System Updating…
Rational and Irrational Decision-Making in a Changing Task.

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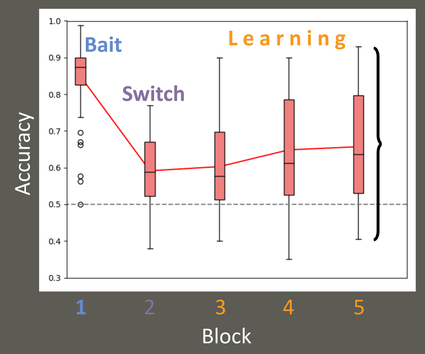
Introduction

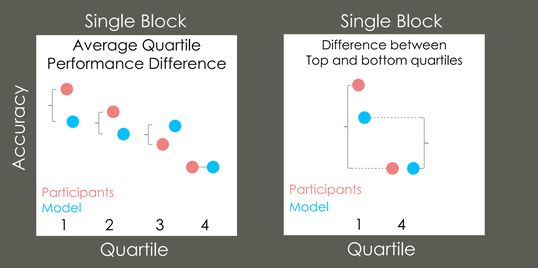
- Most visual category learning experiments include a subset of participants that remain at chance performance. Typically these participants are excluded or accounted for by so-called “random responder” models.
- The current study includes a large proportion of “non-learners” that cannot be attributed to non-compliance or motivation.
- Typical models of category learning struggle to account for stable chance performance as well as gradual learning since even partially relevant rules or impoverished representations do better than chance.
- The ability to model the variance in addition to average performance is achieved through a flexible cognitive architecture capable of both success and failure based on simple, interpretable mechanisms.

Modeling Behavior

All Participant Performance

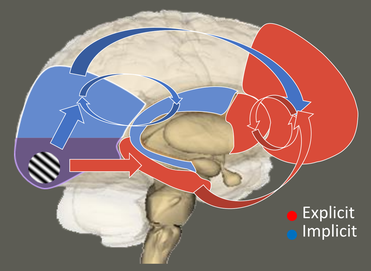


- Explicit strategy is learned and used during the “Bait”.
- Large variability in behavior across the rest of the experiment requires flexible strategy generation and evaluation

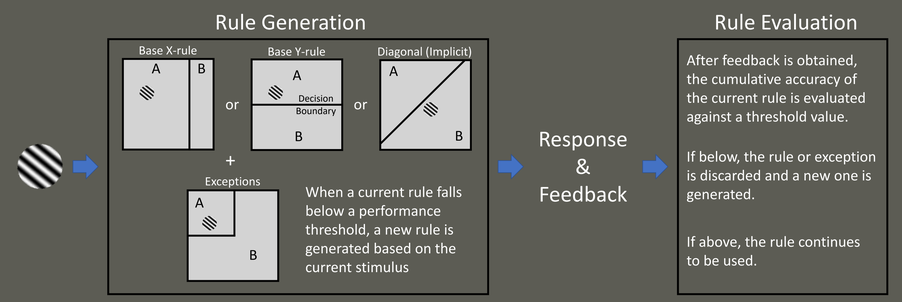


$$e = \sum_{\substack{b=1 \\ q=1}}^{5,4} |P_{b,q} - M_{b,q}| + \sum_{b=1}^{5} |(P_{b,q1} - P_{b,q4}) - (M_{b,q1} - M_{b,q4})|$$

Pinnacle 2.1a Framework

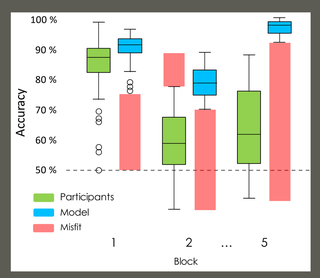


“Parallel Interactive Neural Networks Active in Competitive Learning”



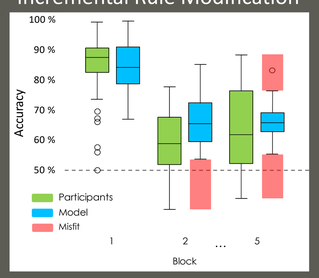
- Rules and exceptions are randomly generated as needed.
- If the rule or exception falls below a performance threshold, they are replaced.

