Preference: Choice Primitive or Constructed Value?

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Overview of Tutorial

- Mental "construction"
  - Constructed perception

- Constructed preference
  - Evidence from apparent preference reversals
  - Behavioral and neural processes

- Implications for
  - Prediction of behavior
  - Intervention, i.e., behavior change

Mental "Construction"

- One-to-many mapping from objective reality to mental representation
- Applies to
  - Perception (earlier Mike Woodford Tutorial)
  - Inference
  - Preference
- Result of
  - finite processing capacity/constraints
    - attention, working memory
  - combined with complexity of life
    - multiple roles, multiple goals, multiple selves
- Goal-, task- and environment-specific "construction" of best action probably an asset, rather than liability
  - occasional inconsistency the price to pay

Preference as Construction

- Economics sees preference as a primitive that gets revealed or assessed
  - "if (A>B) and (B>C), then (A>C)"
  - Pioneered by Paul Samuelson
    - **Weak Axiom of Revealed Preference (WARP,** 1938)
  - Diagnose degree of risk aversion from set of pairwise choices (e.g., Holt & Laurie, 2002)

- Behavioral decision theory sees preference as an action selection that is "constructed" *(Payne, Bettman, & Johnson, 1992)*
  - No entry in index of Blue Bible (Glimcher & Fehr, 2014), but shows up under synonyms (e.g., "context-dependent choice")
  - Blueprints for how and why of preference construction
    - Signal detection theory and asymmetric loss function
    - Prospect theory
    - Query theory

Perception as Construction

- Absolute vs. relative encoding
  - "Compared to what?"
    - James Thurber story, 3 buckets of water thought exp't
    - Neural adaptation
- For very basic perceptions
  - Just Noticeable Differences (JNDs)
    - Weber's (1834) law: proportional to starting point
- For more complex perceptions
  - Risk as either variance/std vs. Coefficient of variation

Weber (2004) Perception matters: Psychophysics for economists

- Human literature: economics, finance
  - expected utility model
  - risk--return models
    - Capital Asset Pricing Model
- Animal literature: behavioral ecology
  - risk-sensitivity theory
    - energy-budget model
- Common feature of models
  - risk-sensitivity is function of variability of risky option
    - variance (standard deviation) of outcomes
- yet, variability/risk perceived in relative fashion

CV as a measure of risk

- Coefficient of variation (CV)
  - standard deviation / expected value
  - measure of relative risk
    - risk per unit of return
  - psychologically (psychophysically) plausible
    - Weber's law
      - difference in magnitude required to perceive two stimuli as different is proportional to absolute stimulus magnitude
  - dimensionless
  - used in many applied areas
    » engineering, medicine, agricultural economics, etc.

Meta-Analysis of Risk Sensitivity in Animals (Shafir, 2000)

- 59 studies of risky foraging decisions
  - constant reward vs. 2-outcome variable reward with equal EV
  - rewards
    - concentration or amount of sucrose, popcorn kernels, seed pellets, mealworms
  - animals
    - wasps, bees, fish, rats, shrews, macaques, birds)
  - energy budget
    - positive in 50 studies
    - negative in 9 studies

- Dependent measure
  - proportion of respondents choosing constant option C (sure-thing) over variable option X

- Should be linear or logistic function of variable option's risk
  - $E[u(X)] = u[EV(X)] - b\,R(X)$
  - for options X and C with equal EV [EV(C)=EV(X)]:
  - $E[u(C)] - E[u(X)] = u[EV(X)] - [u[EV(X)] - b\,R(X)] = b\,R(X)$
  - $p(C) = b\,R(X)$ or
  - $p(C) = e^{E[u(C)]} / \{e^{E[u(C)]} + e^{E[u(X)]}\} = 1 / \{1 + e^{-bR(X)}\}$

- Yet, when risk = variance plotted against proportion sure-thing choices for studies that had same type of rewards, NO relationship
- However, beautiful relationship when risk = CV!

Shafir (2004)

for positive energy budgets
$p(C) = 0.53 + 0.001\ CV$
$R^2 = 0.33$, $p<.0001$

for negative energy budgets
$p(C) = 0.52 - 0.0012\ CV$
$R^2 = 0.42$, $p<.06$

Proportion choice of constant, $\Pr(C)$

Coefficient of variation, CV

Aside: Two paths to CV sensitivity
(Weber, Shafir, & Blais, 2004)

- Perceptual/encoding process
  - Scalar utility theory (Kacelnik & Abreu, 1998)

- Associative learning process
  - Fractional adjustment model (Bush & Mosteller, 1955)
    - Predicts that risk sensitivity should be proportional to CV

Is CV risk-sensitivity "adaptive"?

Prevalence of Zipf's law distribution functions in environment

- $f(i) = (a/i^k)\, b^k$
  - a, b, and k are constants (b usually close to 1, and 1<k<2)
  - i indexes rank order along some continuum
- examples
  - nectar amounts in plant community near Athens, Greece (Petanidou & Smets, 1995)
  - distribution of personal incomes (Pareto)
  - city size, word frequencies, etc.
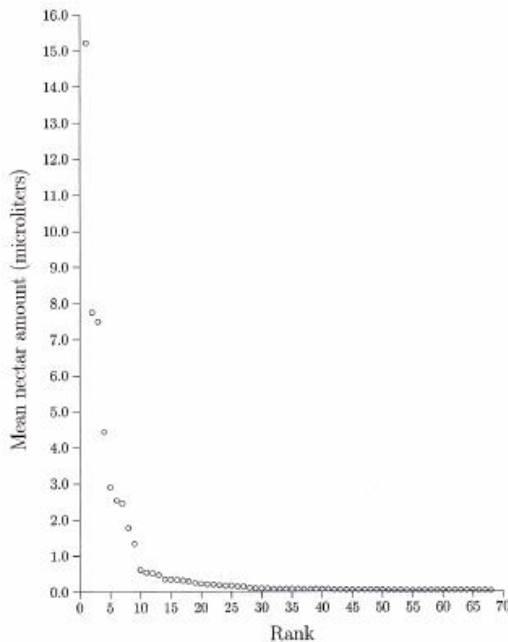
- If objective is to maintain a similar degree of discrimination between all members of a Zipf's law distributed class, then one needs to perceive variability in a relative fashion
  - CV = standard deviation / EV

- Relates to observed Weber's (1834) JND regularity

- Helpful to resolve Rabin's (2000) calibration theorem paradox

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    - Prospect theory
    - Query theory

Preference Construction

- Guided by
  - Internal factors
    - Drive states, goals, values, past experience

  - External factors
    - Transient: momentary environment
    - Chronic: cultural environment

What is "culture"? How does it work?

- A perspective, reinforced by people around us, a set of "glasses" that shape

  - what we see and infer

  - what we fear

  - what we value and try to achieve

  - what tradeoffs we make
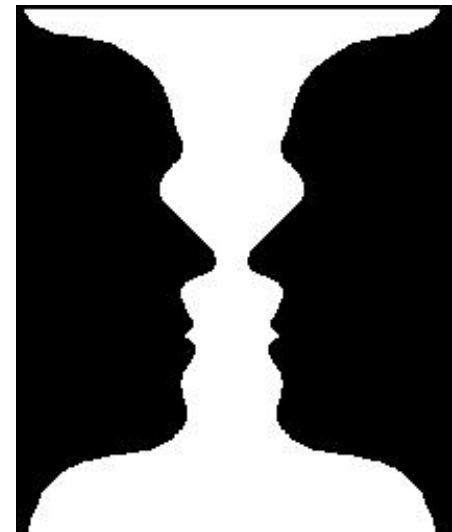
what we see and infer
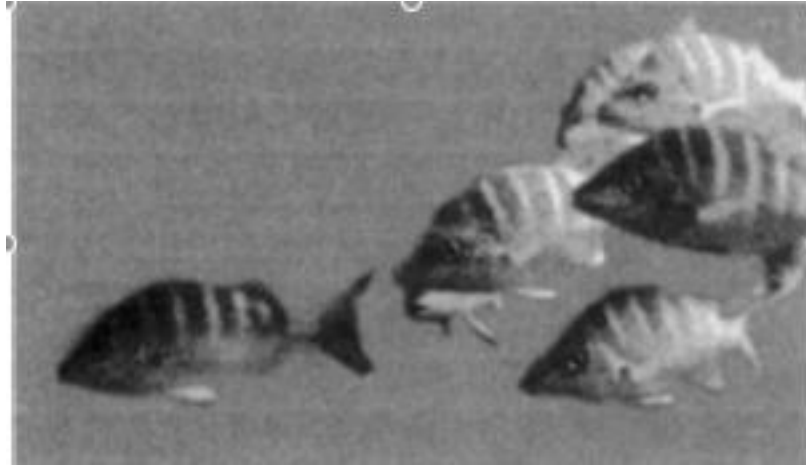
- Americans see the fish leading the group
- Asians see the group chasing the fish

Hong, Y., Morris, M., Chiu, C. & Benet-Martinez, V. (2000). Multicultural minds: a dynamic constructivist approach to culture and cognition, *American Psychologist, 55,* 709-720.

Culture imbues Meaning and Value

Who makes the decisions?

