Probabilistic Cuing of Visual Search: Neither Implicit nor Inflexible

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Pre-registration

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Reference

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Introduction

The probabilistic cuing task is extensively used to study how experience shapes the allocation of visual spatial attention. In this task, participants search for a visual target among several distractors. The target is more frequently located in one area of the display, although participants are not explicitly instructed about this feature of the task.

Participants develop a visual search bias towards the frequent quadrant. Thus, response times become faster for trials in which that target appears in the rich (frequent) quadrant compared to the sparse quadrants.

It has been suggested that this attentional bias is implicit because most participants fail to report that the target appeared more frequently in a specific quadrant when they are asked to guess the rich quadrant, and also because the proportion of participants providing the correct response is not different from what we would expect by mere chance.

It has also been claimed that probabilistic cuing is inflexible because the bias towards the rich quadrant persists in a subsequent testing (unbiased) stage in which the target is evenly distributed.

We argue that previous results supporting the implicitness and inflexibility claims are undermined by methodological shortcomings including inadequate statistical power, the inclusion of an unbiased stage between the biased stage and the awareness test, and the use of insensitive measures of awareness.

In two experiments we explored whether high-powered experiments would show evidence of a reduction in the attentional bias through the unbiased stage (testing the inflexibility hypothesis) and evidence of explicit recognition of the biased spatial distribution (testing the implicitness hypothesis). We also explored whether administering the unbiased stage just before the awareness test might attenuate the awareness scores.

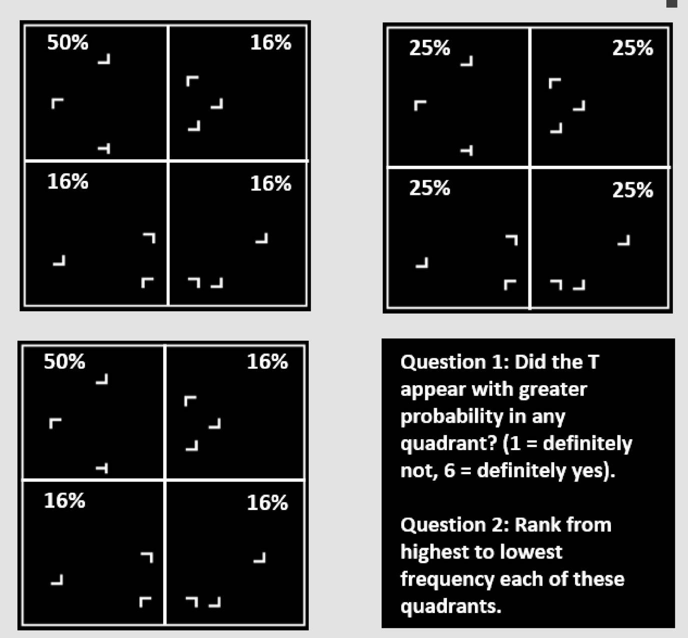
Experiment 1

Unbiased-first

N = 78

Awareness-first

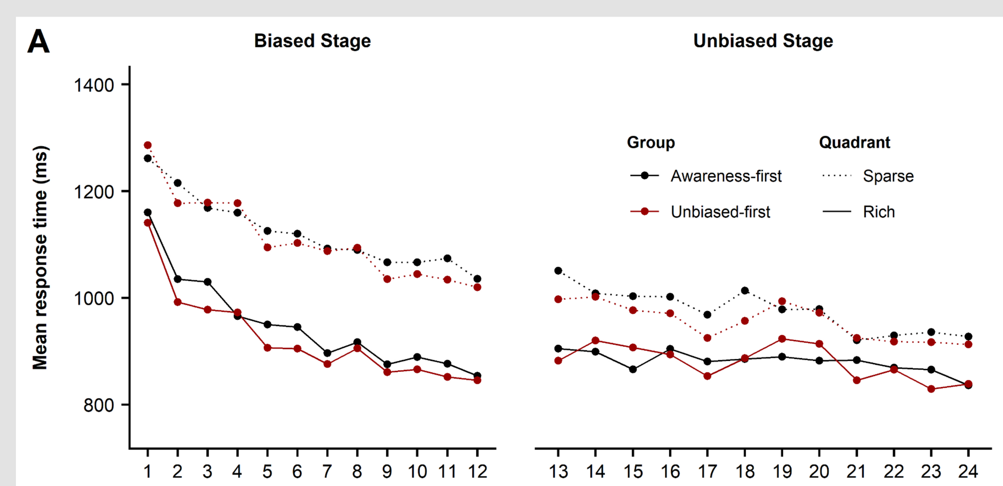
N = 79



Two groups carried out a biased and an unbiased stage but for one of the groups, the awareness test was included before the unbiased stage.

