Positions priming in briefly presented search arrays
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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, given the pop-out explanation of PoP when applied within a TVA-framework (Bundesen, 1990)?

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 presented for 10–180 ms.

The subjects’ task was to record 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 males, aged 20–26). Each subject participated in at least 15 blocks of 100 trials. Trials following incorrect trials are discarded, since it may be meaningless to speak of repetitions/alternations from an experimental view.

Eye-movement data was recorded by a Cambridge Research Systems Video Eyetracker. The experiment was programmed in the Psychophysics Toolbox (Brainard, 1997; Pelli, 1997).

Results

A 2x2 within subjects analysis revealed significant main effects of position and color repetition (p < 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.

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


Pelli (1997). The Video toolbox for Psychophysics: Seeing it as you wish it.


Acknowledging 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 (IPRM). 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 performance values (t). Pertinence can be adjusted voluntarily by current goals or involuntary factors and the current importance of a target category is affected by its importance on the previous trial.

The model has 4 free parameters (t0, alpha, gamma, C). Pertinence non-smoker in the placebo group. The slope of the curve at the asymptote of the fitted curve.

Table 1: Summary of the Data and Fitted Curve

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>t0</td>
<td>50</td>
</tr>
<tr>
<td>alpha</td>
<td>0.19</td>
</tr>
<tr>
<td>gamma</td>
<td>0.8</td>
</tr>
<tr>
<td>C</td>
<td>0.98</td>
</tr>
</tbody>
</table>

Figure 2: Weight and Rate Equations

The model also applies to pooled, rather than individual data. However, the goodness of fit is still acceptable.

The model is only instructional, since it is limited to one-target 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). The model also applies to pooled, rather than individual data. However, the goodness of fit is still quite promising.

The model has 4 free parameters (t, alpha, color & position rep.) and a fixed C (processing speed). The P parameter is fixed at 0.0327 (table 1). The fit in figure 3 show the curves predicted by the model.

Figure 3: The fit in figure 3 show the curves predicted by the model.

The experiment

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