

Dynamic estimation of prior probabilities in an orientation-discrimination task

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Introduction

Signal detection theory: Unequal prior probabilities → shift in decision criterion¹

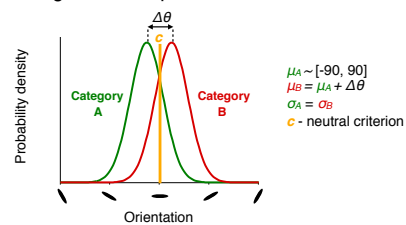
Previous studies: Vary category probability between blocks, assume a fixed criterion, and explicitly state probability (e.g. Refs 1-2)

Q1: Can observers track sudden changes in category probability?

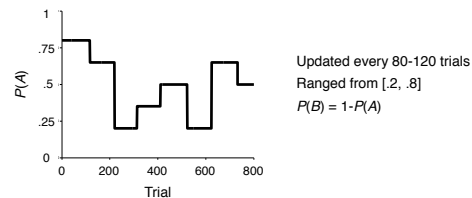
Q2: How is prior probability estimated?

Stimuli

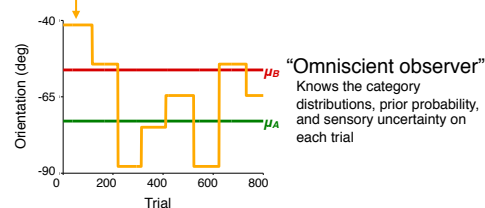
Categories of ellipses:



Random stepwise changes of $P(A)$:

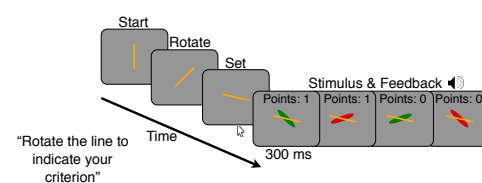


Omniscient criterion:

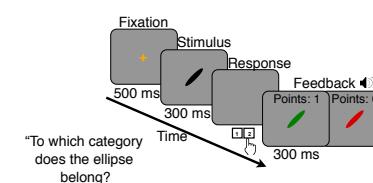


Experimental tasks

Overt-criterion task

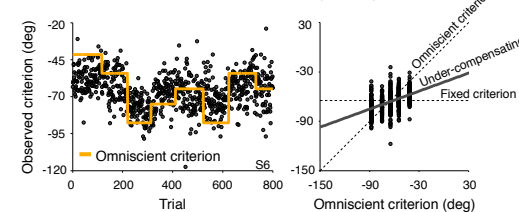


Covert-criterion task

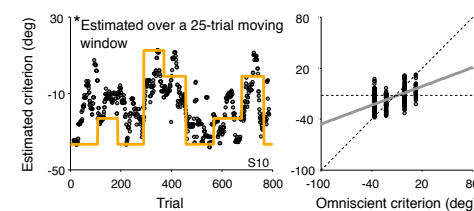


Results

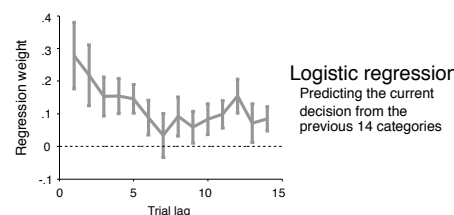
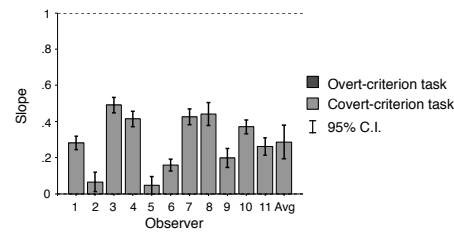
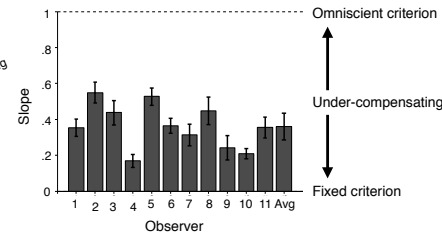
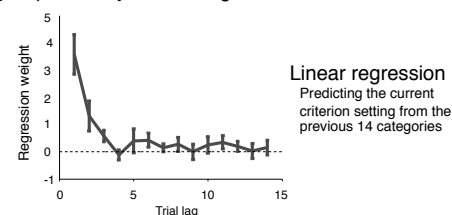
Observed vs. omniscient criterion (overt):



Estimated* vs. omniscient criterion (covert):



History of previously seen categories:



Models

FC: Fixed Criterion

Fixes neutral criterion

RLC: Reinforcement-learning on criterion

Updates criterion by a proportion of the error when receiving negative feedback

EMA: Exponentially weighted moving-average

Estimates probability as an exponentially weighted average of previously seen categories

RLP: Reinforcement-learning on probability

Estimates probability by a proportion of the error when receiving negative feedback

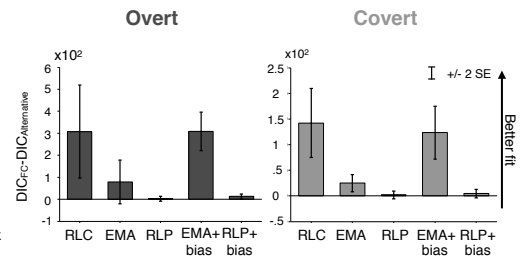
EMA + bias

Weighted average of EMA estimate and a prior of 0.5

RLP + bias

Weighted average of RLP estimate and a prior of 0.5

Model fits



Conclusions

A1: Observers dynamically update criterion as probability changes, but under-compensate (i.e., they exhibit conservatism).

A2: Prior probability is estimated as an exponentially weighted average of previously experienced categories with bias towards a prior of 0.5.

References / Acknowledgements

¹Green, D. & Swets, J. (1966). Signal detection theory and psychophysics. New York: Wiley.
²Ackermann, J. F. & Landy, M. S. (2015). Suboptimal decision criteria are predicted by subjectively weighted probabilities and rewards. *Attention, Perception & Psychophysics*, 77, 638-658.
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