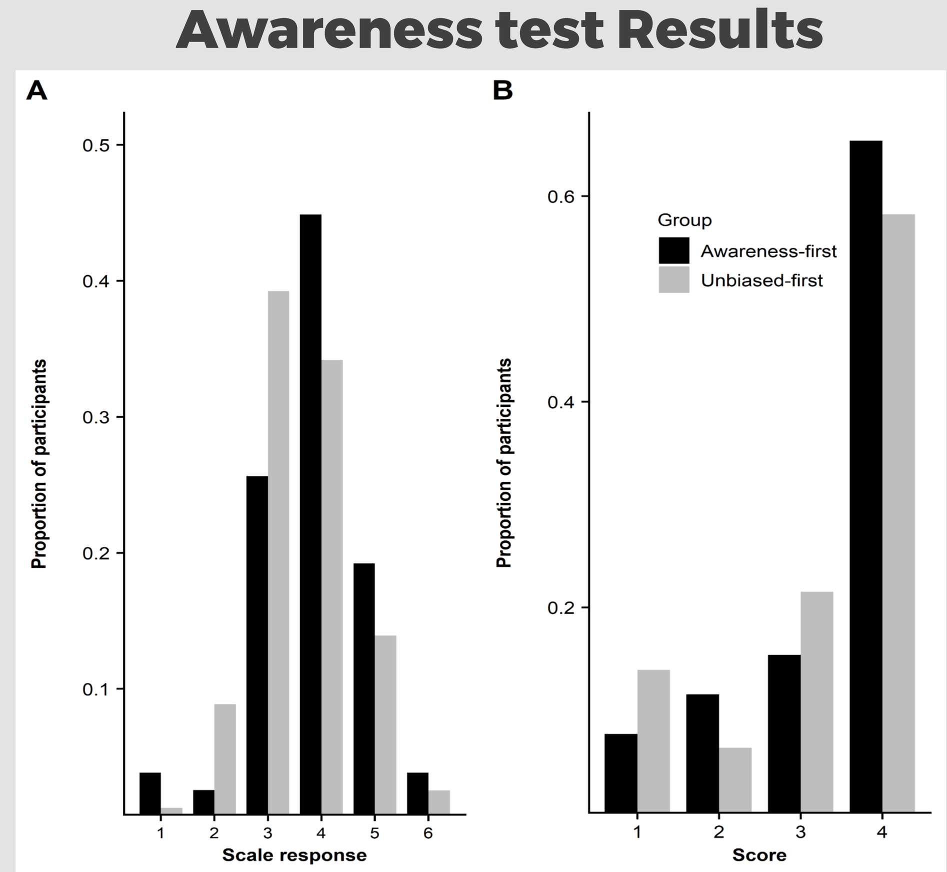
In the awareness test we first asked if the T had appeared with greater probability in any quadrant using a 6-point scale. Then participants ranked from highest to lowest the target frequency in each of these quadrants.

Time Response Results



A significant Epoch x Quadrant interaction, $F(9.96, 1543.03) = 1.96$, $p = .028$, $\eta_p^2 = .01$, on the response times during the unbiased stage suggests that the advantage of the rich over the sparse quadrant is reduced during the unbiased stage.

Awareness test Results



The awareness-first group had higher scale scores than the unbiased-first group ($Z = 2.01$, $p = .044$, $r = .16$). However, we did not find a significant difference between groups in their ability to rank the quadrants.

Of note, the proportion of participants selecting the rich quadrant first was above chance for both groups.

Discussion

The Epoch x Quadrant interaction supported the hypothesis that the bias learned during the biased stage was attenuated during the unbiased stage, challenging the idea that this bias is driven by an inflexible mechanism. Contrary to the hypothesis that this type of learning is implicit, participants in both groups showed above-chance scores for the awareness questions. In addition, the presence of an unbiased stage affected participants' level of awareness.

