Beyond Mutual Information:
Does Utility Affect Categorical Perception?

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## Theoretical Background

- <u>Feature Learning:</u> Effect of experience on perceptual features
- <u>Categorical Perception:</u> Modification of perceptual sensitivity near category boundaries [1]
- <u>Acquired Distinctiveness:</u> Improved discrimination for category-relevant features [3,4]
- <u>Mutual Information:</u> Reduction in uncertainty about one variable given knowledge of another [1]
- <u>Utility Theory:</u> Assignment of values to outcomes and selecting options that maximize utility [5]

Previous Experiment

- <u>Pre Discrimination Phase:</u> Can you tell the difference between both shapes?
- <u>Category Learning Phase:</u> Can you classify which is an A or B?
- <u>Post Discrimination Phase:</u> Can you tell the difference between both shapes?
- <u>Results:</u> Feature Learning is proportional to the mutual information between the feature and the category
- <u>Hypothesis:</u> In this experiment our results suggest that informative features drive feature learning, could utilities about a feature <u>also</u> drive feature learning?
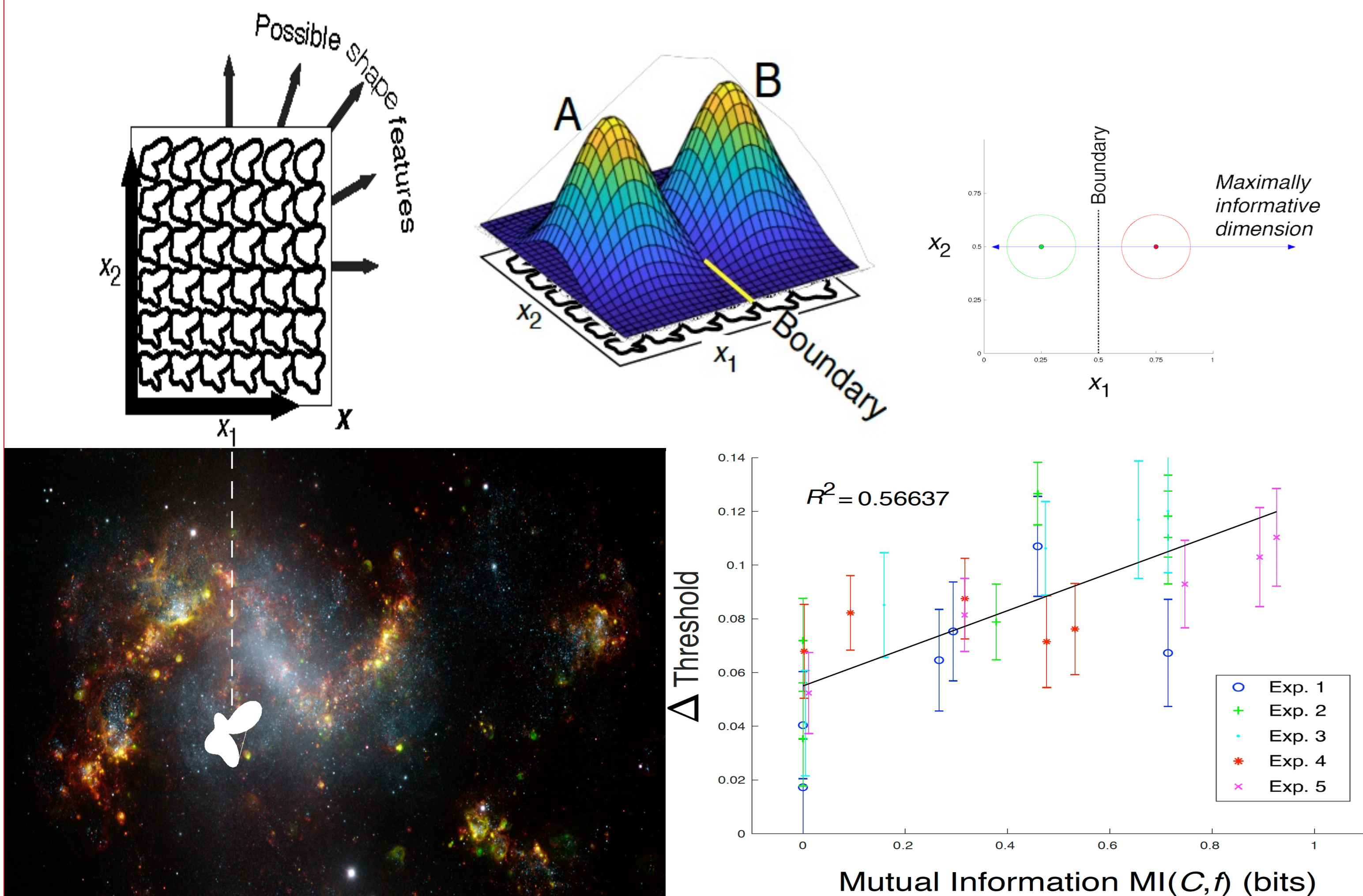

