Discussion of "Leveraging Cognitive-inspired Machine Learning to Understand Multi-attribute Preference Construction"

Memory and Attention Workshop

Josh Schwartzstein

June 5, 2025

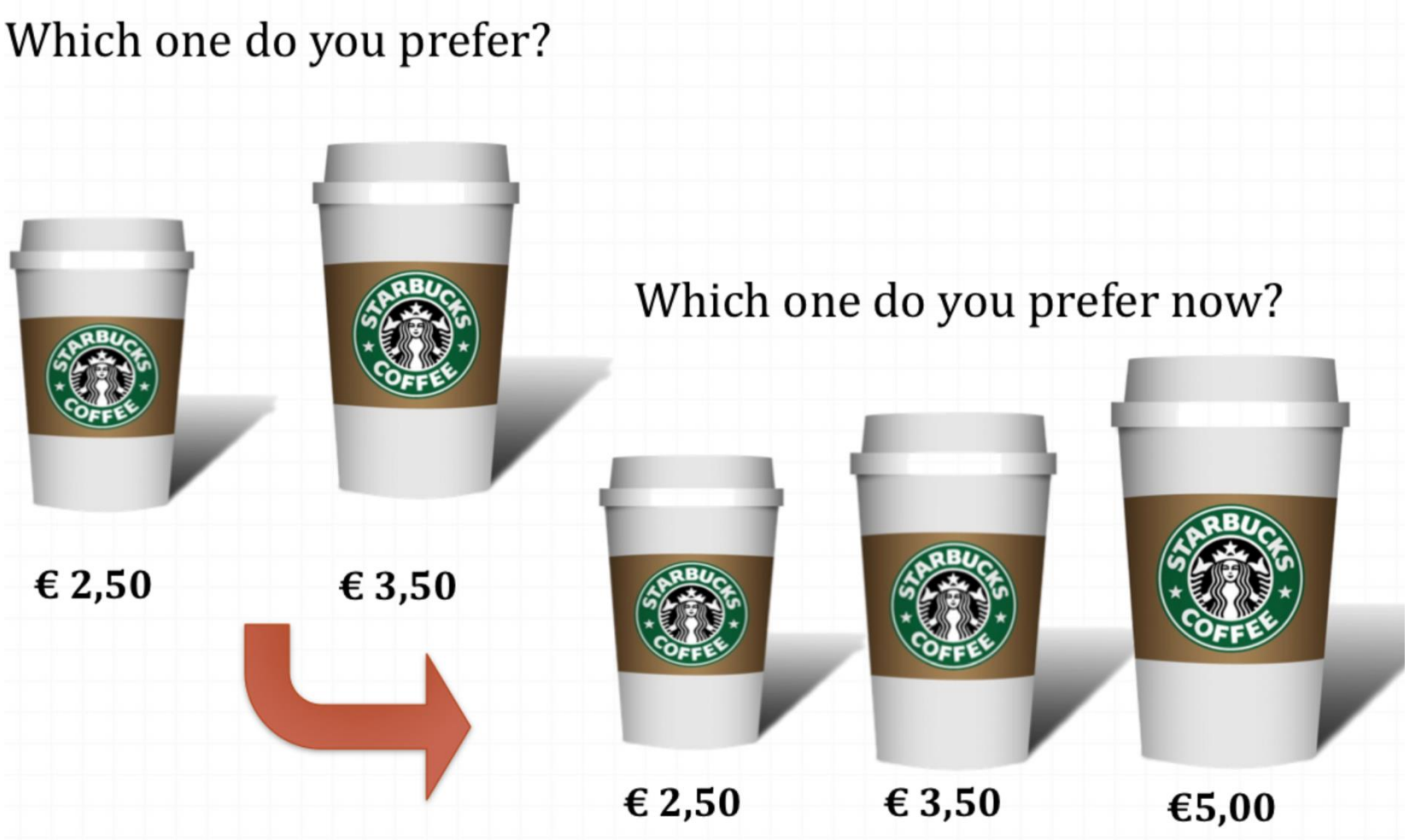
Background

- Economics: Independence of irrelevant alternatives (IIA) is a core assumption
  - x chosen from S and $x \in T \subseteq S \Rightarrow x$ chosen from T
  - $U(x|S) = U(x)$
- Psychology and marketing: Long history of evidence and theory of IIA violations

Classic Example

Simonson and Tversky (1992)

Another Example



Random Blog

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- Psychology and marketing: Long history of evidence and theory of IIA violations
- Cognitive economics: Current boom arguably began with models that took this evidence seriously (BGS, KS, …)
  - $U(x|S) = \sum_j w_j(x, S) \cdot u_j(x)$

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- Cognitive economics: Current boom arguably began with models that took this evidence seriously (BGS, KS, …)
  - $U(x|S) = \sum_j w_j(x, S) \cdot u_j(x)$
- In parallel, small literature from psychology and marketing that questions real-world relevance of context effects

Example

Suppose you are thinking of having a snack. Which fruit would you choose?

A

B

C

Source: Frederick et al (2014)

This Paper

A)

Which place would you prefer to visit?

Use the number keys to choose: 1=LEFT, 2=MIDDLE, 3=RIGHT.


