Neuroeconomics
New Approaches to Risky Decision Making

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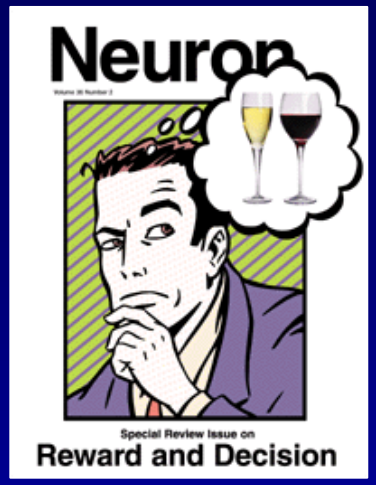
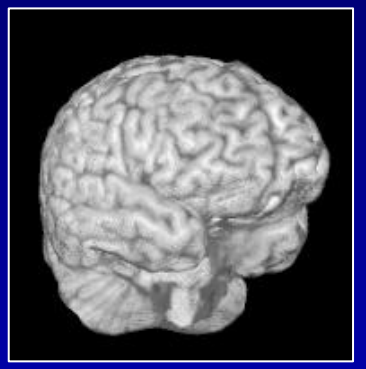
Groups

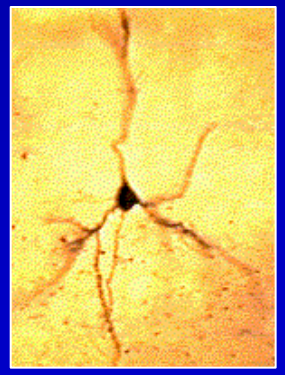


Behavior



Systems

Genes



Cells

Picture of DNA courtesy of Paul Thiessen
www.chemicalgraphics.com

Taxonomies of Decision Making

- **Psychoanalytic: Drive theories of motivation (Freud's Pleasure Principle)**
- **Behaviorist: Classical and operant conditioning**
- **Computational: AI & Machine learning**
- **Economic: Expected Utility (rational choice theory, satisficing)**
- **Sociopolitical: Smith, Marx, Weber, etc.**

Jeremy Bentham (1748-1832)

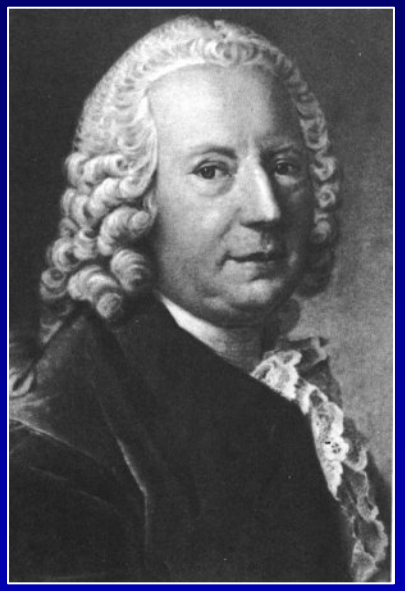
Utility

"By the principle of utility is meant that principle which approves or disapproves of every action whatsoever, according to the tendency which it appears to have to augment or diminish the happiness of the party whose interest is in question…"

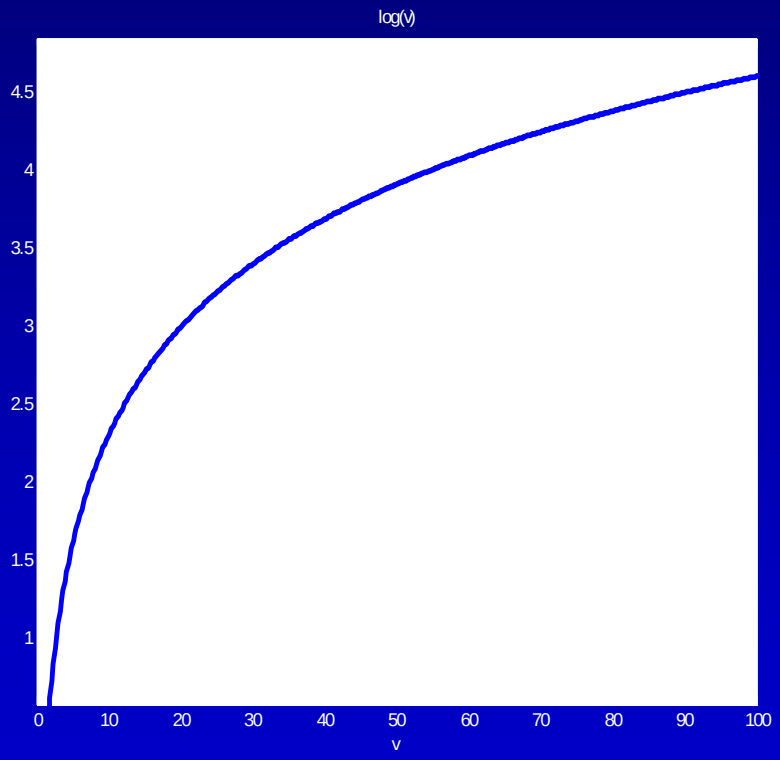
"By utility is meant that property in any object, whereby it tends to produce benefit, advantage, pleasure, good, or happiness … or to prevent the happening of mischief, pain, evil, or unhappiness…."

