

There's Waldo! A normalization model of visual search predicts single-trial human fixations in an object search task

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Supplementary Figures Legends

Figure S1. Normalization reduces the effect of absolute modulation intensity.

The proposed model uses normalized multiplication followed by selecting the maximum of the resulting map. As a result, increasing the modulation equally across the entire map should have very little effect on model choice. This is confirmed in the current figure where we ran the same experiment again, multiplying all top-down modulations by a factor 10. We show the degree of consistency (within subjects, across subjects, with model) for all trials, target-absent trials and error trials. The format and conventions are the same as those in **Figure 6**. As expected, the results are very similar to those in **Figure 6**.

Figure S2. Image similarity metrics are correlated with subject performance.

Following the results of **Figure 3** for the model, here we show that the visual similarity between an image and the target influences visual search. For all objects in all *target-absent* trials, we computed the average similarity or difference between each object and the target along the various similarity measures used in **Figure 3** (Pixel wise correlation, Euclidean distance, histogram correlation, absolute mean luminance difference, absolute size difference, C2b correlation, 100th non-zero pixel difference). We then separated the populations into objects that were fixated first in their trials (black bars), and objects that were not fixated first (gray bars). . Error bars denote standard error of the mean. Using the Wilcoxon rank sum test, we evaluated whether significant differences exist in the similarity-to-target of objects that were fixated first vs. those that were not (denoted by *). All similarity metrics used resulted in significant differences between fixated-first and non-fixated first objects ($p < 0.001$ for all measures), in the direction expected (lower for distances to target, higher for similarities to target).

Figure S3: Directional biases.

Proportion of saccades for each of the 6 possible directions (30, 90, 150, 210, 270, and 330 degrees) for target present trials (blue) and target absent trials (red).

Figure S4: Distribution of behavioral reaction times for the first fixation.

- a. Latency for each subsequent fixation (mean±SD).
- b. Target present trials. Correct trials (blue), Incorrect trials (red), Correct+Incorrect trials (dotted).
- c. Target present trials (blue), target absent trials (red).

Figure S5: Informal psychophysics experiment with two author subjects (tm, gk).

a. Target localization with unlimited time. In the text, subjects were instructed to move their eyes and try to localize the target as soon as possible. Here subjects fixated on the central cross and strived to maximize accuracy with unlimited time. Both subjects achieved 100% performance. Object size, eccentricity and other task variables are the same as in the main task.

b. Here we asked whether subjects could recognize the objects without making a saccade to them, given their size and eccentricity. Subjects fixated on the central cross and named each object on the screen in a clockwise manner, with unlimited time. Another investigator marked each response as correct/incorrect. Performance was 100% for one subject and 97% for the other subject

