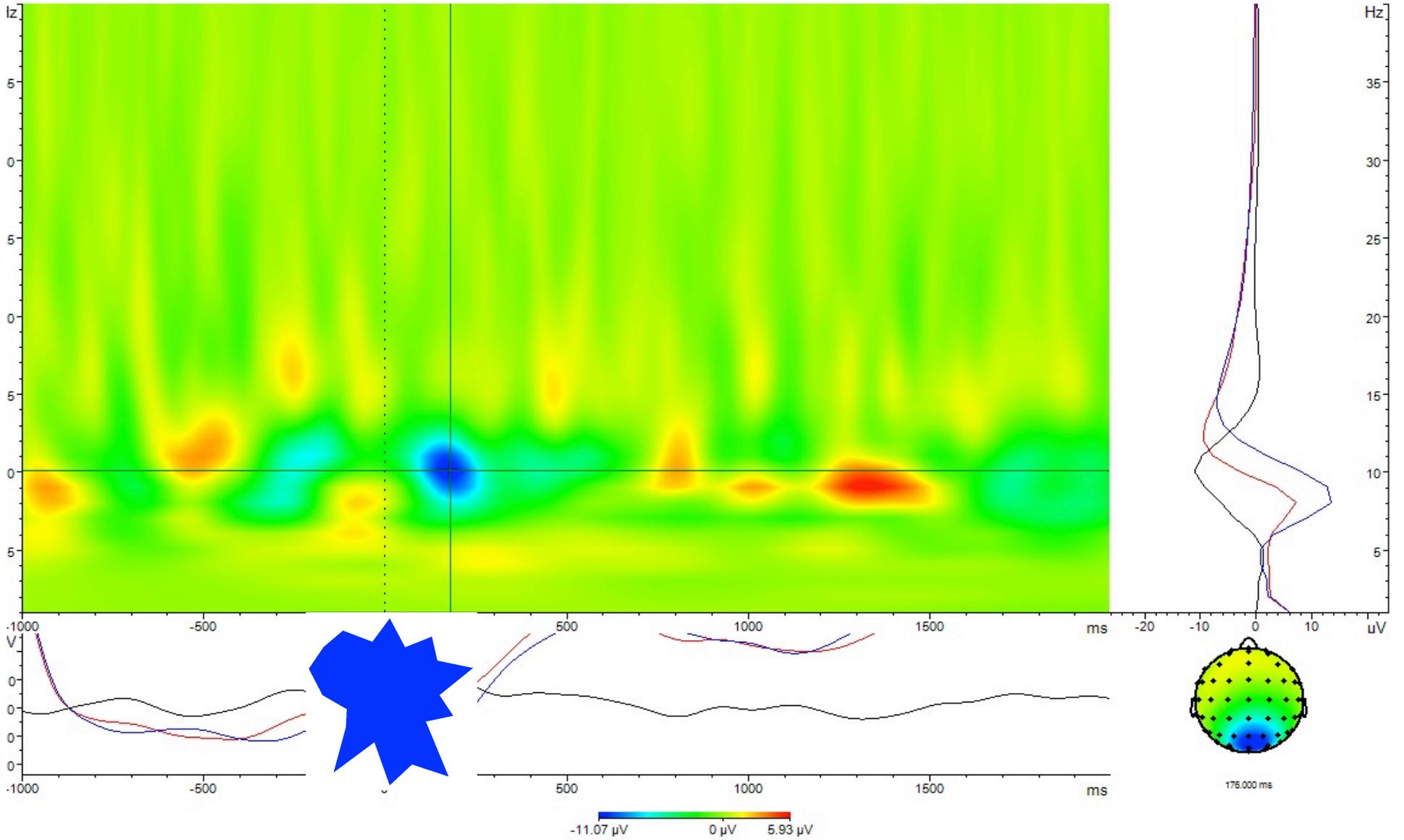
400-600ms

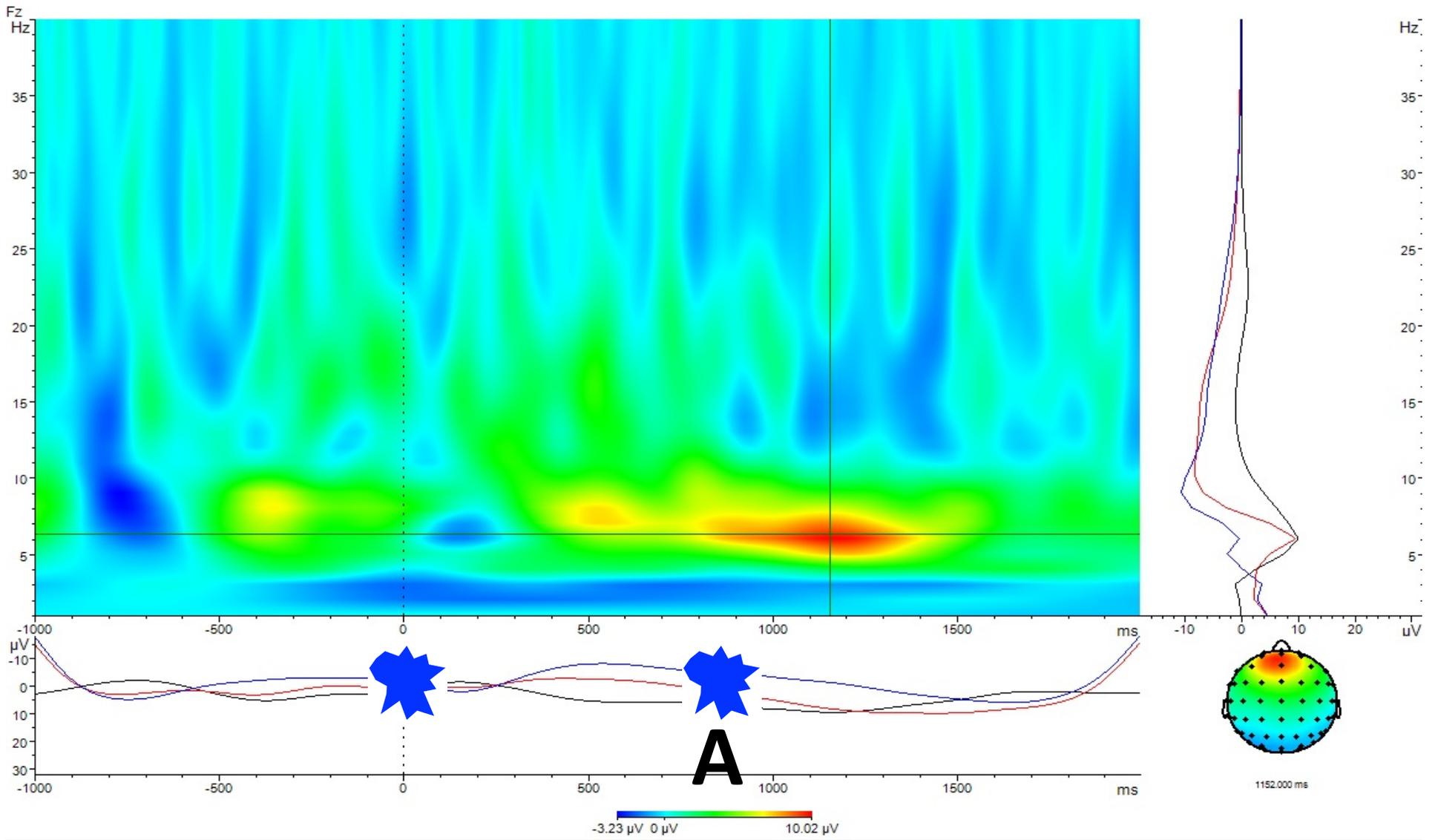
1000 ms

Block Order









Ownership

+



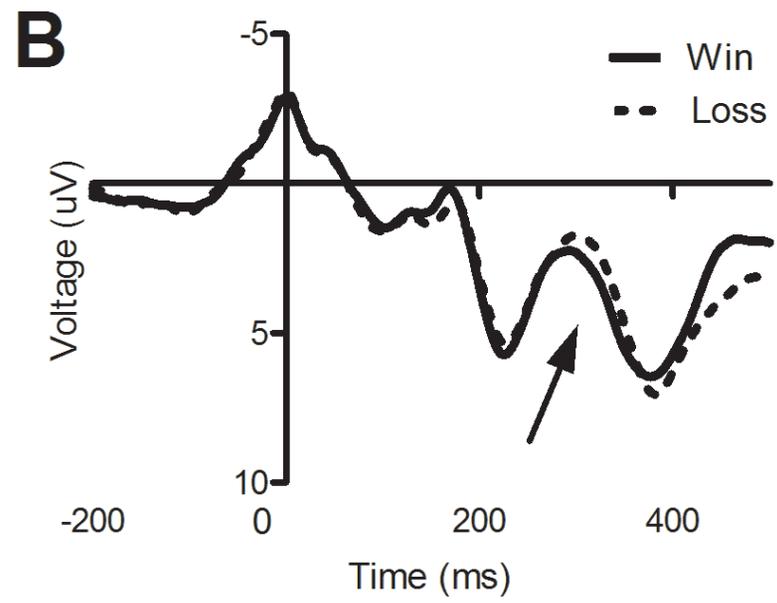
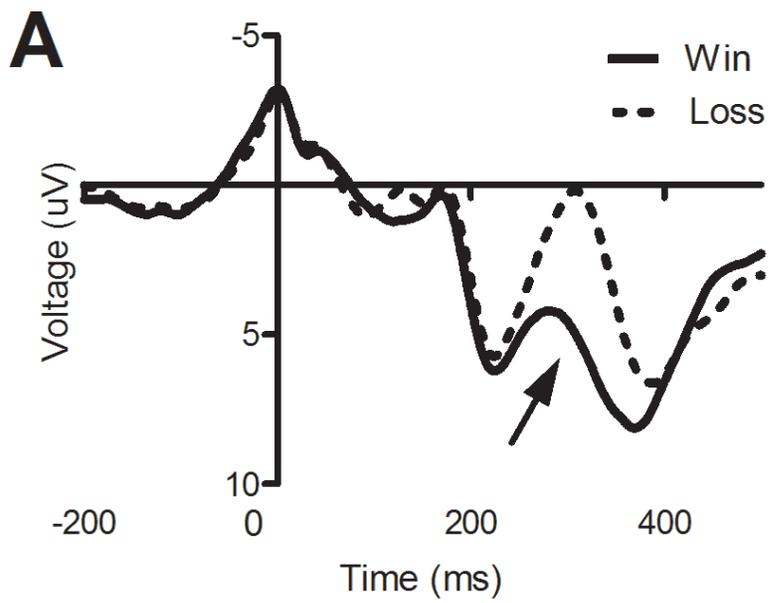
Krigolson et al., 2013



Krigolson et al., 2013

+

Win!



So why do you do the dumb things
you do?

Emotional vs Logical
System I vs System II

Other Factors: Age, Alcohol, etc



Faculty of Medicine
University of Calgary

Kent Hecker
Heather Jamniczky
Pam Hruska

Faculty of Medicine
Dalhousie University

Pat Croskerry

Division of Medical Sciences
University of Victoria

Bruce Wright

Psychology
University of Alberta

Kyle Mathewson

Psychology and Neuroscience
Dalhousie University

Aaron Newman
Ray Klein

Neuroeconomics Lab
University of Victoria

Cameron Hassall



The Neuroeconomics Laboratory
at Dalhousie University