Current Experiment
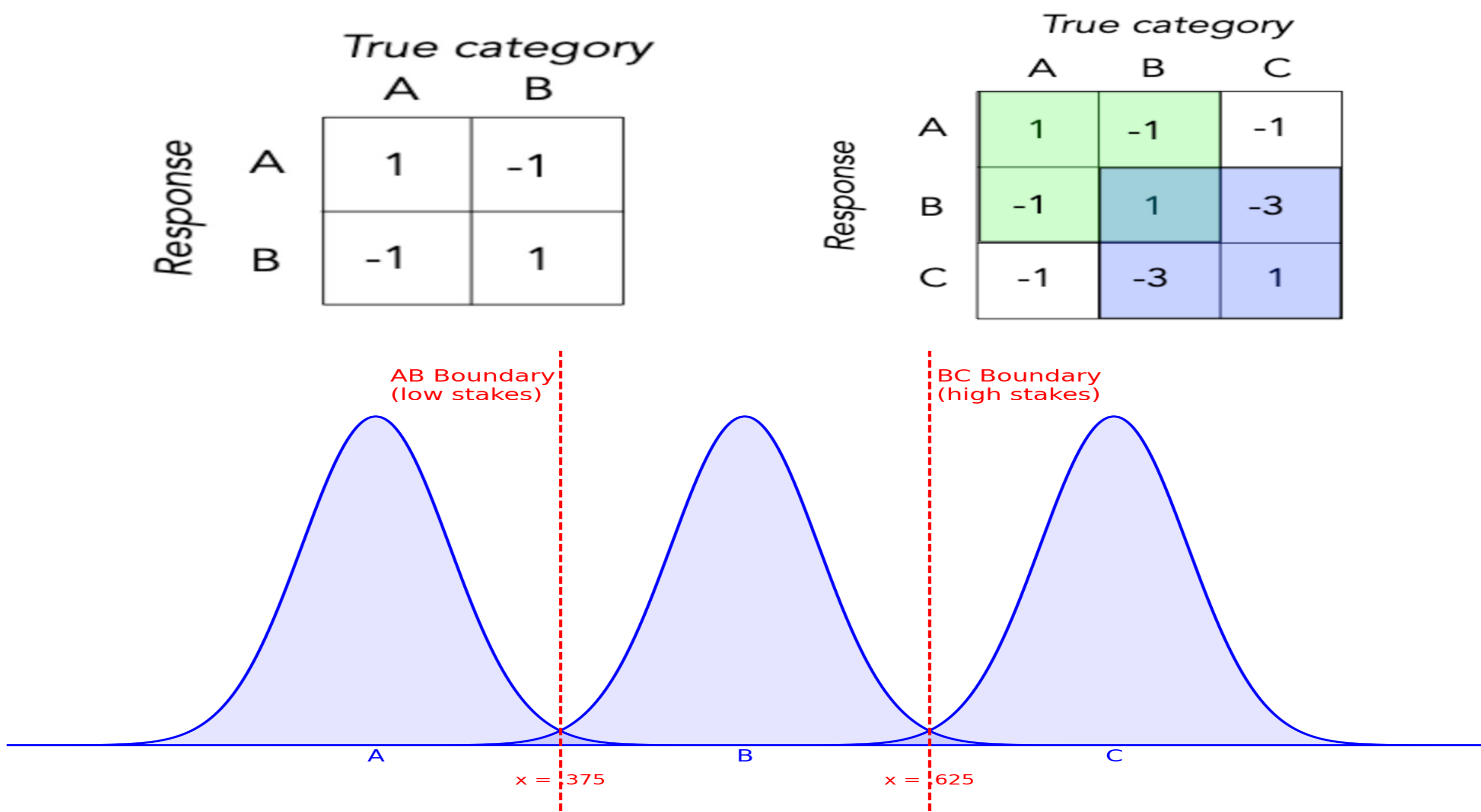
Influencing Motivation Through a Utility Matrix
- 2×2 Matrix: Standard rewards (Old Experiment)
- 3×3 Matrix: Asymmetric penalties (Current Experiment)
- AB Boundary: Low stakes (+1/-1)
- BC Boundary: High stakes (+1/-3)

- <u>Discrimination Task:</u> Features at AB or BC boundary
- <u>Category Learning:</u> 3 Categories with overlapping distributions
- <u>Research Question:</u> Is there a relationship between perceptual learning & utility theory? Do utilities influence what features participants are sensitive to?

