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Elicitation of Cognitive Biases in Military Decision-Making Contexts

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Introduction: Cognitive Biases

Definitions

- "Our judgments and decisions routinely rely on approximations, heuristics, and rules of thumb, even when we are not consciously aware of these strategies. The imperfections of these strategies manifest themselves as cognitive biases." [Dimara et al., 2020] citing [Kahneman, 2011]
- May be defined as "…an error resulting from an unconscious deviation from rational or optimal behavior." [Tversky & Kahneman, 1974]

Issue

- Cognitive biases on the part of warfighters may result in sub-optimal decisions on when and where to deploy units, where to fortify defenses, where to attack, etc.
- Overcoming cognitive biases should, in theory, give forces an advantage in the battlespace

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Cognitive Biases in our Study

- Focused on Decision tasks in taxonomy of [Dimara et al., 2020]
- Baseline sub-category [cognition is biased by comparison with a baseline]
  - Attraction Effect [Simonson,1989]
  - Compromise Effect [Simonson ,1989]
- Association sub-category [cognition is biased by connections between items]
  - Zero-risk Bias [Baron et al.,1993]

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Attraction Effect

- Have two dimensions of decision and two alternatives
- Each alternative is strong in one dimension and weak in other
- Additional third alternative that is a little weaker than one of the first two alternatives in both dimensions
  - Idea to induce selection of the "dominating option"

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Attraction Effect

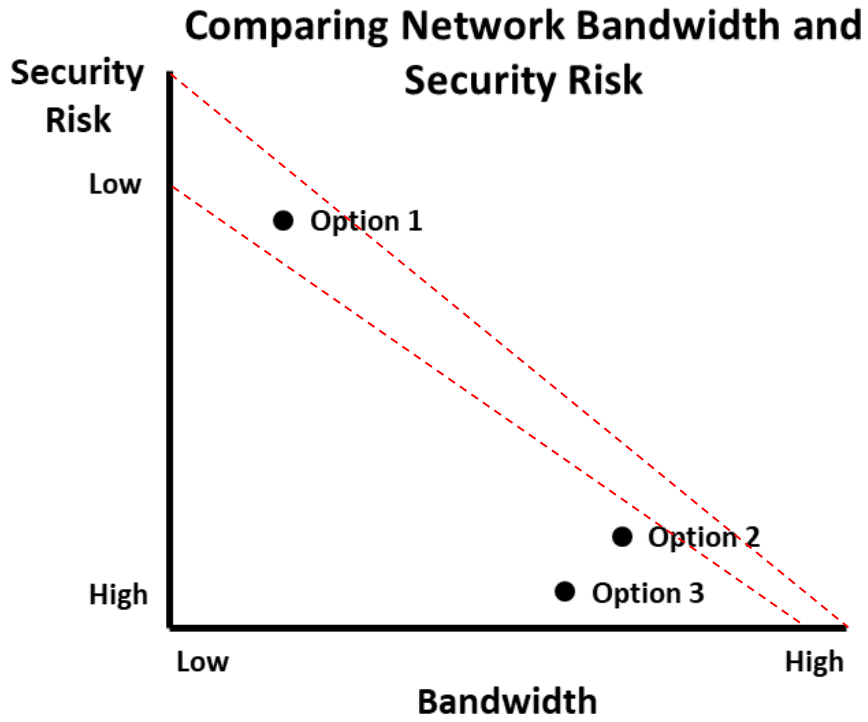
Example Question

You are in charge of building your group's internal network and protecting it from outside threats. You know that some in your group rely on good network performance for their job, whereas others rely on tight network security. Please choose a network design that you think best serves your group.