- Rational agents, social planner
  - from economics and statistics
    - calculating optimal judgments and best choice
      - Bayesian belief updating, expected utility maximization
  - little room for individual or cultural differences
    - degree of risk aversion as the only parameter

- Human agents
  - from psychology & neuroscience
    - multiple and conflicting goals
    - different ways / modes of making decisions
      - With head (calculations), heart (emotions), by the book (rules)
  - Plenty of opportunity for inconsistency and apparent preference reversals

Preference Reversals

- P-bet vs. $-bet choice
  - Lichtenstein & Slovic (1971)
    - P-bet: (Win $4.00, .99; Lose $1.00, .01)
    - $-bet: (Win $16.00, .33; Lose $2.00, .67)
    - EVs are the same
    - P-bet chosen, but larger selling price (WTA) for $-bet !
  - Grether & Plott (1979), *American Economic Review*
    - Examined 13 explanations, including "Misspecified Incentives" and "Experimenters were Psychologists"
    - Replicated results, controlling for all economic-theoretical excuses

- Tversky & Thaler (1990), *J of Economic Perspectives*
  - Identify procedure invariance as the culprit (not EU transitivity or independence axiom)

Types of Preference Reversals

- Framing effects
  - Gain vs. loss framing
  - Attribute labeling
- Context effects
  - Asymmetric dominance (Huber, Payne, Puto, 1982)
- Preference elicitation task effects
  - Choice vs. ratings
  - Even when both procedures are incentive compatible (Grether & Plott, 1979)

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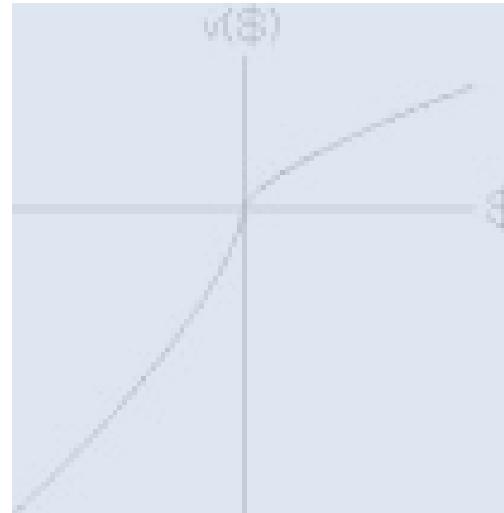
Risky Choice and Prospect Theory

- Psychological extension of or band aid on Expected Utility theory
  - by Kahneman and Tversky (1979) and Tversky & Kahneman (1992)

- Prospects are evaluated by
  - Value function
  - Decision weight function

value

reference point

losses · gains
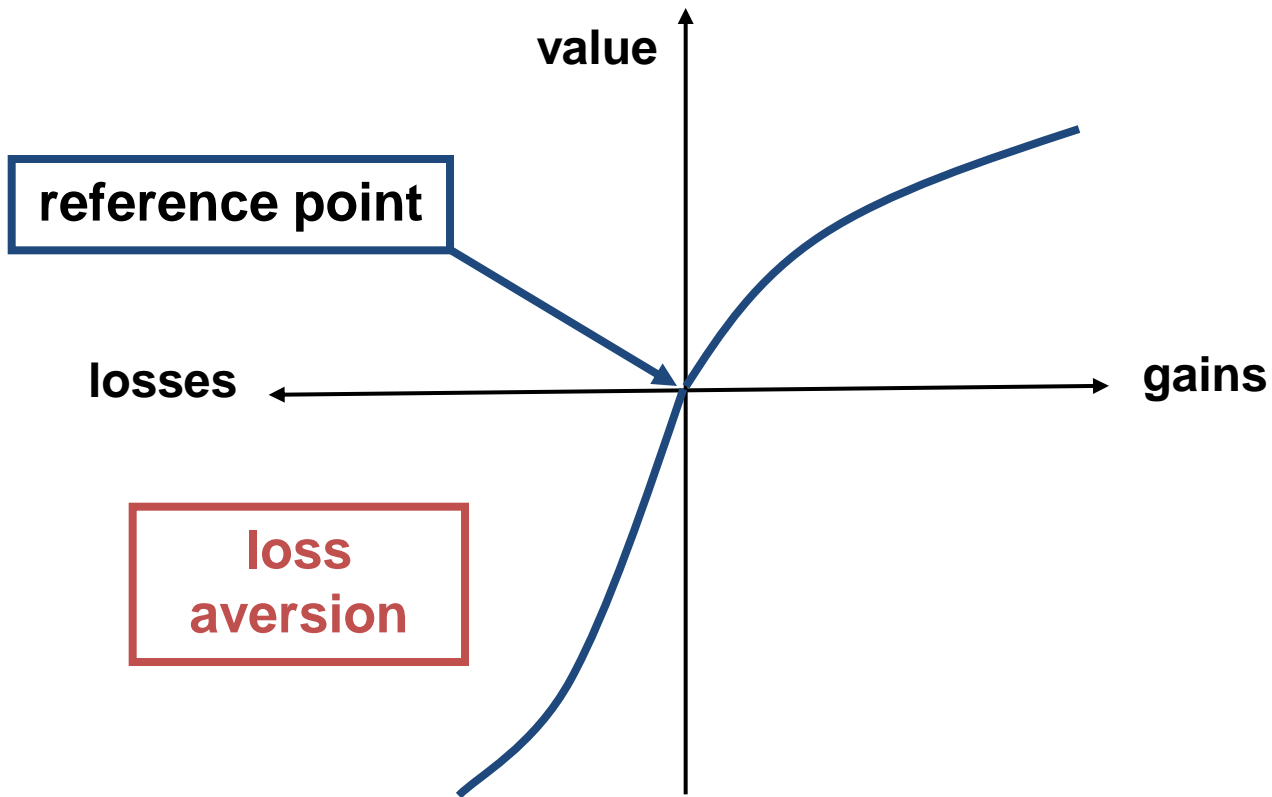
loss
aversion

Prospect theory value function

Loss Aversion

| Pain| ≠ Pleasure

"Before he slept he reflected, as he had often reflected in other moments of triumph at the card table, that the gain to the winner is, in some odd way, always less than the loss to the loser."

From <u>Moonraker</u>, by Ian Fleming (1955)

A medical example (McNeil et al., 1982)

Survival Frame:

"Of 100 people having surgery, 90 will survive during treatment, 68 will survive after 1 year and 34 will survive after 5 years. Of 100 people having radiation, all will survive the initial treatment, 77 will survive after 1 year, and 22 will survive after 5 years. Which treatment do you prefer?"

Death Frame:

"Of 100 people having surgery, 10 will die during treatment, 32 will have died by 1 year, and 66 will have died by 5 years. Of 100 people having radiation therapy, none will die during treatment, 23 will die by 1 year, and 78 will die by 5 years. Which treatment do you prefer?"

PREFERENCES FOR RADIATION OVER SURGERY:

GROUP	N	SURVIVAL Gain Frame	DEATH Loss Frame
STUDENTS	357	17%	43%
PATIENTS	504	22%	40%
PHYSICIANS	435	16%	50%

Types of Preference Reversals

- **Framing effects**
  - Gain vs. loss framing
  - **Attribute labeling**
    - **Famous study on ground beef (Levin & Gaeth, 1988)**
- Context effects
  - Asymmetric dominance (Huber, Payne, Puto, 1982)
- Preference elicitation task effects
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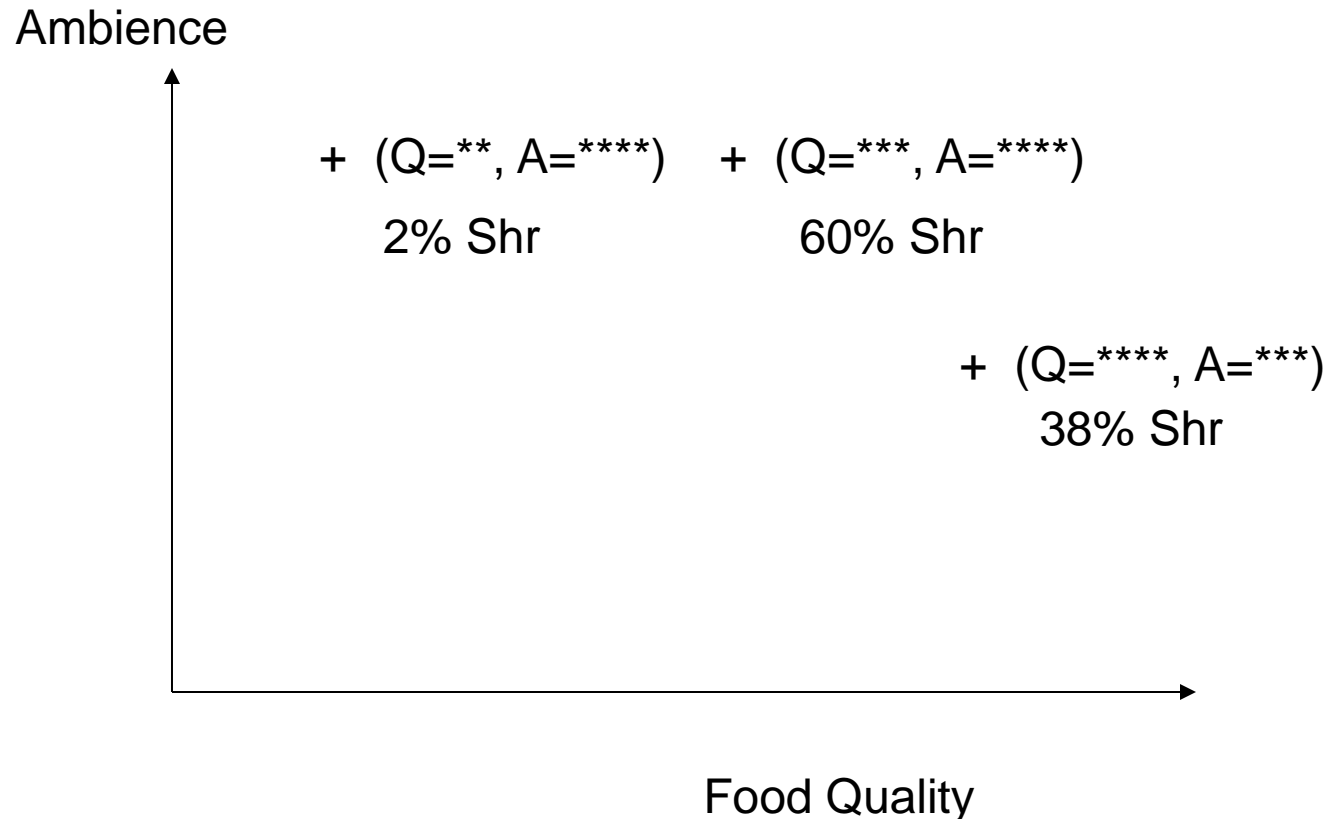
Choice

Suppose you are purchasing a round trip flight from Los Angeles to New York city, and you are debating between two tickets, one of which includes a carbon tax [offset]. You are debating between the following two tickets, which are otherwise identical. Which would you choose?