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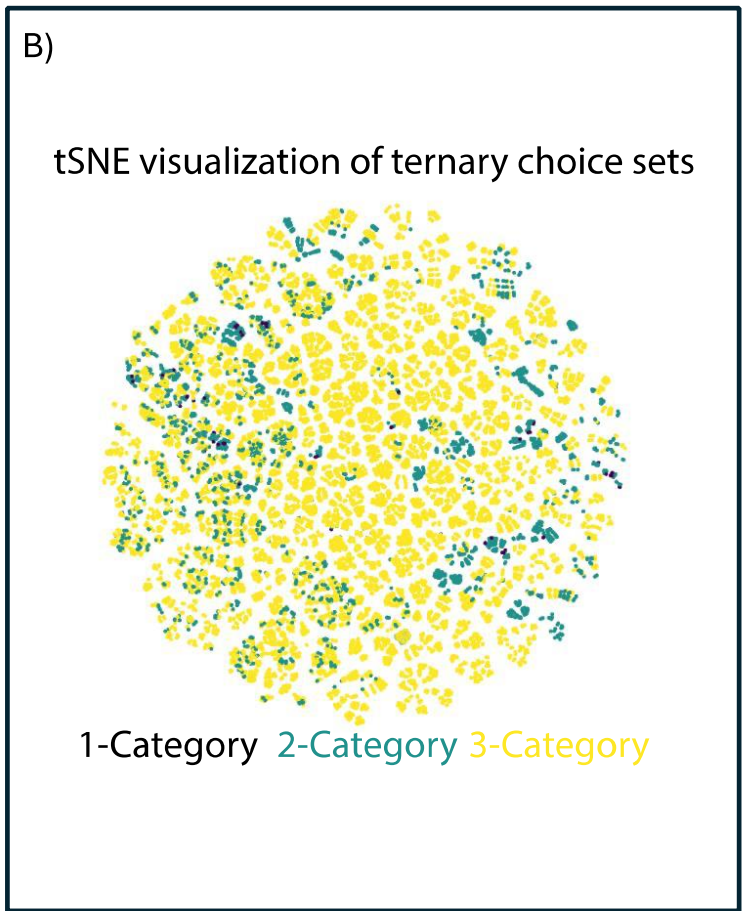
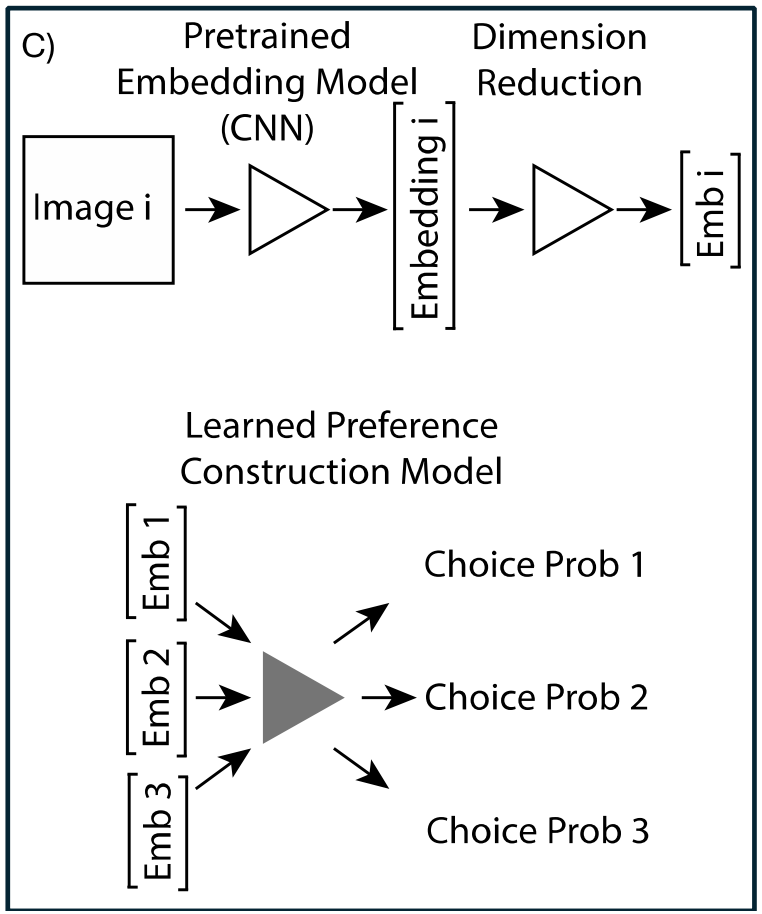

B)
tSNE visualization of ternary choice sets
1-Category
2-Category
3-Category


C)
Pretrained Embedding Model (CNN)
Dimension Reduction
Image i
Embedding i
Emb i
Learned Preference Construction Model
Emb 1
Emb 2
Emb 3
Choice Prob 1
Choice Prob 2
Choice Prob 3

Comments: Cool Methods!

- Methods from this paper open up all sorts of possibilities
  - Embeddings + neural nets: Test implications of standard theories on diverse stimuli

This Paper: Punchlines

Key finding:

> Non-contextual models predict choice as well as contextual models

Punchline (as written in abstract):

> "in naturalistic multi-attribute choice, preferences are constructed from low-dimensional, nonlinear attribute representations and are largely insensitive to the context created by the choice set"

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Comments: Intriguing Finding

- People satisfy IIA in (arguably) more naturalistic settings
- Perhaps connects to recent work that indicates people's choices become more "procedural" in higher-dimensional settings (Arrieta and Nielsen 2024)

Comments: What's the Interpretation?

"in naturalistic multi-attribute choice, preferences are constructed from low-dimensional, nonlinear attribute representations and are largely insensitive to the context created by the choice set"

Models: $U(x|S) = \sum_j w_j(x,S) \cdot u_j(x)$

Interpretations: Add contextual cues k (e.g. description, frame, presentation)

1. If $k \in \{lab, field\}$, $w_j(x,S,k) \rightarrow w_j(x,k)$ when $k = field$
2. Contextual cues crucial to how people approach problems: $w_j(x,S) \rightarrow w_j(x,S,k)$ -- connects to BGLS (2025)

Comments: First Interpretation?

1. If $k \in \{lab, field\}$, $w_j(x, S, k) \rightarrow w_j(x, k)$ when $k = field$
   - Lab evidence consequence of artificial presentations?

