On the Nature of Decision States: Theory and Data

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Two Questions about Decision States

- What does it mean to make a decision?
- What is a decision state?

One Answer

- Decisions are made when a enough evidence has been accumulated to cross a threshold.

- The decision state itself is a discrete state: you've chosen one of the options.

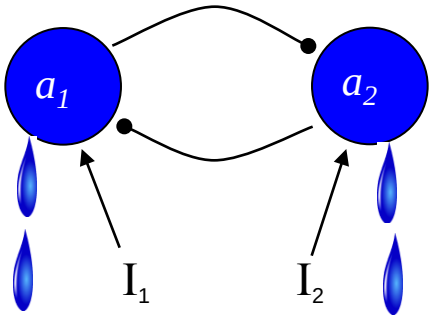
Another Answer

- Decision states are *continuous* in nature although the responses we are called upon to make may be discrete.
- Decision states will maintain their continuous nature even when they also show signs of discreteness
- Decision states may be reversible, if evidence reverses.

Decision States in the LCA

- The model posits accumulators of noisy evidence, with leakage and mutual inhibition:

$$da_1/dt = I_1 - \lambda a_1 - \beta o_2 + \xi_1$$
$$da_2/dt = I_2 - \lambda a_2 - \beta o_1 + \xi_2$$
$$o_i = 0 \text{ if } a_i < 0; \text{ else } o_i = a_i$$

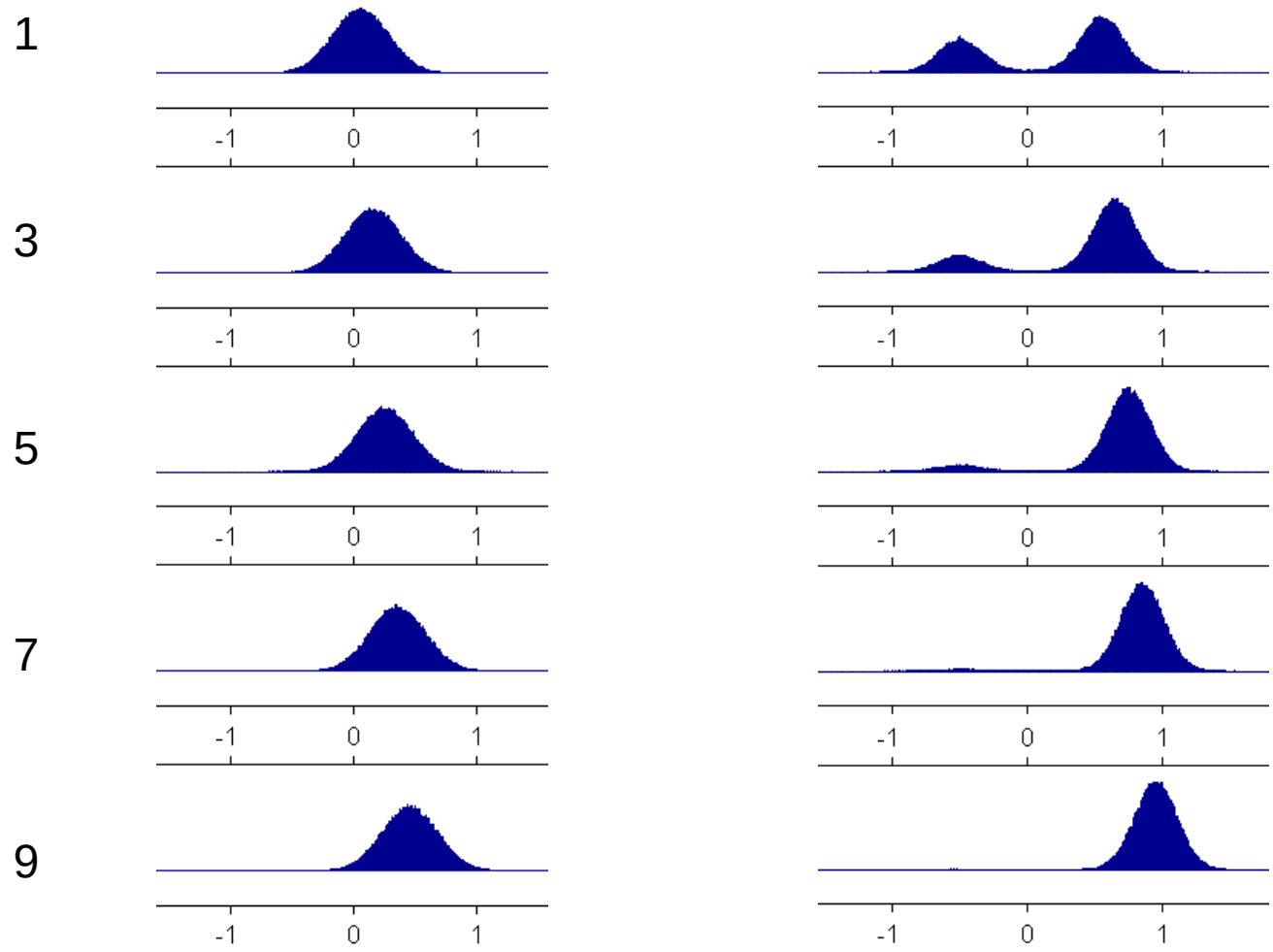


- $I_1 = B + \alpha S$; $I_2 = B - \alpha S$;

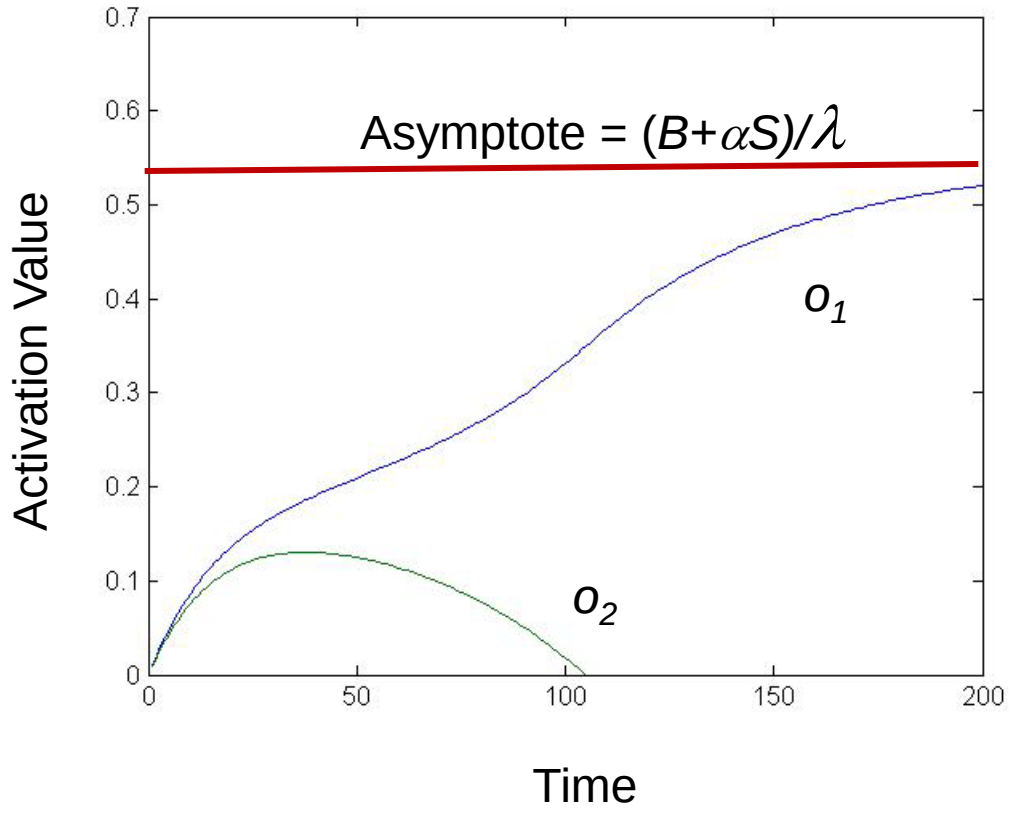
- The decision state corresponds to the pattern (o_1, o_2) which evolves through time as evidence accumulates

