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Interactions between proximity and similarity grouping: an event-related brain potential study in humans

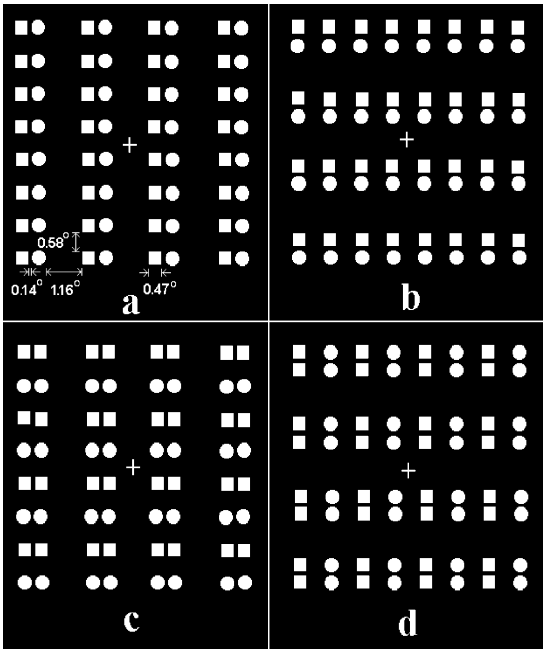

Fig. 1. Stimulus arrays used in the present study. (a and b) Congruent stimuli; (c and d) incongruent stimuli.

by either proximity or similarity in separate blocks of trials while high density ERPs were recorded to the identification of orientations of perceptual groups. The difference between ERPs in the congruent and incongruent conditions revealed the time course and brain areas that mediate interactions between proximity- and similarity-grouping operations.

Fourteen adults (12 men, 2 women, aged between 18 and 35 years) were employed. All participants were right-handed, had normal or corrected-to-normal vision, and gave informed consent. The stimuli consisted of a square lattice of white elements (either filled circles or squares) in an 8 × 8 array on a black background (Fig. 1). The circles and squares were arranged into rows or columns by adjusting the distances between two adjacent rows or columns of local elements so that the distances between two near or remote rows (or columns) were 0.14° and 1.1°, respectively. The local elements were also grouped into columns or rows by shape similarity cues. The proximity and similarity cues were congruent for half of the stimuli whereas incongruent for the others. Each local shape and stimulus array subtended an angle of 0.47° × 0.47° and of 7.8° × 7.8° at a viewing distance of 57 cm, respectively. The background and a local shape had a luminance of 0.02 and 3.46 cd/m^2, respectively. The stimulus duration was 200 ms and interstimulus intervals varied between 800 and 1200 ms randomly. A white fixation cross of 0.3° × 0.2° was continuously visible at the center of the screen.

Subjects identified orientations of perceptual groups formed by proximity or similarity in separate blocks

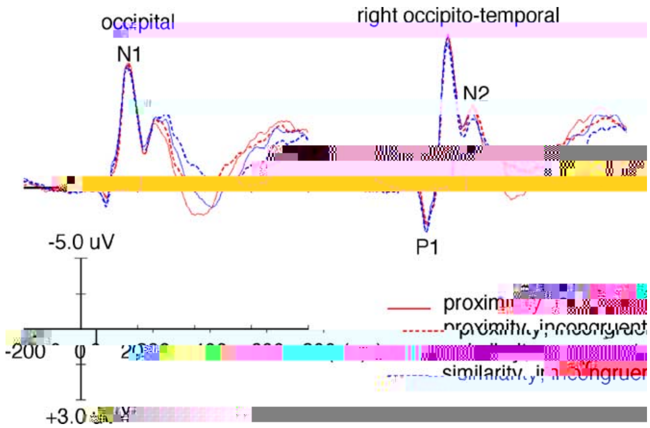

Fig. 2. ERPs in different stimulus conditions at electrodes over the posterior sites.

Fig. 2 shows grand averaged ERPs in different conditions. To illustrate the difference between proximity and similarity grouping, difference waves were obtained by subtracting ERPs in the similarity-grouping condition from ERPs in the proximity-grouping condition. The difference waves at electrodes over the posterior occipital areas were first characterized with a positive wave between 100 and 140 ms (Pd120) (Fig. 3), which was confirmed by ANOVAs showing a significant main effect of Grouping between 120 and 140 ms ($F(1, 13) = 5.17$, $P < 0.04$). The Pd120 was slightly larger over the left than the right hemisphere ($F(1, 13) = 10.17$, $P < 0.007$) but was not different between congruent and incongruent conditions ($F < 1$). Proximity grouping also elicited larger P3 amplitudes between 300 and 440 ms at electrodes over parietal, temporal, and occipital areas ($F(1, 13) = 8.00$–13.65, $P < 0.02$). Grouping modulation of the early phase of the P3 (300–340 ms) was stronger over the right then left parietal cortex ($F(1, 13) = 9.65$, $P < 0.008$). The P3 peaked earlier in the proximity-

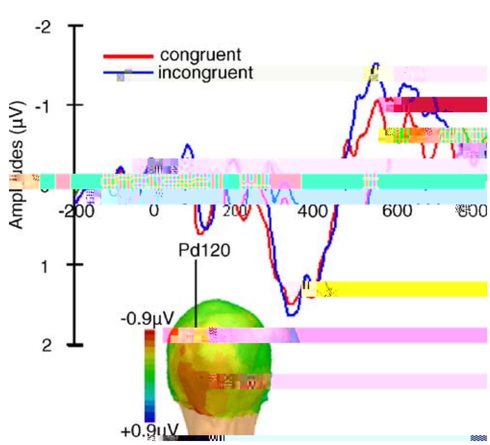

Fig. 3. The difference waves indexing eav1c/F5 1 Td84.ms effect of Tf 0.9515ti8lie2i6poral,9515ti8l5(of Tti8l5(of Tbout7(ms)-260.82)-428(electrode6]TJ /Frode6]TJa

the stimulus arrays were identical in the proximity and sim-