Saliency-Dependent Distractor Suppression at One Specific Location and the Underlying Neural Mechanisms

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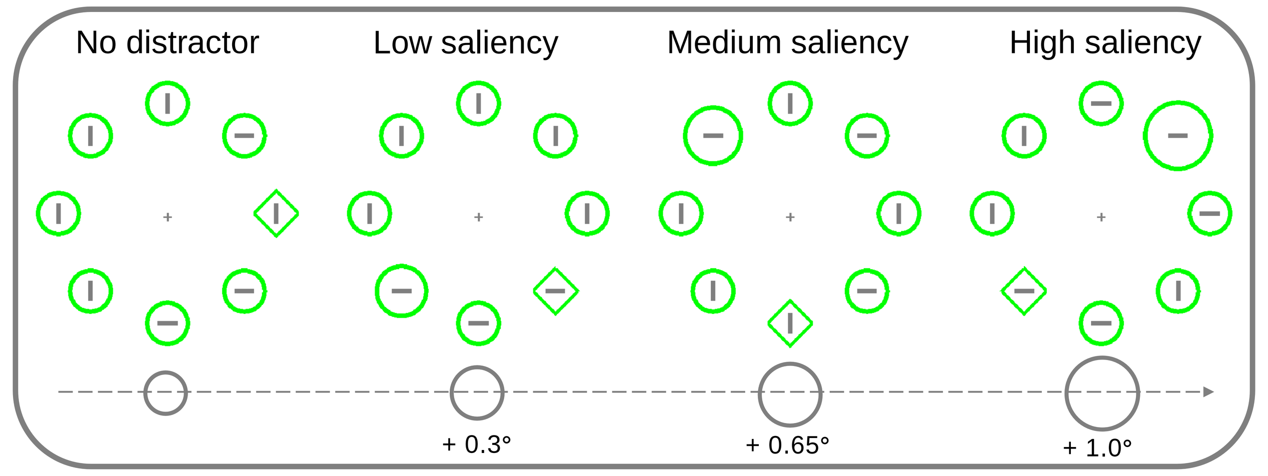
Introduction

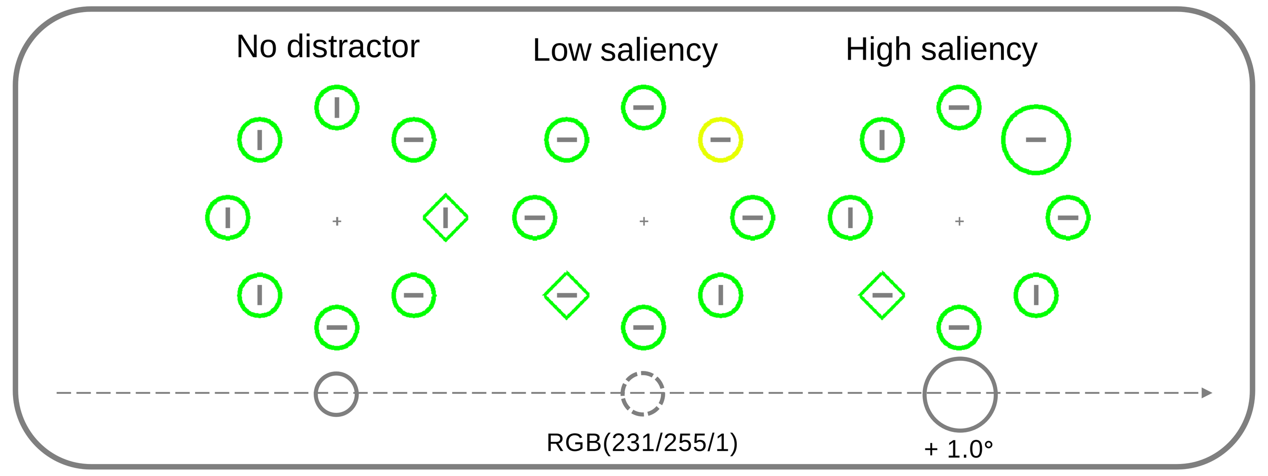
- During everyday tasks, salient distractors may capture our attention. Recently it was shown that through implicit learning, capture by a salient distractor is reduced by suppressing the location where a distractor is likely to appear.
- In the current study, we present distractors of different saliency levels at one specific location and demonstrate a saliency-dependent mechanism of distractor suppression that is distinct from previous findings.
- Specifically, we show that when different types of distractors share the same spatial location where they are more likely to appear, the amount of suppression applied to that location is contingent on the actual saliency of the distractor presented every time, irrespective of the feature dimension of the distractor but sensitive to the overall saliency context of the current environment.
- We analyzed behavioral data and gave neurobiological interpretations based on the V1 saliency theory (Li, 1999, 2002). Specifically, we explained this saliency-dependent suppression mechanism as the neural adaptation of V1 cells that cover the high probability location with their classical receptive fields. The degree of neural adaptation for the group of V1 cells representing the high saliency size distractors is high, while the degree of adaptation for the other group of V1 cells representing the low saliency is low, which finally leads to specific suppression contingent to the saliency of the distractor.

