Vision Research 87 (2013) 1–9

Contents lists available at SciVerse ScienceDirect

Vision Research

journal homepage: www.elsevier.com/locate/visres

The preview benefit for familiar and unfamiliar faces

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ARTICLE INFO

Article history:
Received 12 July 2012
Received in revised form 30 April 2013
Available online 18 May 2013

Keywords:
Visual search
Preview benefit
Face perception

ABSTRACT

Previewing distracters improves visual search – the preview benefit (Watson and Humphreys, 1997). Recent fMRI evidence suggests that the preview benefit rests on active inhibition in brain regions concerned with spatial memory, as well as in content selective areas (Allen et al., 2008). Using familiar and unfamiliar faces in a preview search task we show that search performance is much better with familiar than with unfamiliar faces. With both types of stimuli we obtained preview benefits of at least 10%, measured in terms of the advantage in reaction time relative to the no preview condition. The preview benefit increased up to 30% when distracter faces and their locations were previewed, compared to a benefit in the range of 10–25% for previewing just distracter locations. Analysis in terms of search time per item showed that familiar faces were processed with more than double the efficiency of the unfamiliar faces. Further, efficiency was enhanced relative to the no preview condition only when distracter locations and content were previewed, but not when participants previewed just distracter locations. These findings corroborate that the preview benefit involves both spatial and content-specific mechanisms, and indicate contribution of existing long-term memory representations independent of spatial memory.

1. Introduction

Efficient goal directed selection is most important for orientation in visual scenes. Watson and Humphreys (1997) found evidence that active ignoring applied to locations of known objects enhances the efficiency of selecting new ones. They reported that searching for feature conjunctions (e.g. finding a blue H among green Hs and blue As), which is an attention demanding task, improves remarkably when halve of the distracters are shown prior to the search display ("preview benefit"). Previewing distracters improves visual search only when they are presented for at least 400 ms before the search display, indicating that the underlying mechanism is not a rapid cueing mechanism redirecting spatial attention, but a mechanism that involves active distracter stimulus processing (Watson and Humphreys, 1997). Since the strength of the preview benefit is attenuated by parallel attention demanding tasks, the authors proposed that top-down attentional inhibition is applied to the previewed distracter locations.

The claim that the preview benefit rests on a local inhibition mechanism is corroborated by evidence showing that luminance changes are harder to detect at previewed distracter locations than at non-occupied, neutral positions (Humphreys et al., 2004). Further, previewed distracters appear to have reduced contrast (Allen and Humphreys, 2007a, 2007b). These findings indicate that sensitivity is reduced at the previewed locations. fMRI studies on the preview benefit consistently show that there is enhanced activity linked to the preview displays (Allen & Humphreys, 2006; Allen, Humphreys, & Matthews, 2008; Olivers et al., 2005; Payne & Allen, 2011). A recent fMRI study was able to dissociate two stages of processing previewed distracters (Payne & Allen, 2011). At the first stage there is enhanced activity in precuneus and primary visual cortex while previewing distracter texture elements. Afterwards, during search, precuneus activity is maintained while V1 activity is reduced when elements are successfully excluded from search. These findings let authors propose that there is active ignoring in early visual cortex, guided by extrastriate top-down control. This comprises active distracter encoding at the initial stage at preview, and active inhibition of these items later at search.

The preview benefit so conceived implies that there is more than just inhibition of locations since there is active distracter stimulus processing, including distracter stimulus encoding. This suggests inhibition not only of distracter locations, but also of content. This is corroborated by observations demonstrating that the preview benefit interferes with visual working memory, and is accompanied by activation in brain areas involved in spatial memory, and in face-specific areas when face stimuli are used as distracters (Allen, Humphreys, & Matthews, 2008).

However, evidence for content-specificity of the preview benefit is generally rare, since most studies focused on the spatial mechanism and used low level visual features in the search task. In this context it is worth noting that the classical preview search task confounds the effects of the 'what' and the 'where': showing

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0042-6989/$ - see front matter © 2013 Published by Elsevier Ltd.
http://dx.doi.org/10.1016/j.visres.2013.05.005

actual distracters at their locations of the search display during preview informs the viewer about distracter locations, but also about the nature of the distracter stimuli. It is therefore likely that the visual system uses both kinds of information to enhance search performance. In order to learn about the specific contributions of content it is worth to disentangle both kinds of information at preview by comparing the effects of previewing just locations to the effects of previewing locations and content. If it could be shown that previewing locations and content enhances the preview benefit compared to previewing just locations, this would indicate that both kinds of distracter information, the 'what' and the 'where', bolster visual search.

