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Letter to the Editor

The global effect may not be as adaptive as it seems

When a distractor is presented at the same time as a target to which people are asked to quickly make saccades, saccade endpoints are sometimes not only distributed around the target, but also around the distractor or around a position between the two (e.g. Arkesteijn et al., 2020). As the centre of the latter distribution is close to the centre of the global configuration, this phenomenon is sometimes referred to as the 'global effect'. In a recent paper, Heeman et al. (2024) determined the fraction of saccades that end closer to the midpoint between the target and distractor than to either individually. They find that there are more such 'averaging saccades' when the target and distractor are close to each other and when their brightness is more similar. Based on this increase, they conclude that these factors lead to an increase of the prevalence of saccades directed to the global configuration.

When reading the paper, we questioned this conclusion. The fact that a saccade lands close to the midpoint between target and distractor does not necessarily imply that it was directed at that position. It could also be a saccade that was directed towards the target but ended close to the midpoint due to motor noise. How can we determine the fraction of saccades that was actually directed at a position between the target and distractor? This question resembles that of whether an experimentally observed distribution of endpoints represents a single normal distribution (centred on the global configuration) or the sum of two normal distributions (centered at the target and distractor; Van der Stigchel and Nijboer, 2013). However, the distributions reported by Heeman et al. (2024) in their figures 4C and 6C cannot be described by one of those two possibilities. We therefore tried to reconstruct the experimentally observed distributions using a combination of both alternatives. We thus assume three normally distributed populations of saccade endpoints: one centred on the target, one centred on the distractor and one centred somewhere between the two. Critically, we wanted to determine whether the fraction of saccades directed at the global configuration had to depend on the luminance to explain the data.

To simulate the distributions of saccade endpoints that were reported by Heeman et al. (2024) using this approach, we made several simplifying assumptions. The first is that the standard deviations of the endpoints of saccades to the target and distractor are equal and constant across conditions: 7°. The second is that the standard deviation of saccades directed at the centre of the configuration scales with target-distractor distance (Van der Stigchel and Nijboer, 2013). We fix this standard deviation to 20 % of this distance. We furthermore assume that when averaging the locations to determine the centre of the global configuration, the weights of target and distractor scale with their brightness, so the weighted average is biased towards the brightest item. Most importantly, in contrast to the conclusion of Heeman et al. (2024), we assume that the fraction of saccades that is directed to target, distractor and global configuration is constant across conditions and experiments: 60 %, 20 % and 20 %. Only the location of the centre of the global configuration depends on the items' luminance.

The results of these simulations capture the patterns in the experimental data in figures 4 and 6 of the study by Heeman et al. (2024) very well: there are more 'averaging saccades' when the target and the distractor are closer together and when they have a similar luminance (Fig. 1B, E). The underlying distributions of endpoint deviations also resemble the data very well (Fig. 1C, F). Although our simulations have a fixed proportion of saccades directed at the global configuration (20 %), the resulting proportion of averaging saccades (saccades that land closer to midway between target and distractor than to either of them) varies with the distance between target and distractor and their luminance. The influence of the distance between target and distractor arises because we assume that the variability in the endpoints of saccades towards the target or distractor does not depend on the distance between them, while the borders used for classifying averaging saccades do. Therefore, whether a target-directed saccade that deviates 6° towards the distractor is classified as an averaging saccade depends on the location of the distractor: it is an averaging saccade if the distractor is at 20°, but not if the distractor is at 30°. The influence of the relative brightness of target and distractor arises because the closer the saccades directed at the centre of the configuration are aimed to the midpoint between the two, the more they will be classified as averaging saccades. Thus, the prevalence of saccades that land closer to midway between the target and distractor than to either the target or the distractor, following the definition of an averaging saccade by (Heeman et al., 2024), is not a reliable measure of the fraction of saccades that are directed towards the global configuration.

For our simulations, we know the fraction of saccades that was directed at the global configuration. It was 20 %, independent of the brightness of and separation between target and distractor. Our simulations do not demonstrate that the fraction of saccades that is directed at the global configuration is independent of brightness and separation. However, they do show that the results in the original paper can be explained without assuming that the fraction does change, so we conclude that accepting the interpretation provided in Heeman et al. (2024) is premature.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

The code used for the generation of Figure 1 is available at OSF (https://osf.io/t3x72/).