Figure S1

Cerebral Cortex

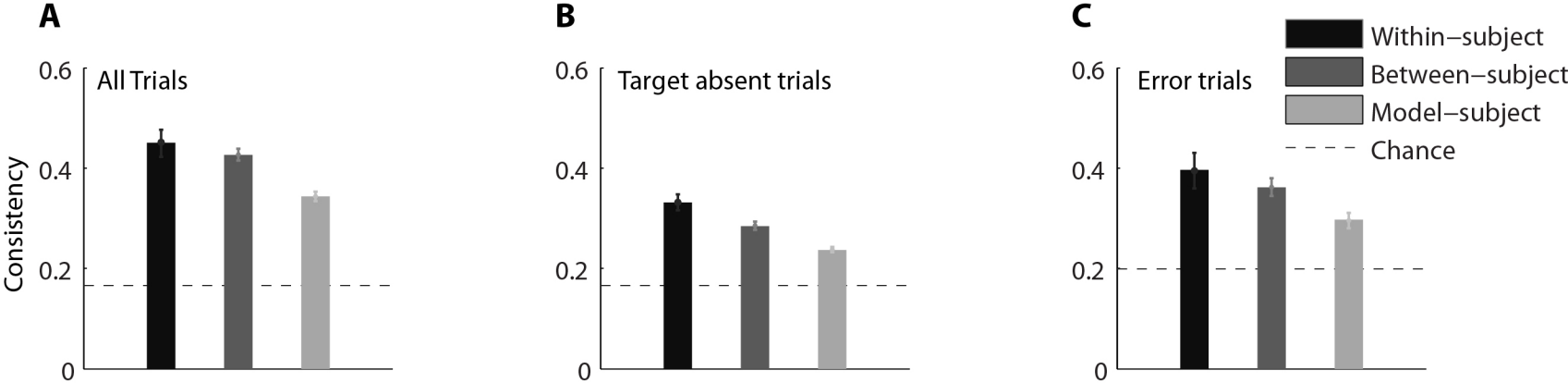


Figure S2

