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Rapid top-down control over template-guided attention shifts to multiple objects

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ABSTRACT

Previous research has shown that when observers search for targets defined by a particular colour, attention can be directed rapidly and independently to two target objects that appear in close temporal proximity. We investigated how such rapid attention shifts are modulated by task instructions to selectively attend versus ignore one of these objects. Two search displays that both contained a colour-defined target and a distractor in a different colour were presented in rapid succession, with a stimulus onset asynchrony (SOA) of 100 ms. In different blocks, participants were instructed to attend and respond to target-colour objects in the first display and to ignore these objects in the second display, or vice versa. N2pc components were measured to track the allocation of spatial attention to target-colour objects in these two displays. When participants responded to the second display, irrelevant target-colour objects in the first display still triggered N2pc components, demonstrating task-set contingent attentional capture while a feature-specific target template is active. Critically, when participants responded to the first display instead, no N2pc was elicited by target-colour items in the second display, indicating that they no longer rapidly captured attention. However, these items still elicited a longer-latency contralateral negativity (SPCN component), suggesting that attention was oriented towards template-matching objects in working memory. This dissociation between N2pc and SPCN components shows that rapid attentional capture and subsequent attentional selection processes within working memory can be independent. We suggest that early attentional orienting mechanisms can be inhibited when task-set matching objects are no longer task-relevant, and that this type of inhibitory control is a rapid but transient process.

1. Introduction

In visual search tasks, observers try to find a specific target object that appears among task-irrelevant distractor objects. Although the location of target objects is not known, search can be guided by knowledge about the features of these objects. Representations of the visual properties of looked-for objects are assumed to be activated prior to the start of a particular search process, and these representations have been described as attentional task set or attentional templates (Duncan and Humphreys, 1989; Folk et al., 1992; Wolfe and Horowitz, 2004; Olivers et al., 2011). Once a particular attentional control set is activated, stimuli with features that match this set will attract attention, while stimuli with non-matching features do not. As a result, attention can be deployed preferentially to candidate target objects that possess one or more template-matching features (e.g., Wolfe, 2007; see also Eimer (2014, 2015a), for a more detailed discussion of the cognitive and neural basis of template-guided visual search).

Although attentional templates are critical for the guidance of attention during visual search, activating a particular feature-specific target template can also result in attentional capture by task-irrelevant distractor objects, provided that these objects possess a template-matching feature. This has been shown in spatial cueing experiments that demonstrated task-set contingent involuntary attentional capture effects (Folk et al., 1992; Folk et al., 1994; Folk and Remington, 1998). When search arrays are preceded by spatially uninformative and task-irrelevant cue arrays that have to be ignored, cue stimuli that match current target attributes trigger spatial cueing effects (i.e., faster RTs to targets at cued versus uncued locations), indicating that these cues are able to attract attention in a task-set contingent fashion. This was also confirmed by event-related potential (ERP) studies that have measured the N2pc component as an electrophysiological marker of spatially selective attentional processing. The N2pc is an enhanced negativity that is elicited at posterior electrodes