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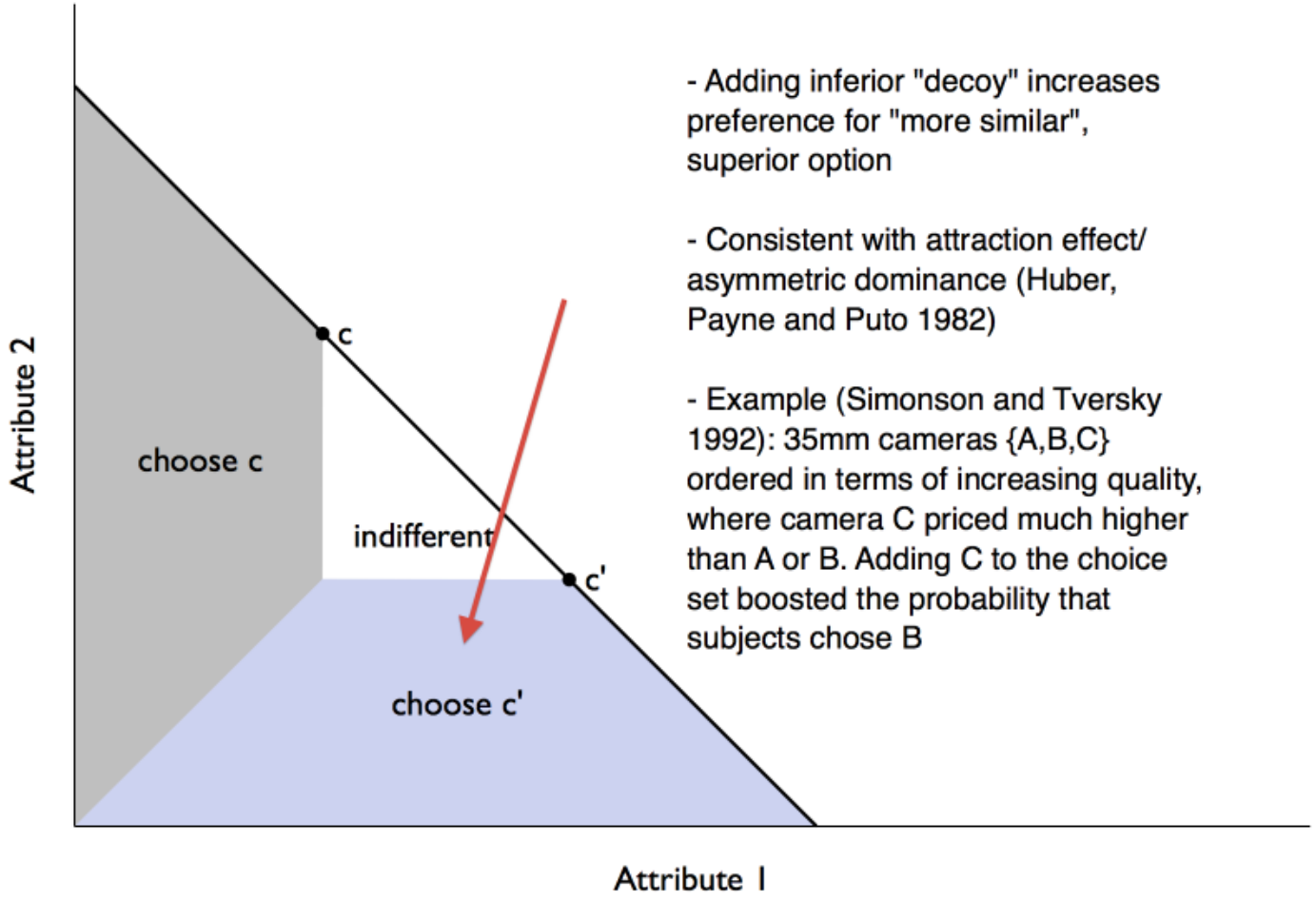
Range-Based Relative Thinking



- Adding inferior "decoy" increases preference for "more similar", superior option

- Consistent with attraction effect/ asymmetric dominance (Huber, Payne and Puto 1982)

- Example (Simonson and Tversky 1992): 35mm cameras {A,B,C} ordered in terms of increasing quality, where camera C priced much higher than A or B. Adding C to the choice set boosted the probability that subjects chose B

Bushong, Rabin, Schwartzstein (2021) – builds on many papers, including Huber, Payne, and Puto (1982) and Soltani et al. (2012)

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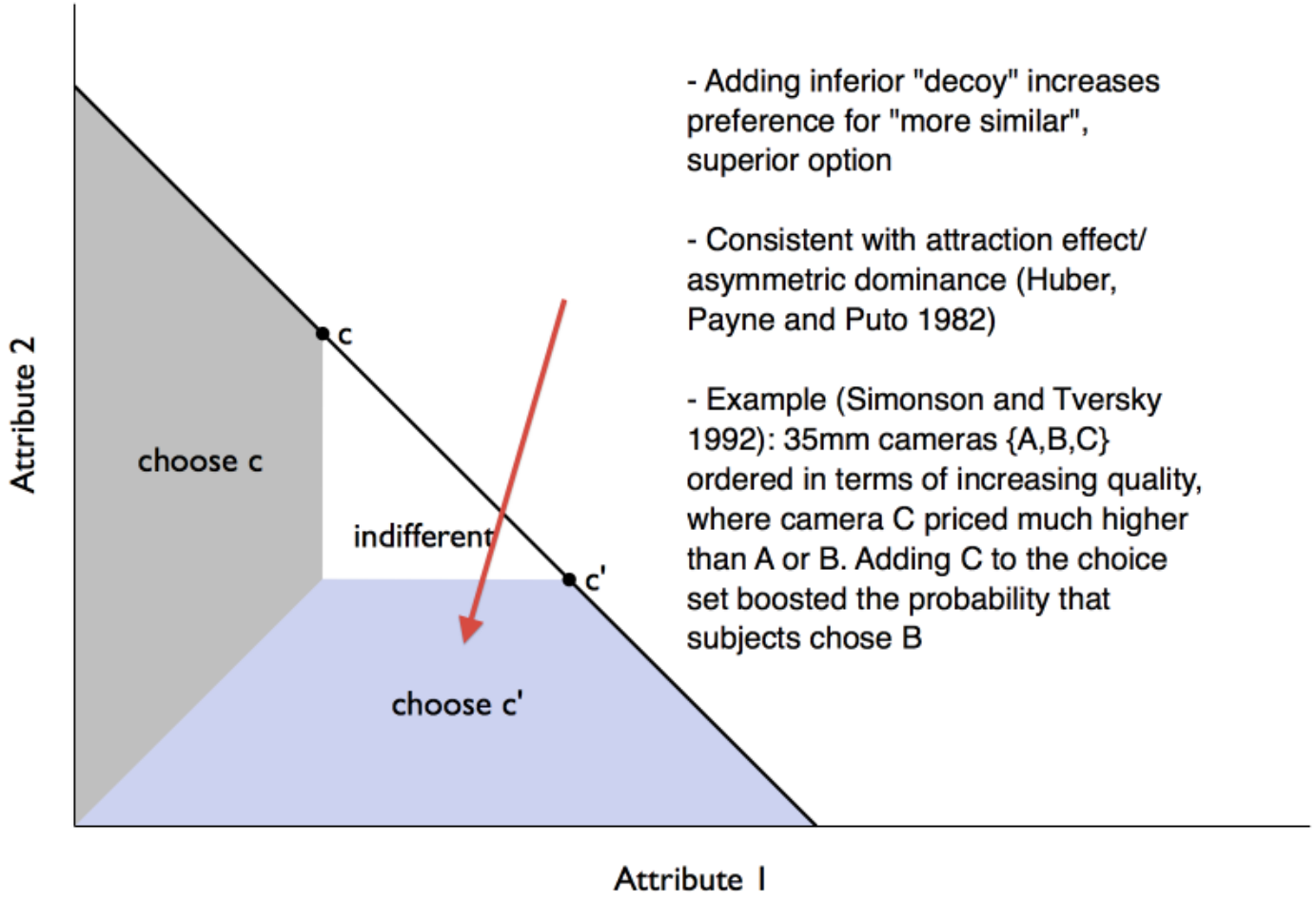