-Jeremy Bentham, "The Principles of Morals and Legislation", 1780

Diminishing Marginal Returns
(Daniel Bernoulli, 1738)



Utility



Value

Expected Utility Theory (EUT)

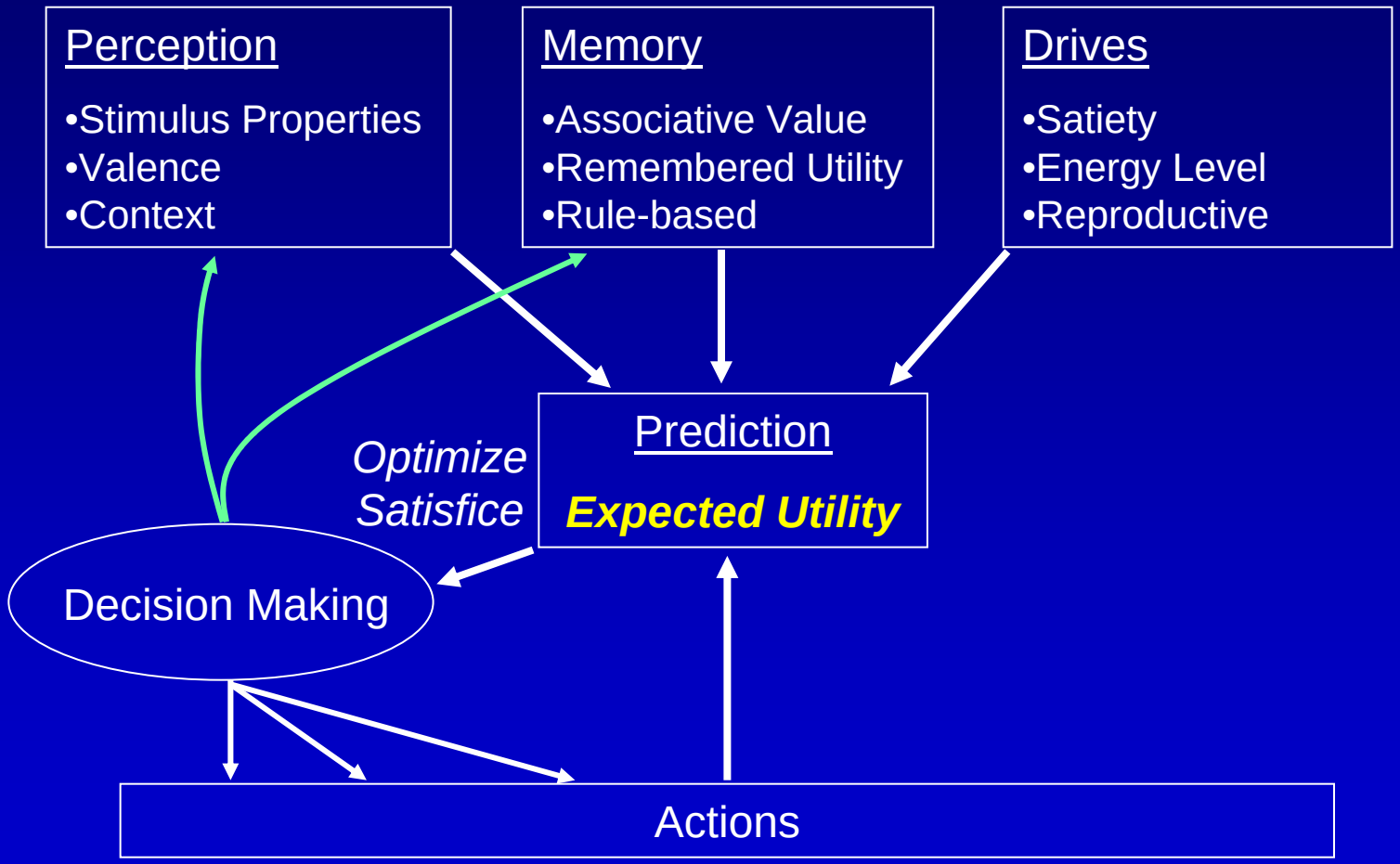
$$E[U] = \sum_i P[x_i]U[x_i]$$

Oskar Morgenstern
(1902-1977)