- Relative evidence favoring one decision or another is the difference (o_1-o_2)

~Asymptotic Distributions of o_1-o_2 for For Five Levels of Stimulus strength S

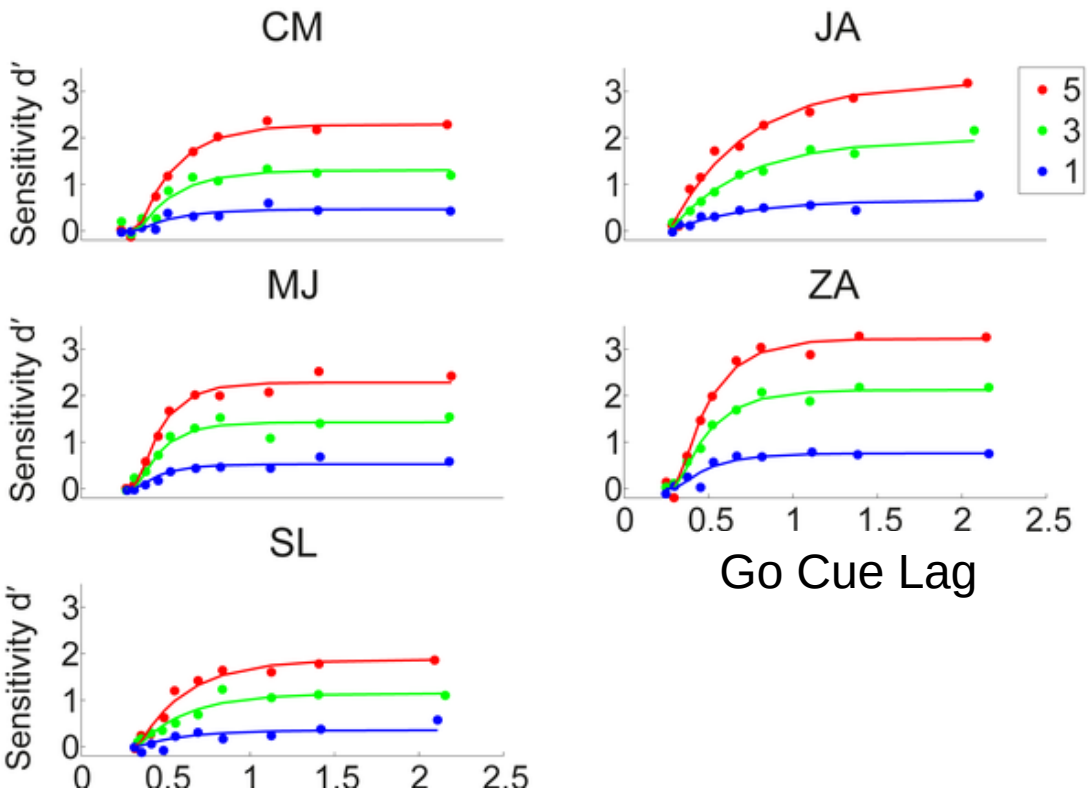


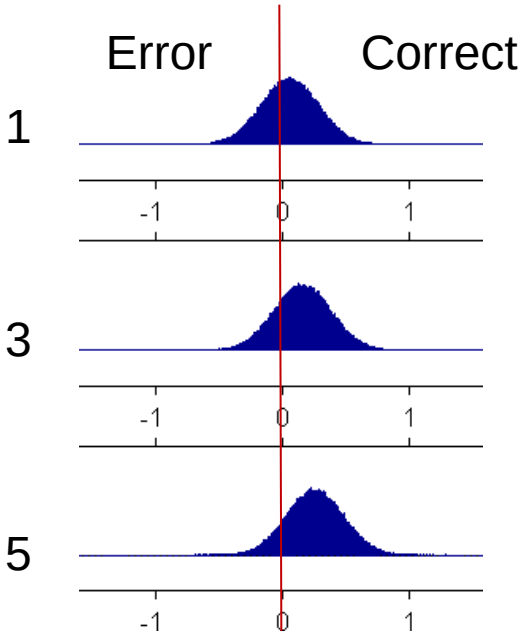
Time Evolution of Decision States When Inhibition > Leak



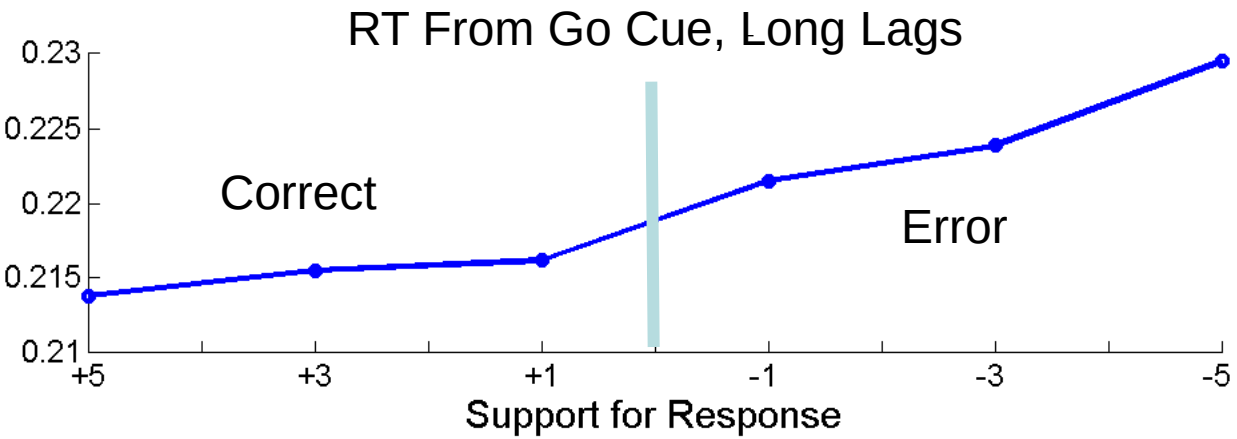
Predictions

- We should be able to find signs of differences in ‘strength’ of decision states even after performance levels off.
- We should be able to see signs of continuity even when there are also signs of discreteness
- We should be able see evidence of recovery of suppressed alternatives