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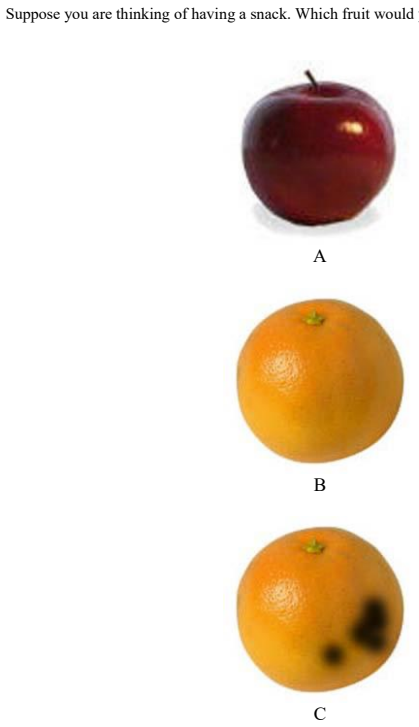

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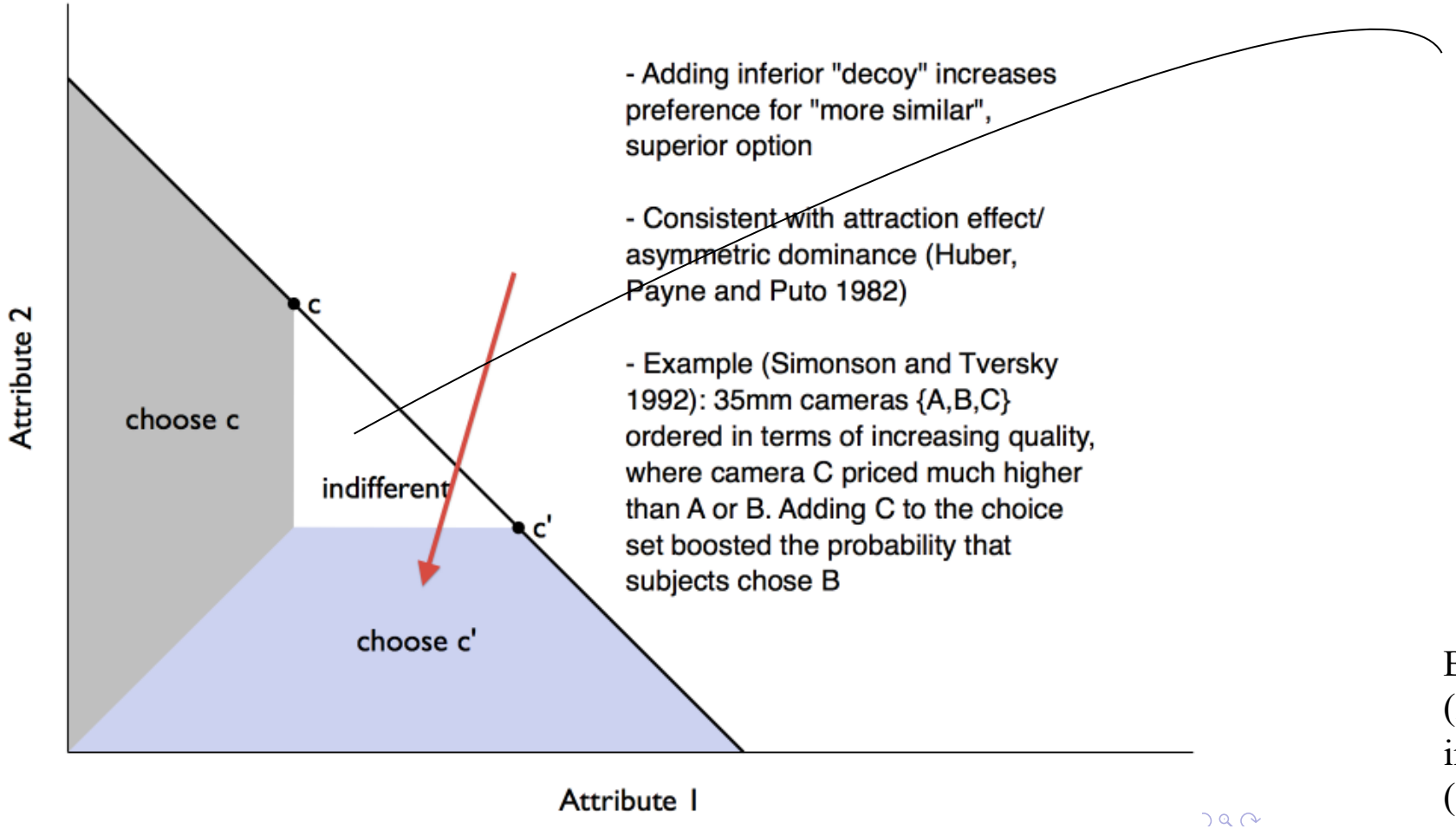