Ticket A	Ticket B
$392.70 round trip ticket includes a carbon tax [offset]	$385.00 round trip ticket

Dirty Word or Dirty World study
(Hardisty, Johnson, Weber, *Psychological Science*, 2010)
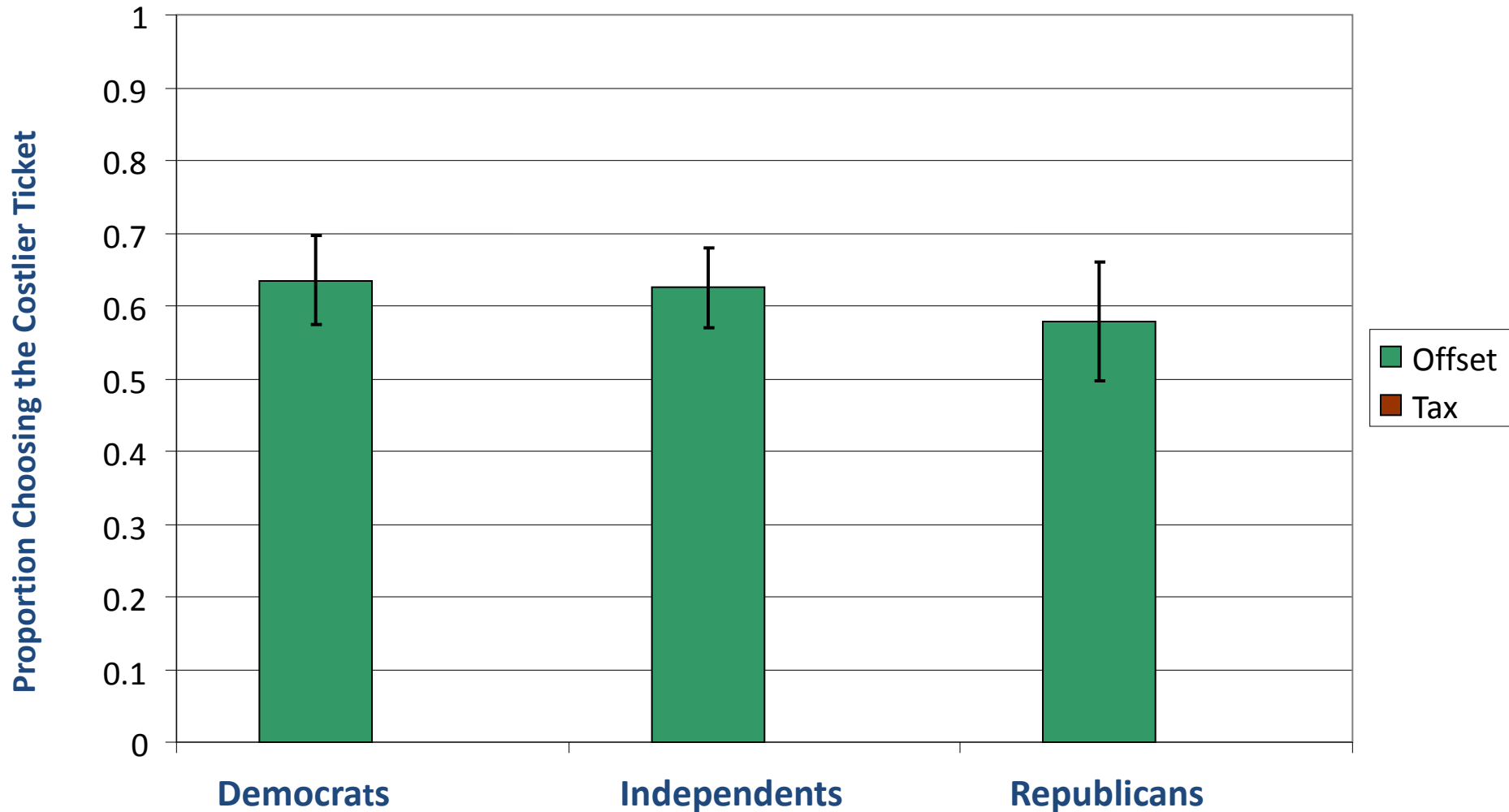
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Example of Asymmetric Dominance

People are indifferent between these two restaurants

Ambience

+ (Q=***, A=****)
50% Shr

+ (Q=****, A=***)
50% Shr

Food Quality

Example of Asymmetric Dominance Effect

What happens if we add a restaurant with great ambience but lower quality?

Ambience

+ (Q=**, A=****)   + (Q=***, A=****)

2% Shr   60% Shr

+ (Q=****, A=***)

38% Shr

Food Quality

Types of Preference Reversals

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Preference elicitation task effects

- Procedure invariance violation already seen in risky choice
  - P-bet vs. $-bet preferences in direct choice vs. WTA ratings
- Choice vs. rating reversals also in multi-attribute choice
  - Joint vs. separate evaluation effect
    - Stereos compared in store vs. experienced at home (Hsee et al., 1999)
      - Greater weight on comparable dimensions in choice
  - Contingent weighting effect
    - Jobs that differ in interest and salary (Tversky, Sattath, Slovic, 1988)
      - Greater weight on more important dimension in choice vs. matching
- Direction of choice or default effects
  - Opt-in vs. opt-out (Johnson and Goldstein, 2003)
  - Accelerating vs. delaying receipt of an immediate reward in intertemporal choice (Weber et al., 2007)
- Choice vs. ratings in intertemporal preference with our without self-control (Figner et al., 2011)

Choosing to become an Organ Donor
(Johnson and Goldstein, *Science*, 2003)

- n=176 Web participants
- "You are moving to a new state. In that state, everyone is (is not) a organ donor unless they choose not (choose to) be.   Click here to change…"
- Neutral Condition: You must make a choice.
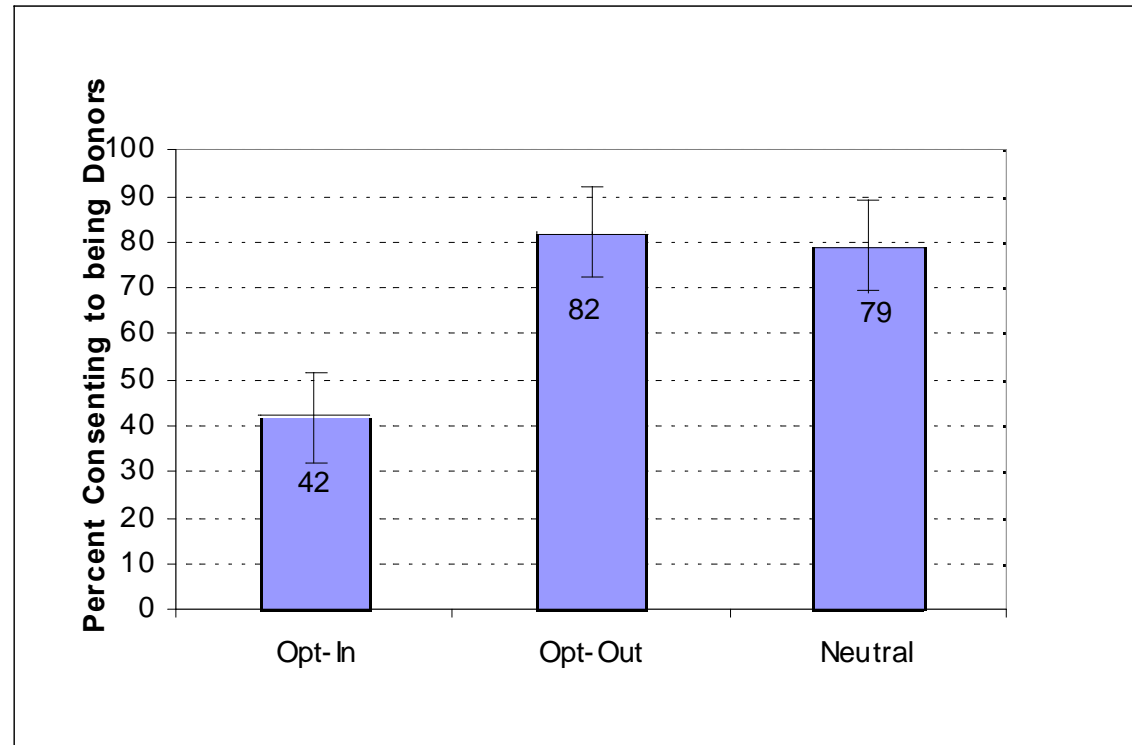
Choice Defaults make a difference, in the lab and the real world

- Agreement rates to donate in different European countries

Preference elicitation task effects

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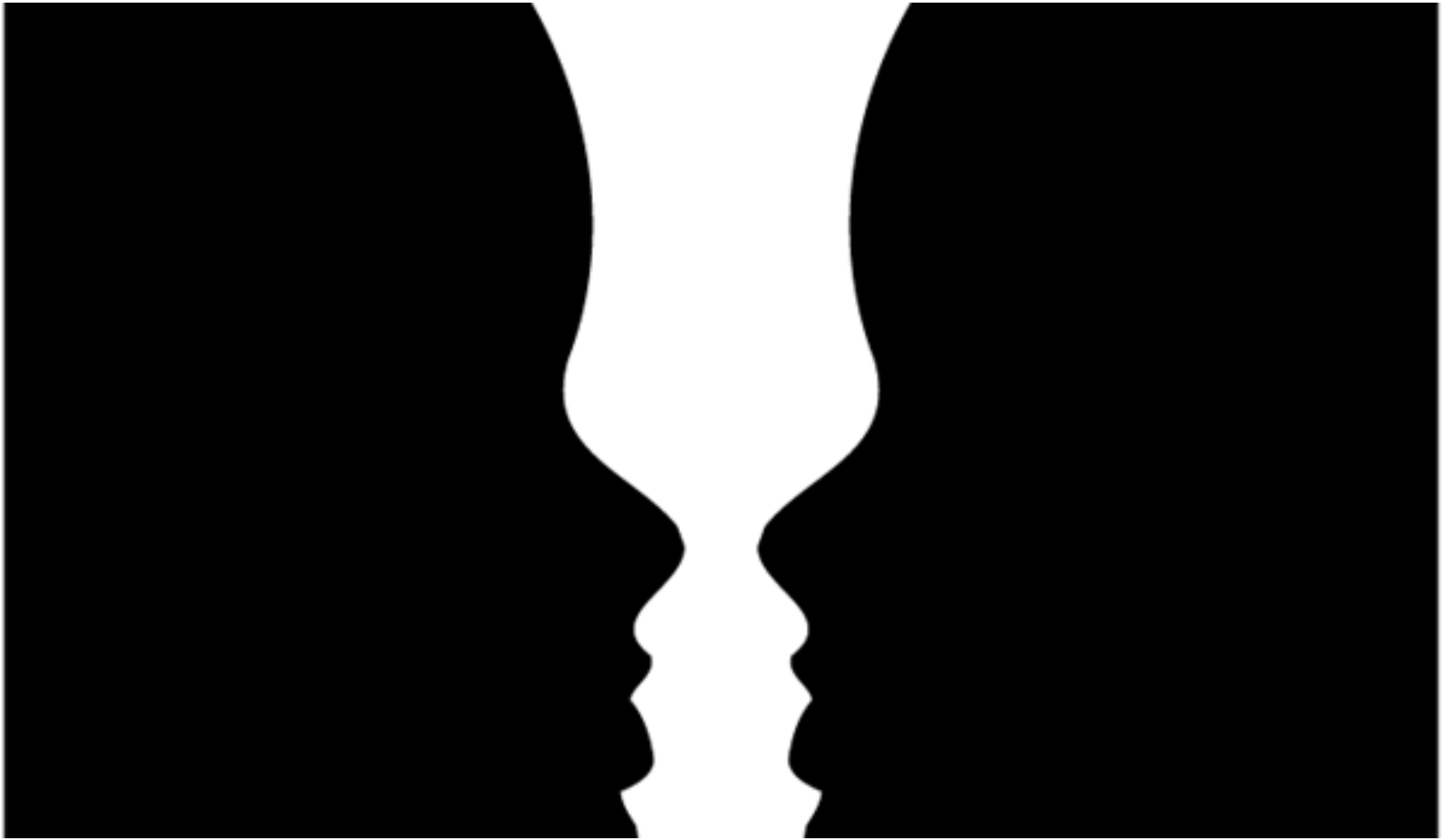
Delaying *vs* *Accelerating Consumption*