Accumulator outputs drive response process triggered by go cue



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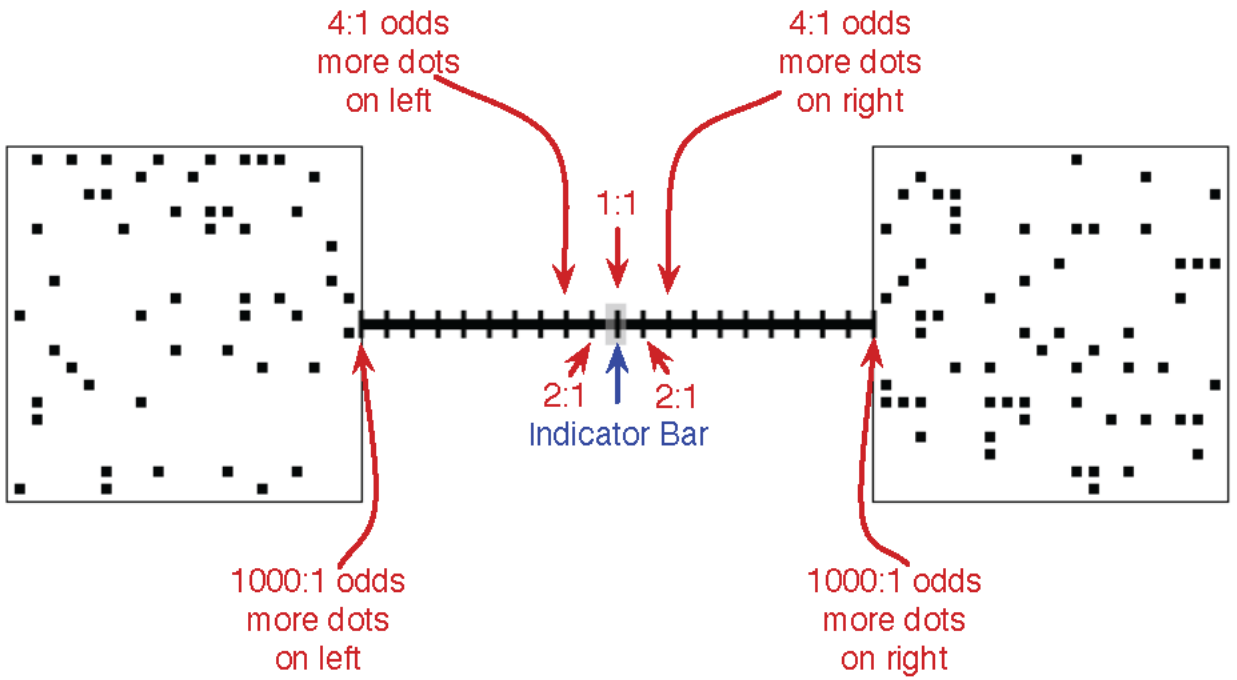
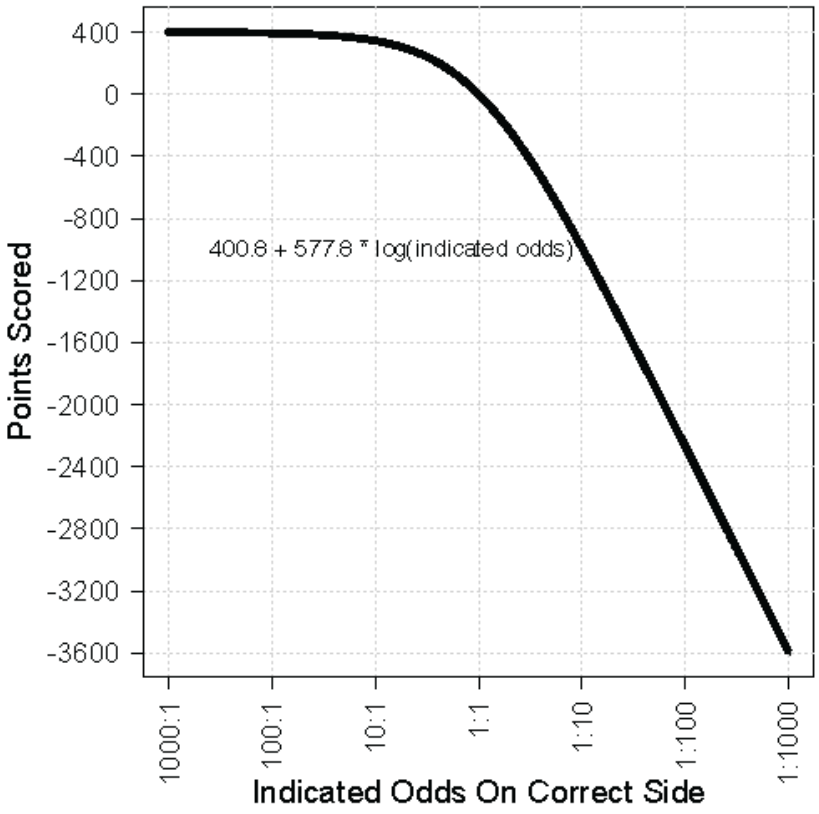
Toward Continuous Measures of Decision States

