Is Color-Based Attention an Effective Filter for Symmetry Detection?

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Introduction

Color-based attention can be used to separate relevant from irrelevant stimulus information. Studies using visual search tasks with color singletons establish a congruency effect, where participants' responses are slower when the distractors' features are incongruent to those of the target (Theeuwes & Van der Burg, 2011). In these, however, stimuli are spatially separate. In research employing paradigms without spatial separation, on the other hand, color-based attention seems to ameliorate separation of targets and distractors, e.g. when participants were asked to conduct centroid estimations or detect coherent motion while attending to a dot cloud of a certain target color while ignoring interspersed distractors (Drew, Chubb, & Sperling, 2010; Müller et al., 2006). Our aim was to extend these findings to symmetry detection. We asked participants to decide whether a cloud of dots of a certain color was symmetric along the vertical axis or not. The target patterns were intermingled with dots of a differently colored pattern that could be symmetric or not. We asked participants to indicate the targets' structure via button press.

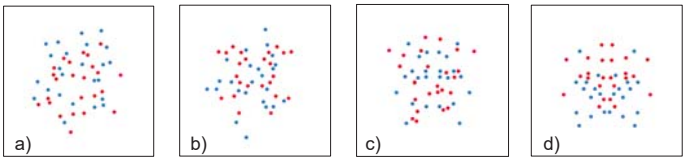
Methods

Participants

N = 21; M_{age} = 21.8 years; SD_{age} = 2.97; 16 female

Stimuli

Design: 2 (Target Color: red / blue) x 2 (Target Structure: symmetric / random) x 2 (Congruence: congruent / incongruent)

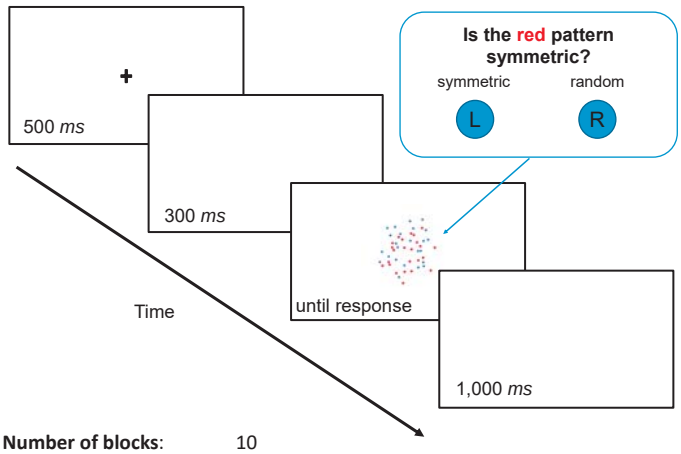


20 stimuli were created for each of stimulus categories above:

Structure	Target	Distractor
a)	Random	Random
b)	Symmetric	Random
c)	Random	Symmetric
d)	Symmetric	Symmetric

Total of 80 stimuli: 40 (Red) 40 (Blue) — Target Color

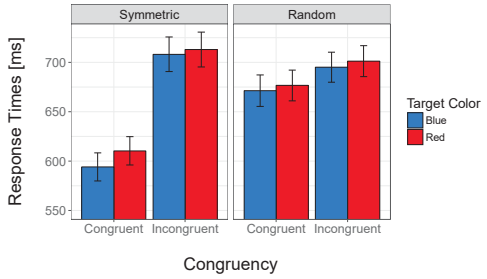
Procedure



Number of blocks: 10
Total number of trials: 400
Counterbalancing: 11 participants started with blue target color; 10 with red target color

Results

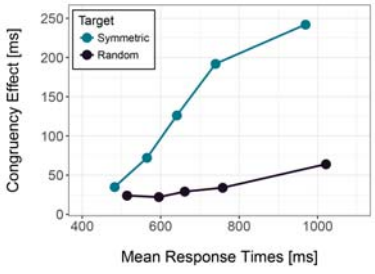
Response Times (RTs)