Exemplar Models



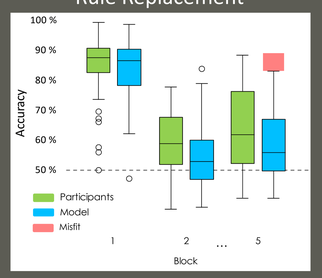
Cumulative Error: 5.56

Single Rule
Incremental Rule Modification



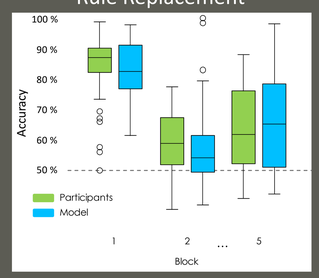
Cumulative Error: 2.55

Single Rule
Rule Replacement



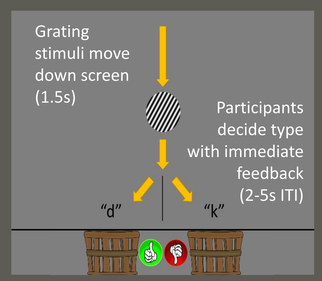
Cumulative Error: 0.75

Hierarchical Rule + Exception
Rule Replacement



Cumulative Error: 0.62

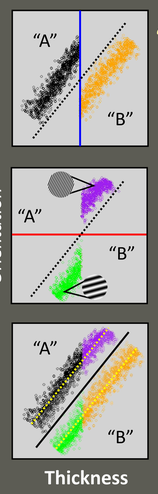
Experimental Design



400 trials in 5 blocks.

fMRI data collected on a 3T PRISMA. TR 2.2s, TE 21ms, MB 2, 2mm ISO voxel size (65 slices), 218 volumes, n = 28

Dynamic Cat Paradigm



“Bait” – 80 trials

Category is diagonal but stimuli are selected to encourage RB (thick/thin) rule discovery

“Switch” – 80 trials

The environment changes requiring participants to discover better strategies.

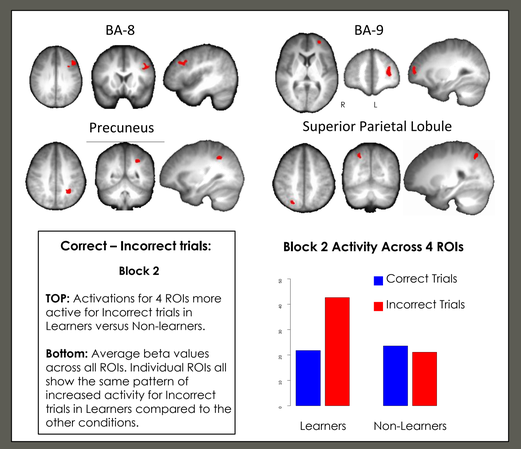
“Learning” – 240 trials

A broad range of strategies are explored.

Some participants identify appropriate strategies while other engage in rationally irrational behavior.

Imaging

Learners vs. Non-Learners During Switch Phase



Learners engage in greater rule refinement recruiting fronto-parietal areas.

This activity reflects network processes associated with:

- Working-memory
- Decision-making
- Strategy retrieval & updating
- Stimulus information accumulation.

Discussion

Many current cognitive models of category learning cannot account for the current dataset given the large variance and broad behavioral profiles. A more flexible model capable of exploring a wider space of strategies is required.

While consistent chance performance on this task is considered poor performance, in real-world scenarios this type of consistent exploration may be adaptive in the long-term.

This work was supported by:

Enhancing Intuitive Decision Making through Implicit Learning: N00014-16-1-2251

NIH T-32 training grant: NS047987

The work continues . . .