Choice 1: 10 gigabit per second bandwidth with a 0.8% security risk

Choice 2: 40 gigabit per second bandwidth with a 2.5% security risk

Choice 3: 35 gigabit per second bandwidth with a 2.8% security risk



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Compromise Effect

- Have two dimensions of decision and two alternatives (again)
- Each alternative is strong in one dimension and weak in other
- Additional third alternative that is nearly an even compromise between first two alternatives

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Compromise Effect

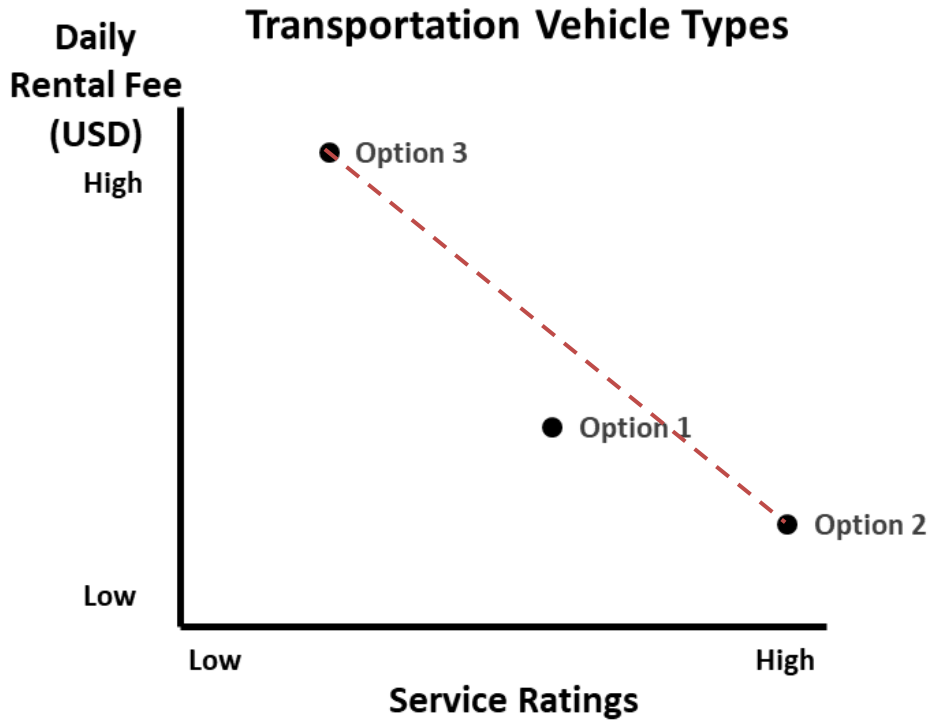
Example Question

You own a transportation company and are deciding what type of vehicles to hold in your fleet. Large busses hold 60 passengers, small busses hold 24 passengers, and vans hold 10 passengers. Which vehicles would you choose for your fleet, given the following rates trade magazine service ratings?

Choice 1: Choose small busses, which rent for $659/day. Trade magazines rate their service at 5.1 out of 10.

Choice 2: Choose large busses, which rent for $950/day. Trade magazines rate their service at 3.4 out of 10.

Choice 3: Choose vans, which rent for $383/day. Trade magazines rate their service at 8.5 out of 10.



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Zero-risk Bias

- Have a two-pronged output and two or more options
- One option reduces the "cost" in one prong to zero
  - In [Baron et al., 1993], overall cost was equal
  - In [Viscusi et al., 1987], overall cost of zero-risk option was higher; we used this design