Methods

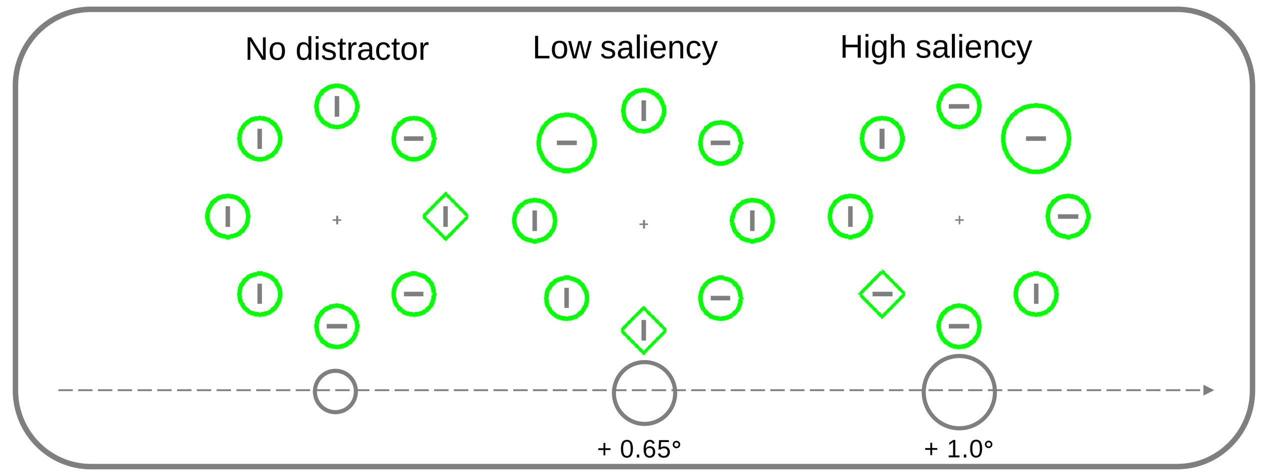
Experiment 1
(size distractors)

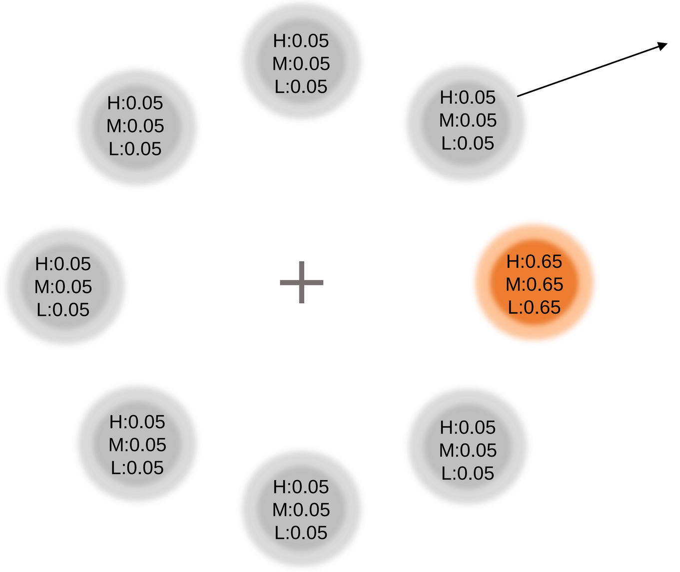


Experiment 2
(color and size distractors)



Experiment 3
(size distractors)