Query Theory (Johnson et al, 2007; Weber et al., 2007),
a theory of preference construction

- Choice involves (implicit) generation of evidence, by querying past experience/memory
  - "Arguing with yourself" about different courses of action

- Normatively inconsequential variations in procedure or context influence order of queries

- Query order matters
  - lower evidence generation success for later queries due to memory interference

Opposing arguments like reversible figures, impossible to see simultaneously

Query Theory (Johnson et al, 2007; Weber et al., 2007)
a theory of preference construction

- Judgment and choice tasks involve (implicit) and sequential generation of evidence, typically by querying memory
  - "Arguing with yourself" about different courses of action

- Normatively inconsequential variations in procedure or context influence order of queries

- Query order matters
  - lower evidence generation success for later queries due to memory interference

Experiment 1

- Empirical test of four QT assumptions
- Amazon gift certificate, received either now or 3 months from now
  - Manipulation: acceleration vs. delay frame
    - b/w Ss manipulation
  - Dependent measure is difference in denomination of gift certificate considered acceptable

Respondents

- 176 users of the www, recruited from CDS Virtual-Lab data base of research volunteers
  - 42% male, 58% female
  - Median age = 38; range of ages: 18 to 75
  - Median household income = $42k

- One in 50 participants randomly selected for whom decision is real
  - Receives a gift certificate either immediately after study or in three months, based on answers

Choice Scenarios

- ## Delay Condition
  - Imagine you have won a gift certificate to Amazon.com, an online store that sells books, music, and movies. **You have been chosen to receive the gift certificate today, and it will be worth $50.** However, if you choose to **delay** receiving the gift certificate until three months from today it will be **worth more**.

- ## Accelerate Condition
  - Imagine you have won a gift certificate to Amazon.com, an online store that sells books, music, and movies. **You have been chosen to receive the gift certificate three months from today, and it will be worth $75.** However, if you choose to **accelerate** receiving the gift certificate to today it will be **worth less**.

Type-Aloud Protocol

- Way of making usually implicit preference construction processes explicit
  - "Please list everything that goes through your mind as you make this decision"
  - Pretrained to do so, one thought at a time
  - List 2-7 thoughts

Choice Titration

The gift certificate you can have three months from today is worth $75. The gift certificate you can have today is for a mystery amount that ranges from $20 to $70 (in $5 increments). The mystery amount has been chosen at random. All amounts between $20 and $70 are equally likely. You can tell us below whether you would prefer the gift certificate three months from today or today based on how large the mystery gift certificate is.

Each row of the table below corresponds to a possible amount of the mystery gift certificate. For each of the two options listed in the table below, tell us which option you prefer. For instance, if you prefer a $75 gift certificate three months from today more than a $20 gift certificate today, you would click on the box in the left column in the first row. Likewise, if you prefer a $20 gift certificate today more than a $75 gift certificate three months from today, you would click on the box in the right column in the first row. Please fill in **all** the rows.

Remember, if you are chosen, your choices here will determine whether you will be mailed a gift certificate 3 months from today or today.

| A gift certificate three months from today	A gift certificate today
○ A $75 gift certificate three months from today	○ A $20 gift certificate today
○ A $75 gift certificate three months from today	○ A $25 gift certificate today
○ A $75 gift certificate three months from today	○ A $30 gift certificate today
○ A $75 gift certificate three months from today	○ A $35 gift certificate today
○ A $75 gift certificate three months from today	○ A $40 gift certificate today
○ A $75 gift certificate three months from today	○ A $45 gift certificate today
○ A $75 gift certificate three months from today	○ A $50 gift certificate today
○ A $75 gift certificate three months from today	○ A $55 gift certificate today
○ A $75 gift certificate three months from today	○ A $60 gift certificate today
○ A $75 gift certificate three months from today	○ A $65 gift certificate today
○ A $75 gift certificate three months from today	○ A $70 gift certificate today

Go to Next Page

Coding of Thought Listing

- Previously provided thoughts coded on
  - Favoring immediate vs. later receipt of gift certificate (vs. both vs. neither)
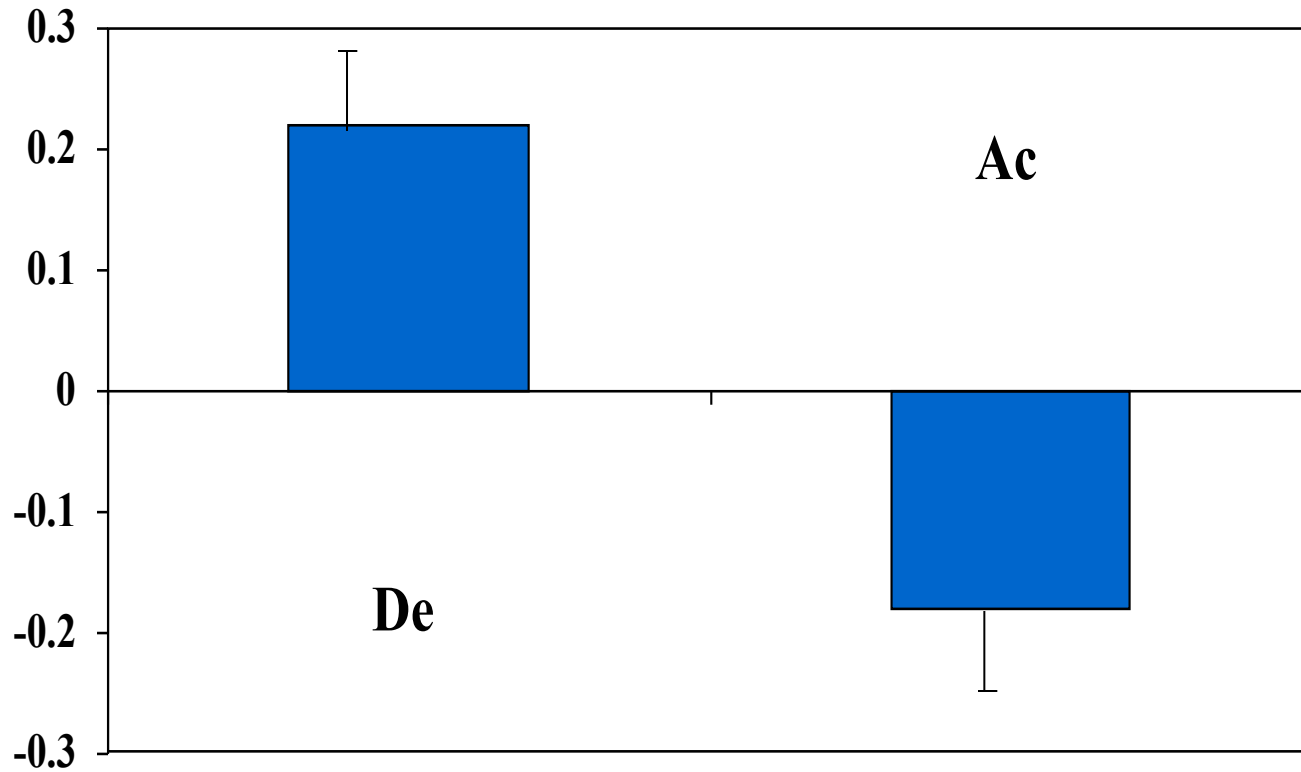
Differences in discounting and balance of support
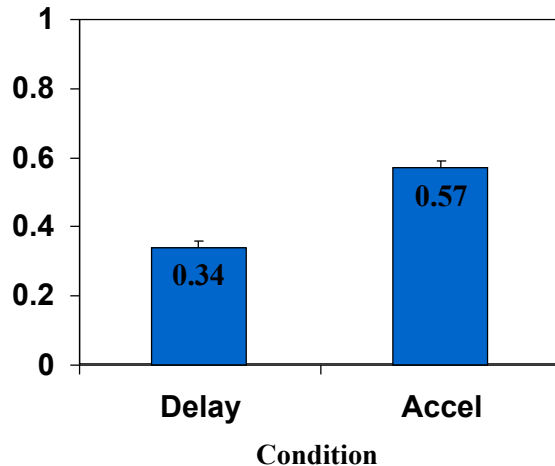
Discount Factor differs p < 0.0001
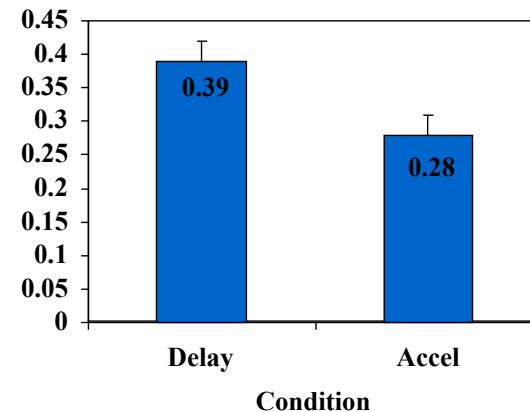
Prop. of Impatient Thoughts Differs p < 0.05