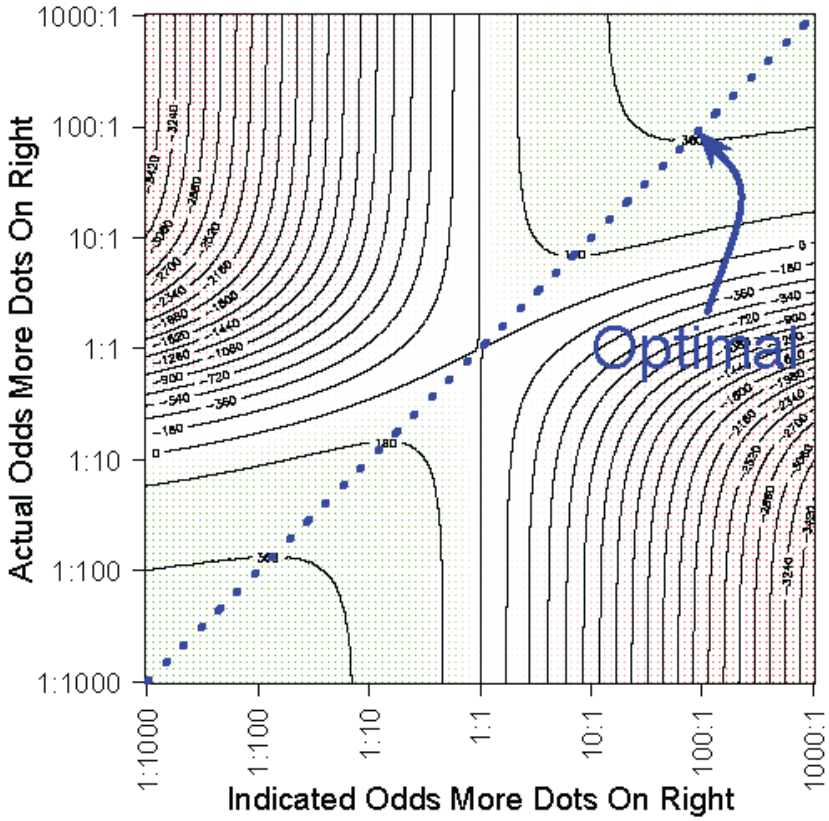
Lachter, Corrado, Johnston & McClelland

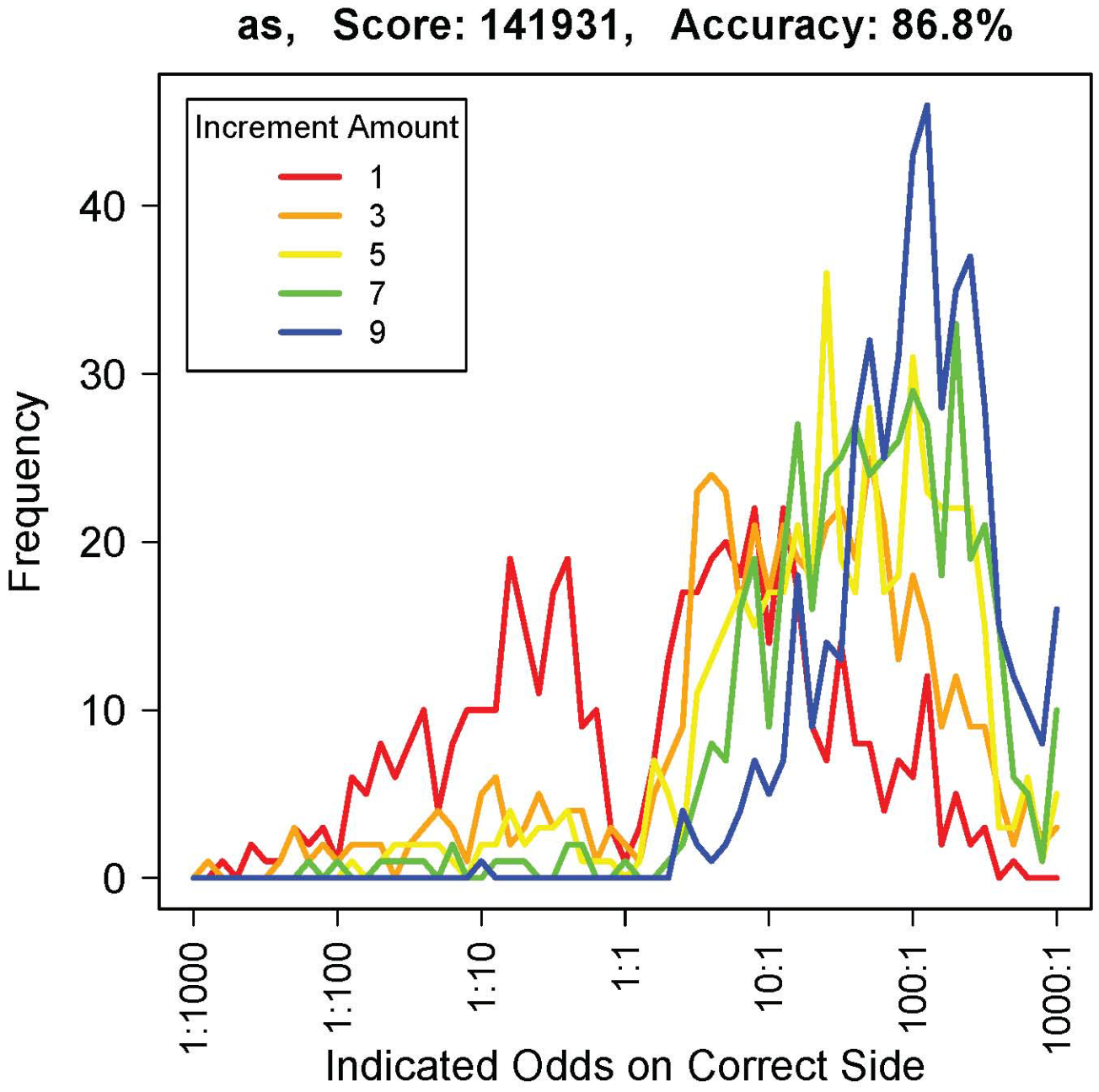
(Poster Last Night)