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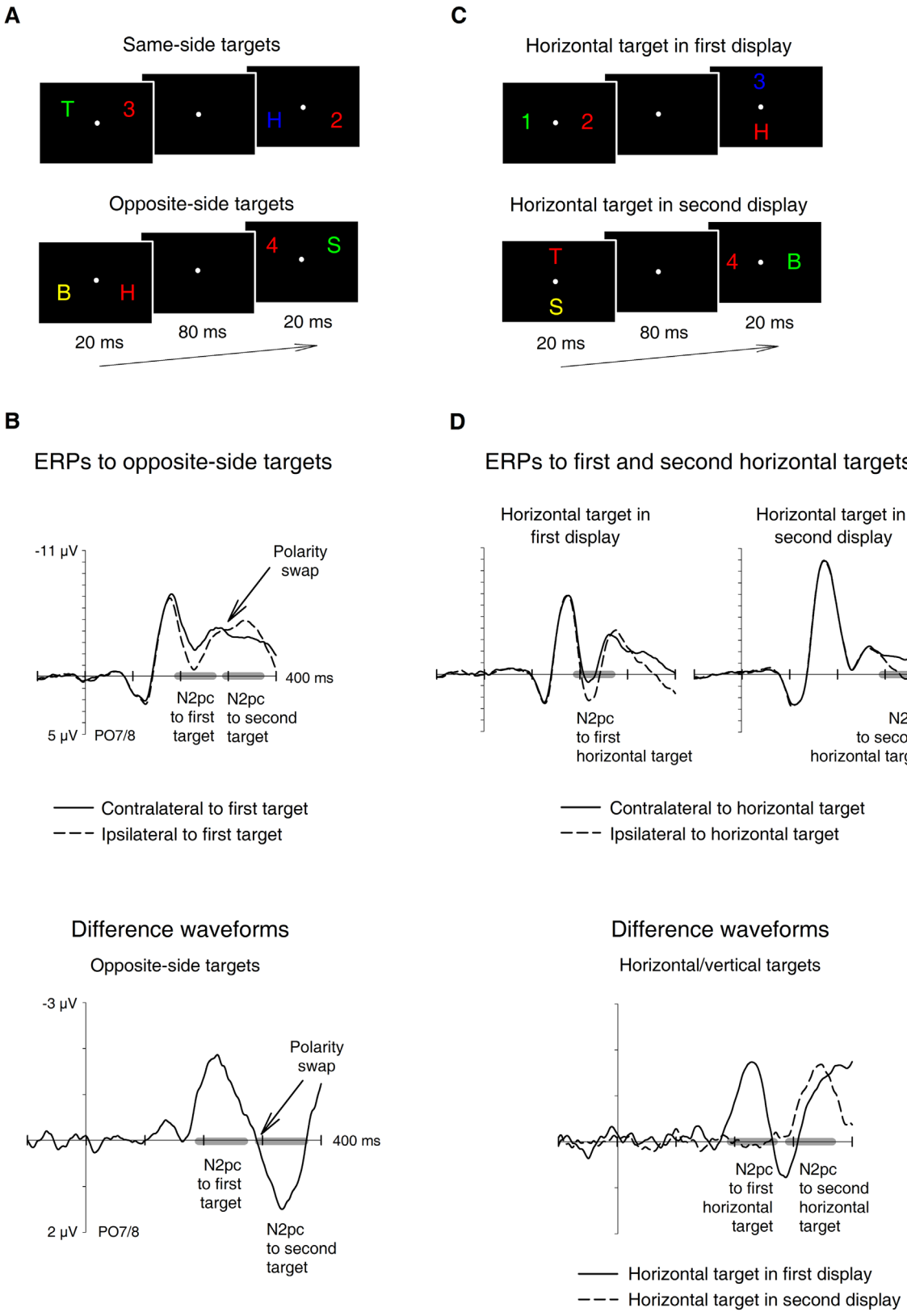

Fig. 1. Top panels: Schematic illustrations of the time course of stimulus events in the bilateral (A) and horizontal/vertical (C) presentation conditions employed by Eimer and Grubert (2014) and in the current experiments. Two consecutive displays, each containing a target-colour and a distractor-colour item, were presented in rapid succession. In the bilateral condition (A), target-distractor pairs were shown on the horizontal meridian, and the two targets appeared on the same or on different display sides. In the horizontal/vertical condition (C), one target-distractor pair was presented on the horizontal and the other on the vertical meridian, and the horizontal target could appear in the first or second display. Bottom panels: N2pc results found by Eimer and Grubert (2014), all time-locked to the onset of the first display. ERP waveforms elicited at lateral occipitotemporal electrode pairs PO7 and PO8 ipsilateral and contralateral to target objects are shown together with the corresponding contralateral-ipsilateral difference waveforms. For opposite-side targets in the bilateral condition (B), ERPs swapped polarity. In the horizontal/vertical condition (D), horizontal targets in the first and second display both elicited N2pc components. See text for details. The grey bars on the *x*-axes represent the respective N2pc time widows.