Thoughts cluster, in different orders

SMRD

p < 0.01

Impatient Thought Prominence predicts Choice

- **Prominence of Impatient Thoughts**
  - *SMRD*: clustering of impatient thoughts
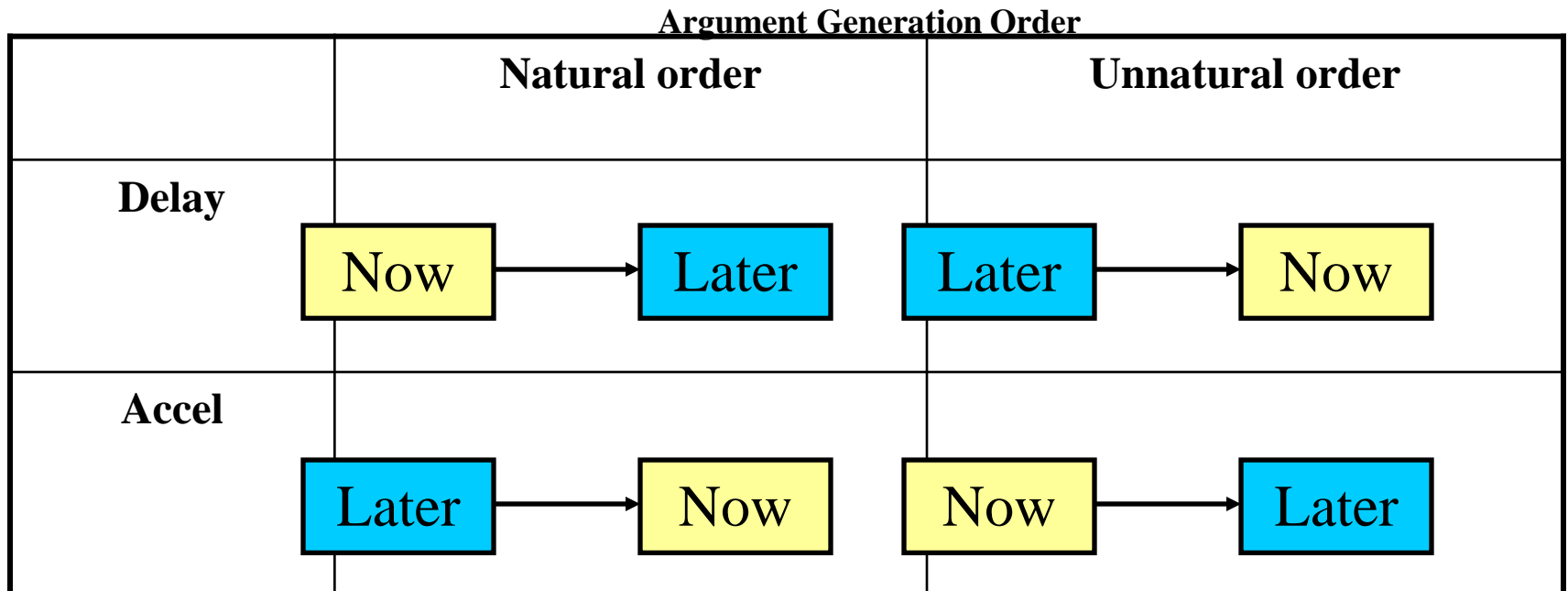 - *Proportion*: prop. of impatient thoughts

- Combined into a single factor
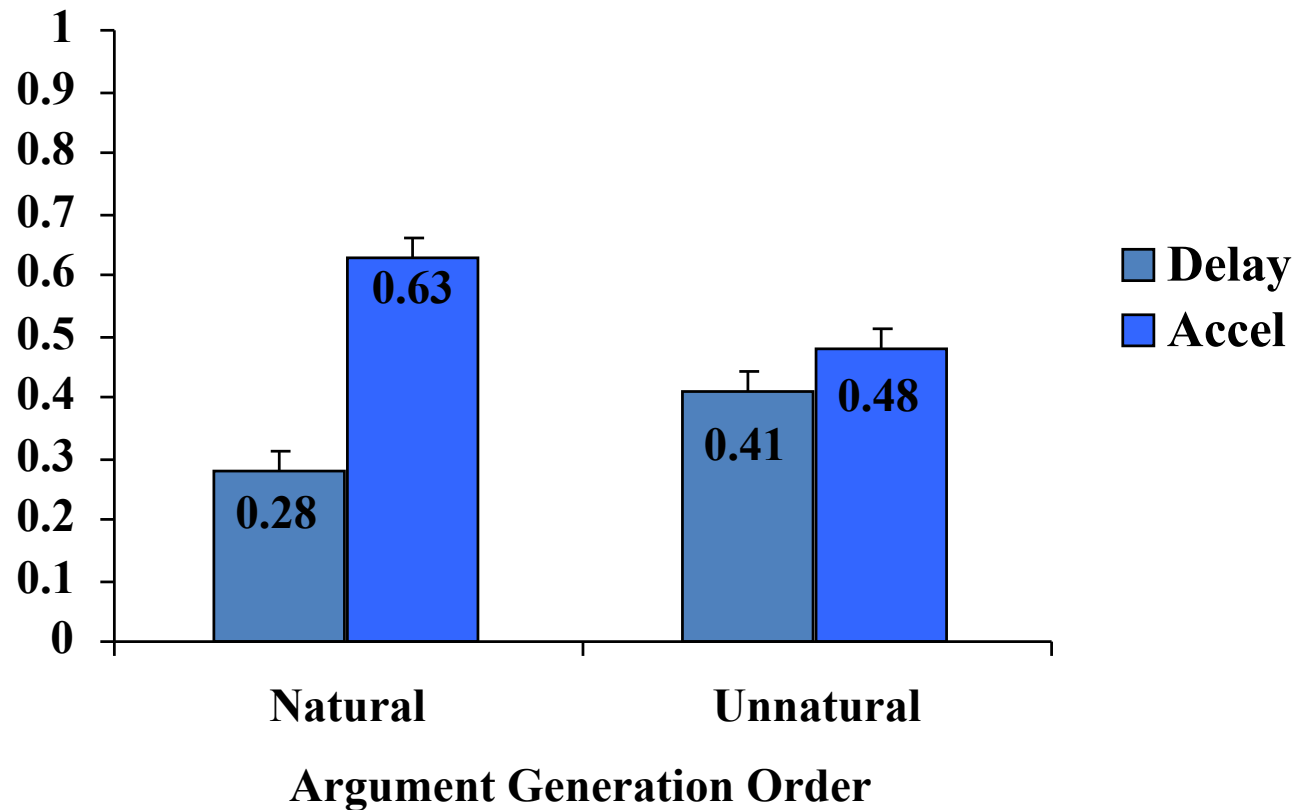 - Predicts 36 percent of variance in discounting across two conditions
  - Mediates difference between acceleration and delay

Rationale for Experiment 2

- Can we reduce or eliminate accelerate vs. delay asymmetry in discounting by reversing the natural order of queries?

	Argument Generation Order			
	Natural order		**Unnatural order**	
Delay	Now →	Later	Later →	Now
Accel	Later →	Now	Now →	Later

Study 2 "unnatural" order makes the asymmetry in discounting disappear

Query order as the *million-dollar* question

- Default option
  - Arguments for default option get queried first and contribute to status-quo bias
    - True for organ donation study
    - Acceleration vs. delay of immediate consumption study
    - Endowment effect (owning or not owning as default)

- What other things determine order of option consideration?
  - Reading order (left to right, top to bottom)
    - Political candidates have 3% to 9% advantage when listed first on ballot (Miller & Krosnick, 1998, Public Opinion Quarterly)
 - Choice option attractiveness, e.g., via attribute labels