Scoring Scheme for Responses



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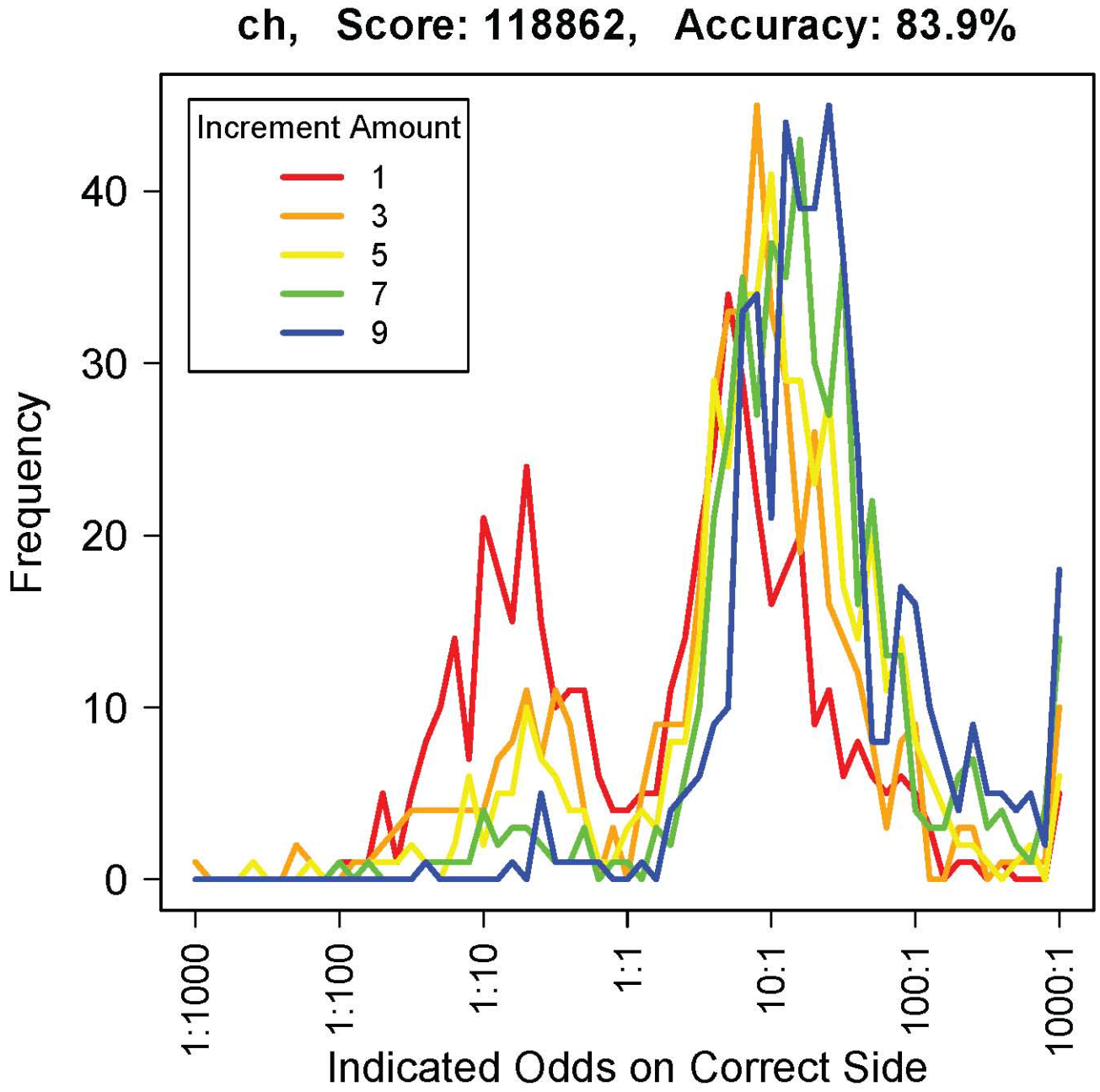
Indicated Odds on Correct Side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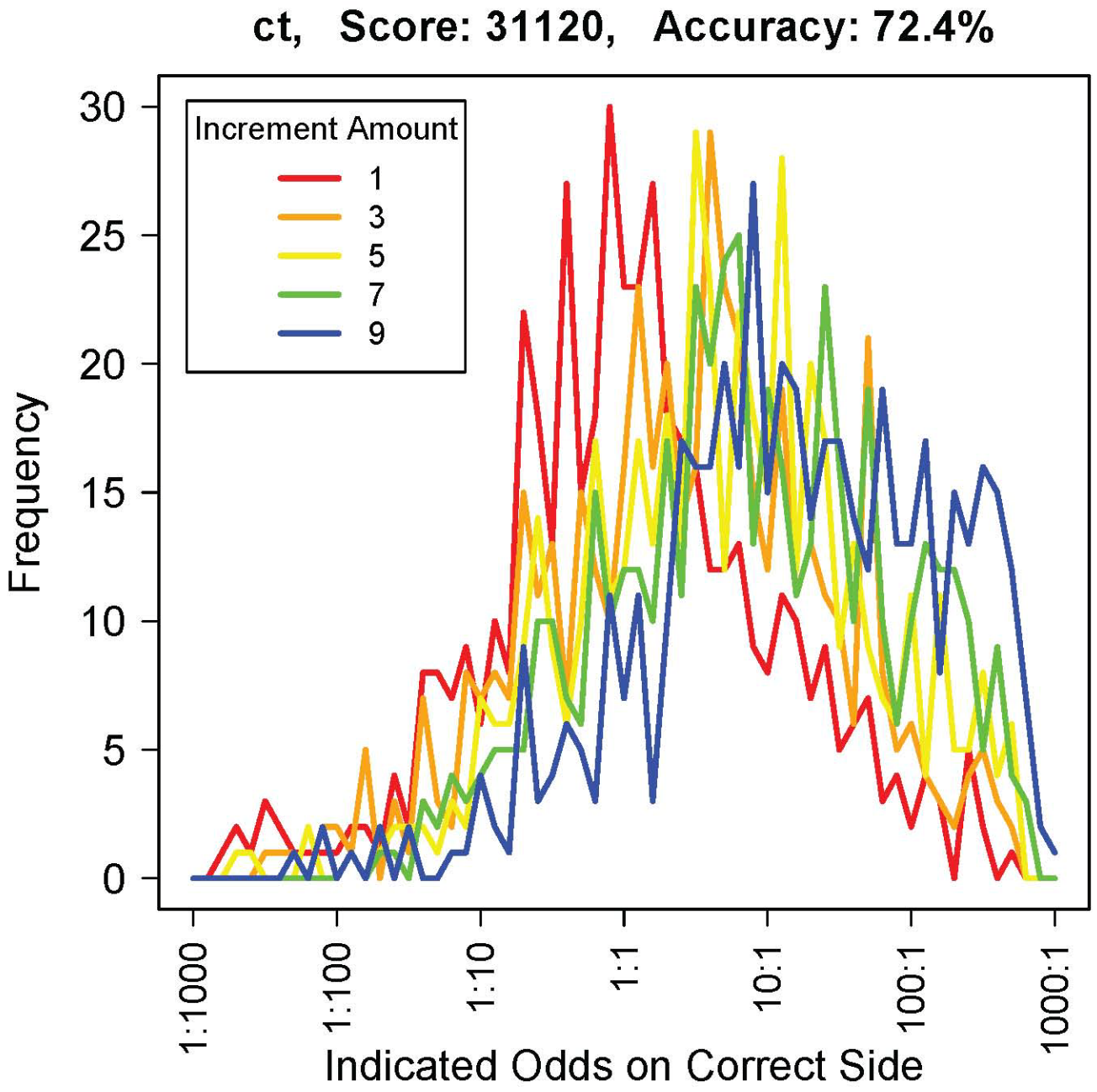
Indicated Odds on Correct