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Published in:
Perception

Publication date:
2011

Document Version
Peer reviewed version

Citation for published version (APA):
Position and color priming in briefly presented search arrays

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Introduction

In efficient visual search, priming of pop-out (PoP; Maljkovic & Nakayama, 1994, 1996) is usually reported as a speeded response when a target feature is repeated on consecutive trials.

Feature facilitation accounts: Sensitization to features via short-term memory. Priming at perceptual level.

Post-perceptual accounts: PoP affects response times, not accuracy, via response repetition benefits, decision bias or other “late” effects.

Questions:

1. Do color and/or position repetitions increase accuracy at brief exposure durations?
2. If so, is a category weighting account viable an explanation of the PoP when applied within a TVA-framework (Bundesen, 1990)?

Methods

Participants were 30 students at the University of Iceland (26 male, 4 female). They were all right-handed and were paid for their participation.

Stimuli

Stimuli were 15 consonants, Latin capitals (A, B, C...Z) presented on a black screen. The target would always occupy one of the four corner positions. The displays were present for from 10-180 ms.

The subjects’ task was to report the odd-one-out letter by pressing the appropriate key on a keyboard. The target identity was determined by color and varied randomly (Figure 1).

The experiment

We tried to replicate perceptual priming effects in an accuracy based design (Yashar & Lamy, 2010) while generalizing to alphanumeric stimuli. Our design also has the advantage of multiple responses (15 consonants), which minimizes any effects of response repetition and visuomotor effects, leaving the results more readily interpreted as perceptual effects.

We presented subjects with a 3x3 consonant matrix where a target would always occupy one of the four corner positions. The displays where present for from 10-180 ms.

Figure 1: (1) a trial (black arrow) and (2) between trial stimulus arrays (red arrow).

Accounting for repetition priming within TVA (Bundesen, 1990)

A Theory of Visual Attention (TVA) is a combined theory of selection and recognition. It has been mathematically formalized in a fixed capacity, independent race model (FRRM). The central assumptions of the theory are described by the rate and weight equations (Figure 2).

In TVA selectivity is obtained by adjusting attentional weights for perceptual categories by differentiating their perceptual values (W). Pertinence can be adjusted voluntarily by current goals or instructions, but involuntary factors can also affect it.

Here we treat W as a parameter that can be simultaneously affected from trial to trial by varying target identity during a task. The assumption is that m-calculations are ongoing and the current importance of a target category is affected by its importance on the previous trial.

Results

A 2x2 within subjects analysis revealed significant main effects of position and color repetition (ps <0.001 and 0.003, respectively). No interaction was found between the two (p=0.619).

Position priming effects ranged from 2.5-11.4 pp, between subjects.

Color priming effects ranged from 1.7-11.8 pp, between subjects.

All subjects showed the same pattern of lowest accuracy under the “no-repetition” condition and highest accuracy under the “both repeated” condition. These within-subject differences ranged from 10-23 pp.

The fits in figure 3. show the curves predicted by a simple additive TVA-based model of PoP. The model is only instructional, since it is limited to one-trial-based processing speed, not accuracy, via memory, which will not suffice to describe PoP in detail. PoP has shown to be a cumulative effect, building up over several trials and decaying relatively slowly (Maljkovic & Nakayama, 1994).

Figure 2: Weight equation and rate equation.

Acknowledgments

Thanks to Signe Vangkilde and eye-tracker control was examined by Delphi, using the VET and the Psychophysics toolbox.

Conclusions

• PoP affects accuracy at very brief exposures.
• The effects cannot be explained by reference to response related mechanisms.
• The results suggest a perceptual component in PoP. This does in not exclude response related PoP.
• A simple additive TVA model can be fitted quite well to experimental data.
• Recent literature suggests that repetition are the result of two or multiple mechanisms (see Lamy & Yashar, in press; Kristjánsson & Campana, 2010).

References


Acknowledgements

Thanks to Signe Vangkilde for allowing the use of tools and graphics in the experiment and on the paper.