Choice

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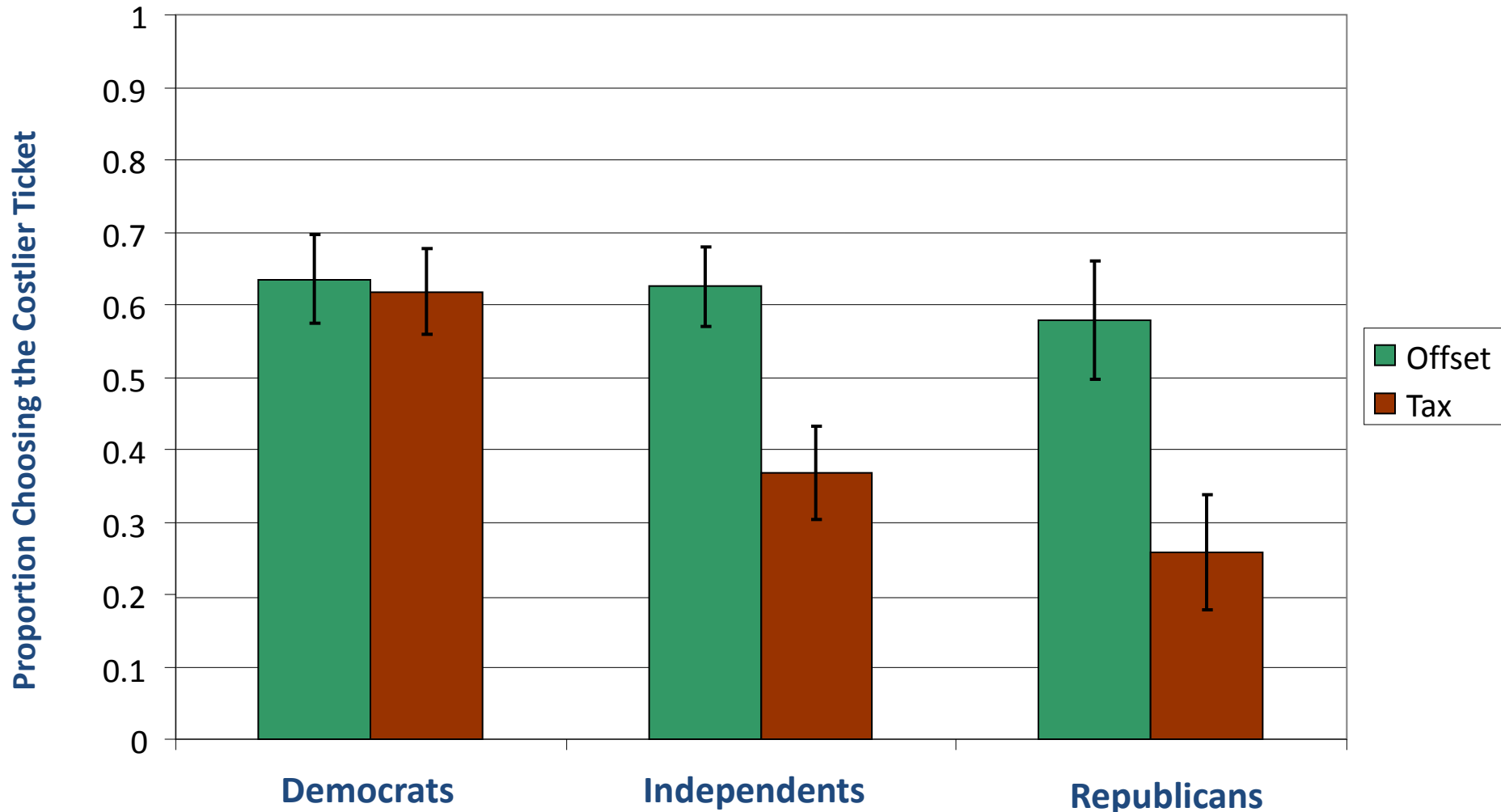| Ticket A	Ticket B
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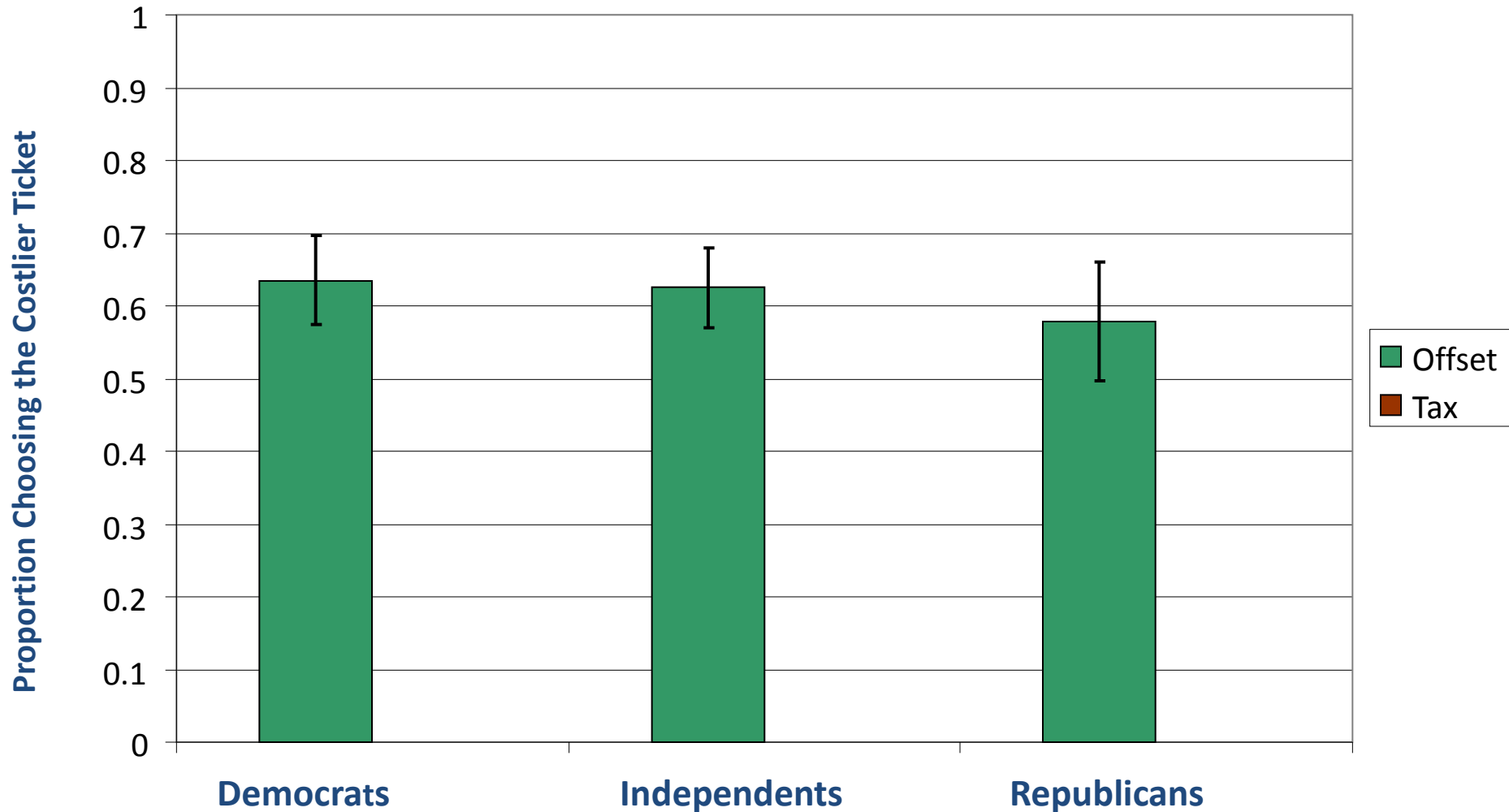
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Results: Thought Listings

- Participants listed 2.7 thoughts ($SD = 1.4$)
- No differences between parties or frames in the number of thoughts

Thought List (Subject 53)

- good for the environment
- carbon offset is not that much more than regular ticket
- what does the extra money do to offset the carbon

Thought List (Subject 286)

- Why would I ever pay extra for this?
- I really don't care about a 'carbon tax'
- if it's the same thing, get rid of the tax.
- the government needs to stop taxing us randomly
- I will be old or dead by the time this world has an energy crisis
- and by that i mean a huge one where we are all[doomed]
- this is a ridiculous thought to have

Thought List (Subject 286)

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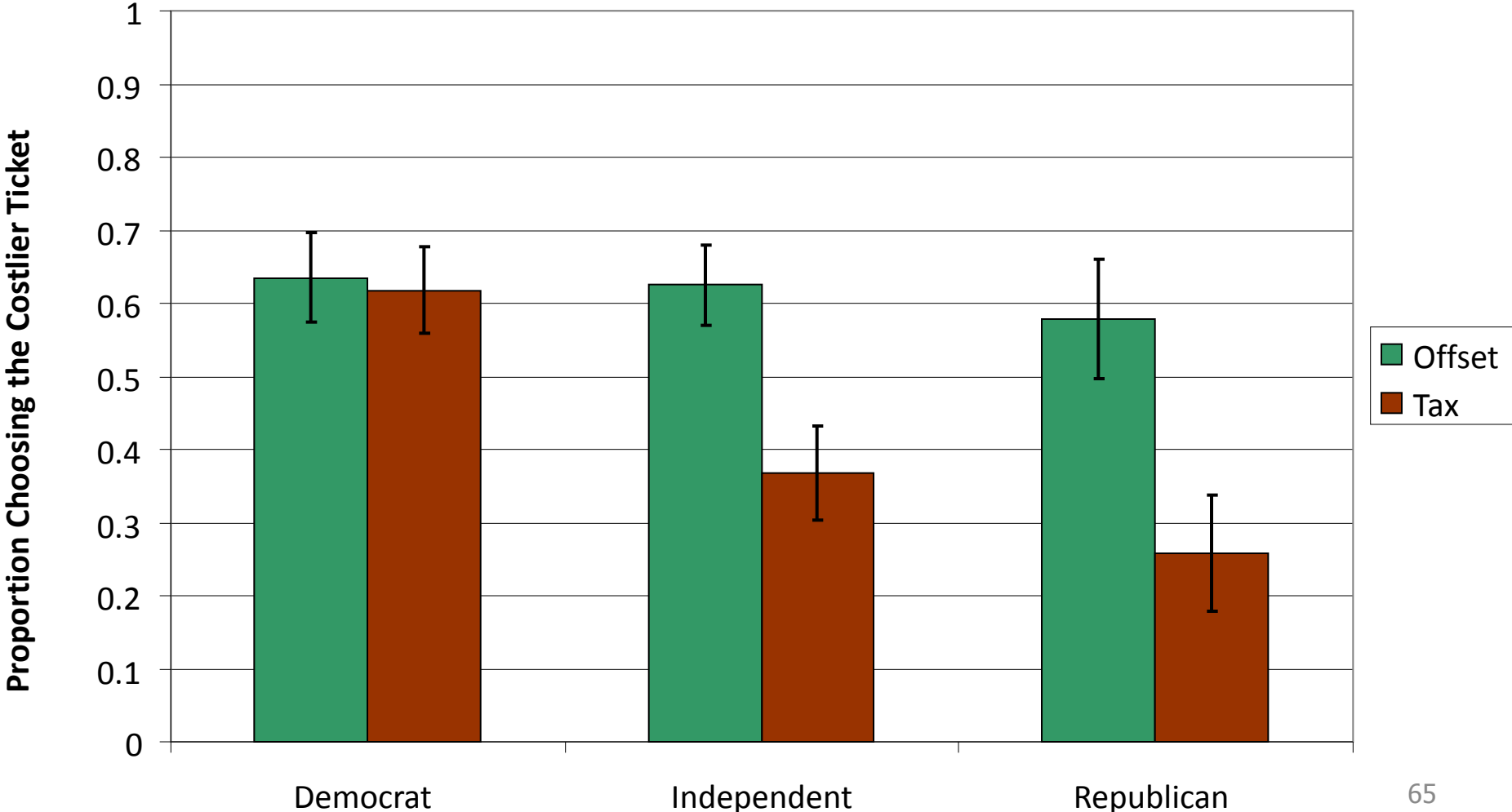- this is a ridiculous thought to have