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Zero-risk Bias

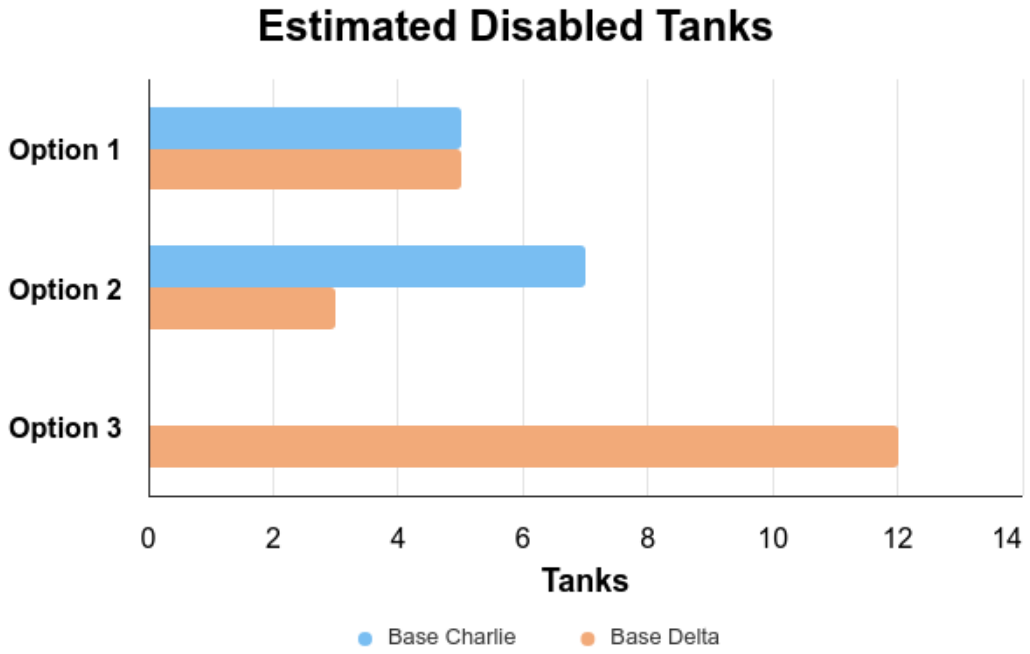
Example Question

You have recently come through a long series of sandstorms, depleting the protective covers for your tanks. Another storm is on the way which will hit two of your bases. You have only enough covers for one base's tanks and must decide where to place protective covers. The weather forecasters on your staff predict that without the protective covers, tanks will need extensive repairs if the storm hits. Given the severity predicted at each location, they suggest three courses of action to protect your tanks.

Option 1: Cover half the tanks at Base Charlie and half the tanks at Base Delta. The storm will likely disable five tanks at Base Charlie and five tanks at Base Delta.

Option 2: Cover all the tanks at Base Delta and some tanks at Base Charlie. The storm will likely disable seven tanks at Base Charlie and three tanks at Base Delta.

Option 3: Cover all the tanks at Base Charlie and some tanks at Base Delta. The storm will likely disable twelve tanks at Base Delta, but no tanks at Base Charlie.



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Study Procedure

1. Informed Consent
2. Demographics Questionnaire
3. Cognitive Reflection Test (CRT) [Frederick, 2005]
4. Rational-Experiential Inventory (REI) [Pacini & Epstein, 1999]

} [Sleboda & Sokolowska, 2017] found these predictive of Attraction & Compromise Effects

5. Terrain Orientation Task [Coyne et al., 2024]

{6-9} Attraction Effect (AE)
Compromise Effect (CE)
Zero-risk Bias (ZR)
Tank Game

} Ordered according to Latin square counterbalanced for first-order sequence effects

After each half of {AE, CE, ZR} sections, asked for strategy and (on graph portions) whether graphs were useful

Dismissed trials in which reading speed was measured at > 1000 words/min

Tank Game to be reported in [Dasgupta et al., 2025]