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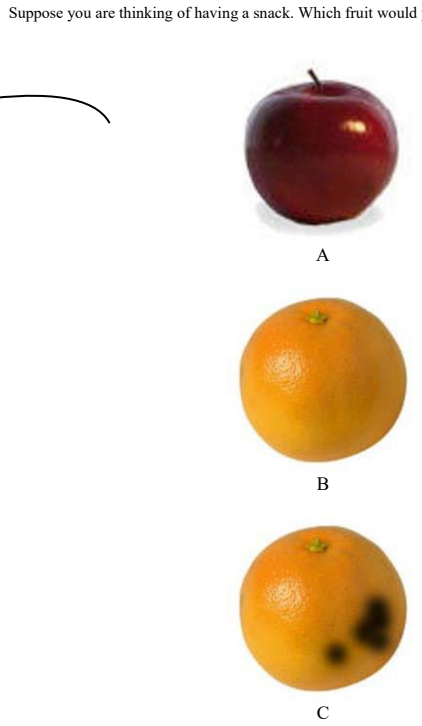

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   - Lab evidence stronger because it's easier to control what people think about in the lab?
   - Lab evidence consequence of low stakes?

Classroom Evidence: Baseline Appeal

For completing this survey, you have earned a bonus of $0.10. You can choose to give away your bonus to GiveDirectly.

This money could help them provide unconditional cash transfers to the poorest populations in the world. One For The World ranked GiveDirectly as one of the top rated charities in the world.

If you would like, you can give away your $0.10 to GiveDirectly.

Would you like to leave the bonus as it is, or give it away as a donation?

- Leave the bonus as is
- Change it so I give away the bonus I earned

Student Appeal

Congratulations! You have earned 1 dollar for completing this survey.

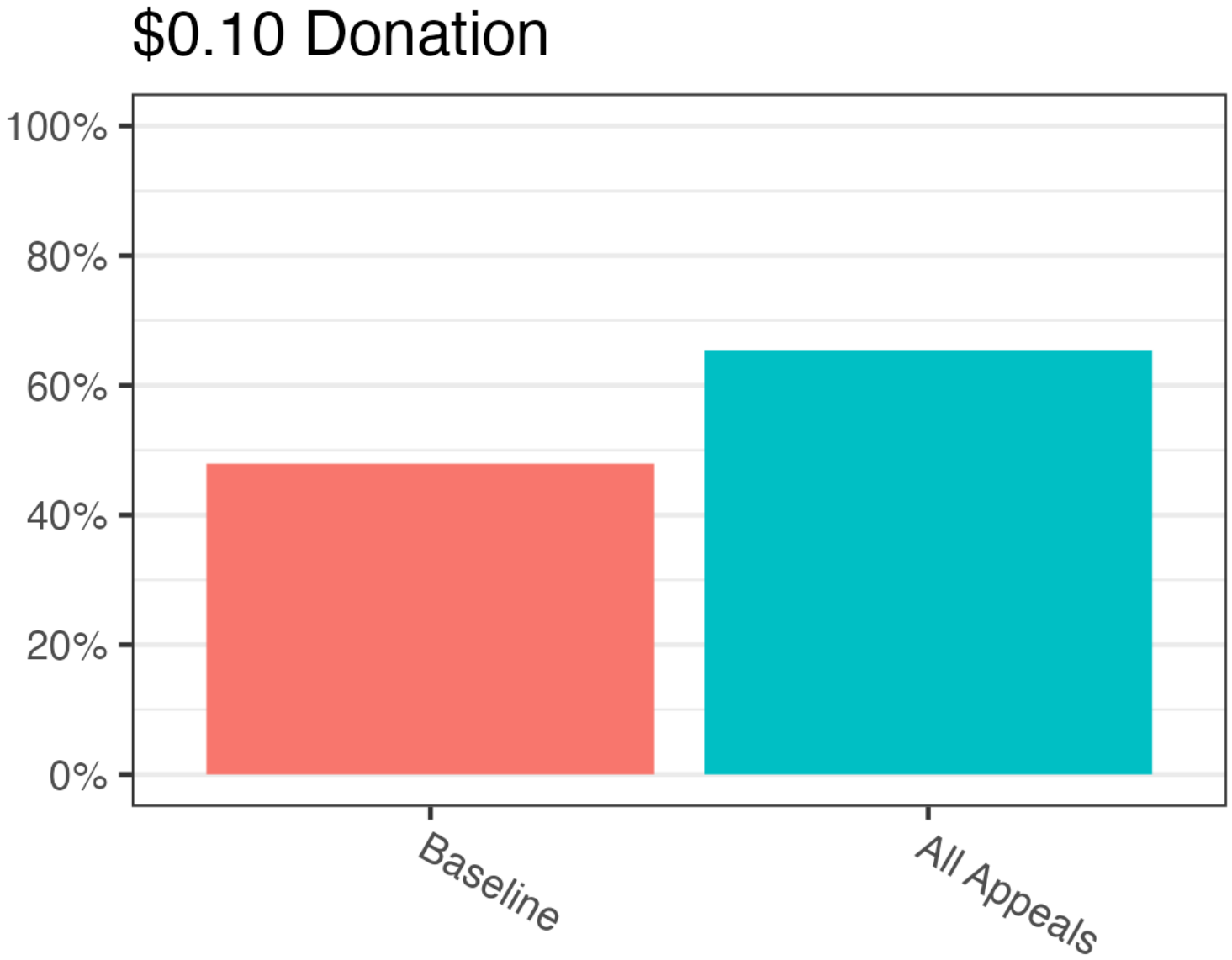
In addition, we can donate 10 cents to GiveDirectly on your behalf. GiveDirectly gives unconditional cash transfers to the poorest populations in the world. Although 10 cents may seem inconsequential, it can have a tangible impact. For example, 10 cents can buy a fresh bag of produce for a GiveDirectly recipient in Kenya. You can also choose to keep this 10 cents instead.