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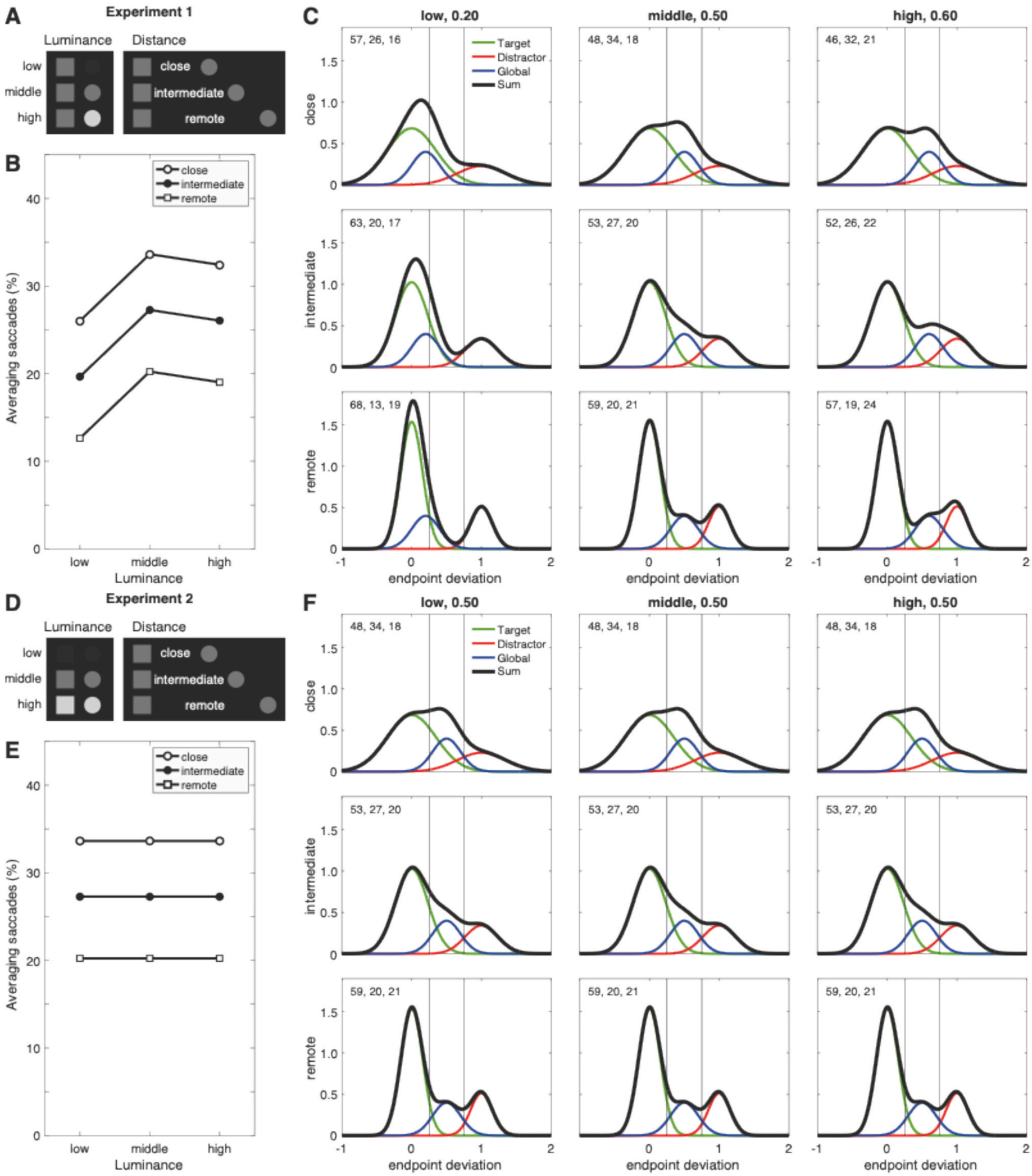

Fig. 1. Simulations of the experiments of Heeman et al. (2024). A, D: Distractor (disc) luminance and distance were varied in both experiments. Target (square) luminance was either constant (A: Experiment 1) or varied with the luminance of the distractor (D: Experiment 2). Results are presented in the same format as that of the original paper (Figs. 4b,c and 6b,c). B, E: the fraction of saccades that are closer to the average position than to the target or the distractor as a function of distractor luminance. C, F: the distributions underlying the nine datapoints in panels B and E. The endpoint deviation is expressed as a fraction of the target-distractor distance. We simulated three types of saccades: saccades towards the target (green curve), the distractor (red curve) and towards a point between the two (blue curve). The black curves indicate the sum of these three curves. As the horizontal axes are scaled by the target-distractor distance, the 7° wide red and green distributions appear smaller for larger target-distractor distances. The rows in C and F indicate the three distances between target and distractor and the columns the distractor luminance. The numbers above the columns indicate the assumed location of the centre (shifted towards the brighter item by an arbitrary amount); Vertical lines divide the endpoints into those that are closest to the target, the midpoint between target and distractor, and the distractor, respectively. The three numbers in the upper left corner of each subpanel indicate the percentage of saccades that ended in each of the three zones. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

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