Reward and Cue Effects on Orientation Judgements: A Gaze Contingent Eye Tracking Study

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Does Reward Shape Perception By Attentional Mechanisms?

For many activities reward is graded and results from sensory input composed with a motor action (throwing a spear at prey). Does the shape of the reward performance function influence our perceptual experience? And is this dependent on other systems that also affect the speed and precision of perceptual reports, such as exogenous spatial cues?

Methods/Participants

Two runs of the same experiment were performed.

Exp	N
1	57
2	59

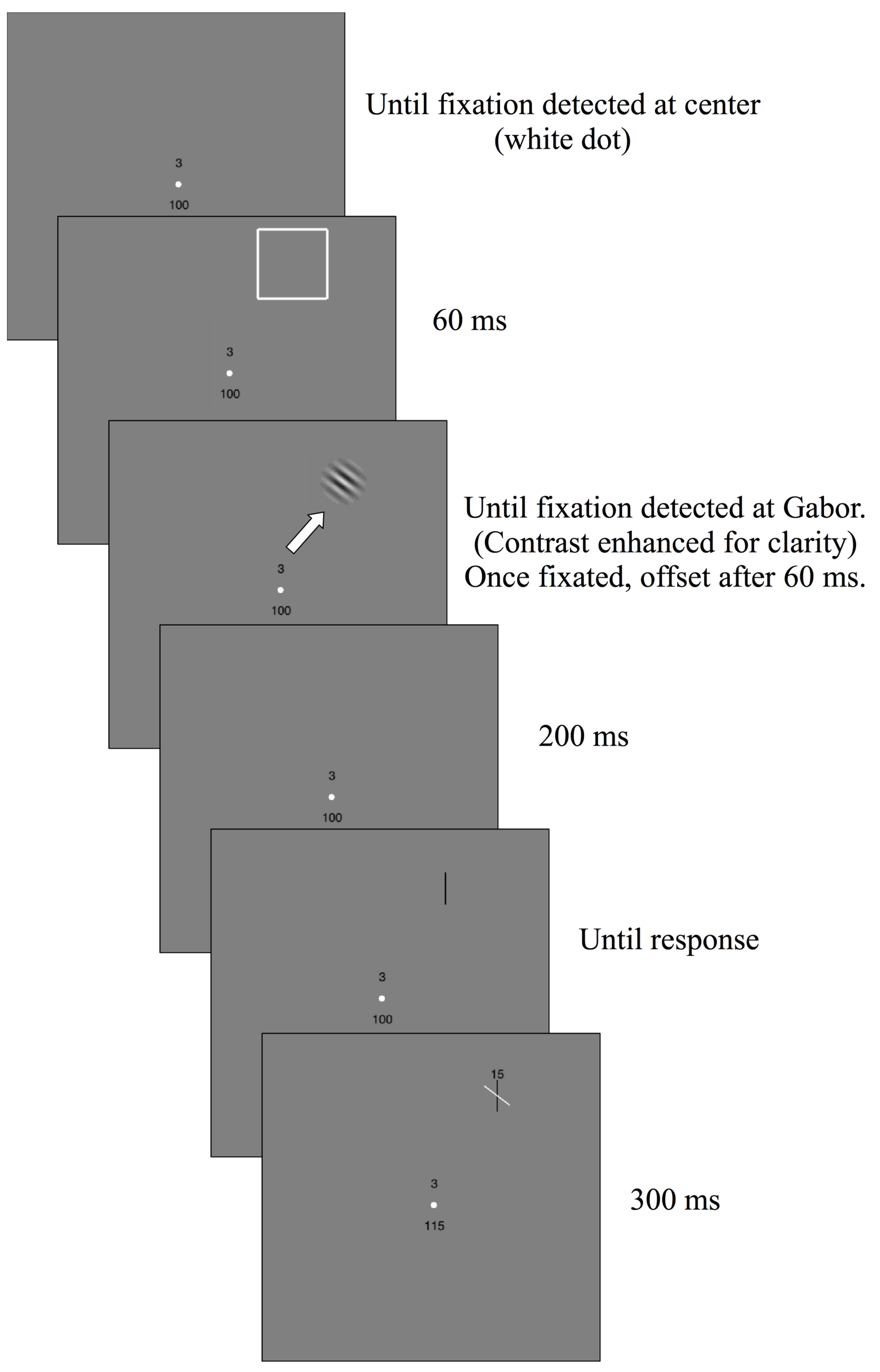

Fig. 1: Cues appeared on 80% of trials and and were 50%/80% valid (E1/E2). A Gabor appeared **and remained on** until 60 ms post first fixation. Participants reported orientation by rotating a response line. Once a response was entered the correct orientation was shown and their percentile position displayed.

