Computation and update of neural value signals are biased by attention in multidimensional decision-making task

Y. Leong, R. Daniel, A. Radulescu & Y. Niv
ycleong@stanford.edu rekad@princeton.edu angelar@princeton.edu yael@princeton.edu

Introduction

- Activity in the ventromedial prefrontal cortex (VMPFC) and posterior cingulate cortex (PCC) track measures of subjective value in simple choice tasks
- Most real-world decisions involve choices with multiple attributes
- Reinforcement learning (RL) models of human decision-making are inefficient in multidimensional environments, yet people are able to learn quickly
- We propose that selective attention biases both learning and decision-making such that reward-relevant dimensions of the environment are weighted more than irrelevant dimensions.

The Task

- Reward history predicts attention switches, as measured using eye-tracking and MVPA.
- Neural signal in VMPFC most correlated with value estimates generated by FA model

Measuring Attention

Eye-Tracking + MVPA → Attn to Faces, $\Phi_F$
Attn to Houses, $\Phi_H$
Attn to Tools, $\Phi_T$

Models

Attention weighted reinforcement learning

Choice

Prediction Error

Learning

Models:

- Full Attention (FA)
- Attention at Choice (AC)
- Attention at Learning (AL)
- Uniform Attention (UA)

Neural Value Signals

- Reward history predicts attention switches, as measured using eye-tracking and MVPA.
- Neural signal in VMPFC most correlated with value estimates generated by FA model

Attention Switches

- Reward history predicts attention switches, as measured using eye-tracking and MVPA.
- Clusters correlated with attention switches, $p < 0.05$

Conclusion

- Our work suggests a dynamic interaction between attention and learning during decision-making
- Behavioral results suggest that attention influences both value computation during choice and value update during learning
- Neural results suggest that computation and update of value signals in the brain are similarly biased
- Attention is modulated by the outcomes of ongoing decisions
- Switches in attention are correlated with activity in a frontoparietal control network
- Future work: to model and predict trial-by-trial changes in attention