Results: Order of Thoughts
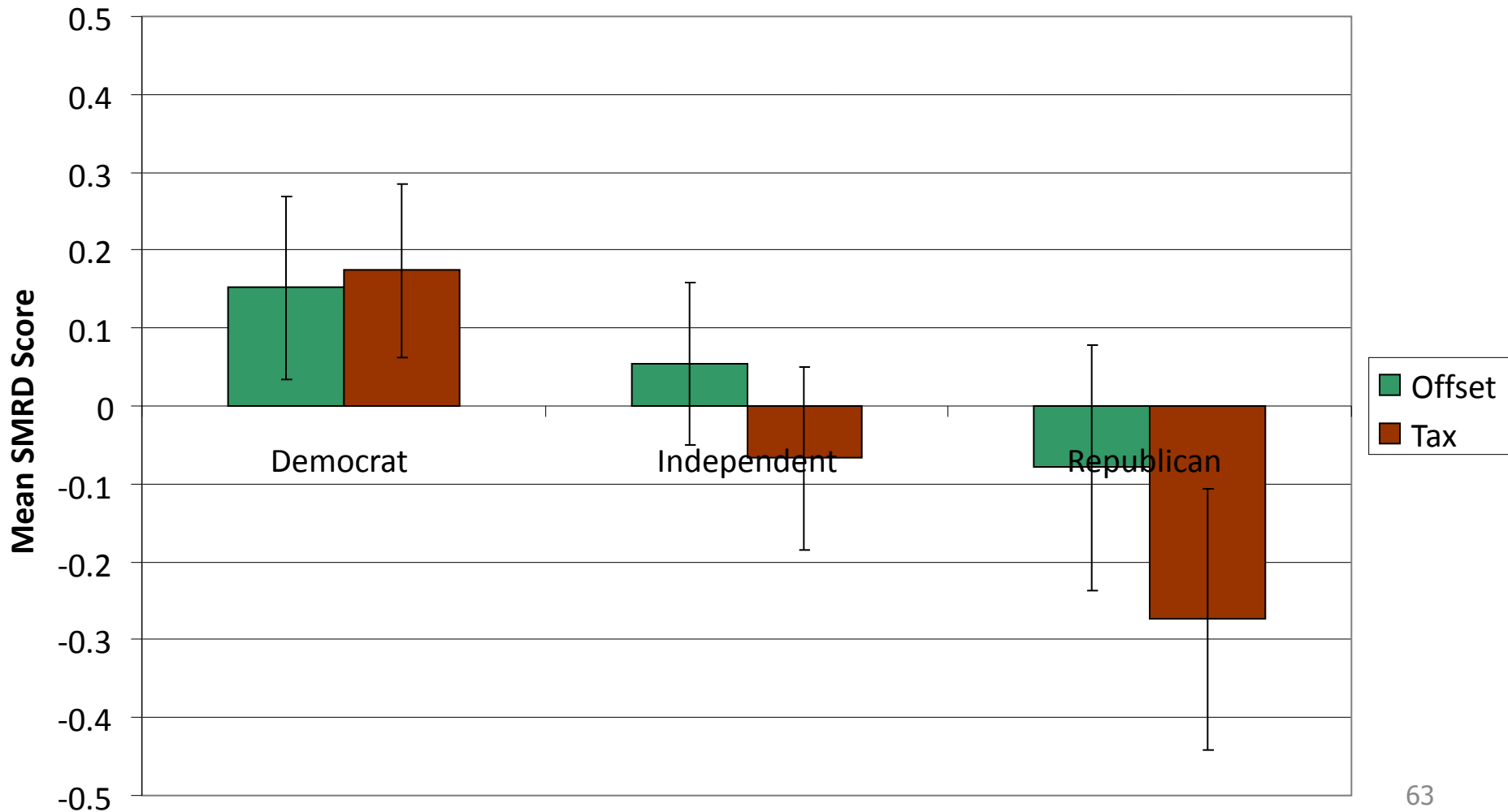
Results: Frequency of Thoughts

Frequency and Order of Thoughts highly correlated (r=.68)

64
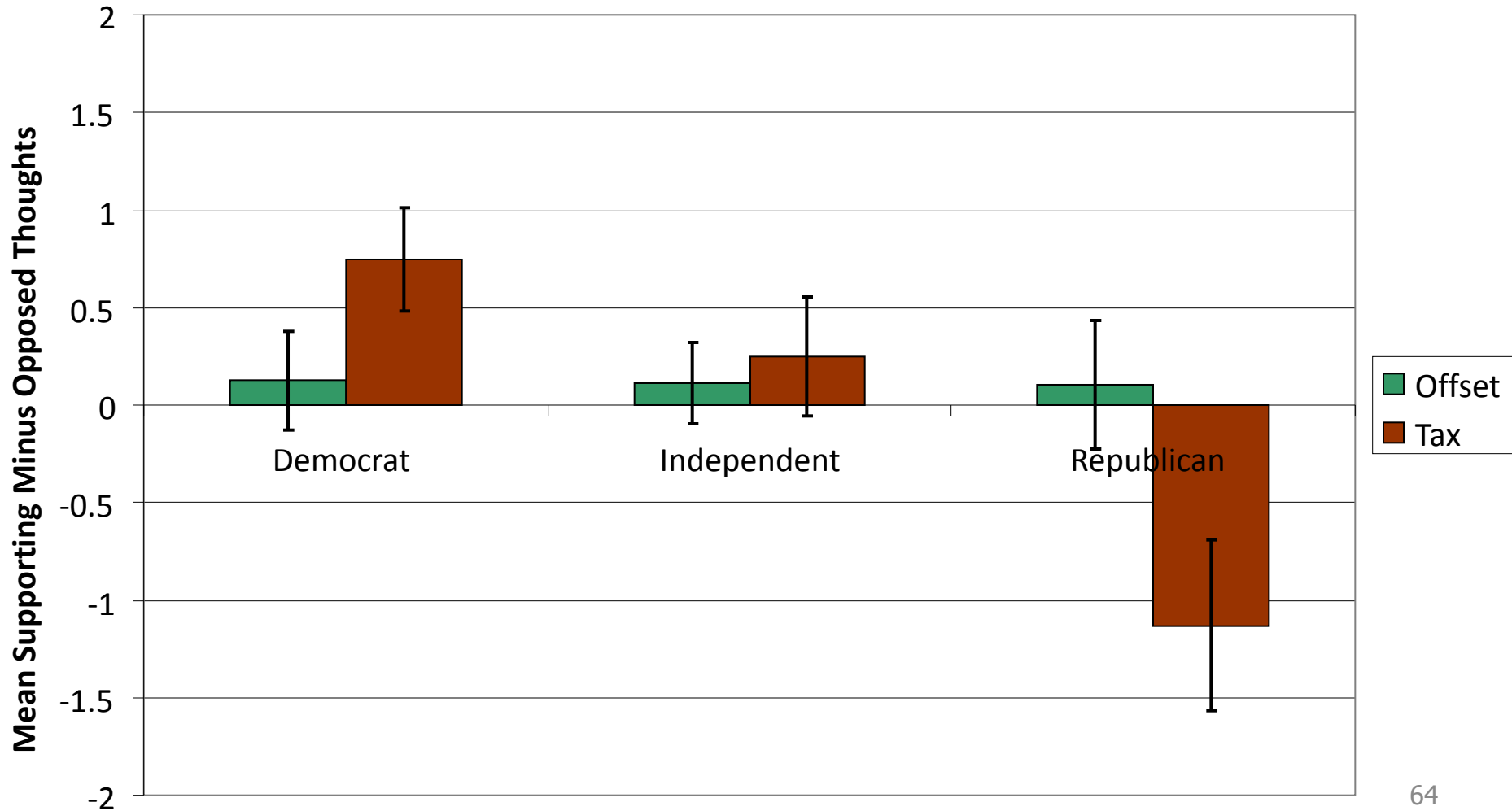
Choices explained ("mediated") by order and frequency of arguments
→ Recipe for Interventions

Preference elicitation task effects

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  - P-bet vs. $-bet preferences in direct choice vs. WTA ratings
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TMS = Transcranial Magnetic Stimulation

http://jscms.jrn.columbia.edu

- Very brief, very strong magnetic field is created
- Magnetic field influences activity of brain area under the coil
- Can be used to temporarily influence function of a selected brain area
- *Causal* method to investigate role of specific brain areas (≠fMRI)

TMS Study

Figner, Knoch, Johnson, Krosch, Lisanby, Fehr, & Weber (2010). Nature Neuroscience

- Intertemporal choice influenced by goal-conflict
  - impulse to choose immediate reward
  - deliberative motivation to wait to get more

- Disrupting control area (dlPFC) should lead to more impatient choices (sooner smaller option on „now" trials)

Task Design

72 choices between a sooner smaller and later larger reward

- Time
  - ✓ Half of them were made right after TMS
  - – Half of them were made 30 minutes after TMS
- Sooner smaller reward 'today' vs. 'in 2 weeks'
  - ✓ In half of them the SS was 'today' (now trials)
  - – In half the SS was 'in 2 weeks' (notnow trials)
- Differences between sooner smaller and later larger reward
  - – Small: 0.5%, 1%
  - ✓ Medium: 10%, 15%, 20%, 25%, 30%
  - – Large: 50%, 75%

Study Design

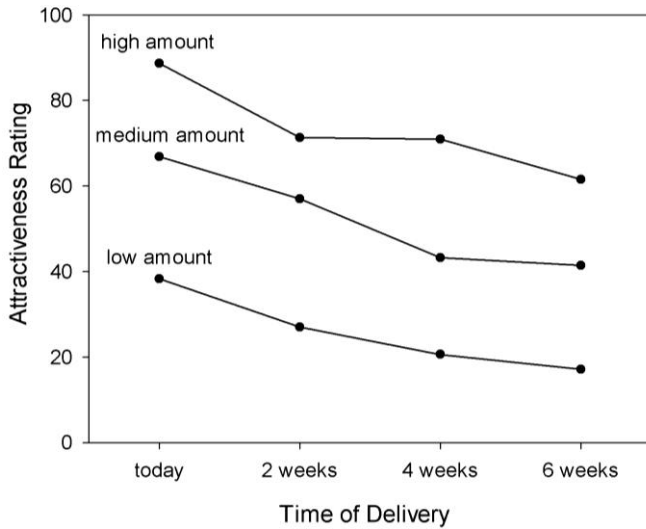52 participants (all male, right-handed)