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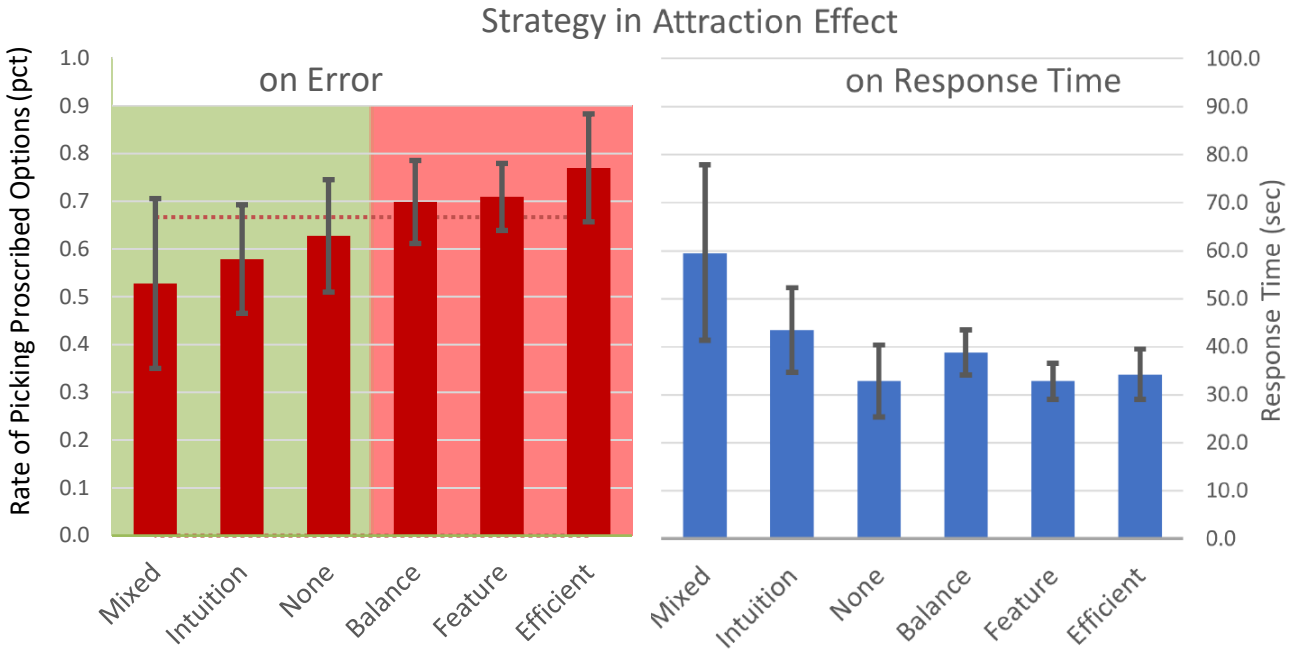
Results: Attraction Effect

What we Found

- Effect of sentiment towards graphs
  - F(2,61)=3.423, p<0.039, ges=0.101
  - Participants were "fooled" by attraction set-up when they had negative sentiment for graphs slightly less often (61.1%) versus neutral (66.7%) or positive (73.5%)
- Effect of decision-making strategy
  - F(5,84)=3.228, p ≈ 0.010, ges=0.161
  - Two groups of strategies: one group with lower rate of selecting the "wrong" options
  - Mix of strategies trended slowest: F(5,84)=1.990, p ≈ 0.088, ges=0.106

ges = generalized effect size



Intuition="went with [their] gut"	19
Feature=explicitly picked from one feature	42
Efficient=said they aimed for efficiency	14
Balance=said they tried to "balance" interests	28
None=said they had no particular strategy	17
Mixed=mentioned more than one of above	8

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Results: Compromise Effect

What we Found

- Strategy was explicitly finding a "balance" or choosing option "in the middle" on 33.6% of trials
  - Used one feature for 27.0% of trials; all other strategies were under 11.5%.