Second, using face stimuli is particularly apt to gauge the influence of stimulus content, independent of stimulus location. Faces are known to be processed by domain specific brain modules dedicated to this particular object category (Grill-Spector et al., 2004; Kanwisher et al., 1997; Kanwisher and Yovel, 2006). Different from the distal sites processing low level visual features, these extrastriate brain areas operate independent of the retinotopic stimulus mapping (Kanwisher, McDermott, & Chun, 1997). Therefore, inhibition of content cannot be achieved by applying suppression to detector families which are tuned to visual features at specific locations in V1 or V2. Evidence for enhanced visual search performance with face stimuli, brought about by previewing locations and content, would indicate that inhibition of previewed items concerns distinct sensory routes for locations and content.

A second reason why faces are particularly suited to demonstrate the influence of content in preview search stems from the fact that faces are processed differentially with respect to their degree of familiarity (Ellis et al., 1979; Veres-Injac and Persike, 2009). The familiarity advantage indicates that existing long term memory representations modulate perceptual performance. Familiarity has been shown to enhance visual change detection (Buttle and Raymond, 2003), and also visual search (Tong and Nakayama, 1999), indicating that existing long term memory entries lower the amount of information that has to be encoded per item.

If the present study could show that face familiarity affects not only visual search, but also strengthens the preview benefit, then this would be additional evidence that, besides spatial memory, content-specific long-term memory enters in active ignoring of distracters. To show the beneficial effect of previewing locations and content, compared to just previewing locations, and to show that the preview benefit is enhanced by face familiarity are thus the major aims of this study. Both findings, taken together, can serve as strong evidence that the preview benefit is much more than just spatial.

2. Methods

2.1. Experimental outline

The study was designed as a classical search task within the framework of the distracter preview paradigm. Search array outline and trial sequences closely resembled those used by Allen and Humphreys (2007a, 2007b). A circular stimulus arrangement was used as a search array, which contained a *deviant* target stimulus (a face stimulus that differed from the other stimuli in the array, which were all identical), or not. The task of the participant was to indicate whether a deviant was present, or not. Prior to the search array a preview display was shown, cueing specific properties of the stimuli in the search display. Three preview conditions were used (see Fig. 1 for an illustration). In the *no preview* condition (No) a fixation screen appeared, followed by mark-

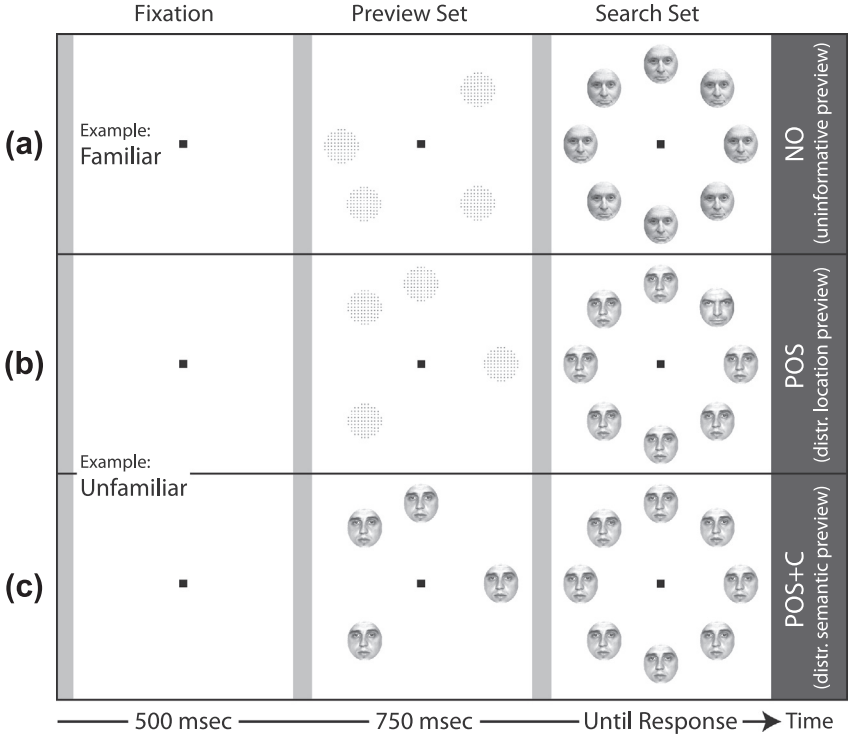

Fig. 1. Trial sequences in the three preview conditions, shown exemplarily for the smaller set size of eight elements. (a) No preview (NO): after fixation a selection of four stimulus locations on the circular search array is marked by dotted gray plaids for 750 ms. Afterwards the circular search arrangement is shown until response. (b) Distracter location preview (POS): Same as (a), but the marked positions indicate distracter locations where a target, if shown, never appears. (c) Distracter face preview (POS + C): same as (b), but instead of markers the distracter face of the search set is previewed at four positions. Afterwards the remainder four faces add, containing a target, or not. The upper panel (a) shows a trial example with familiar faces (Michael Douglas) in the target-absent variant. The lower two panels (b and c) show trial examples with faces which were unknown to the participants (unfamiliar faces). In (b) a target is present, (c) is an example of a target-absent trial.