Planning Rapid Movements to Maximize Gain in Scenes with Multiple Regions Carrying Reward or Penalty

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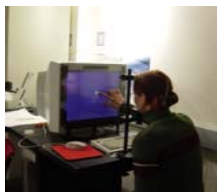
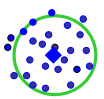
MOVEMENT UNDER RISK

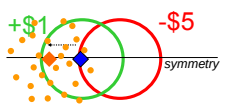


We previously[1,2] proposed a **maximum expected gain model** intended to predict how people plan movements in scenes where there are rewards and penalties associated with touching within overlapping colored circles. The configuration of circles is briefly presented at random locations and orientations on a touch screen.

Repeated execution of a movement plan might lead to a distribution of end points whose **mean end point (MEP)** is the blue diamond. This plan would earn frequent $1 rewards.



Executing the same plan with the red penalty circle present would incur frequent $5 penalties as well as frequent $1 rewards. A plan with the MEP shifted to the orange diamond gives a better tradeoff between penalty and reward.



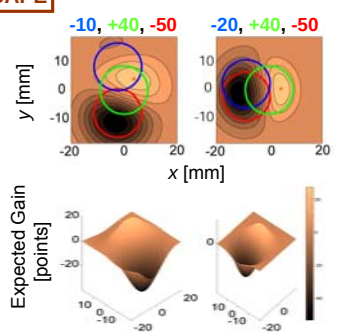
In previous experiments, we found that subjects' choices of MEP came close to optimizing expected gain. However, in all these experiments, the optimal MEP fell on an **axis of symmetry** (black line). Subjects only needed to optimize in one dimension along that axis.

Here, we introduce **multiple penalty regions** carrying different penalties. As a result, estimating the optimal MEP requires a full **two-dimensional maximization** of expected gain.

THE EXPECTED GAIN LANDSCAPE

The expected gain landscape for two stimulus configurations is shown in contour and surface forms. Each subject, given his or her motor variability (σ), would have a unique landscape.

The MEP corresponding to maximal expected gain is marked in orange (subject mf: σ = 5.75).



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EXPERIMENTAL DESIGN

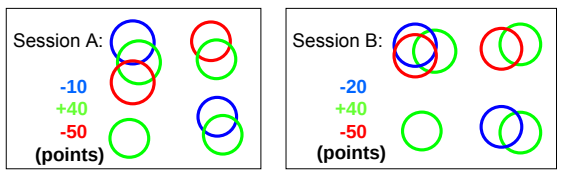
Six naïve participants

Practice session: 300 trials (no penalties)

Two sessions of data collection:
session A and B, counterbalanced across participants,
4 configurations per session, (see below), presented in 4 orientations

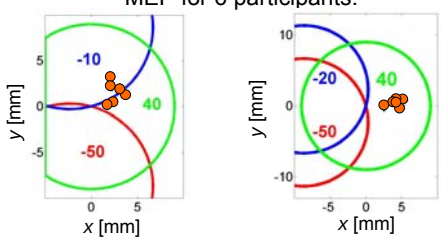
20 warm-up trials, 12 blocks of 26 trials per session,
(8 repetitions per condition, collapsed over orientation),

2000 points = $1

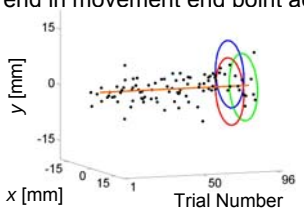


RESULTS

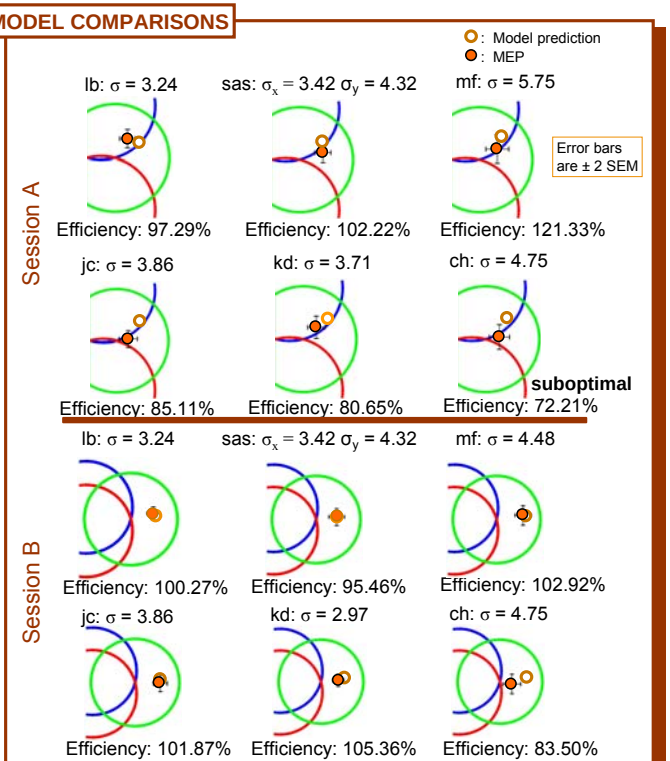
MEP for 6 participants:



No trend in movement end point across trials:



MODEL COMPARISONS



CONCLUSIONS

Earnings: 5 out of 6 subjects were indistinguishable from optimal.

Aim points: Subjects' MEPs deviated from the predictions of the model. The deviations were small and cost the subjects little in earnings. There is a possible pattern in the deviations (toward the higher penalty region) in Session A.

[1] Trommershäuser, J., Maloney, L. T., & Landy, M. S. (2003a). Statistical decision theory and trade-offs in the control of motor response, Spatial Vision, 16(3-4), 255-275.
[2] Trommershäuser, J., Maloney, L. T., & Landy, M. S. (2003b). Statistical decision theory and the selection of rapid, goal-directed movements. Journal of Optical Society of America, 20 (7), 1419-1433.