Balance	41	Feature	33
Intuition	14	Mixed	13
None	13	Efficient	8

What we Didn't Find

- Statistical significance on error for strategy
- Correlation with REI scores
  - Conflict with [Sleboda&Sokolowska,2017]
- Correlation with CRT scores
  - Conflict with [Sleboda&Sokolowska,2017]
- Effect of presence of graphs
- Effect of sentiment for graphs
- Effect of reported gender
- Effect of reported education level

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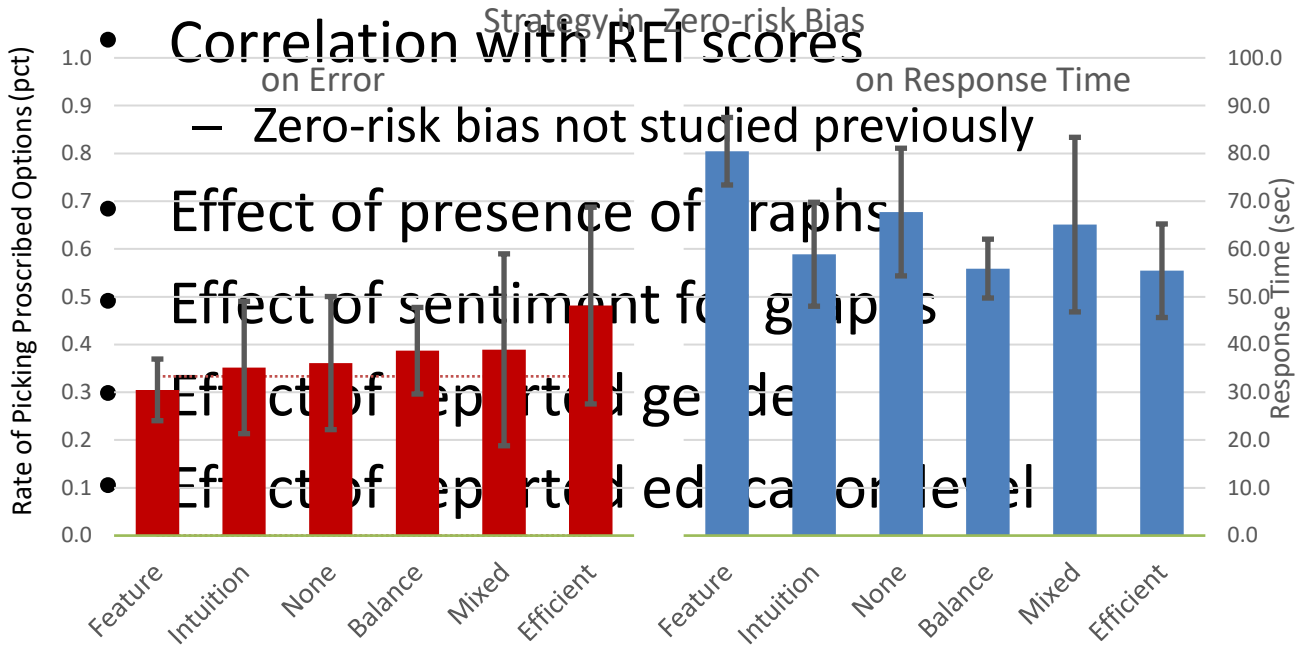
Results: Zero-risk Bias

What we Found

- Trend on error for strategy
  F(5,76)=2.188, p≈0.064, ges=0.126
  - Feature strategy had lower error than Balance strategy, trended better than Efficient
- Significant correlation with CRT score and rate of selecting zero-risk option
  - t(56)=2.954, p<0.005
  - Giving intuitive-but-incorrect answers on CRT predicts picking the (perhaps) intuitive-but-incorrect zero-risk option

What we Didn't Find

- Correlation with REI scores
  - Zero-risk bias not studied previously
- Effect of presence of graphs
- Effect of sentiment for graphs
- Effect of reported gender
- Effect of reported education level



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Summary & Future Directions

- Some success in eliciting biases
  - Many selections of options that would indicate the biases, but not a majority
  - Statements from participants indicating Compromise Effect
- Limited success in identifying contributing factors
  - Strategy seemed to influence Attraction Effect and Zero-risk Bias
  - Graphs did not mitigate bias
  - Previous results with CRT and REI had limited success as predictors
- Possible future research: problem-solving strategies & preferences for how people receive information (visual, verbal, etc.)

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Thank You

- Research in ONR 6.1 Base Program at NRL

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