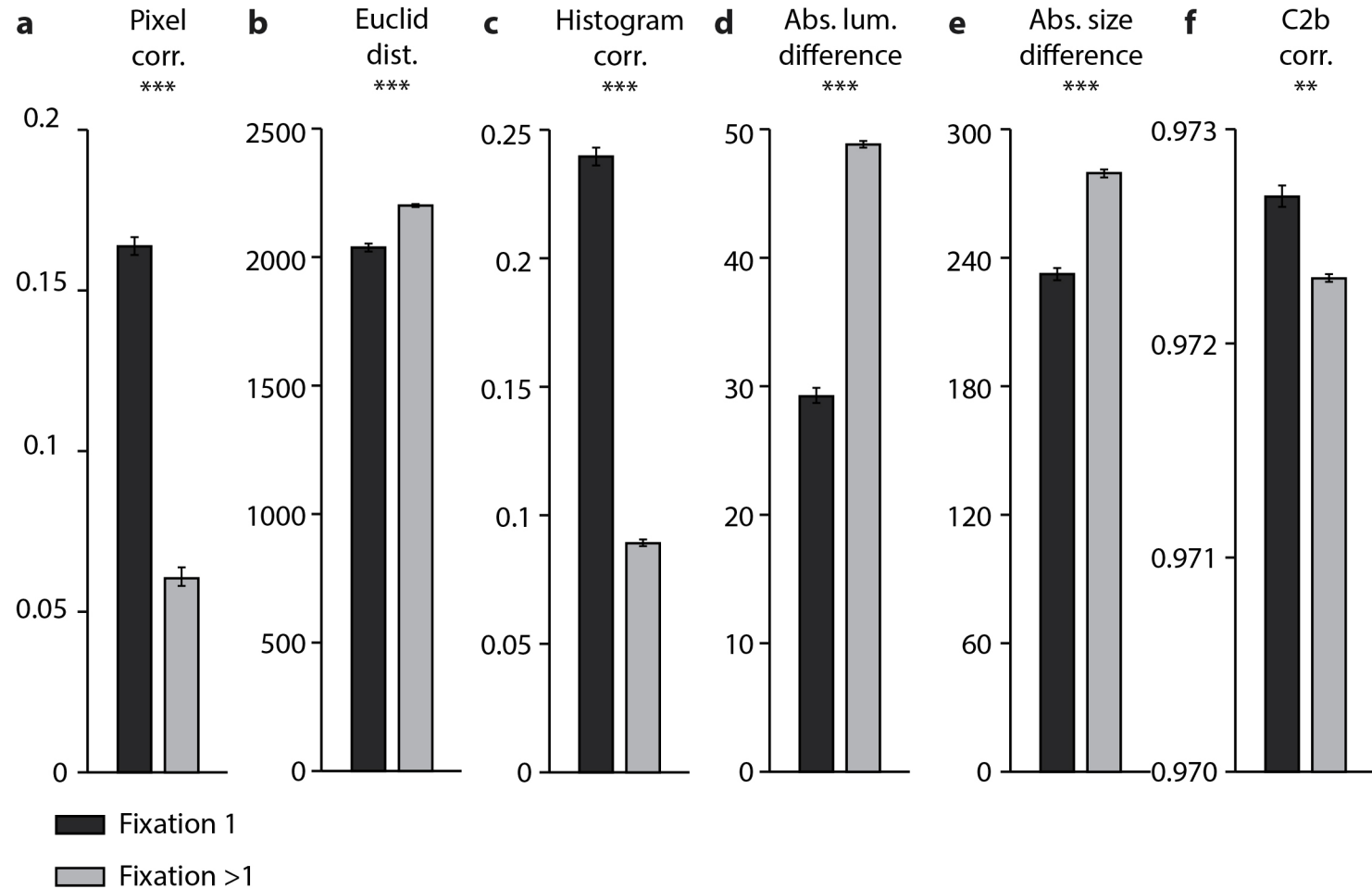


Figure S3

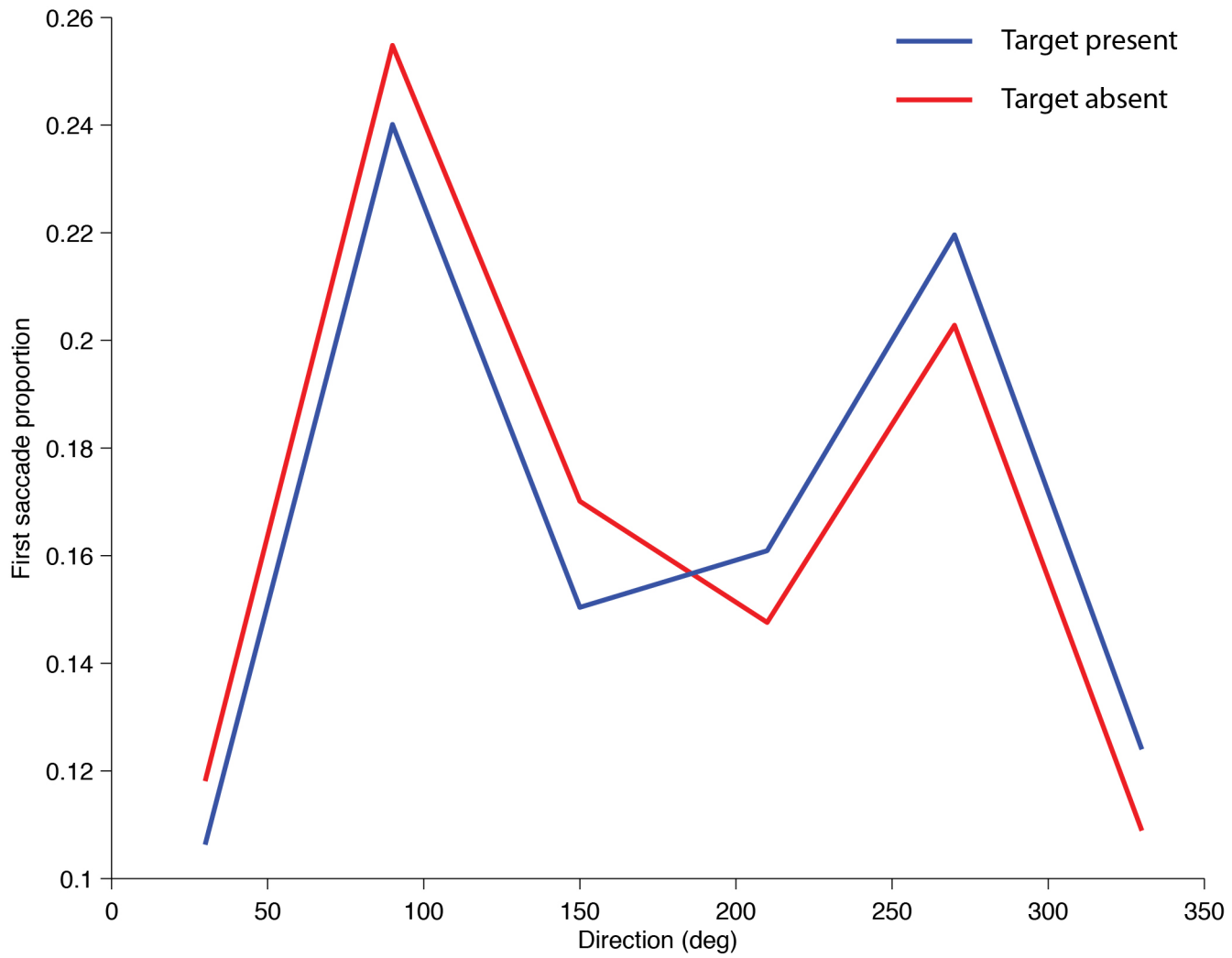


Figure S4

