Probability cueing in large-scale environmental search – a role for landmark cues in statistical learning

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Introduction

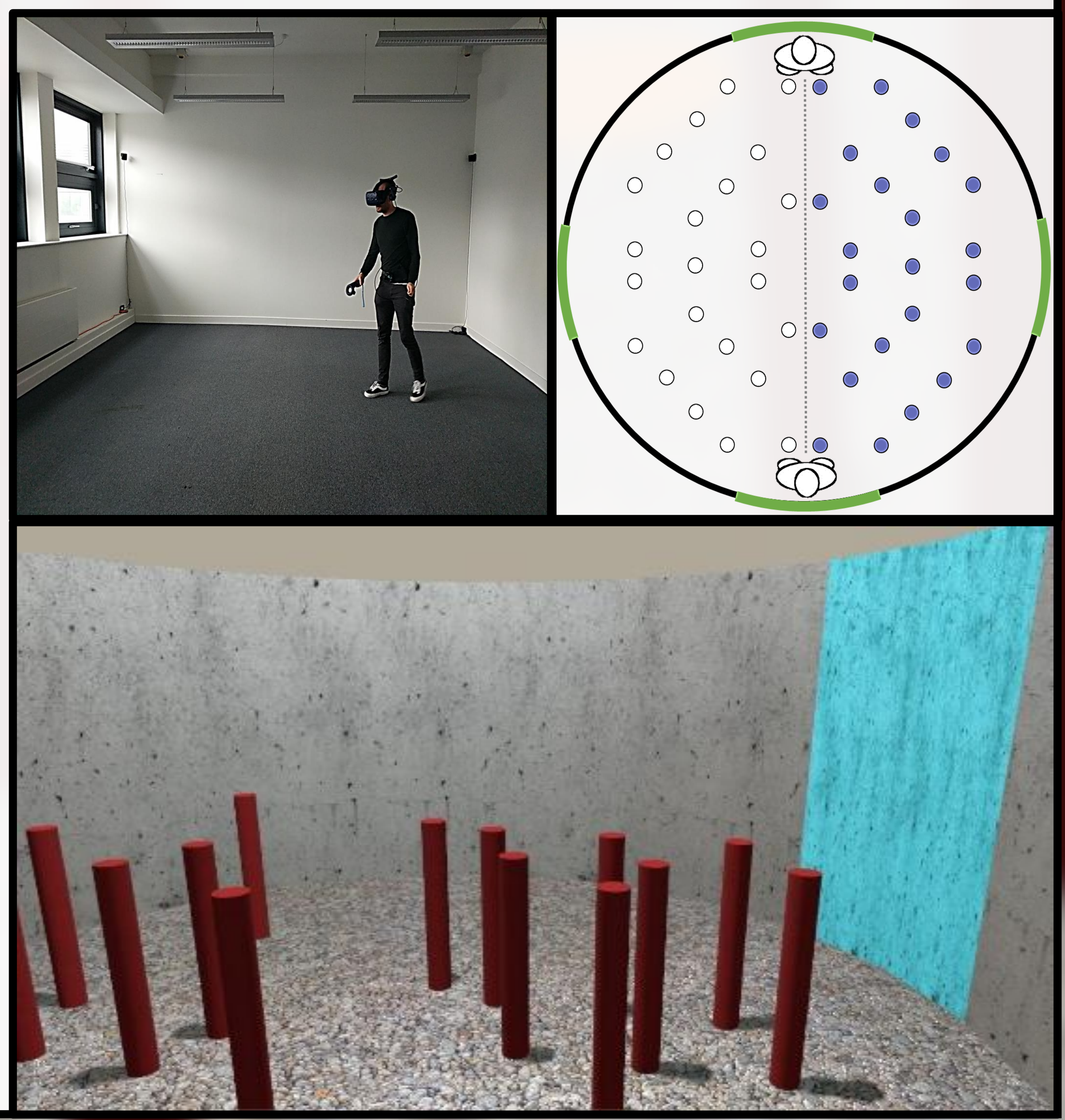
- Efficient environmental search is an important everyday skill. Objects are rarely distributed evenly in the environment – efficient large-scale search is, therefore, reliant on an individual's ability to learn and respond to where an object is likely to appear.
- Cueing by probability has been established in simple 2D visual search. However, large-scale search requires one to make use of both egocentric (viewer centred) and allocentric (environmentally centred) spatial information.
- Smith et al. (2010) and Baxter and Smith (2020) concluded that participants were able to learn the spatial contingencies of an environment when relying on both allocentric and egocentric information, but not when egocentric information was unreliable.
- Related literature has yielded equivocal findings, with a lack of consensus over the role of allocentric information and environmental cues in learning spatial contingencies (e.g. Jiang et al., 2014).
- Here we systematically explored the role of landmark information in an allocentrically-cued contingency. Experiment 1 presented an environment devoid of structural information beyond the configuration of the search array, as in Baxter and Smith (2020). Follow-up experiments 2 and 3 introduced a single landmark into the array, and manipulated its location.