Side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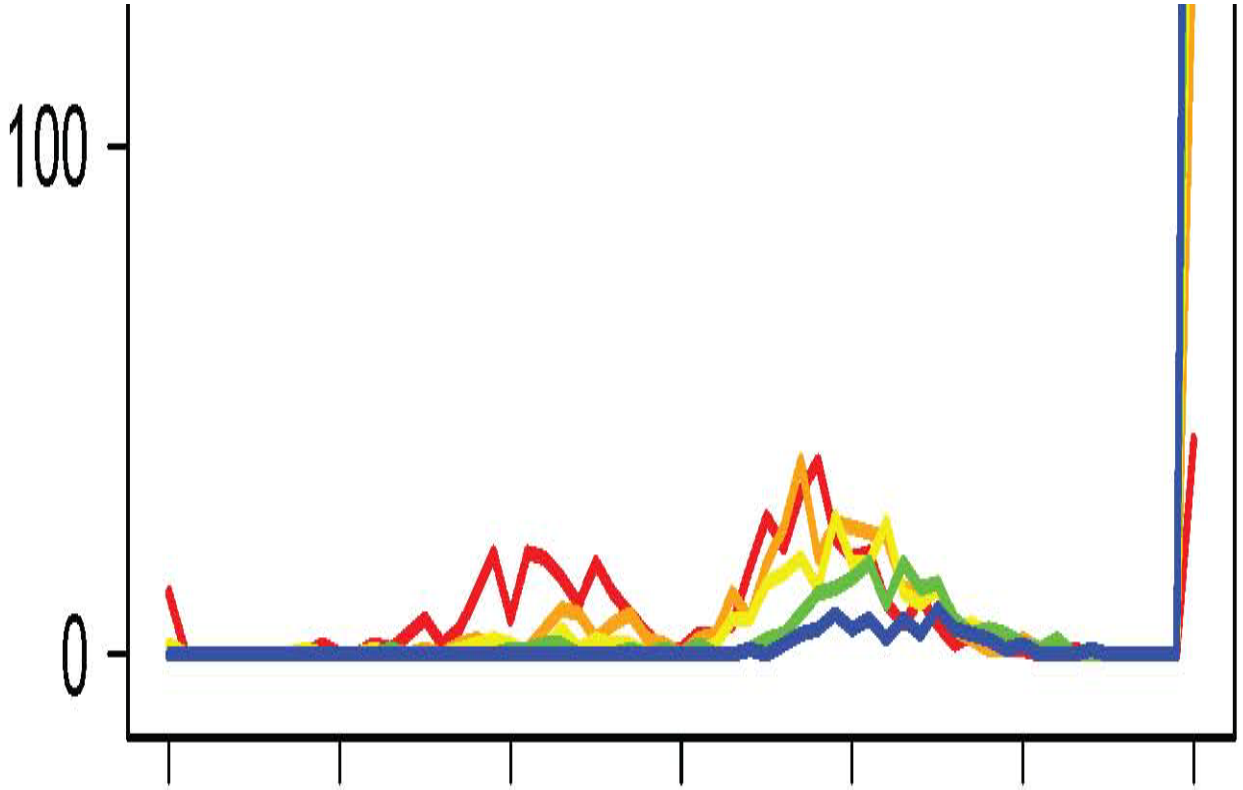
Indicated Odds on Correct Side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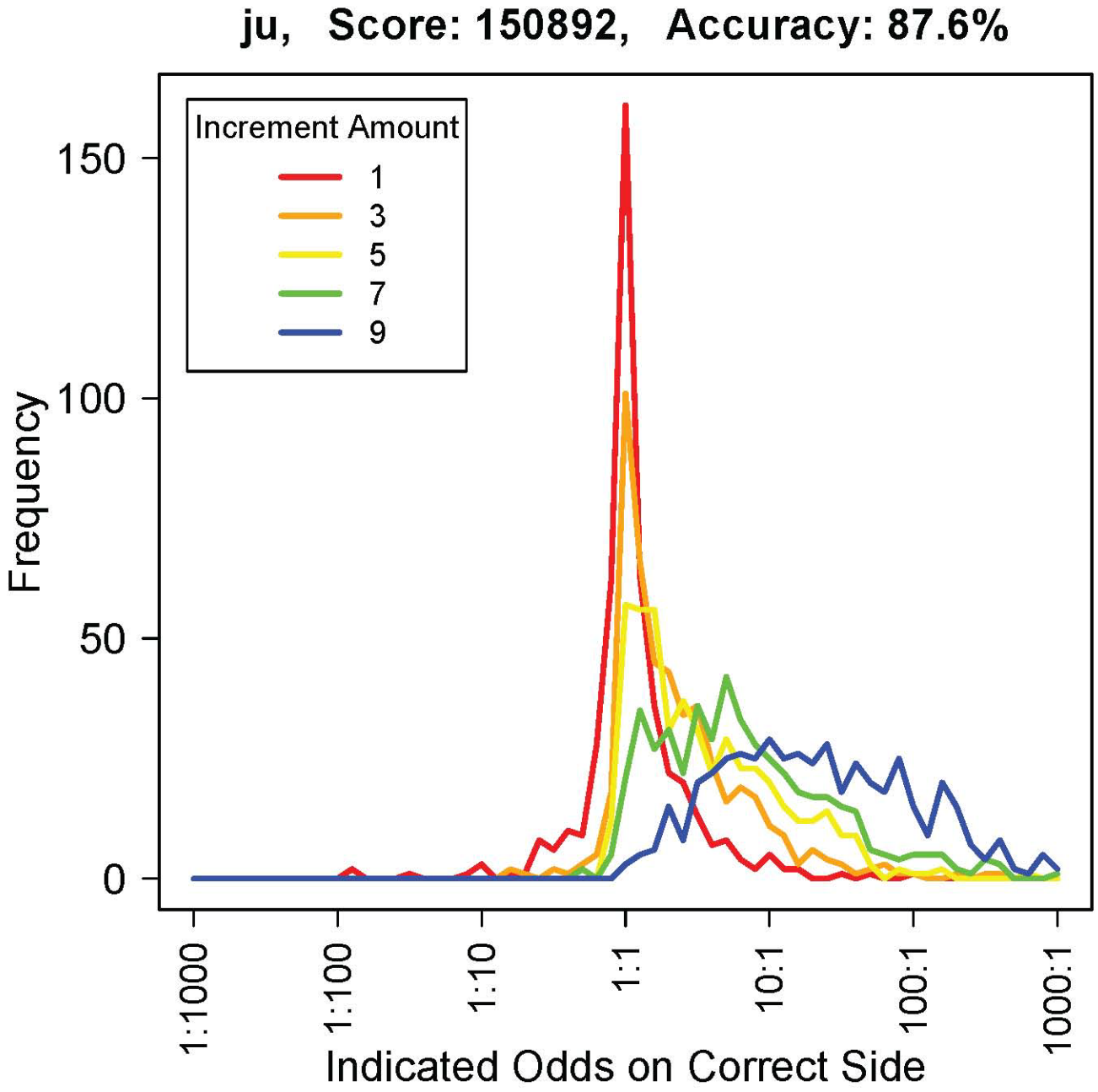
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100:1
1000:1
Indicated Odds on Correct Side