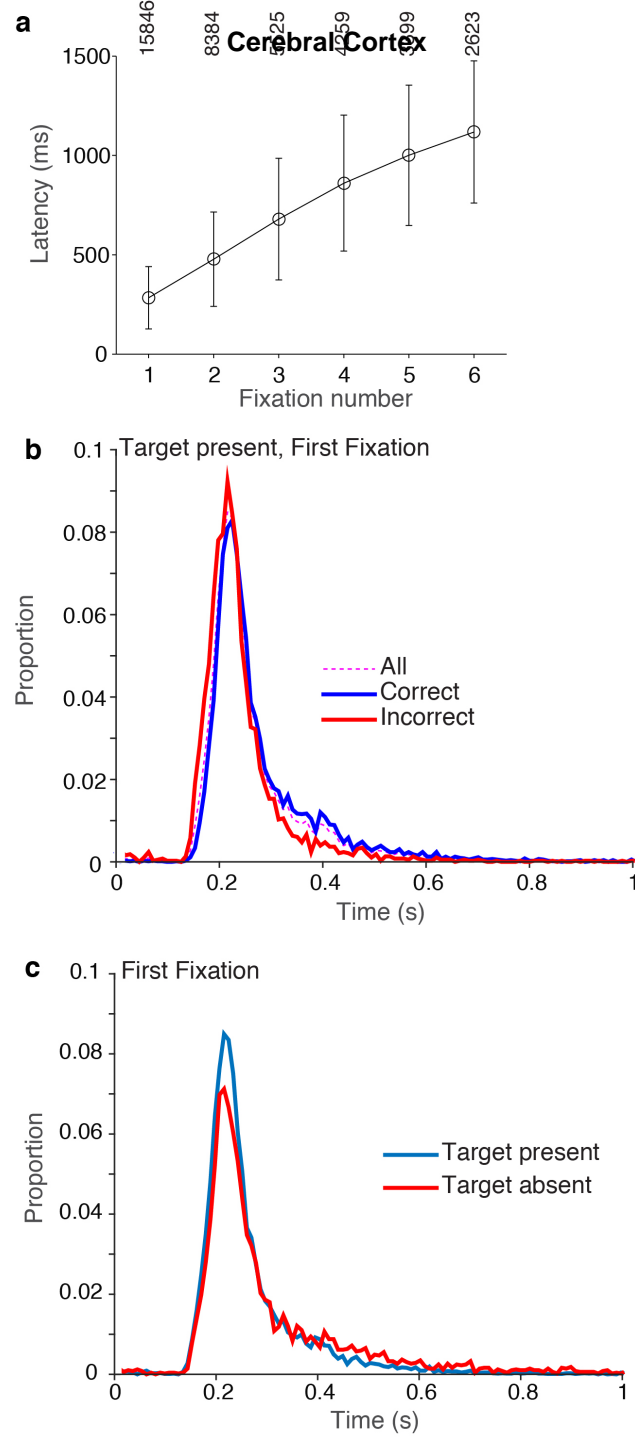


Figure S5

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