A decision-theoretic model of the temporal dynamics of visual priming

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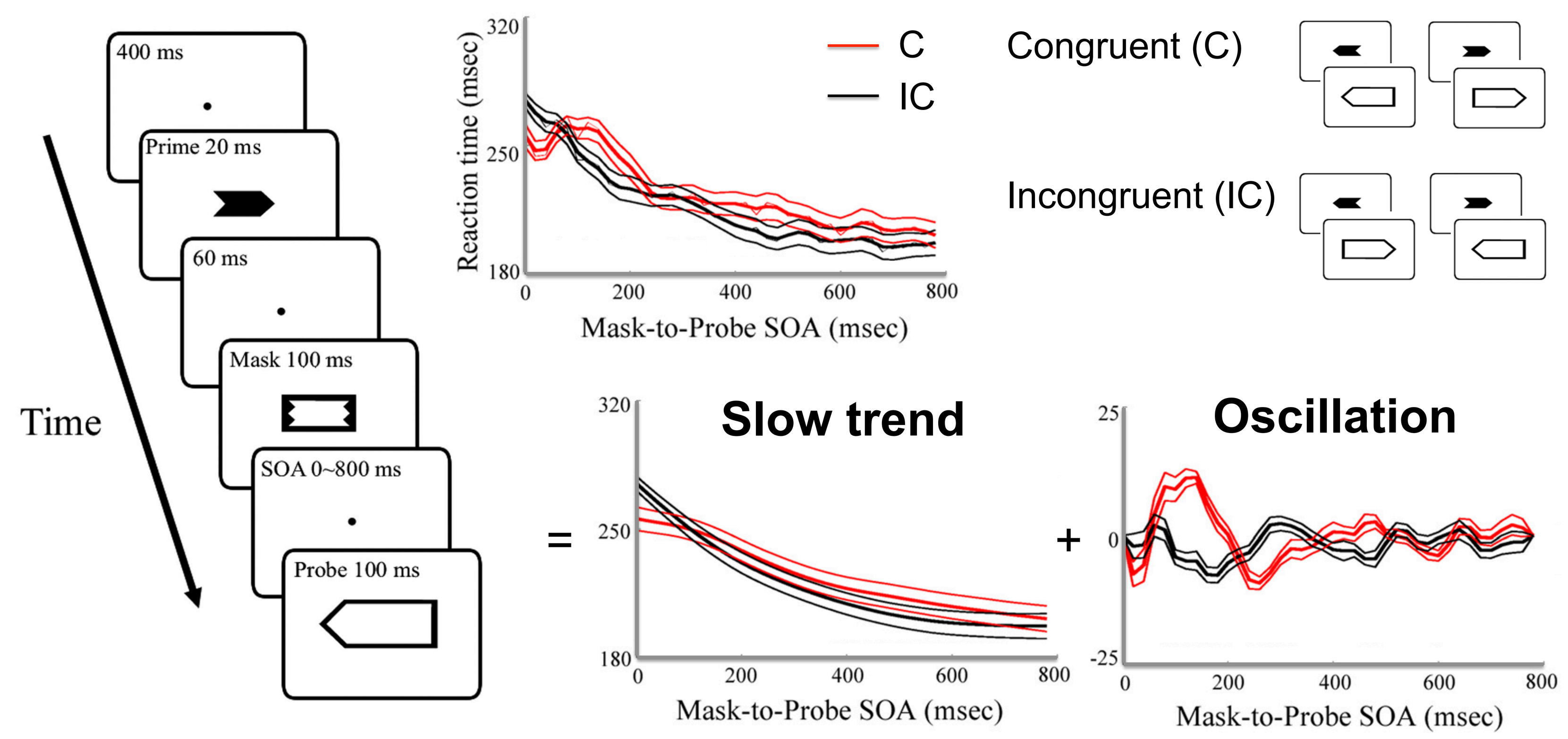
Introduction

Reaction time of visual priming is a function of SOA, which has two components—slow trend and oscillation (Huang, Chen, & Luo, 2015).