Should we donate this 10 cents on your behalf?

☑ Yes, help GiveDirectly continue to make a global impact.

☐ No, I need to keep this 10 cents for myself.

Classroom Evidence



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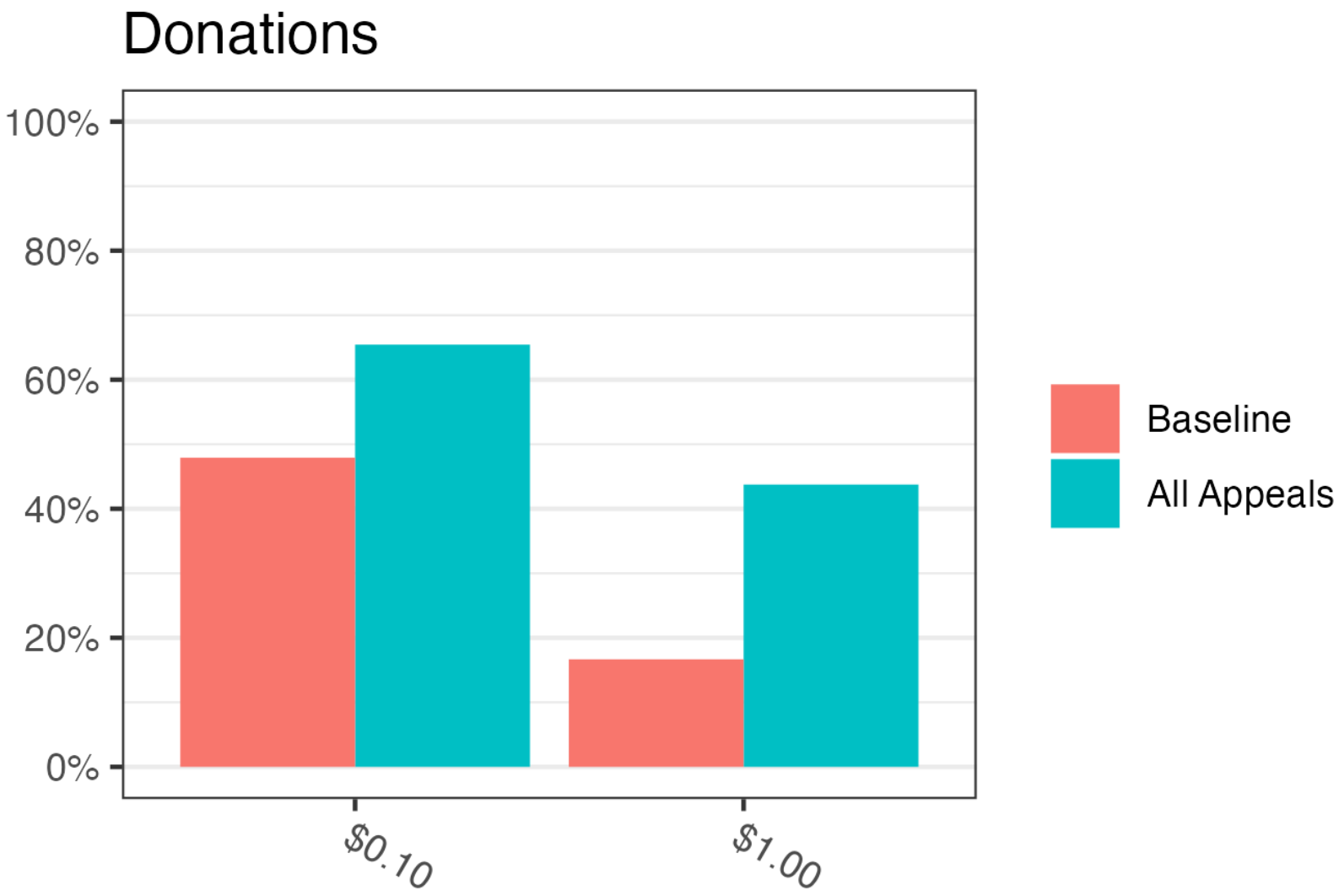


Comments: Second Interpretation?

1. If $k \in \{lab, field\}$, $w_j(x, S, k) \rightarrow w_j(x, k)$ when $k = field$
   - Lab evidence consequence of artificial presentations?
   - Lab evidence consequence of specific choice sets?
   - Lab evidence stronger because it's easier to control what people think about in the lab?
   - Lab evidence consequence of low stakes?
2. Contextual cues crucial to how people approach problems: $w_j(x, S) \rightarrow w_j(x, S, k)$
   - Presentation influences how people approach problems?

Example: Inference Problems

Balls and Urns (Edwards 1968)

Urn A contains 80% green and 20% blue balls,

Urn B contains 20% green and 80% blue balls.

A computer selects urn A or B with probabilities 25% and 75%, and draws a ball from it. The ball is green.

What is the probability it was drawn from urn A?

Taxicabs (KT 1972)

There are two taxicab companies, Blue and Green, according to the color of the cabs they run.

25% of the cabs are Green, 75% are Blue.

A cab is involved in a hit and run accident, and a witness reports the cab as Green. A test reveals that the witness can correctly identify each color cab with probability 80%.