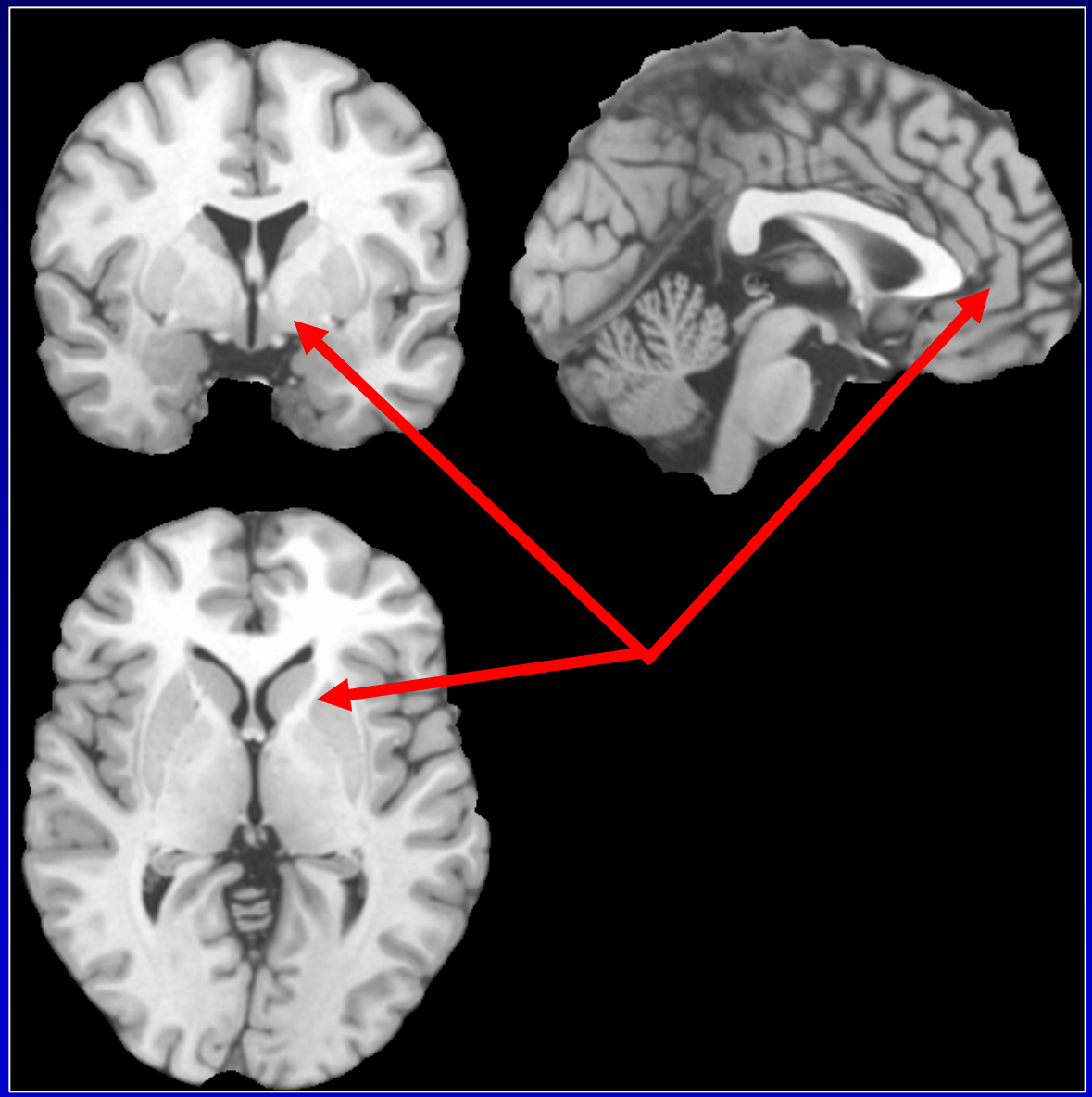
John von Neumann
(1903-1957)

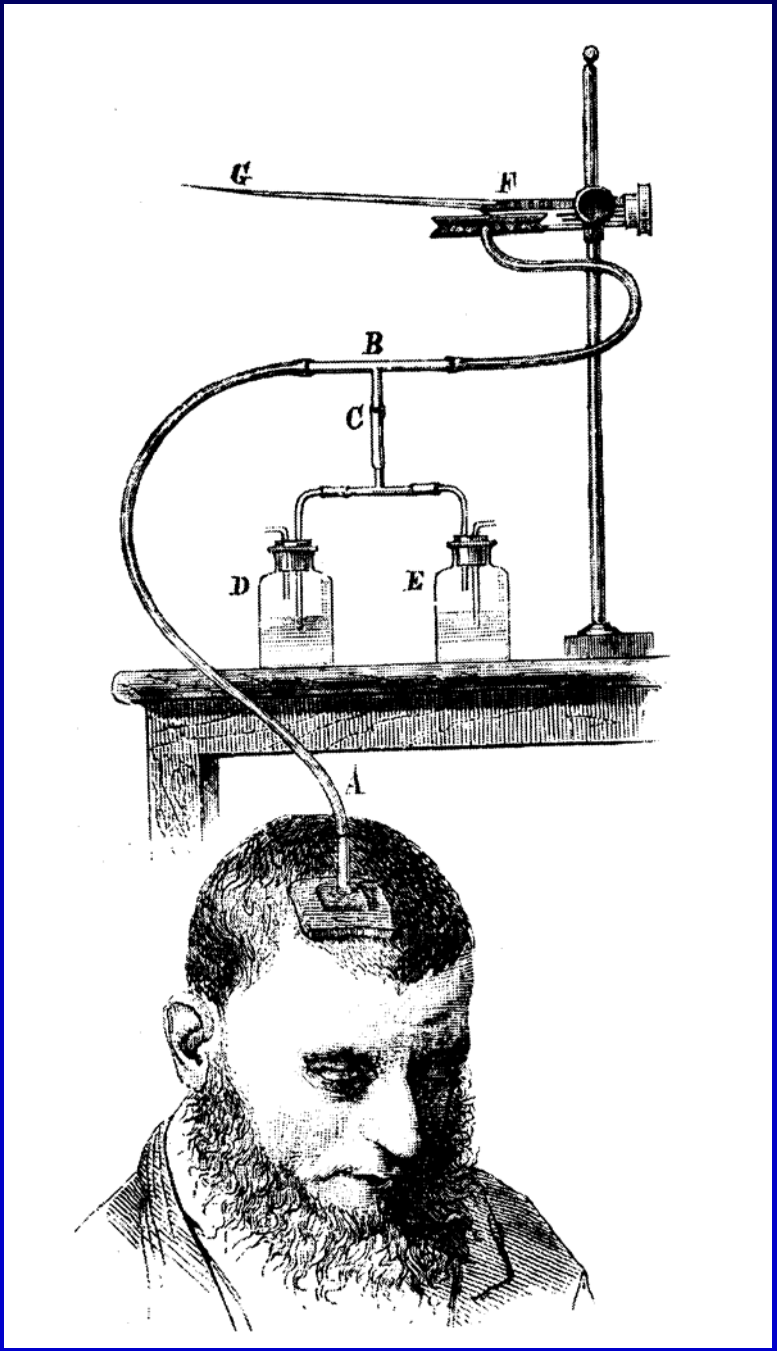
John Nash
(b. 1928)