H/M/L in Experiment 1
H/L in Experiment 2 and 3

H: High saliency distractor
M: Medium saliency distractor
L: Low saliency distractor
[Experiment 1 and 2: Equal number of trials for each distractor type]
[Experiment 3: HS group (high saliency distractors account for 80%), LS group (low saliency distractors account for 80%)

Results

Experiment 1

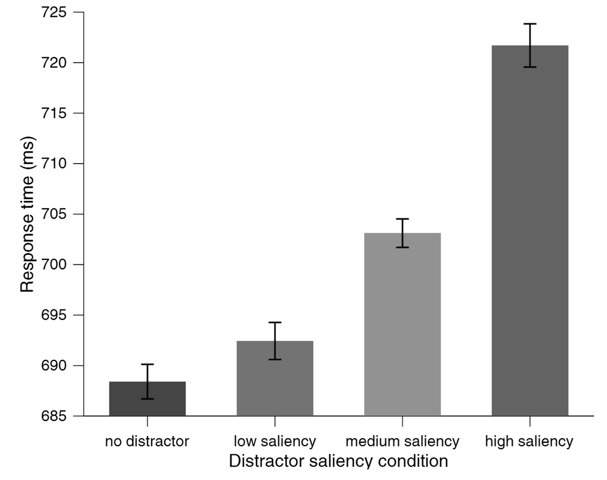


Fig 1: Mean RTs for different distractor saliency conditions. Our saliency manipulation successfully caused attentional capture, and the amount of capture did increase with the saliency of the distractor.

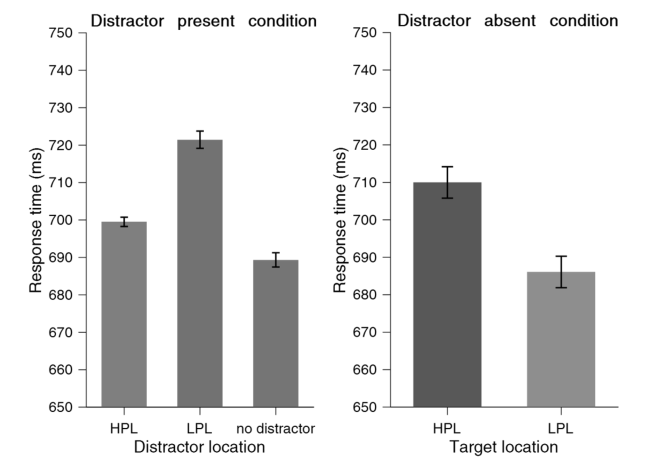


Fig 2: **Location-based suppression. Left panel:** mean RTs for different distractor location conditions (HPL/LPL: high/low probability location). **Right panel:** mean RTs when the target is presented at the HPL and LPL location in the no-distractor condition.

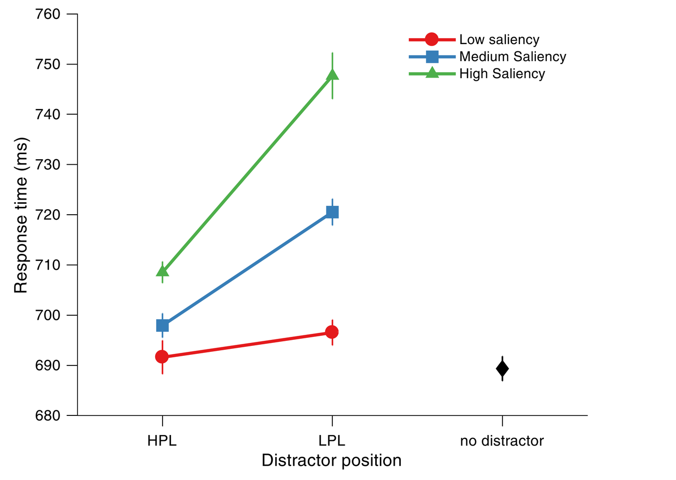


Fig 3: **Saliency-specific suppression.** We submitted RT data to an ANOVA with factors of distractor saliency (low vs. medium vs. high) and distractor position (HPL vs. LPL) and the results showed a significant interaction($F(2,60) = 29.429$, $p < .001$, $\eta_p^2 = .495$).