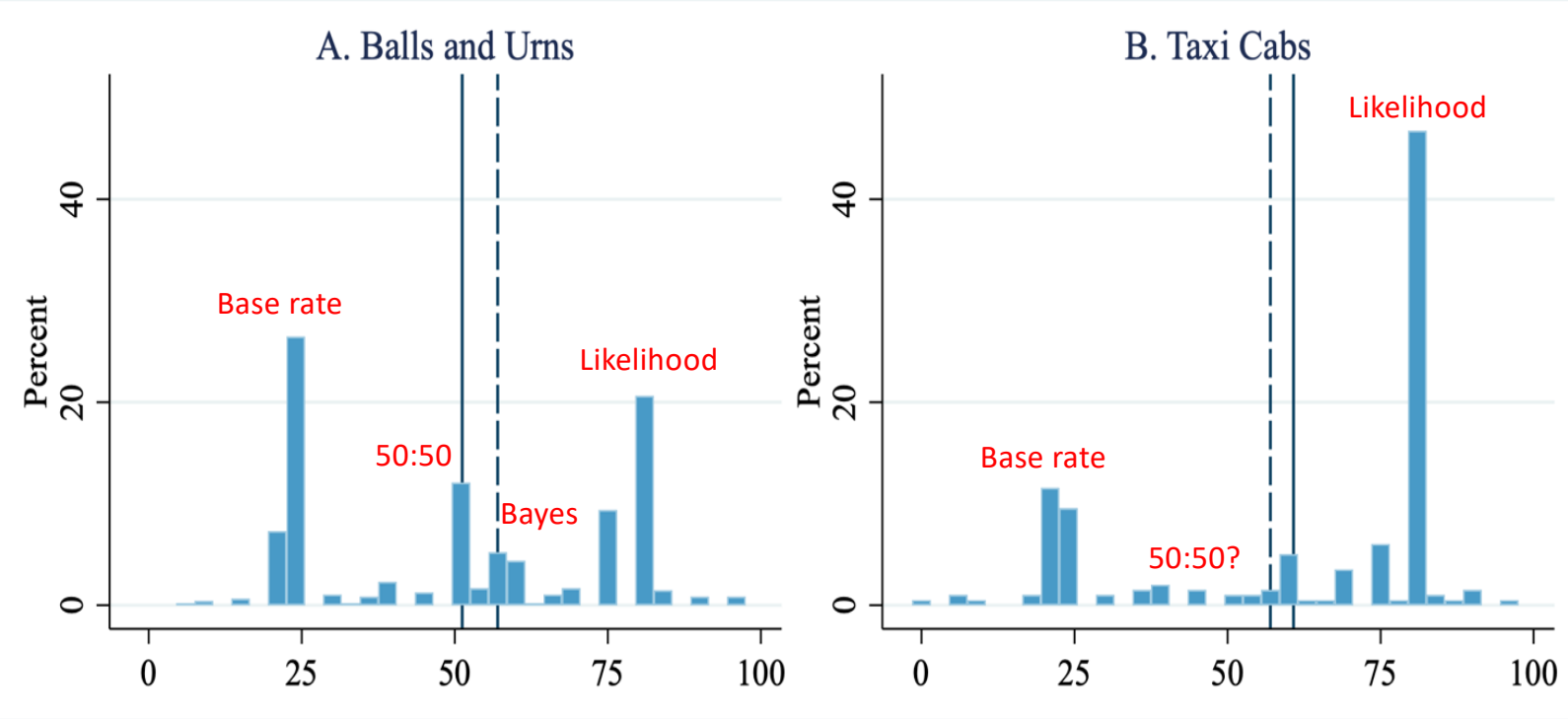
What is the probability that the errant cab was Green?

In both cases:

Prior = 25%, Likelihood = 80% → Correct Answer ≈ 57%

BCGKS 2024: How people use statistics

Distribution of Estimates



BCGKS 2024: How people use statistics

Analogy Here?

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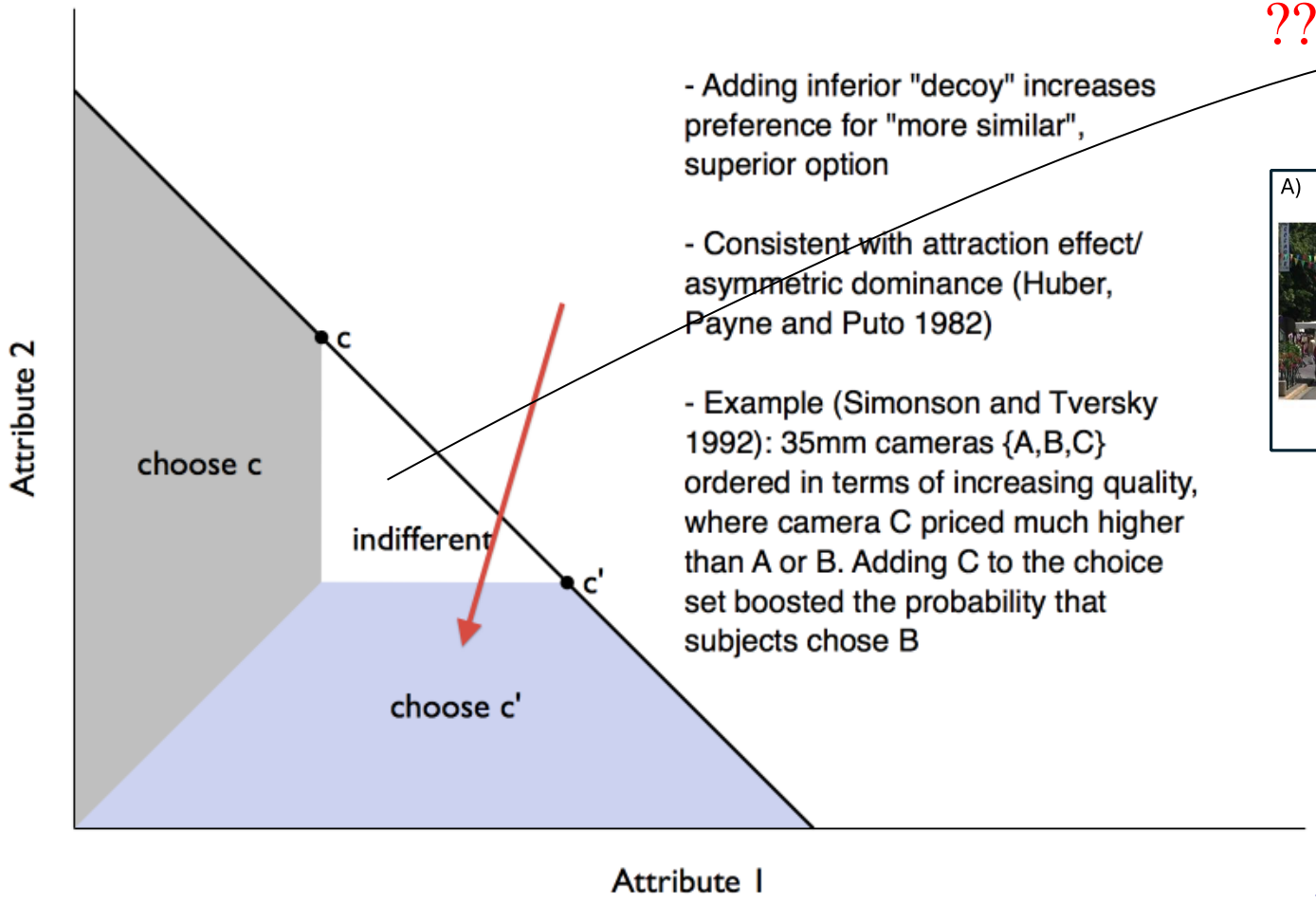
Use the number keys to choose: 1=LEFT, 2=MIDDLE, 3=RIGHT.