Neuroeconomic Map of Decision Making

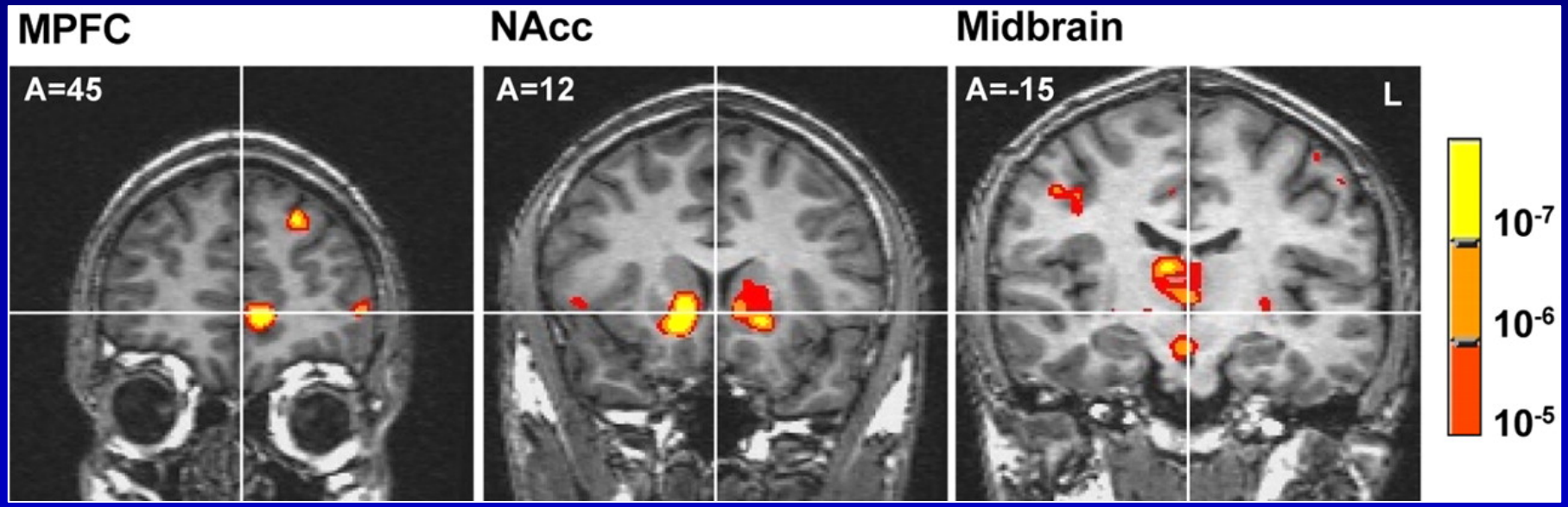


Brain – 3 Views



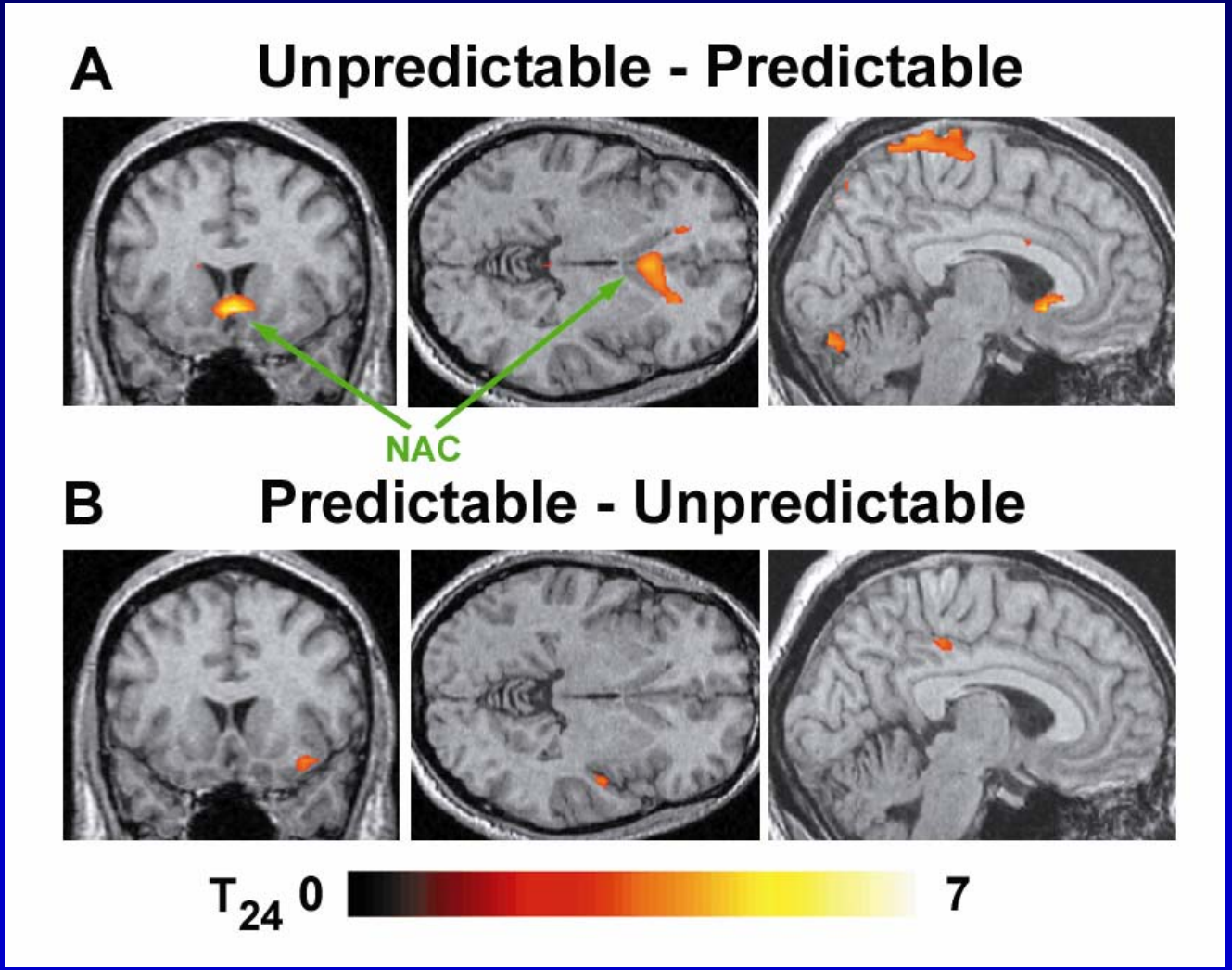

G
F
B
C
D
E
A

Monetary Expected Value



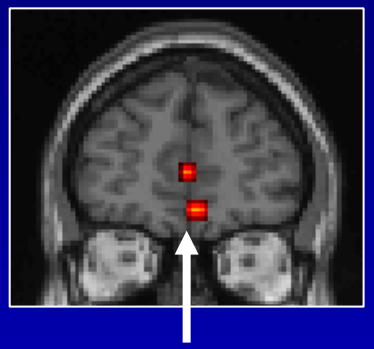