The experiments began with an adaptive, "3 down, 1 up" staircase procedure for scaling the contrast to equate visual search difficulty.

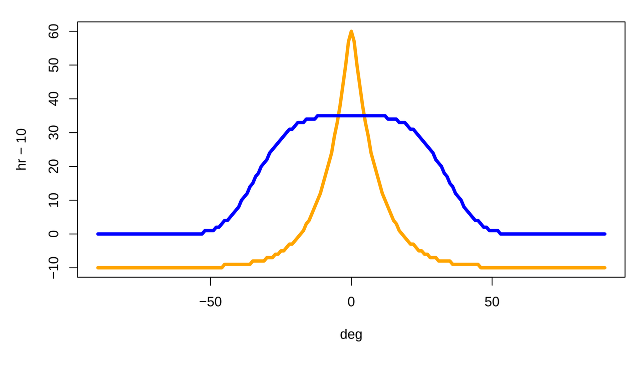

Fig. 2: Points for Performance (coarse: blue; fine: orange)

Point rewards were displayed above the stimulus; the total cumulative score below center fixation dot and percentile position above the fixation dot. There were three between-subjects groups with different reward condition orderings (fine/-coarse;coarse/fine;none/fine). Eye tracking used a head-mounted Eyelink II.

Attentional Cues Improve The Speed of Orientation Judgments Via Faster Target Fixation

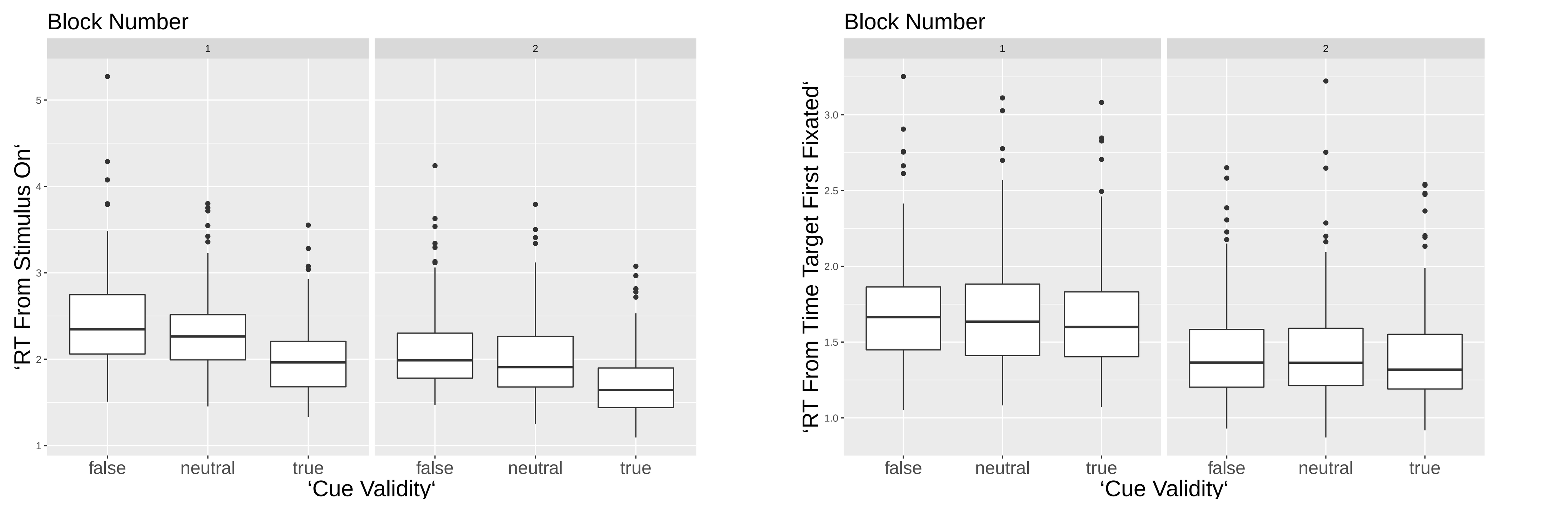

Fig. 3: Two Measures of RT. In the left panel the time from when participants vacate fixation until response shows that the validly cued trials are faster, but when the RT is calculated from when participants first fixate the stimulus (right panel) the difference disappears. NB: there is also learning across blocks shown by generally faster responses in Block 2.