Method

- Participants explored a fully-immersive virtual environment and were tasked with finding a target column among distractor columns (i.e. the column that changed colour upon activation).
- An array of 16 columns was randomly generated over two distinct hemispaces with each hemispace containing eight columns.
- Targets were not evenly distributed. Targets appeared within the cued side of the array during 80% of trials and in the uncued side on the remaining 20%. A total of 80 trials were conducted equally divided between two blocks.
- Participants' starting position pseudo randomly switched between one of a possible two locations either side of the mid line.
- Experiment 2 and 3 contained a single landmark on the peripheries of the environment. Orthogonal to the starting position in experiment 2 and adjacent to one of the starting positions in experiment 3.
- Participants who are able to learn the spatial contingencies of the environment are expected to search more efficiently, biasing their search to the cued side of space. More efficient search paths should be reflected in fewer inspections during cued trials when compared to uncued trials.

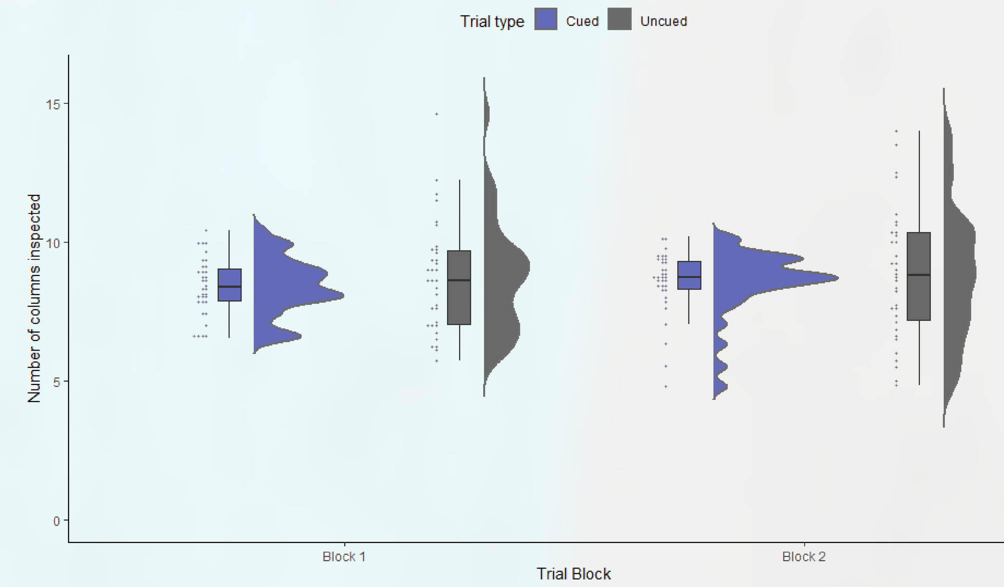
Figure 1.

Top left. The laboratory where the experiments were conducted.
Top right. A schematic of all possible column locations, starting positions are indicated either side of the mid line and possible landmark locations are indicated in green.
Bottom. A screen shot of a participant conducting the task.