Can the model fit all of the data?

- Leak vs. Inhibition Dominance explains Gap vs. No Gap
- Without further embellishments the model captures the qualitative pattern shown by several participants
- We must add a threshold above which a ‘certain’ response is made to capture the ‘peak at 1000:1’ participants
- We must add the assumption that some subjects compress the decision value into a very small range around 0 to capture the behavior of 3 of the participants
- Whether this will be enough or whether a better model exists remains to be explored more fully.

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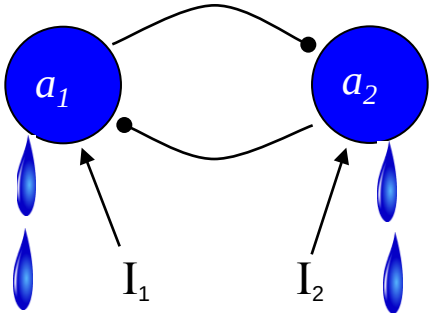
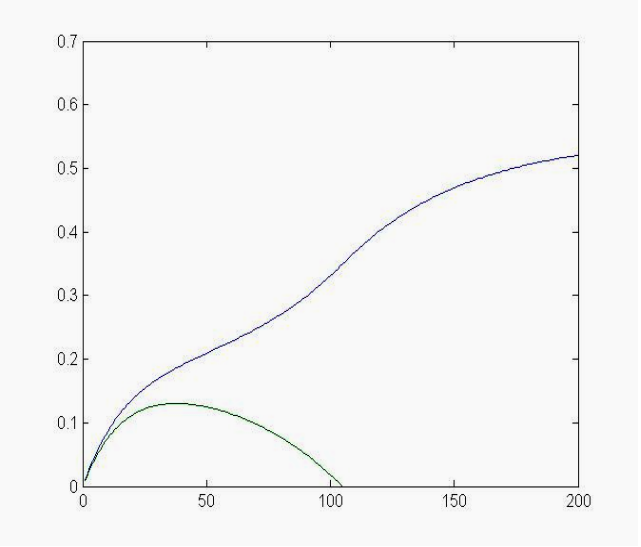
Conclusions

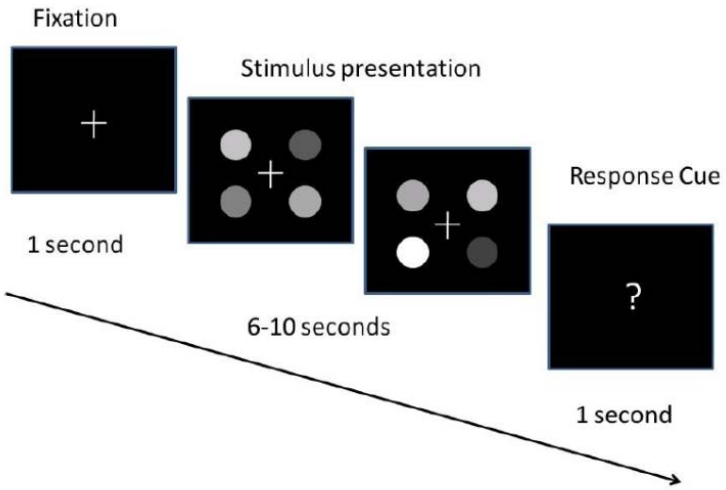
- Evidence from several studies is consistent with the idea that continuity is present in decision states, even when there are also signs of discreteness.
- The LCA model provides a simple yet powerful framework in which such states arise.
- More work is needed to understand if the LCA will turn out to be fully adequate, and whether the full set of data might be addressed with other approaches.

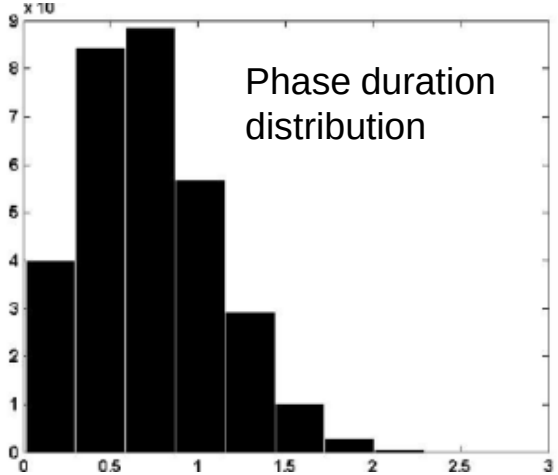




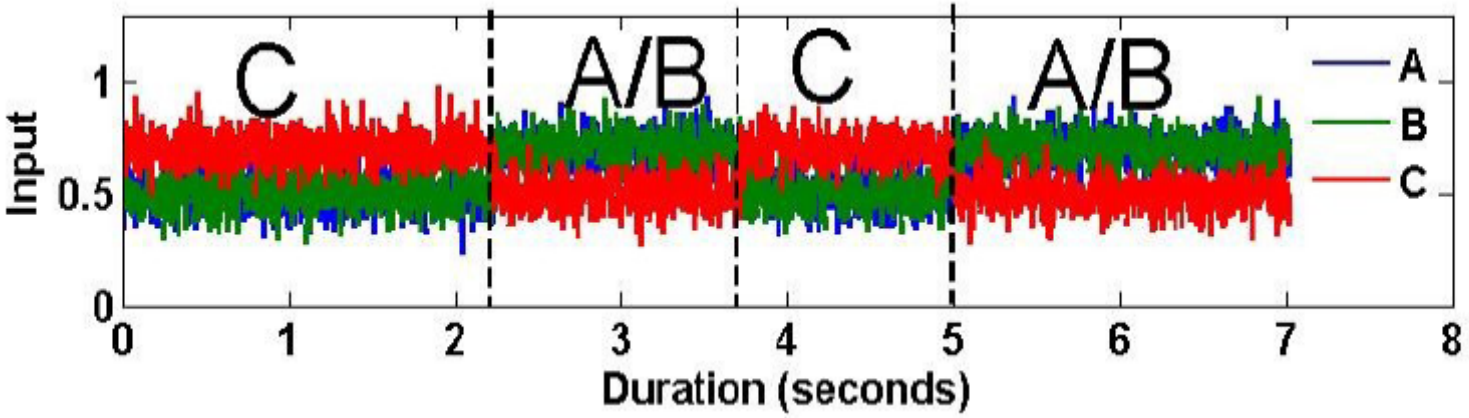
Decision making with non-stationary stimulus information

(Tsetsos. Usher & McClelland 2011)