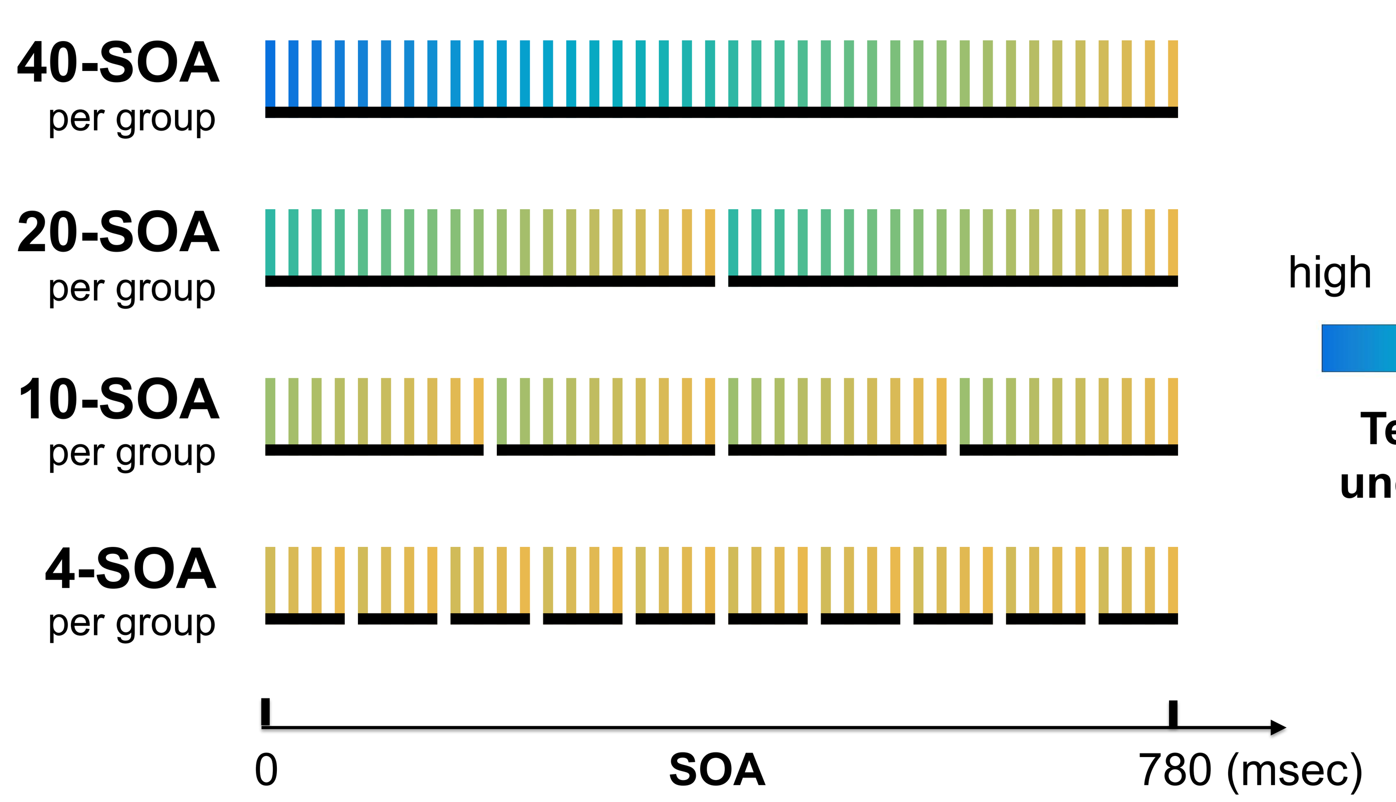
The problem: The temporal uncertainty of the probe co-varies with SOA. The longer you wait, you are more certain the target will come at the next moment.

Which determines the dynamics of reaction time, SOA or temporal uncertainty?