Results

- Suggests utility-based sensitivity differences
- High-stakes boundaries may enhance perceptual learning
- Not yet statistically significant ($p > 0.05$)
- Moderate effect size suggests practical relevance
- Statistical methodology currently in progress
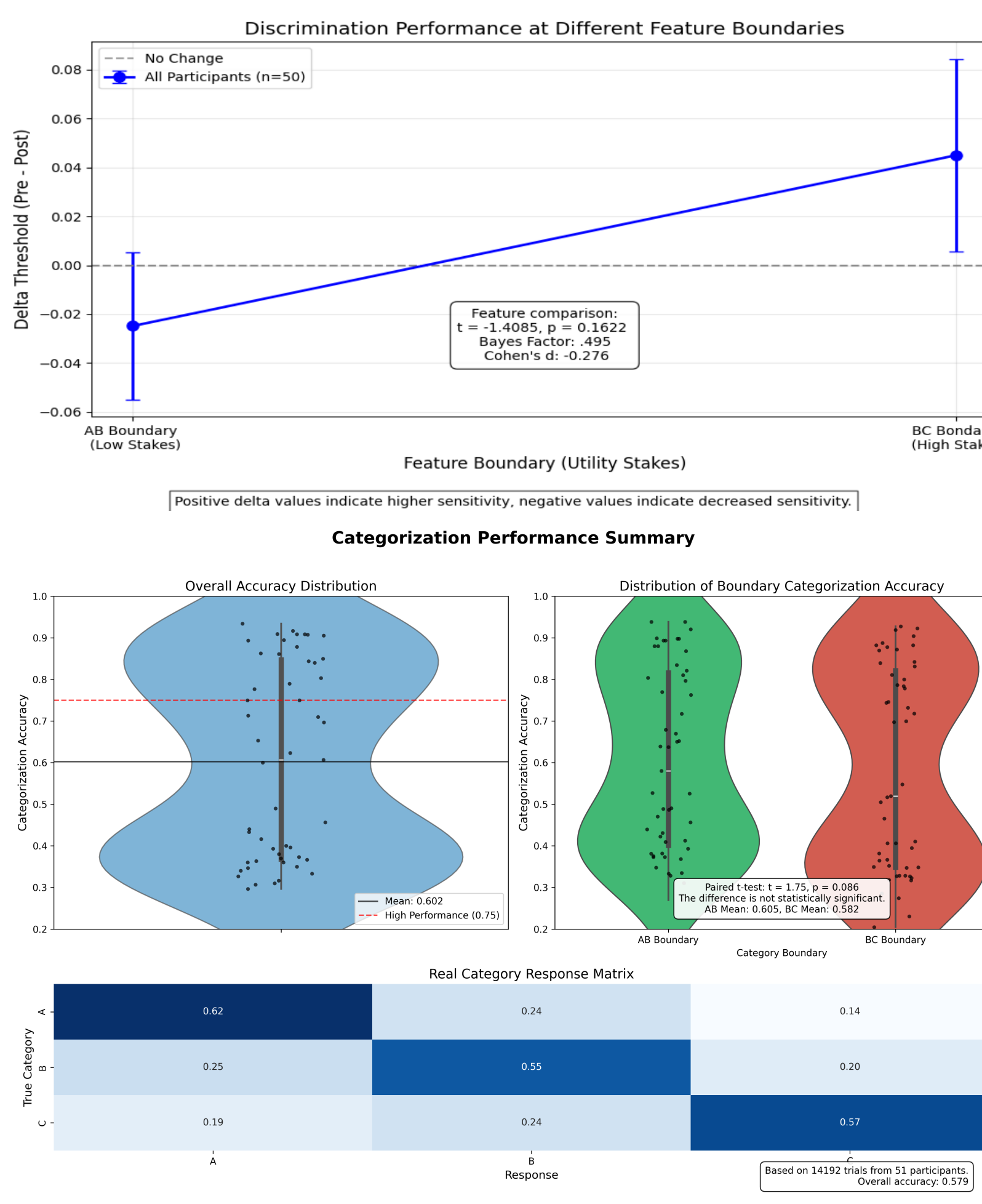
Discussion

- Assuming preliminary results can be confirmed, the conclusion is that feature learning <u>can</u> be influenced by utilities
- People learn to improve their discrimination on higher stakes features, suggesting a more unified framework where perceptual systems are sensitive to both the informational content and practical consequences of category distinctions
- No previous work has demonstrated how utilities might influence basic perceptual discrimination
- Much of the research in utility theory is in the field of behavioural economics, making our research a novel intersection between traditional category learning models and utility theory
- Future work would investigate asymmetric rewards

References

- [1] Feldman, J. (2021). Mutual information and categorical perception. *Psychological Science*, *32*(8), 1298-1310.
- [2] Fishburn, P. C. (1968). Utility theory. *Management science*, *14*(5), 335-378.
- [3] Goldstone, R. L. (1994). Influences of categorization on perceptual discrimination. *Journal of Experimental Psychology: General*, *123*(2), 178.
- [4] Honey, R. C., Close, J., & Lin, T. E. (2010). Acquired distinctiveness and equivalence: A synthesis. *Attention and associative learning: From brain to behaviour*, 159-186.
- [5] Holt, C. A., & Laury, S. K. (2002). Risk aversion and incentive effects. *American economic review*, *92*(5), 1644-1655.

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