Knutson et al., J Neurosci 2005

Unpredictable Good Tastes

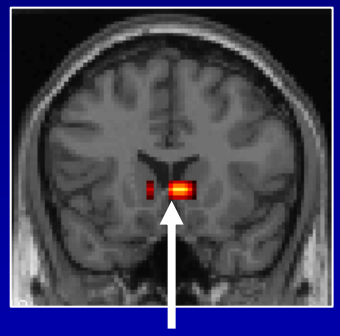


Berns et al., J Neurosci 2001

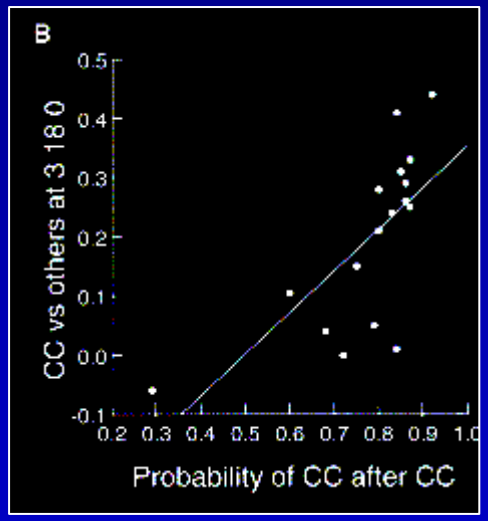
Social Cooperation



OFC



caudate/septum/
Nac/AC

