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Position and color priming in briefly presented search arrays

Árni Gunnar Ásgeirsson¹, Áðri Kristjánsson², Søren Kyllingsbæk¹, Kristbjörg Þóra Hárafsdóttir², Heiðrún Hafþórsdóttir² and Claus Bundesen¹

1: Center for Visual Cognition, Department of Psychology, University of Copenhagen.
2: Laboratory for Visual Perception and Visuomotor Control, Faculty of Psychology, University of Iceland.

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 a viable explanation of the PoP when applied within a TVA-framework (Bundesen, 1990)?

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 pertinence values (P). Pertinence can be adjusted voluntarily by current goals or instructions, but involuntary factors can also affect it.

Here we treat P as a parameter that can be voluntarily 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 experiment

We tried to replicate perceptual priming effects in an accuracy based design (Yashar & Lamy, 2010) while generating to alphabetic 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 10-180 msec.

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).

Methods

Participants were 8 students at the University of Iceland (3 male), ages 22-28. Each subject participated in at least 15 blocks of 108 trials. Trials following incorrect responses were repeated until one correct response was achieved. Trials were blocked within a session.

We presented 15 consonants common to the Icelandic and English alphabets. These were presented as APRIL DOUGLAS. All letters were equally likely to appear at any time, but only one sample at each letter could appear on a single trial. Targets and distractors were presented in random order, and positions and colors were randomized over trials. All trials were equally likely, i.e. probability of target being in position i would always be 1/9. All stimulus positions were marked by pattern masks, made from bits of Arial Bold capitals.

All experiments were controlled for by making the start of each trial dependent on a random number generator which could fix the presentation order. The movement data was recorded by a Cambridge Research Systems Eye-tracker.

Results

• 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

7. Yashar & Lamy. (in Press). Refining the dual-stage account of intertrial feature priming: Does motor response or response related mechanisms account?