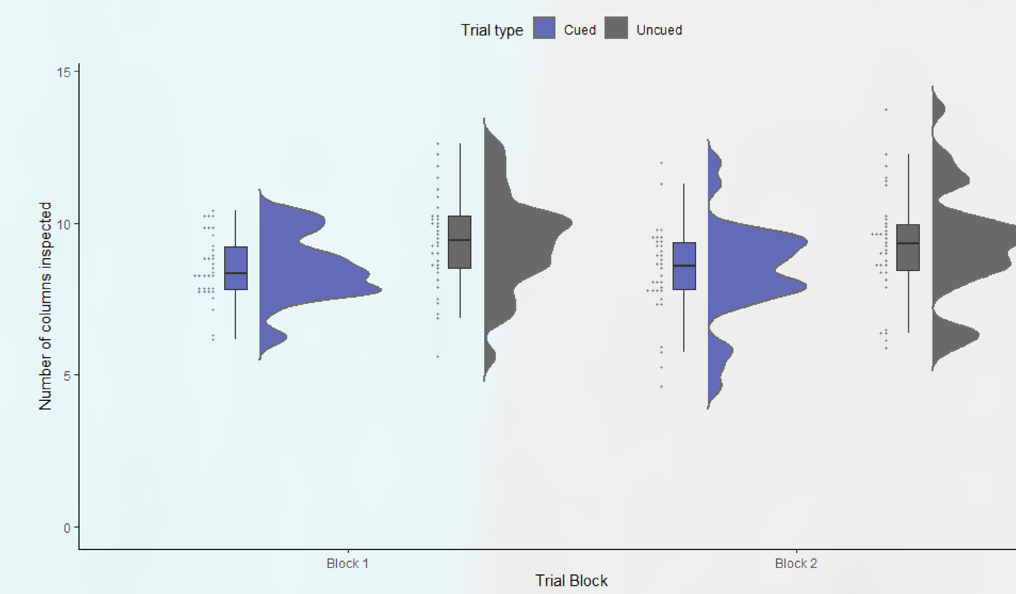
Experiment 1 – No landmark

- **Participants did not make fewer inspections during cued trials when compared to uncued trials** ($F(1, 33) = 0.60$, $p = .44$, $\eta_p^2 = 0.18$, $BF^{10} = 0.29$).
- **There was no difference in the number of inspections made by participants between trial blocks 1 and 2** ($F(1, 33) = 0.23$, $p = .63$, $\eta_p^2 = 0.07$, $BF^{10} = 0.20$).
- **There was no interaction between trial type and block** ($F(1, 33) = 0.01$, $p = .94$, $\eta_p^2 < 0.01$, $BF^{10} = 0.27$).



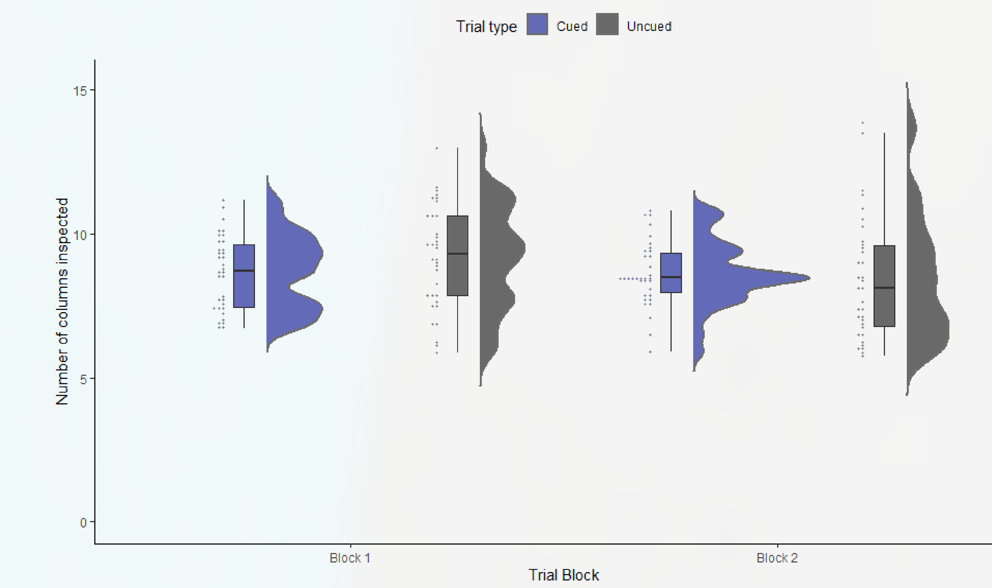
Experiment 2 – Landmark orthogonal to the starting position axis

- **Participants made fewer inspections during cued trials when compared to uncued trials** ($F(1, 33) = 4.73$, $p = .04$, $\eta_p^2 = 0.13$, $BF^{10} = 30.97$).
- **There was no difference in the number of inspections made by participants between trial blocks 1 and 2** ($F(1, 33) = 0.57$, $p = .45$, $\eta_p^2 = 0.02$, $BF^{10} = 0.21$).
- **There was no interaction between trial type and block** ($F(1, 33) = 0.00$, $p = .97$, $\eta_p^2 < 0.01$, $BF^{10} = 0.25$).



Experiment 3 – Landmark adjacent to a starting position

- **Participants did not make fewer inspections during cued trials when compared to uncued trials** ($F(1, 33) = 0.19$, $p = .66$, $\eta_p^2 = 0.06$, $BF^{10} = 0.21$).
- **There was no difference in the number of inspections made by participants between trial blocks 1 and 2** ($F(1, 33) = 3.20$, $p = .08$, $\eta_p^2 = 0.09$, $BF^{10} = 0.53$).
- **There was no interaction between trial type and block** ($F(1, 33) = 1.90$, $p = .18$, $\eta_p^2 = 0.05$, $BF^{10} = 0.55$).



General Discussion

- Participants in Experiment 1, where no landmark was present, exhibited no reliable indication of having learned the spatial contingency, replicating previous findings (Baxter and Smith, 2020; Smith et al., 2010).
- In Experiment 2, the presence of a landmark positioned orthogonal to the starting position assisted participants in learning the spatial contingencies of the environment.
- Although it was also spatially informative, the location of the landmark in Experiment 3 (adjacent to the starting position) did not assist learning, and participants were no more efficient than in Experiment 1.
- The presence of a stable landmark is not itself sufficient in assisting learning of spatial contingencies. The landmark was only effective when it was along the same axis as the probability distribution. Statistical and perceptual cues may, therefore, only be combined when their relationship is more salient.

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References

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