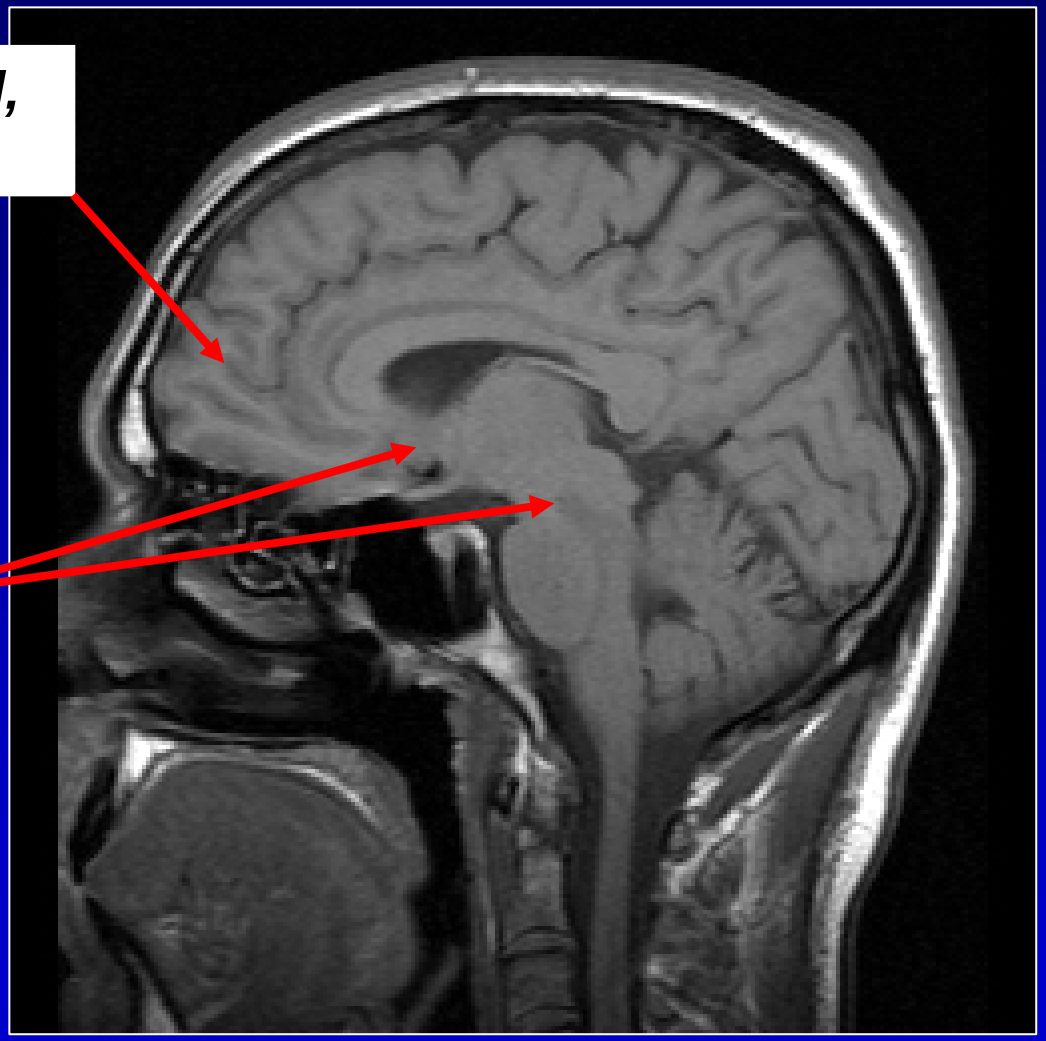


Rilling et al., 2002

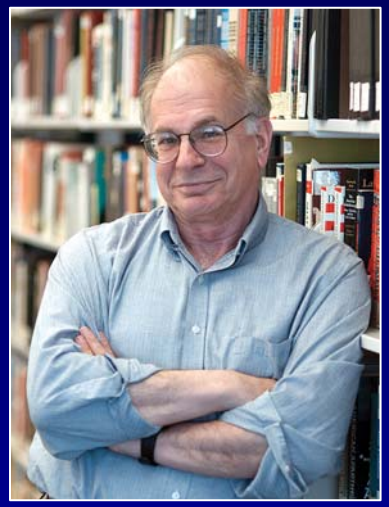
Common Currency Valuation Circuit

Value (reward, value, etc)

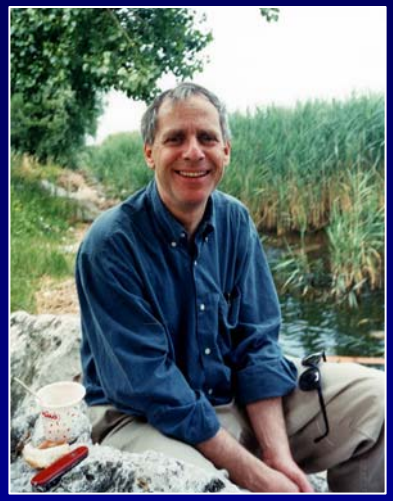
Expected Value (prediction error)