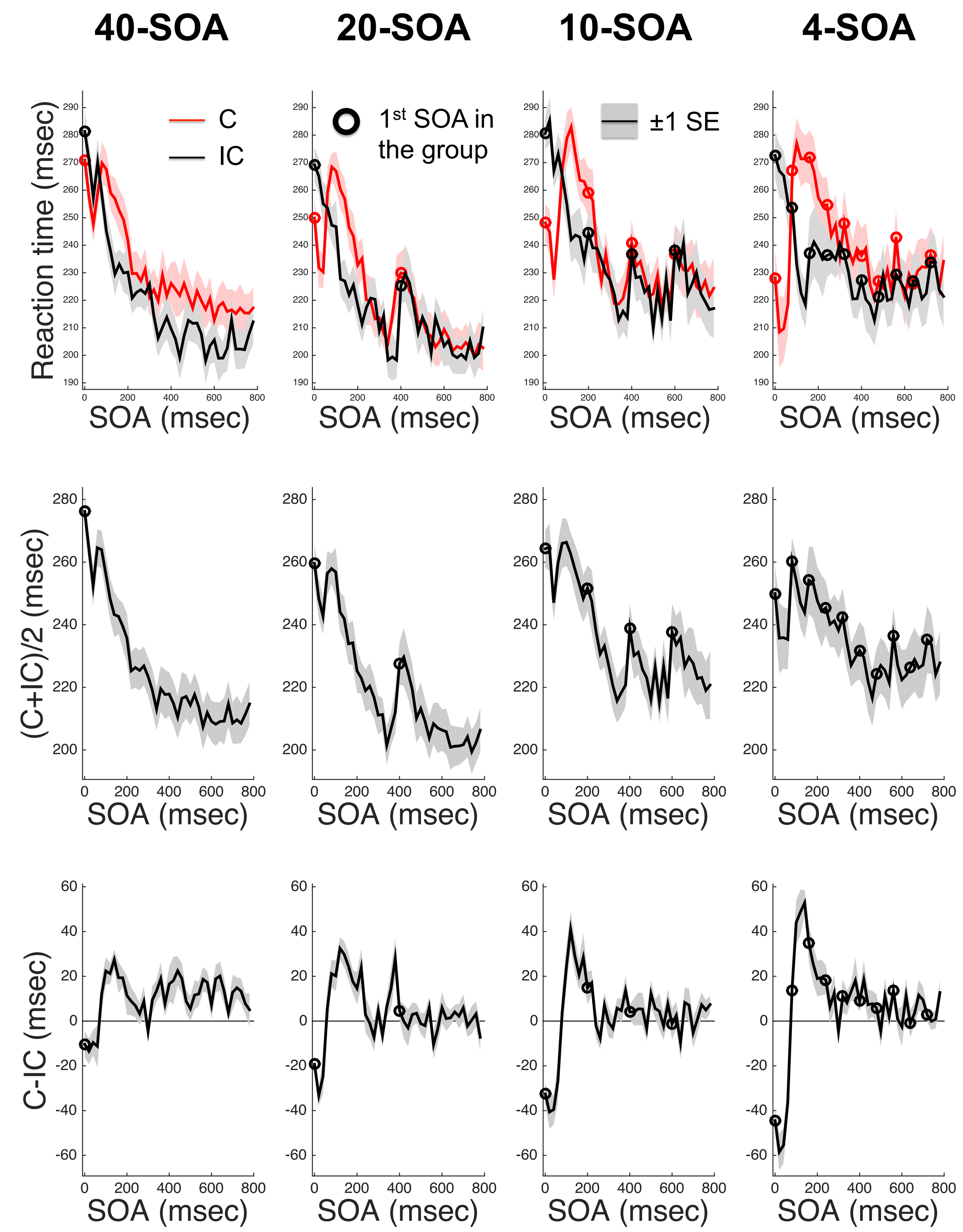
Experiment: separating SOA and uncertainty

Four SOA conditions (16 subjects each condition) for visual priming task

Each condition has the same 40 SOAs (0–780 msec, equally spaced) but differs in whether the 40 SOAs are all randomly mixed as one group (40 SOAs per group), or divided into two groups (20 SOAs per group), or four groups (10 SOAs per group), or ten groups (4 SOAs per group).



Empirical reaction times



Observations:

1. **The reaction time of visual priming declines with the decrease of temporal uncertainty as well as with the increase of SOA.**
2. **The effects of SOA and temporal uncertainty are non-additive.**
3. **Both the slow trend and oscillation are modulated by temporal uncertainty.**

References

Huang, Y., Chen, L., & Luo, H. (2015). Behavioral Oscillation in Priming: Competing Perceptual Predictions Conveyed in Alternating Theta-Band Rhythms. *Journal of Neuroscience*, *35*(6), 2830-2837.

