Available online at www.sciencedirect.com
ScienceDirect
Vision Research 47 (2007) 1570–1583
Vision Research
www.elsevier.com/locate/visres

Filtering items of mass distraction: Top-down biases against distractors are necessary for the feature-based carry-over to occur

Jason J. Braithwaite *, Glyn W. Humphreys

Behavioural Brain Sciences Centre, School of Psychology, University of Birmingham, Edgbaston, Birmingham B15 2TT, UK

Received 20 January 2006; received in revised form 7 February 2007

Abstract

In preview search a new target is difficult to detect if it carries a feature shared with the old distractors [Braithwaite, J. J., Humphreys, G. W., & Hodsoll, J. (2003). Color grouping in space and time: Evidence from negative color-based carry-over effects in preview search. *Journal of Experimental Psychology: Human Perception and Performance, 29*(4), 758–778.] Two experiments are presented which examined whether this negative color carry-over effect is dependent on an attentional-set to ignore old, irrelevant distractors. Consistent with this, the data show that the negative carry-over effect is greatly reduced if the attentional-set to ignore the old preview items is removed and replaced by a set to prioritize the old items instead. The findings demonstrate that preview search, and the carry-over effect, are at least partly determined by a top-down intentional bias against old, irrelevant information.

Keywords: Visual search; Preview-search; Inhibition, Carry-over effects

1. Introduction

Visual search performance can be greatly improved if observers receive an initial preview of half of the distractor items before presenting the additional distractors and the target (Watson & Humphreys, 1997; see Watson, Humphreys, & Olivers, 2003; for a review). Although, within this procedure, the initial distractors remain present in the visual field (the second items being added to unoccupied locations in the display), they do not compete strongly for selection. These findings demonstrate that, provided the interval between the first preview display and the second display is sufficient (see Humphreys, Jung-Stalmann, & Olivers, 2004; Humphreys, Olivers, & Braithwaite, in press), the first distractors can be effectively ignored. Performance in the preview condition is thus greatly facilitated relative to a baseline condition where all the items appear simultaneously (the full-set baseline; see Watson & Humphreys, 1997 for the original demonstrations). This advantage to search has become known as the 'preview-benefit' (Watson et al., 2003).

The factors that lead to this preview benefit have been subject to considerable debate. In the original account, Watson and Humphreys (1997) argued that the benefit stemmed from top-down, goal-based inhibition applied to the locations of the old distractors. By means of this inhibition, old items were filtered from search (a process they termed 'visual marking'), enabling new items to be prioritized for selection. Watson and Humphreys proposed that visual marking was under top-down control and took time to become manifest (see Humphreys et al., 2004, in press, for evidence on the time course of the effects). Central to this original account was that static old preview items were inhibited on the basis of their locations and not their featural attributes; in this sense inhibitory filtering was held to be 'feature-blind'. This claim has received some further recent support. For example, Watson and Humphreys (2002) showed that, with static items, there is no impact

* Corresponding author.
E-mail address: j.j.braithwaite@bham.ac.uk (J.J. Braithwaite).

0042-6989/$ - see front matter © 2007 Elsevier Ltd. All rights reserved.
doi:10.1016/j.visres.2007.02.019

on search efficiency when color changes take place in preview displays as the search stimuli are added. If old items were ignored by inhibiting their color (e.g., Treisman & Sato, 1990), then changing the color of the old items should 'release' them from inhibition, decreasing the preview benefit. This was not observed (see Olivers, Watson, & Humphreys, 1999; for further evidence of location-based inhibition).

In contrast to the notion of inhibitory filtering, Donk and Theeuwes (2001) have argued strongly that the preview benefit reflects nothing more than automatic attentional capture induced by the new onsets produced by the second, search display. Donk and Theeuwes (2001) examined preview search in both the presence and absence of abrupt onsets by presenting items that were or were not isoluminant to their background. Performance was assessed where either (i) both the preview and search displays were isoluminant (no onset signals at all), (ii) just the new items were isoluminant with their background (no onset signals associated with the arrival of new items), or (iii) the preview display was isoluminant while the search display arrived with an abrupt onset. Donk and Theeuwes (2001) found that preview benefits only emerged when the new items arrived with an abrupt onset. Based on this finding, Donk and Theeuwes argued that new onsets were necessary to establish a preview advantage (see also Donk & Theeuwes, 2003; for further recent argument).