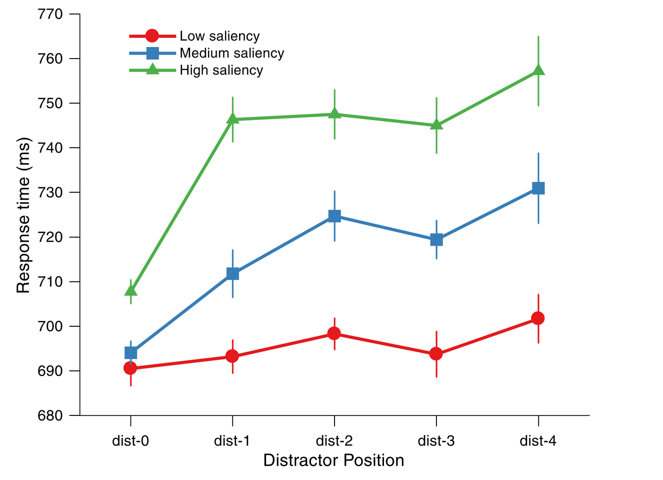


Fig 4: **Spatial gradient of suppression.** Mean RTs by distractor saliency for different distractor positions relative to the HPL. A one-way ANOVA on slope with distractor saliency (low vs. medium vs. high) as factor showed a significant main effect of distractor saliency.

Experiment 2

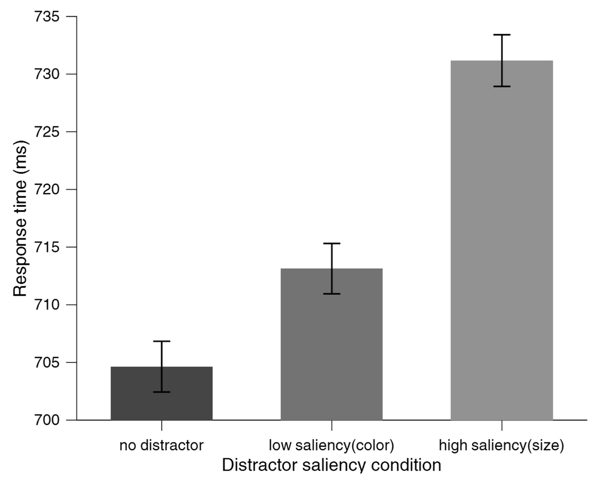


Fig 1: The high saliency size distractor caused a larger interference effect than the low saliency color distractor ($t(30) = 4.703$, $p < .001$, $d = .187$).

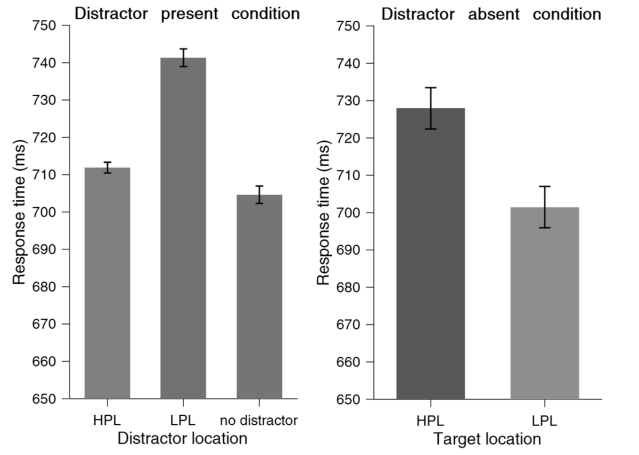


Fig 2: **Location-based suppression.**

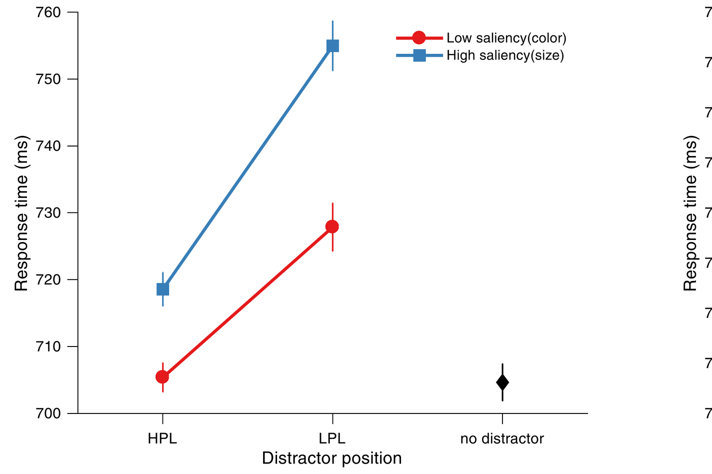


Fig 3: **Saliency-specific suppression.** The significant interaction ($F(1,31) = 5.283$, $p = .028$, $\eta_p^2 = .146$) demonstrates that the saliency-specific suppression that we found in Experiment 1 can also occur when the saliency is derived from different feature dimensions.