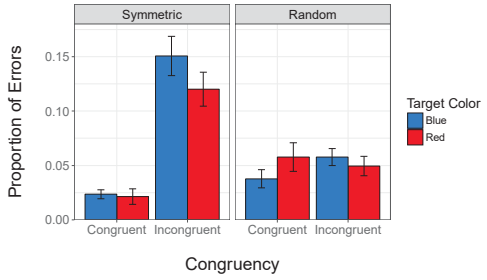
Main Effects
- Target Color: $F(1,20) = 1.92$; $p = .181$; $\eta_p^2 = .088$
- Target Structure: $F(1,20) = 20.5$; $p < .001$; $\eta_p^2 = .506$*
- Congruency: $F(1,20) = 213.1$; $p < .001$; $\eta_p^2 = .914$*

Interactions
- Color x Structure: $F(1,20) = .671$; $p = .422$; $\eta_p^2 = .032$
- Color x Congruency: $F(1,20) = .518$; $p = .480$; $\eta_p^2 = .025$
- Structure x Congruency: $F(1,20) = 65.2$; $p < .001$; $\eta_p^2 = .765$*
- All three: $F(1,20) = 1.60$; $p = .221$; $\eta_p^2 = .074$

Delta Functions



Errors

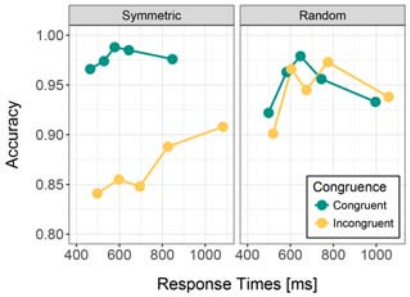


Main Effects
- Target Color: $F(1,20) = .635$; $p = .435$; $\eta_p^2 = .031$
- Target Structure: $F(1,20) = 16.3$; $p < .001$; $\eta_p^2 = .450$*
- Congruency: $F(1,20) = 66.8$; $p < .001$; $\eta_p^2 = .769$*

Interactions
- Color x Structure: $F(1,20) = 2.75$; $p = .113$; $\eta_p^2 = .121$
- Color x Congruency: $F(1,20) = 3.66$; $p = .070$; $\eta_p^2 = .155$
- Structure x Congruency: $F(1,20) = 52.3$; $p < .001$; $\eta_p^2 = .723$*
- All three: $F(1,20) = .0$; $p = 1.0$; $\eta_p^2 < .001$

* significant

Conditional Accuracy Functions (CAFs)



Discussion

Symmetric targets were processed faster and more accurately when the overall patterns were congruent, whereas for incongruent ones processing slowed down greatly in the symmetric condition. Especially for symmetric targets, the congruency effect increased strongly with response time. The conditional accuracy functions show that a rise in time spent on conflict resolution led to little reduction in errors. Lastly, random distractors impeded the processing of symmetric targets but not vice versa. This is in accordance with research that finds *search asymmetries* in visual search tasks (see Wolfe, 2001, for a review), including those using symmetric and asymmetric singletons (Niimi, Yokosawa, & Watanabe, 2006). All in all, our results suggest that color-based attention was not effective in this case.

References

- Drew, S. A., Chubb, C. F., & Sperling, G. (2010). Precise attention filters for Weber contrast derived from centroid estimations. *Journal of Vision, 10*(10), 20-20.
- Müller, M., Andersen, S., Trujillo, N., Valdes-Sosa, P., Malinowski, P., & Hillyard, S. (2006). Feature-selective attention enhances color signals in early visual areas of the human brain. *Proceedings of the National Academy of Sciences, 103*(38), 14250-14254.
- Niimi, R., Yokosawa, K., & Watanabe, K. (2006). Attentional set for axis of symmetry in symmetry-defined visual search. *Attention, Perception, & Psychophysics, 68*(7), 1153-1162.
- Theeuwes, J., & Van der Burg, E. (2011). On the limits of top-down control of visual selection. *Attention, Perception, & Psychophysics, 73*(7), 2092.
- Wolfe, J. M. (2001). Asymmetries in visual search: An introduction. *Attention, Perception, & Psychophysics, 63*(3), 381-389.

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