The absence of a significant result in the ranking test might be due to the fact that from a strictly rational point of view, it required the same response in both groups. Therefore, when asked to rank which quadrant contained the target most often, both groups should provide the same response. In Experiment 2 we tried to overcome this problem

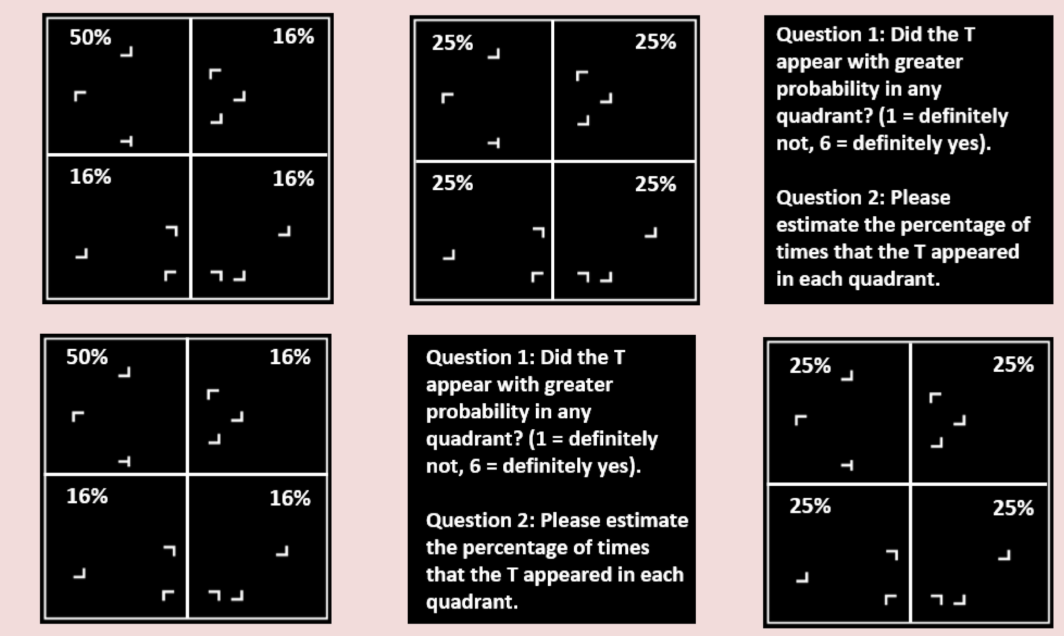
Experiment 2

Unbiased-first

N = 78

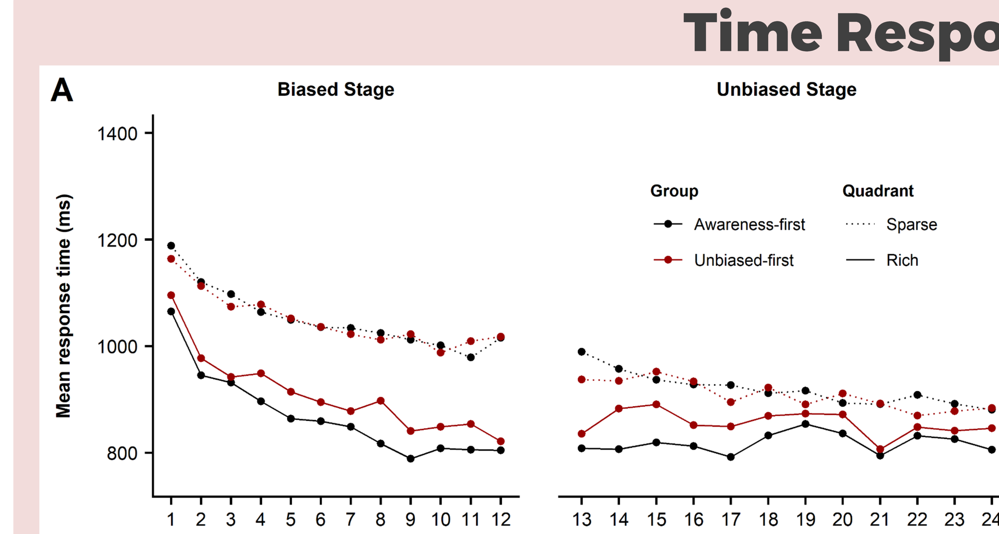
Awareness-first

N = 81



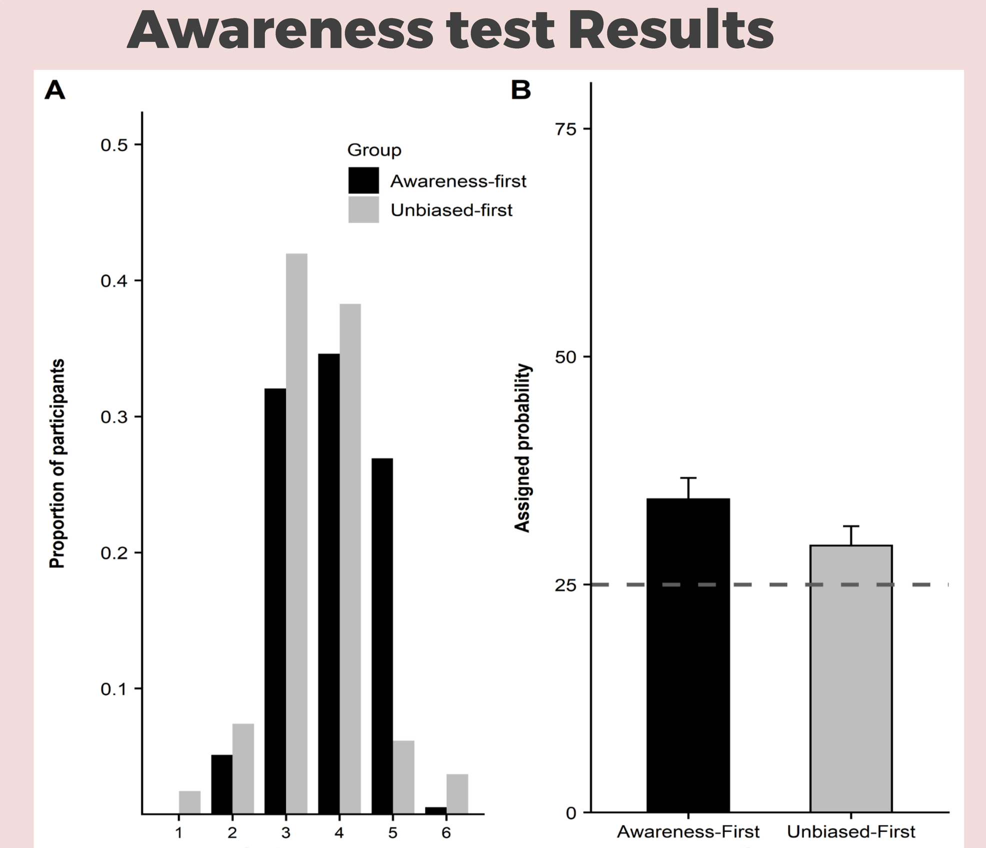
Experiment 2 was a replication of Experiment 1 but in the second question of the awareness test, we asked participants to estimate the relative frequency with which each quadrant had contained the target.

Time Response Results



As in Experiment 1, we found a significant Epoch x Quadrant interaction, $F(11, 1727) = 6.18$, $p < .001$, $\eta_p^2 = .03$, replicating the finding that advantage of the rich over the sparse quadrant is reduced during the unbiased stage.

Awareness test Results



Again, the awareness-first group had a higher awareness score than the unbiased-first group ($Z = 2.56$, $p = .005$, $r = .20$).

Additionally, the awareness-first group made higher estimates for the rich quadrant (34.35%) compared to the unbiased-first group (29.28%), $t(158) = 3.18$, $p = .002$, $d = .50$.

Conclusions

Overall, our results challenge the idea that probabilistic cuing is implicit given that in Experiment 1 approximately 60% of participants correctly identified the rich quadrant, and in Experiment 2 both groups assigned greater frequency of target appearance to the rich quadrant compared to the sparse ones (70.51% of participants in the awareness-first group and 48.15% in the unbiased-first group).

Additionally, The measured level of awareness was greater when participants reported their awareness immediately after the biased stage compared to when they received an unbiased stage before reporting their awareness.

Finally, we found a significant interaction demonstrating that the attentional bias acquired in a probabilistic cuing task with one rich quadrant was attenuated during an unbiased target location stage in which the target appeared in each quadrant with equal probability