Just to Take an Example



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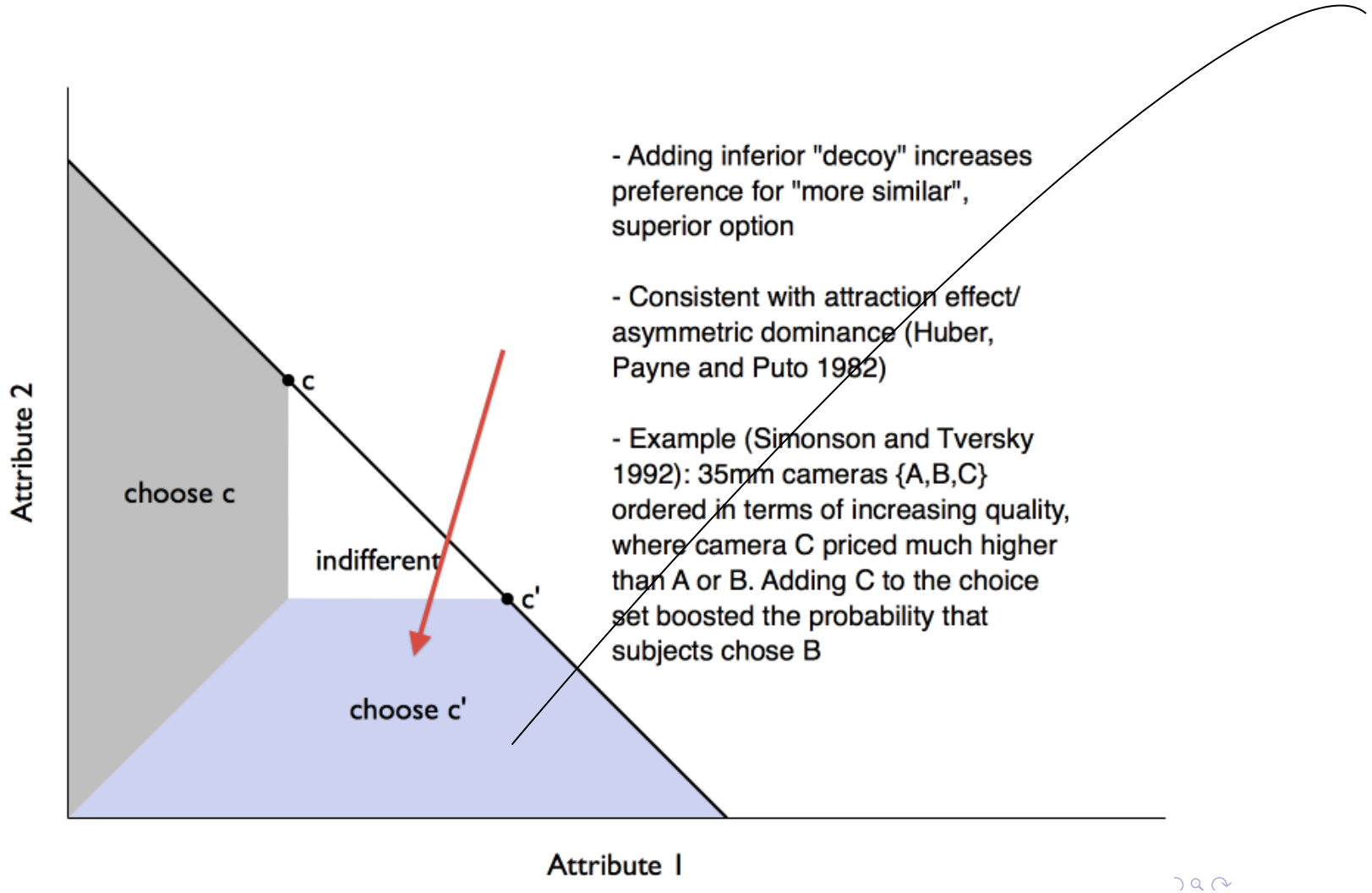

Want choice set that (in embedding form) falls in a region like this (given preferred choice model)

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Summary

Upshot: Exciting work!

A potential next step: Use this technology to systematically explore how presentation and other cues impact classic choice-set effects