The Shape of Error Distributions Is Not Changed by Reward Distribution Shape

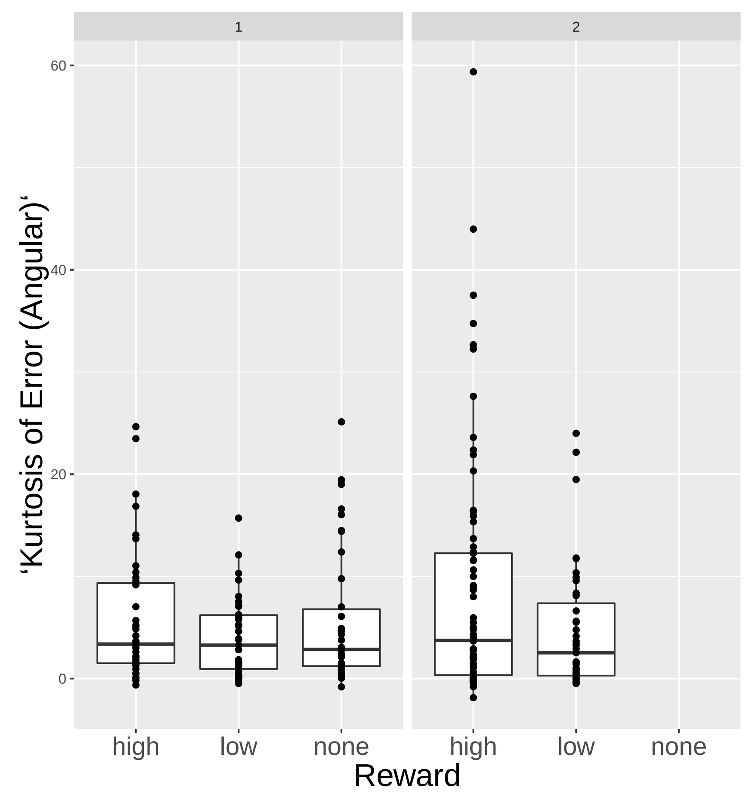

Fig. 4: Differences in Kurtosis of Error By Reward Conditions for Each Block.

Saccadic Reaction Time is Slower for No Cue Trials.

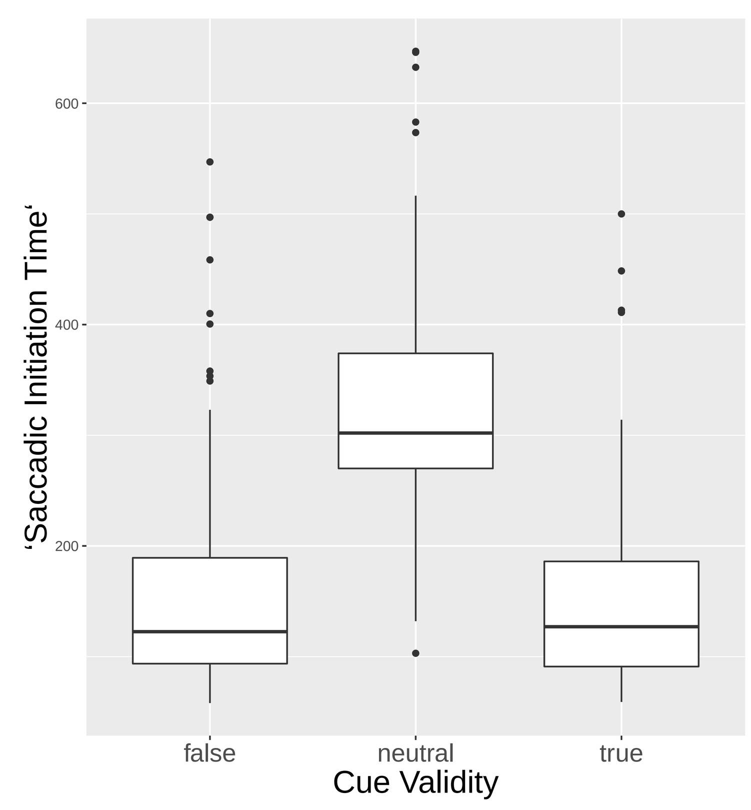

Fig. 5: How Long to Initate the First Saccade After Stimulus Appears?

