

Is probabilistic cueing of visual search an inflexible attentional habit?

A meta-analytic review



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INTRODUCTION

When a target that we are looking for appears more often in one region of a search display, our attention is rapidly directed to that region. This phenomenon is called *probabilistic cueing of visual search* and has been characterized as an inflexible attentional habit, independent from goal-driven attention. This claim is partly based on the evidence that, once established, it persists even when is no longer advantageous. Studies exploring this issue usually include a *biased* stage, in which the target is more frequently presented in a rich quadrant, followed by an *unbiased* stage, where the target is evenly distributed across quadrants. We carried out a meta-analysis with the aim to test whether the mean size of probabilistic cueing decreases from the biased stage to the unbiased stage.

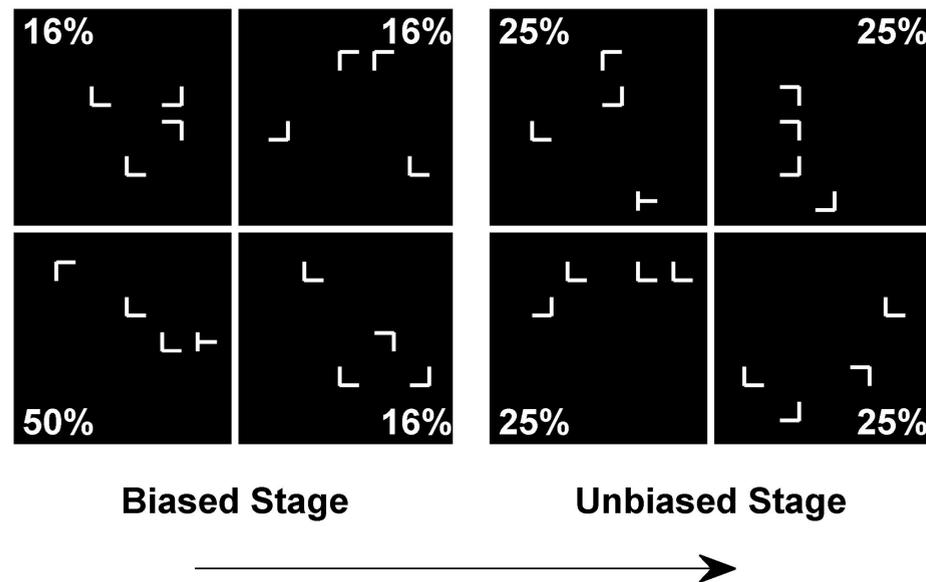


Figure 1. In both stages the participant's task is to report, pressing a key, the left or right orientation of the tilted T. In the biased stage the T appears in one of the quadrants of the display (lower left in this example) on half of the trials. In the unbiased stage, it appears evenly distributed across quadrants.

METHOD

We were interested in comparing the bias towards the rich versus sparse region in the biased and unbiased stages. Most of the selected studies report the results of one ANOVA for the biased stage and another for the unbiased stage. Usually, these ANOVAs include a factor (e.g., quadrant) coding whether the target was presented in the rich or sparse region. Since all of these entail within-subject contrasts, we computed Cohen's d_z for each study for these comparisons, that is the standardized mean difference from two related measures. To compare effect sizes, we fitted a multi-level random-effects model.

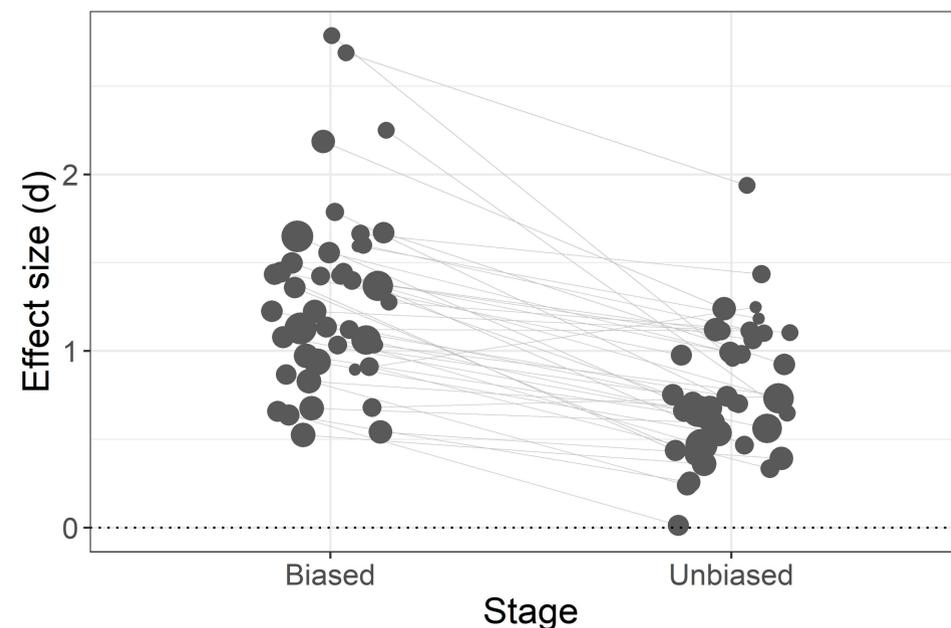


Figure 2. Effect size (d_z) of the probabilistic cueing effect in visual search in the biased (where targets appear more frequently in one quadrant of the display) and unbiased (where targets appear evenly distributed across the display) stages of each of the studies included in the meta-analysis. The size of each point indicates the sample size of the study.

RESULTS

The average size of the probabilistic cueing effect for the biased stage ($k = 42$) was large, $d_z = 1.19$, 95% CI [1.07, 1.32], $z = 18.16$, $p < .001$. For this stage, the meta-analysis also revealed considerable heterogeneity across studies, $Q(41) = 102.71$, $p < .001$, $I^2 = 59.69\%$. The average effect size in the unbiased stage was numerically lower, $d_z = 0.69$, 95% CI [0.60, 0.78], $z = 14.91$, $p < .001$, and heterogeneity was slightly smaller but still significant, $Q(41) = 70.35$, $p = .003$, $I^2 = 40.42\%$. A multi-level meta-analysis, combining data from both stages and including stage as a moderator, found that the average effect size was significantly smaller for the unbiased than for the biased stage, $b_1 = -0.49$, 95% CI [-0.59, -0.39], $z = -9.44$, $p < .001$.

CONCLUSION

A meta-analysis of 42 studies confirmed that probabilistic cueing is significantly reduced from the biased to the unbiased stage. Overall, probabilistic cueing during the unbiased stage was roughly half the size of cueing during the biased stage. Our results challenge the claim that probabilistic cueing is inflexible and suggest instead that it can be easily unlearned in response to changes in the experimental contingencies. We propose that probabilistic cueing should not be regarded as an attentional habit. On the contrary, it is better understood as resulting from top-down attentional control.

See more details in

<https://psyarxiv.com/xkcvn/> and <https://osf.io/yr3mx/>

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