Electroencephalographic evidence for the sparsity heuristic

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INTRODUCTION

- Learning about high-dimensional stimuli is challenging due to the many states that must be represented.
- The world is often sparse - that is, only a subset of dimensions/properties are relevant for predicting reward.
- The sparsity heuristic aids learning in sparse environments by focusing learning on a subset of features (Gershman et al., 2010).
- In particular, it is proposed that humans employ both reinforcement learning (RL) and selective attention when learning about high-dimensional stimuli.
- Our goal here was to find EEG evidence for the sparsity heuristic.
- We focused on two event-related brain potentials: the feedback-related negativity (FRN) and the N2pc.

The N2pc is thought to index an RL prediction error (Holroyd and Coles, 2002).

The FRN is thought to reflect selective attention (Eimer, 1996).

BEHAVIORAL RESULTS

n = 20; 25 blocks of 20 trials each
target dimension/properties chosen randomly for each block
figures randomly generated on each trial
attentional probes on randomly-chosen trials

e.g. target dimension = SHAPE; triangle > circle > square
p(win, triangle) = .95, p(win, circle) = .5, p(win, square) = .05

EEG RESULTS

Ipsi/Contra Response to Higher-Valued Stimuli

N2pc (Selective Attention)

Response to Feedback FRN (Prediction Error)

CONCLUSIONS

- The FRN behaved like a prediction error (as predicted by an RL model), suggesting the involvement of an RL system.
- The N2pc in response to higher-valued stimuli increased over time, suggesting the involvement of selective attention.
- Human performance in a sparse environment is best explained by a combined RL/Bayesian model than by either an RL or a Bayesian model alone.

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