Electrophysiological Indices of Target and Distractor Processing in Visual Search

Clayton Hickey[1,2], Vincent Di Lollo[2], and John J. McDonald[2]

Abstract

■ Attentional selection of a target presented among distractors can be indexed with an event-related potential (ERP) component known as the N2pc. Theoretical interpretation of the N2pc has suggested that it reflects a f

after the onset of a search array and are more pronounced for difficult discrimination tasks than for simple detection tasks and when distractors are near the target rather than far away (Luck, Girelli, et al., 1997).

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button. Four matches were made. In two instances, the initial luminance of the gray patch was ∼2.5 cd/m^2 greater than that of the red, and participants were instructed to decrease the luminance of the gray patch until its brightness matched that of the red patch. In the remaining instances, the initial luminance of the gray

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re-referenced to the algebraic average of the signals recorded at the left and right mastoids. The EEG was amplified with we

vertical meridian. A clear divergence of the ipsilateral and contralateral waveforms is in evidence in the latency of the P1 (∼120–140 msec

Experiment 3 also included displays in which both the target and the distractor were presented on the vertical meridian. The ERP elicited by this nonlateralized display was employed as a baseline to which the lateralized-distractor ERPs could be compared. If the P_D reflects an ipsilateral negativity, the waveform elicited ipsilateral to an ignored stimulus should be more negative than the waveform elicited by the nonlateralized display. In contrast, if the P_D reflects a contralateral positivity, the waveform elicited contralateral to the ignored stimulus should be more positive than

Discussion

Experiment 3 shows that the waveform elicited contralateral to an ignored distractor is, in fact, more positive than that elicited by a nonlateralized display, and thus, demonstrates that the P_D is a positive ERP component elicited contralateral to the location of an ignored distractor. These results are consistent with the idea that the P_D reflects a suppressive mechanism that acts on the cortical representation of distractor stimuli.

The experiments reported to this point have been aimed at isolating neural activity tied to distractor processing. What was not addressed was the issue of the corresponding neural activity related to target processing. The electrophysiological activity related to target processing has been the object of earlier investigations that led to the identification of the N2pc (e.g., Eimer, 1996; Luck & Hillyard, 1994a). Those studies employed stimuli displays that were designed to balance sensory energy across the visual hemifields, allowing for lateralized ERP effects to be unambiguously attributed to attention rather than sensory activity. This was done by presenting a salient nontarget item in the hemifield contralateral to the target, such that each visual hemifield contained an equal number of salient and nonsalient visual stimuli. Results from the present experiments, however, suggest a potential drawback to this strategy. Because the N2pc is defined as the difference between signals recorded over the ipsilateral and contralateral h n

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Condition order: $F(1, 10) = 1.76$, $p = .214$, Condition × Condition order: $F < 1$].

Electrophysiological Results

Figures 4 and 5 present the ERPs

obtained in the present experiment arose from a display that was not balanced across the visual hemifields. This means that the negativity might reflect a combination of sensory

Figure 6A presents the contralateral-minus-ipsilateral difference waves based on the ERPs presented in Figures 4C and 5C. These difference waves show that the N_T peaked before the P_D (250 msec vs. 289 msec, respectively). This latency difference was statistically significant in a RANOVA with a within-participant factor for condition (attend-line vs. attend-square) and a between-participant factor for condition order (attend-line first vs. attend-square first) [Condition: $F(1, 10) = 5.110$, $p = .045$; Condition order: $F < 1$; Condition $\times$ Condition Order: $F(1, 10)$

(1,

evenly across the visual field would cancel out across the cortical hemispheres.

Hypothetical summation of the P_D and N_T components is illustrated in Figure 6. Figure 6A contains two difference waves labeled P_D and N_T. The P_D waveform was calculated by subtracting the contralateral from the ipsilateral waveform in Figure 4C. Similarly, the N_T waveform was calculated by subtracting the contralateral from the ipsilateral waveform in Figure 5C. The outcome of Experiment 4 suggests that the N_T represents attentional modulation of neural activity related to target processing—whether excitatory or suppressive. By the same token, the P_D represents attentional modulation of neural activity related to distractor processing—presumably suppressive. Figure 6B illustrates the absolute algebraic summation of the P_D and N_T waveforms. The waveform in Figure 6B is thus a hypothetical representation of 6009.9626266.054500358.3785207.8364Tm(e)Tj9.96

neural activity associated with enhanced target processing, as reported in the animal liter object features and involved in the processing of target stimuli.

We would like to note that the present results are consistent with what might be expected on the basis of activity at the cellular level. A positive-going effect contralateral to the distractor (P_D) and a negative-going effect contralateral to the target (N_T) are precisely what would be expected given excitatory postsynaptic potentials (PSPs) in processes, one tied to the spatial location of distractor stimuli (P_D), the other to the spatial location of target stimuli (N_T).

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Reprint requests should be sent to Clayton Hickey, Department of Cognitive Psychology, Vrije Universiteit Amsterdam, van der Boechorststraat 1, 1081 BT, Amsterdam, The Netherlands, or via e-mail: c.hickey@psy.vu.nl, or to John J. McDonald, Department of Psychology, Simon Fraser University, 8888 University Drive, Burnaby, BC, V5A 1S6, Canada, or via e-mail: jmcd@sfu.ca.

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