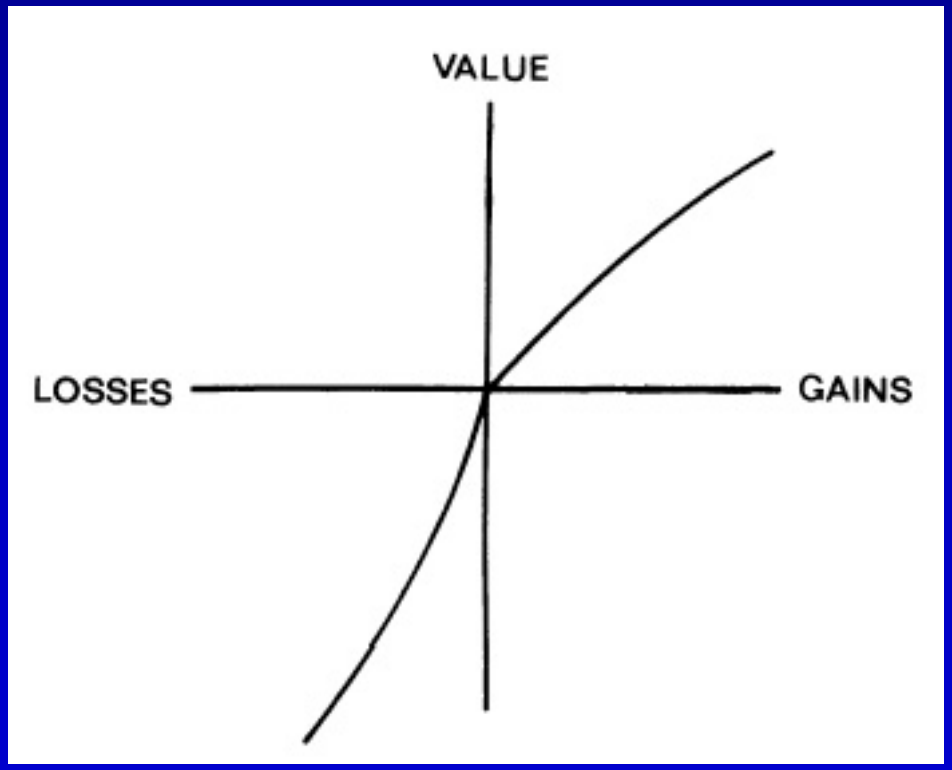
Prospect Theory

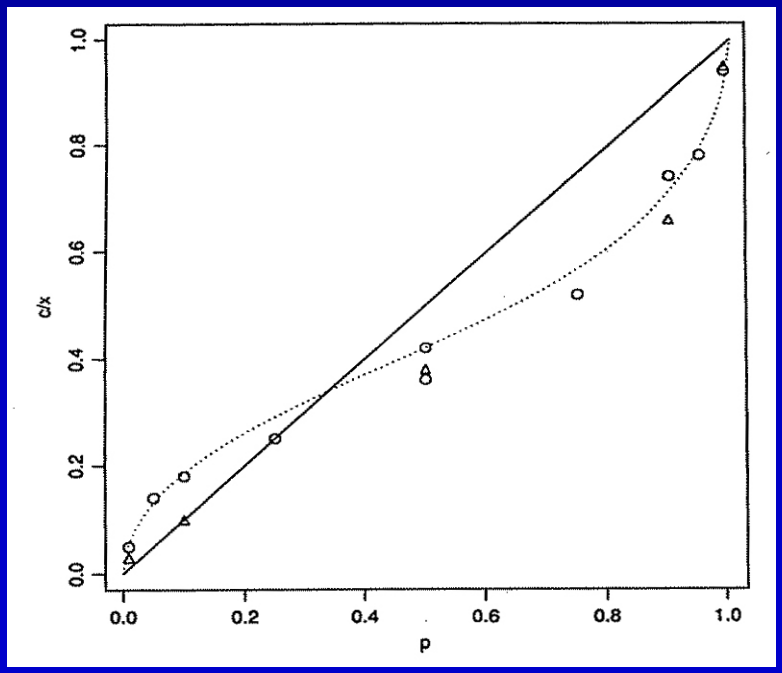


Daniel Kahneman (b. 1934)



Amos Tversky
(1937 – 1996)