- **3 Conditions**
  - rTMS to right DLPFC
  - rTMS to left DLPFC
  - Control (sham rTMS)
- Choices made between SS and LL amounts, half of choices involved immediate outcome („now" trials)
- One randomly drawn choice paid out for real
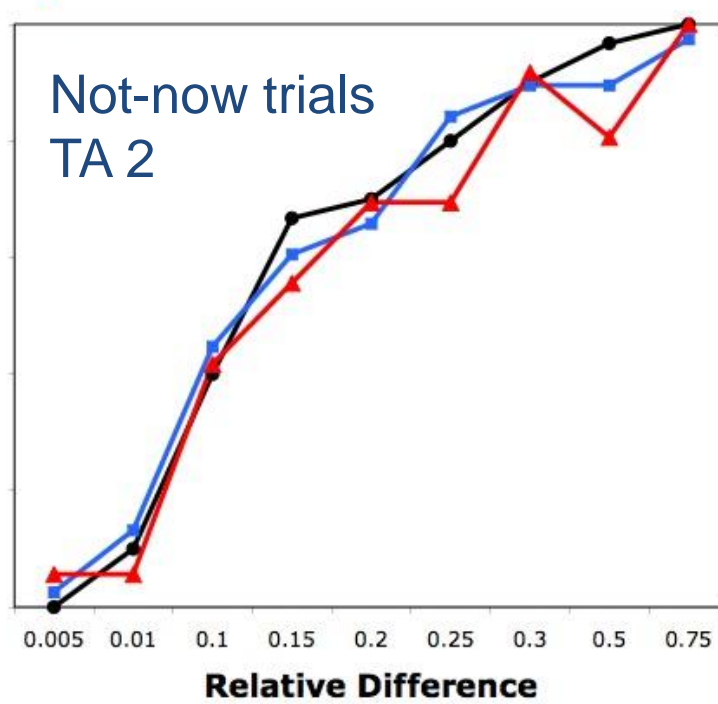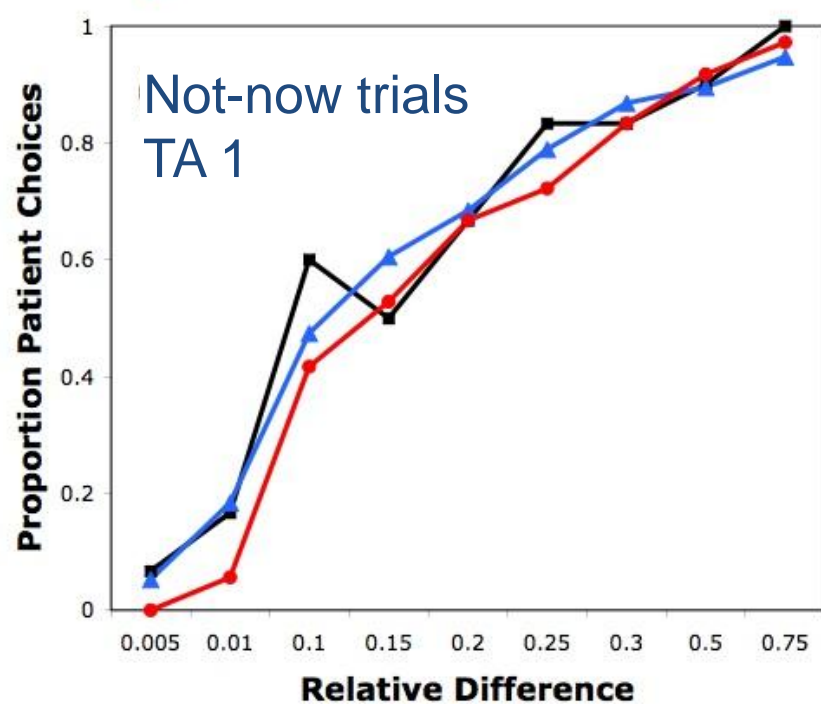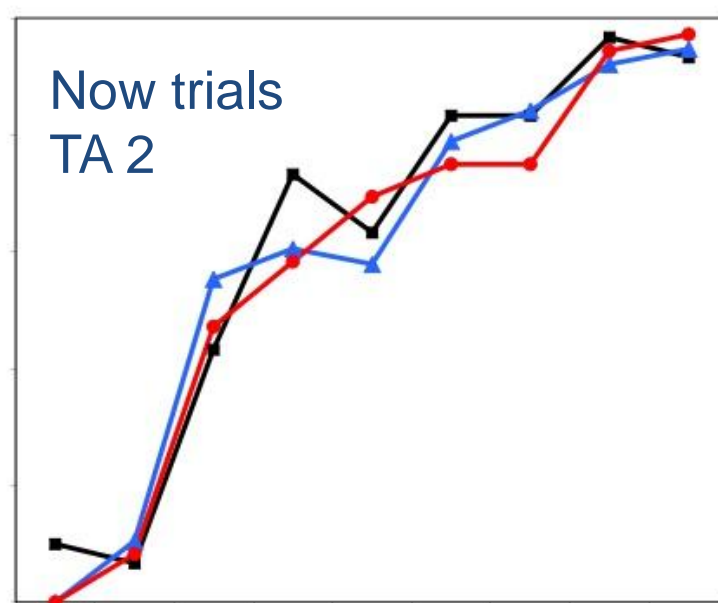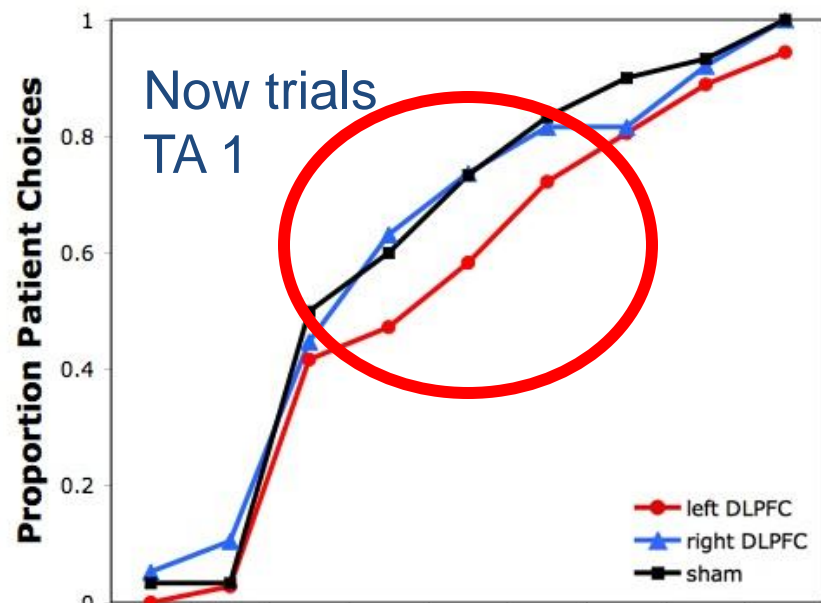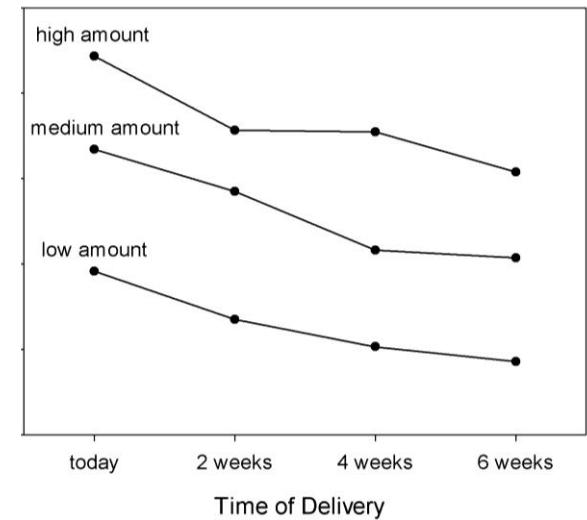
Valuations

Task Administration 1

Sham | **Left DLPFC** | **Right DLPFC**

Preference Reversal Mechanisms

- Driven by selective attention as a function of
  - motivational factors
    - goals that induce asymmetric loss functions
  - cognitive factors
    - ease of comparison, induced reference comparison, order of evidence accumulation
- Those affect
  - the sources and strength of neural response to choice and judgment options
 - their accumulation and evaluation path

Neural implementation mechanisms of preference construction

- Intrinsic context-dependence in neural activity (Louie & DeMartino, 2014)
  - Due to restricted range of spiking activity
    - Barlow's (1961) efficient coding hypothesis
    - Heeger's (1992) divisive normalization; also at cognitive process level (Louie, Grattan, Glimcher, 2011)

Neural implementation mechanisms of preference construction, cont'd

- Some task- or frame-specific differences in neural activation
  - Gain- vs. loss framing of lottery/gamble choices
    - Amygdala and OFC activations (DeMartino et al, 2006)
  - WTP vs. WTA preference for goods
    - WTP correlated with vmPFC activation, WTA with lateralOFC; striatal activation predicted magnitude of endowment effect (WTA-WTP) (DeMartino et al, 2009)
  - Delay vs. Acceleration of immediate reward
    - More dlPFC and hippocampal activation for delay intertemporal choices (Figner et al., 2014)

Neural implementation mechanisms of preference construction, cont'd
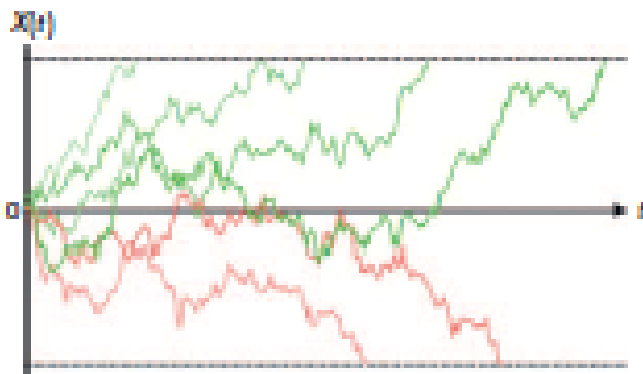
- Sequential sampling models, e.g., in form of drift diffusion models (Laming, 1968; Busemeyer & Townsend, 1993; Shadlen et al., 2006) assume random sampling of evidence space
  - Constructed preference suggests that evidence accumulation may be biased, i.e., task-, context-, and goal-directed

Implications of Constructed Preference

- Evidence in non-human choice
- For prediction of behavior
  - Compatibility principle in preference elicitation
    - E.g., DOmain-SPEcific Risk Taking (DOSPERT) scale (Weber, Blais, Betz, 2002) tends to predict real world risk taking better than abstract lottery preference task
- For intervention or behavior change
  - Broad(er) range of entry points
  - Choice architecture that targets reference point, order of evidence query elicitation, emotional appeal of choice options, and other attentional factors

Thank You!

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