Maloney, L. T., & Zhang, H. (2010). Decision-theoretic models of visual perception and action. *Vision Research*, *50*(23), 2362-2374.

Modeling

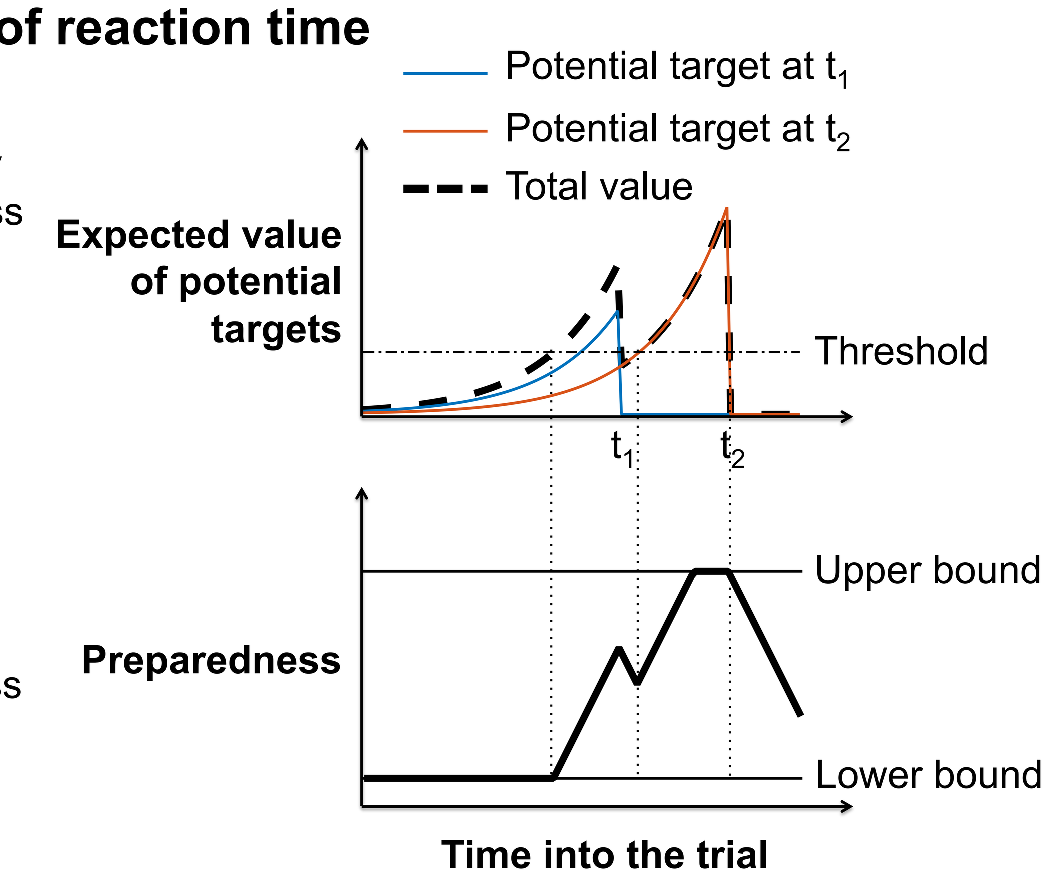
We modeled the slow trend of reaction times ((C+IC)/2) from the decision-theoretic perspective (Maloney & Zhang, 2010).