A similar non-inhibitory account was proposed by Jiang, Chun, and Marks (2002) who suggested that performance was based simply on the ability to temporally segment the preview and second search displays from each other over time. As long as sufficient time was allowed between presentations of the two sets of items—attention could be directed towards the relevant new display without any need to assume the presence of inhibition directed towards the irrelevant display.

1.1. Are non-inhibitory accounts of preview search sufficient?

Although attractive, previous evidence indicates that non-inhibitory accounts of preview search are not sufficient to explain all the results. Two critical pieces of evidence come from (i) probe-detection studies, where probes are presented to assess where attention is allocated during preview search, and (ii) color-based carry-over effects, from old to new displays.

When a probe falls on a preview item it is more difficult to detect compared to when the probe falls at the location of a new item (Braithwaite, Humphreys, & Hullleman, 2005; Olivers & Humphreys, 2002; Watson & Humphreys, 2000) and even relative to unoccupied (neutral) background locations (Humphreys et al., 2004). Importantly, these costs to probe-detection are particularly pronounced when participants are engaged in a search task where new items must be prioritized. Under these circumstances participants appear to use a goal-directed bias against old, irrelevant distractors. However, these costs are greatly reduced when probe-detection is the sole task being carried out (thus removing the negative bias against the old items). This suggests that the preview benefit is influenced by the intention of participants to prioritize the new stimuli and to actively ignore the old items. The evidence for probe-detection being inhibited at the old locations is not consistent with either onset capture or temporal segmentation alone being critical. If those factors were singularly responsible then the cost to probes would not increase as a function of the goal-directed intention to ignore irrelevant items. Furthermore, the greater cost to probes falling at old locations relative to empty background locations cannot be explained by a temporal segmentation account, which would predict no differences between empty locations and those occupied by old items. On the other hand, evidence of worse probe detection on old items than on background locations is consistent with the old stimuli being inhibited.

Alongside the studies on probe detection, support for inhibitory coding comes from the effects of color similarity between the first and second displays. When the new target carries the color of the old distractors, target selection is disrupted relative to when the target has a different color (Braithwaite & Humphreys, 2003; Braithwaite, Humphreys, & Hodsoll, 2003, 2004; Braithwaite et al., 2005; Olivers & Humphreys, 2003). This is the negative color carry-over effect, reflecting a form of sustained attentional blindness to new items with properties of items being ignored (see Braithwaite et al., 2003). The effect suggests that, in addition any process of location-based inhibition (Watson & Humphreys, 1997), there is also inhibition of the color of the old items (i.e., featural attributes). If this inhibition spreads and is applied to the new items carrying the same color, then these items will become difficult to detect. Note that, if either capture of attention by new onsets or temporal segmentation alone were critical, then all the new items should be selected equally and irrespective of their color.

One counter explanation for the inhibitory carry-over effect might be that, rather than inhibition spreading to the same-colored new items making them more difficult to locate, attention is automatically captured by the differently colored new items. It has been typical in prior investigations of the carry-over effect to have the second search display contain items of two colors; one set carrying the color of the preview (i.e., red) and the other set carrying a new unique color (i.e., green). Given this, then the cost for new targets carrying the color of the preview items could reflect attention being drawn to the new distinctive color in the display. This too would predict a cost for new items carrying the color of old distractors (e.g., red, in this case)—but this would have nothing to do with inhibition.

There are, however, a number of findings against this proposal. For example, there is a large advantage to be gained by providing observers with valid foreknowledge of the target's color—even when that color is unique in the new search display (Braithwaite & Humphreys,