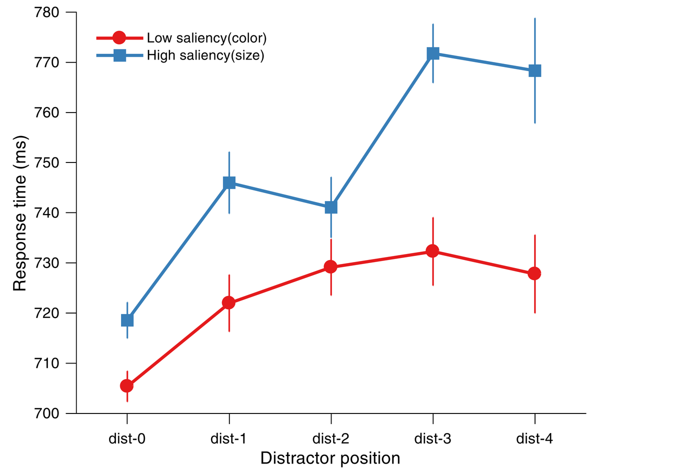


Fig 4: **Spatial gradient of suppression.**

Experiment 3

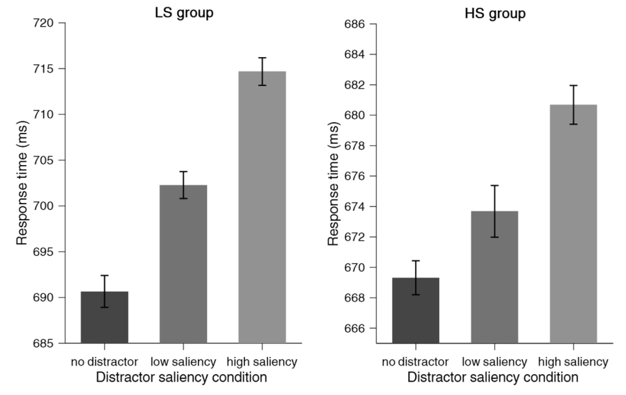


Fig 1: Mean RTs for different distractor saliency conditions. **Left panel:** LS group (low saliency distractors appeared on 80% of all distractor-present trials). **Right panel:** HS group (high saliency distractors appeared on 80% of all distractor-present trials).

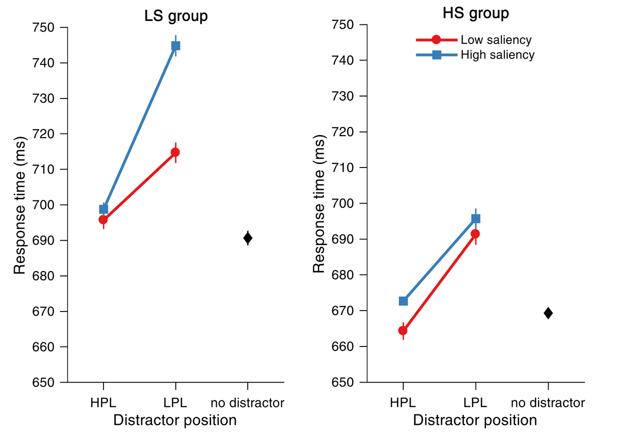


Fig 2: **Saliency-specific suppression.** For LS group, there was a strong interaction ($F(1,18) = 25.849$, $p < .001$, $\eta_p^2 = .590$) between the two factors(distractor position and saliency). However, for HS group the pattern was very different and the interaction was not significant. These demonstrate the plasticity of the visual system in computing the saliency of stimuli, and changes of the actual saliency of low and high saliency distractors in turn reshaped the saliency-specific pattern we observed in Experiment 1 and 2.