More Precise Orientation Estimation with Cueing?

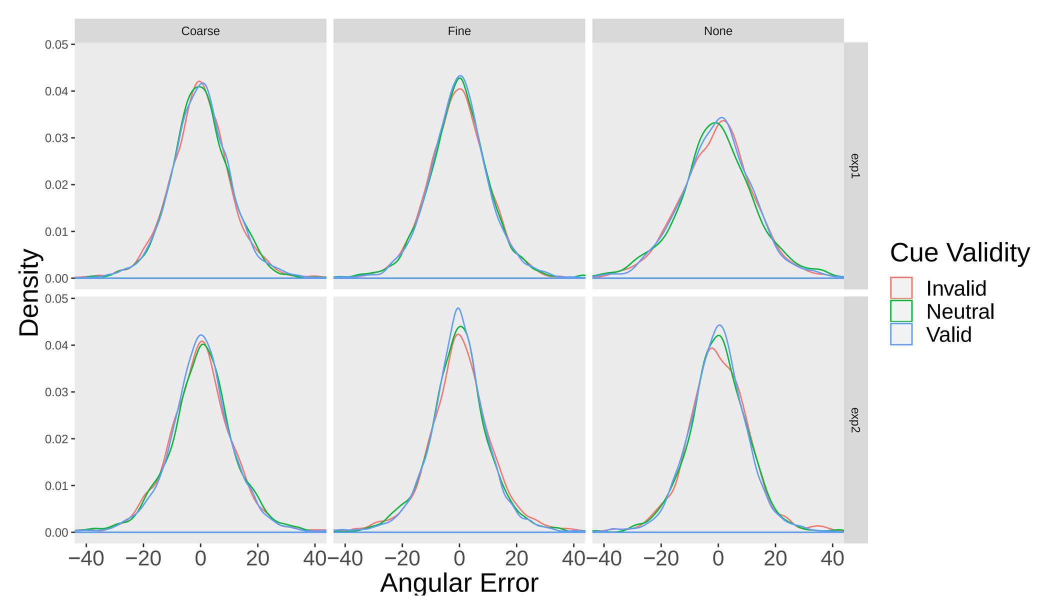

Fig. 6: Orientation Estimation Precision Modified by Cue Validity?

Posterior Distribution of Error Variance

	mean	sd	5.5%	94.5%
Mean Error	-0.21	0.05	-0.30	-0.12
Std Dev When No Cue	13.41	0.07	13.30	13.51
Std Dev When Cue Invalid	13.58	0.07	13.47	13.69
Std Dev When Cue Valid	13.33	0.07	13.22	13.43

Quadratic Approximation to the Posterior Distribution of the Error Distribution (All Trials & All Experiments). The distribution of errors was assumed to be normal. The prior for the mean of this distribution was also normal with mean zero and standard deviation 0.5. The standard deviation of the error distribution was allowed to vary with cue condition where the prior for the standard deviation of each cue condition was uniform between 10 and 16. The `rethinking` package in R was used for these estimates. There is a trend for validly cued trials to be judged on average less variably despite always being the target of a saccade, and all responses following the same fixed.

Eye Movements Can Drive Cueing Benefits. Reward Did Not Shape Errors.

Despite reporting overt motivation to maximize their scores and awareness of the changing point distributions, participants did not change the shape of the error distributions when reward shapes changed. Use of a gaze contingent display that gives all participants a fixed time for target viewing on all trials eliminated the benefit of exogenous cuing almost (?) entirely. In many conventional attentional protocols with fixed stimulus onset and offset times there is a potential for quick and rapid eye movement responses to lead to apparent perceptual advantages for cued stimuli. Supported by an NSERC of Canada Discovery Award to BA.