Temporal discounting model of reaction time

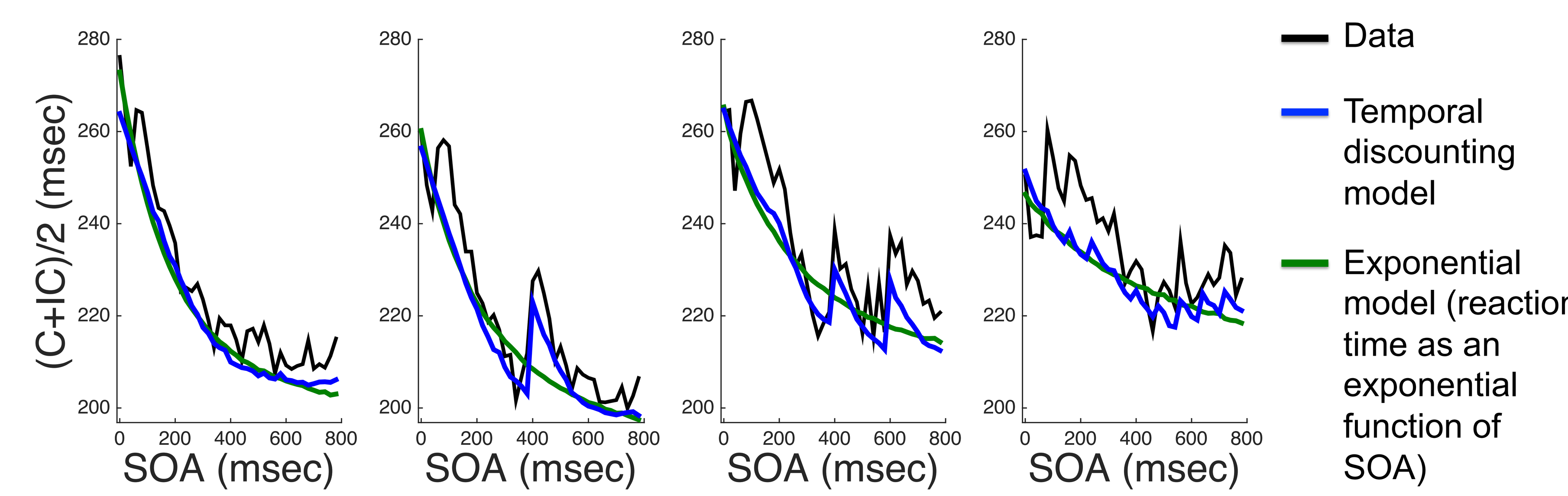
Assumption 1
The reaction time for a target is inversely proportional to the subject's preparedness at the onset of the target.

Assumption 2
Preparedness rises with time when the temporally-discounted expected value of potential targets is above a specific threshold; otherwise declines with time.

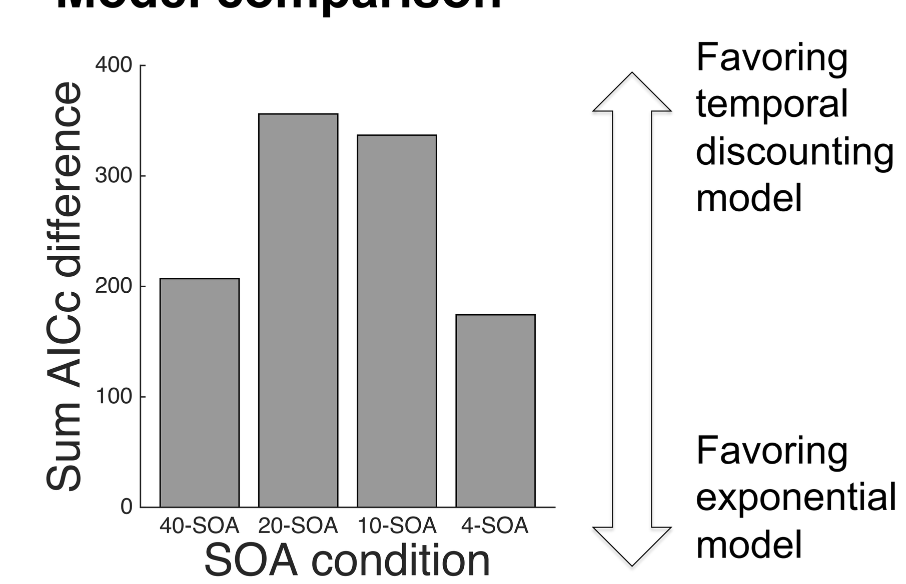
Assumption 3
The distribution of potential targets across time—which determines the expected value at any moment—is learned from previous experience trial by trial.



Model versus data



Model comparison



Conclusion:

The decision-theoretic model of reaction time (temporal discounting model) can explain the non-additive effects of SOA and temporal uncertainty.

A full model that explains the C-IC difference and oscillation coming soon…

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