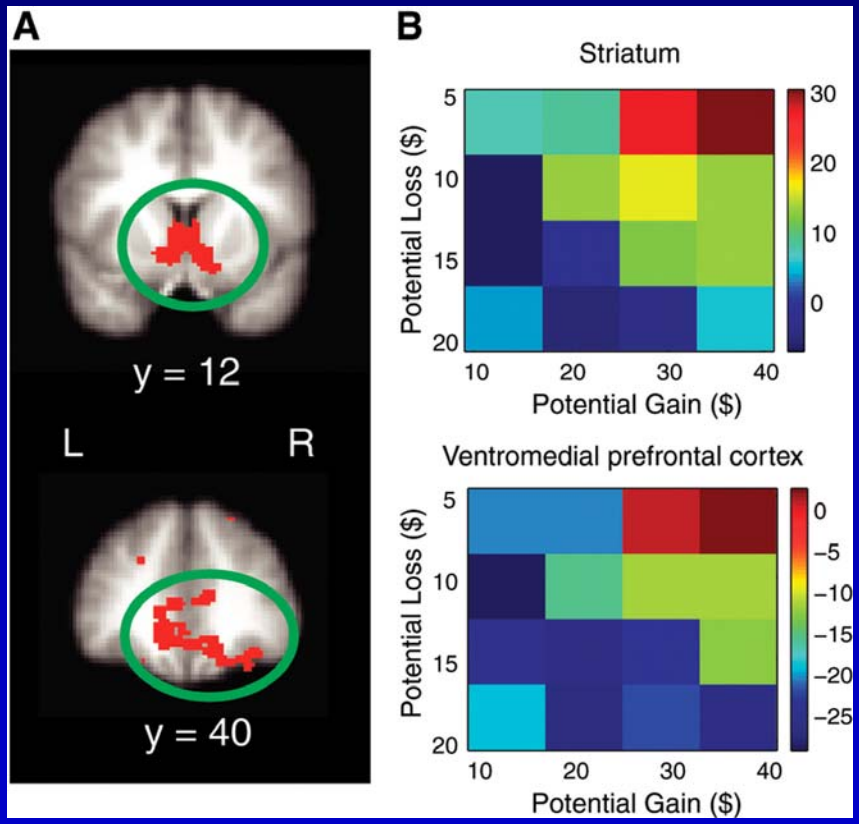




Prospect Theory Implications

- People are loss averse
- Risk-averse for gains
- Risk-loving for losses

Loss Aversion



Tom et al., Science 2007

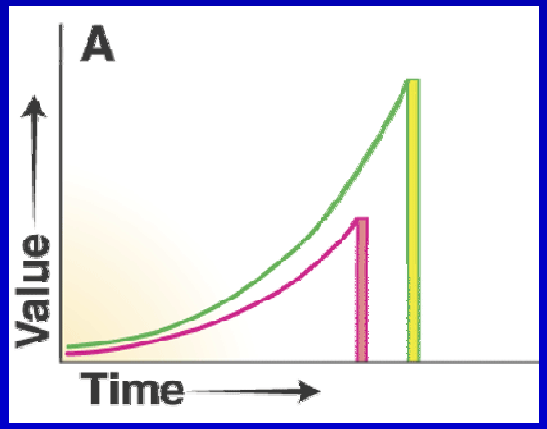
Time and Value

Standard Discounted Utility Theory (Samuelson, 1937):

"The individual discounts future utilities in some simple regular fashion which is known to us":

$$V(x,t) = U(x)e^{-\pi t}$$

Present Value — Utility of Consumption — Exponential Discounting



Ainslie et al, 2004

Time and Value, Part II

Hyperbolic Discounting

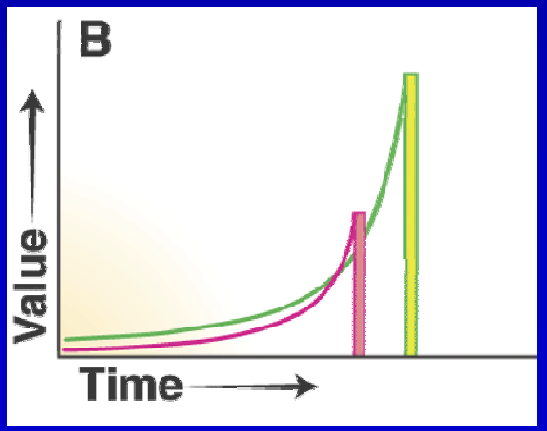
"…people are more sensitive to a given time delay if it occurs sooner rather than later.":

$$V(x,t) = \frac{U(x)}{(1+\alpha t)^{\beta/\alpha}}$$

Utility of Consumption

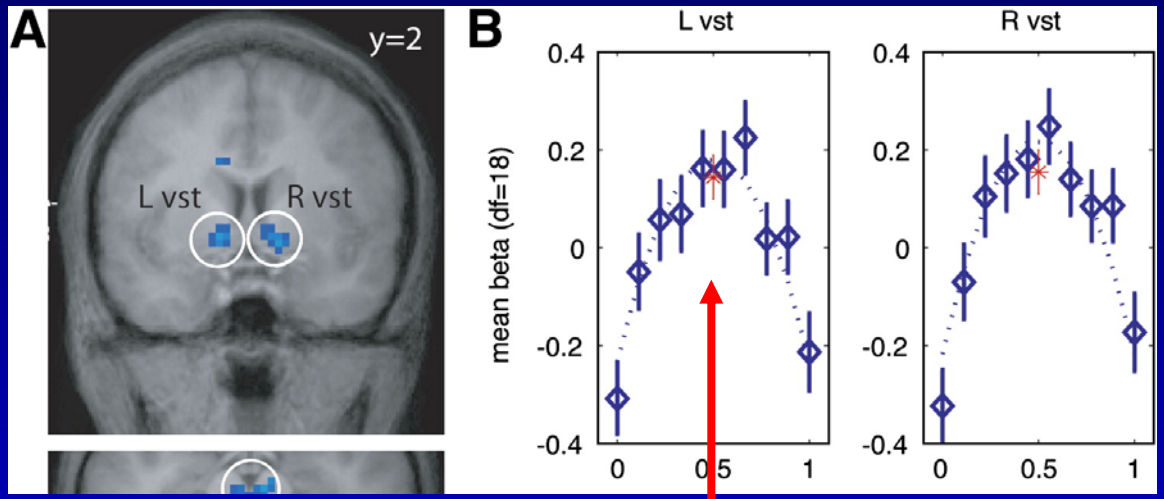
Present Value

Hyperbolic Discounting



Ainslie et al, 2004

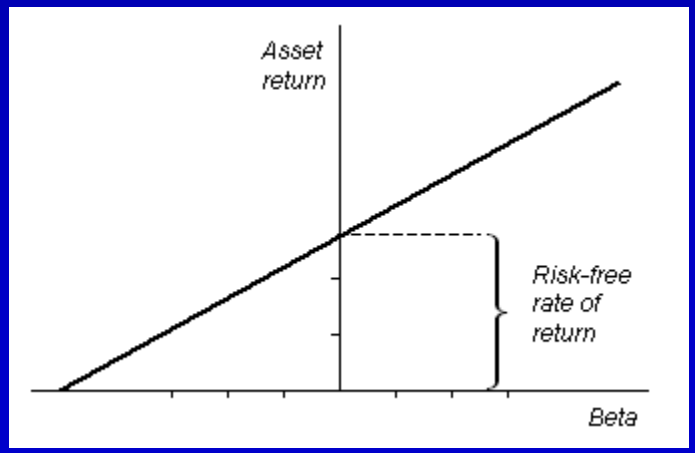
Risk vs. Reward



Preuschoff et al, 2006

Maximal Risk

Capital Asset Pricing Model



Risk = Reward !

Neuroeconomic Summary