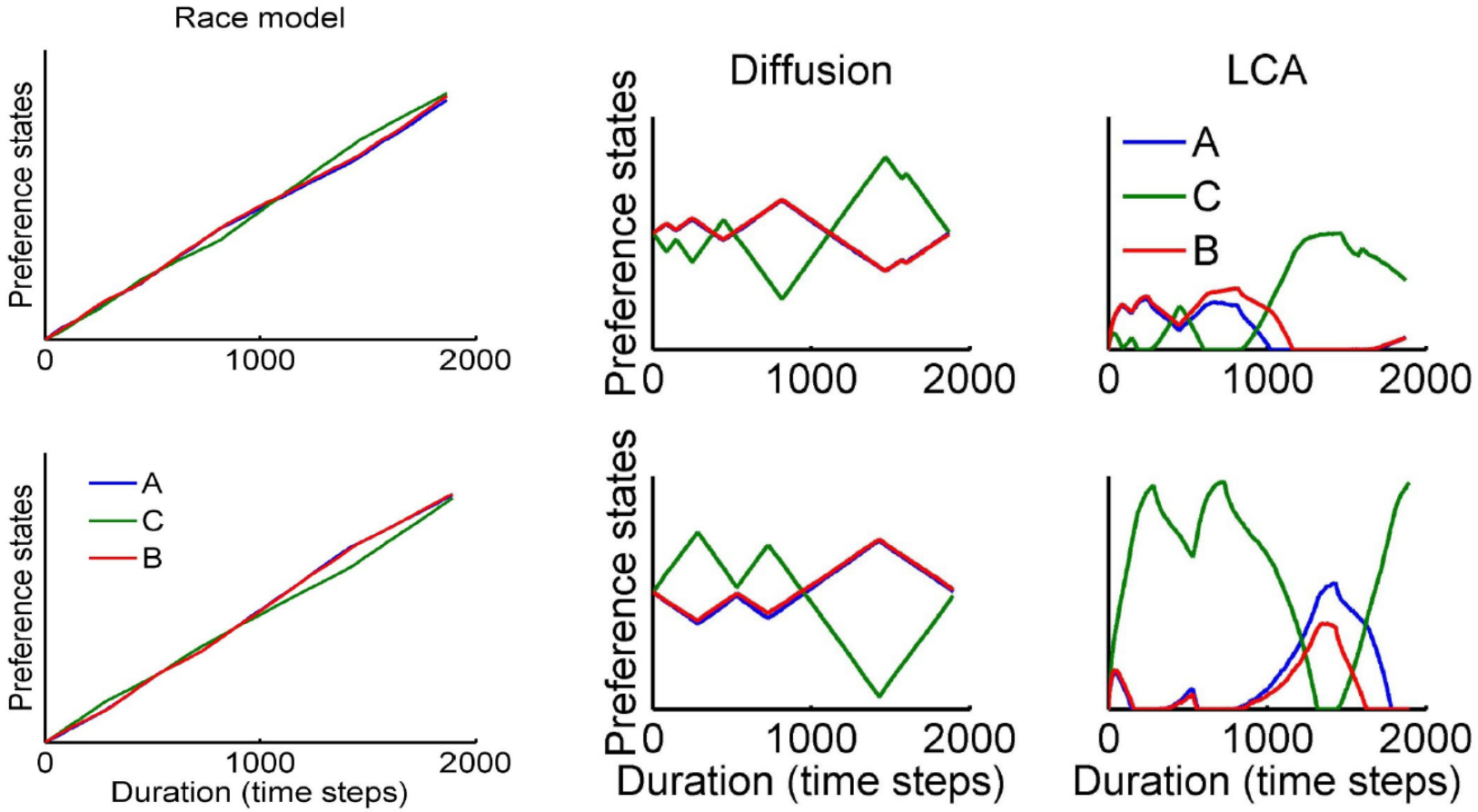
Evidence Switching Protocol in the Correlation Condition:



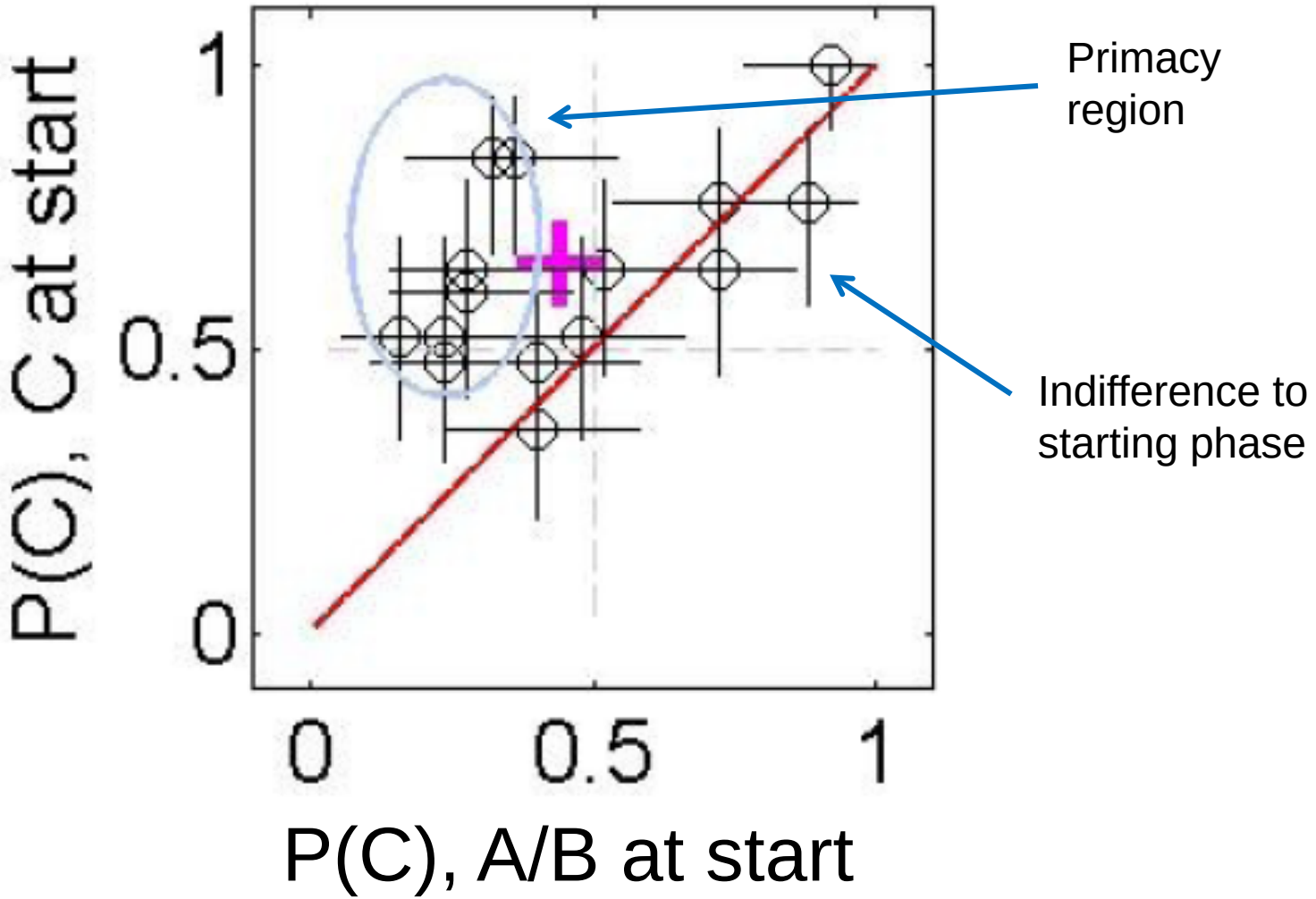
Simulations of Two Correlated Trials

Top: A/B start high

Bottom: C starts high



Individual Data from Correlation Condition



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