High-resolution ERPs in recognizing familiar faces

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1 Introduction

A number of studies have shown that such specific visual objects as faces may elicit brain responses which differ from those elicited by other kinds of visual objects (1-4). Furthermore, the brain regions involved in distinct aspects of face recognition may be topographically separated (for review see 5). It is also known that pairs of matching/non-matching items elicit differential responses. Some specific ERP components, like N350 or N400, were reported to be larger for non-matching words or objects (6,7).

The purpose of the study was to investigate the characteristics of electrical brain activity related to the judgement on familiar face identity in two consecutive stimuli, and compare these ERP components to those in pattern matching task recorded simultaneously during the same experiment.

2 Methods

2.1 Subjects

Nineteen healthy volunteers aged 29-59 years (mean age 43 years, six males, 13 females) participated in this study. All subjects were right-handed (self-reported) and had normal or corrected-to-normal binocular visual acuity. The subjects had no history of neurological disorders, were non-medicated and did not receive payment. The local ethical committee had approved the experiment and all subjects provided an informed consent.

2.2 Stimuli

Stimuli consisted of face pictures and dot patterns which were superimposed. The face stimuli were 22 black and white photographs of 11 persons familiar to the subjects. Each person was represented with two portraits which differed in some features, like head position, hair style, etc. Facial expression was neutral. The pattern stimuli were made of 15 white dots resulting in different abstract figures. They were superimposed on the faces in a random order.

Two different cue stimuli were also used, they were patterns of white dots on a grey background and easy to distinguish from each other. Each visual stimulus was displayed on computer screen for 250 ms. Cues and stimuli samples are presented in Figure 1.

2.3 Procedure

The subjects were seated in an armchair 1.7 m away from the display screen. Experiments consisted of 4 series, 50 trials each, with short resting periods between series. The trial began with one of the two cues (100 trials for each) followed by the pair of picture stimuli. The stimuli were associated in pairs in a such way that in half of the trials the targets were to compare same or different with equal probability, both for faces and patterns. Four types of pairs were used: same/different face and same/different pattern. Since all of the stimuli consisted of both faces and patterns, the choice of the item to be compared depended only on the cue. Before the experiment, subjects received verbal instruction explaining the meaning of the cues and the responses required. According to the meaning of the cue, the experiment consisted of two tasks: waiting and comparison of face stimuli (Face task); and waiting and comparison of pattern stimuli (Pattern task), each of them consisted of Same and Different item conditions. Thus, there were four experimental conditions.

After the second stimulus the subjects had to judge whether they had seen the same person or the same pattern as in the first picture of the current pair. Subjects were instructed to press the keys on the response pad. They were asked to respond quickly, however, accuracy was preferred. The allowed response period was 1000 ms after the second picture disappeared. The results for a period after the onset of the second picture of the pair are reported here.

2.4 Data acquisition and analysis

Continuous EEG was recorded with 128 electrode net utilizing high input impedance amplifiers (Electrical Geodesics, Inc.). During recording, Cz was the reference site. The data were sampled each 4 ms (250 Hz A/D), with a low pass filter of 100 Hz, and a high pass filter of 0.01 Hz.

EEG was segmented and averaged off-line. Epochs containing blinks and otherartefacts were rejected automatically, using 150 μV threshold, and from the accepted trials only those accompanied by correct responses were used. The averaged ERPs were digitally filtered at 30 Hz and baseline-corrected using 100 ms before the stimulus onset. The ERP of one condition for each individual contained from 60 to 90 single sweeps. Grand averaged waveforms were also created for all four conditions.

The non-parametric statistical procedure (Wilcoxon paired test) was used to compare ERPs obtained in different conditions.The analysis was performed for the time period of 600 ms beginning from the onset of the second picture in the pair.

3 Results

Grand averaged ERPs (128-channels, 600 ms from the second picture onset) for Same Face and Different Face conditions are plotted superimposed in Figures 2. The largest waveform components appeared around 120-150 ms, 200-220 ms, 280 ms.

Two-tailed 0.05 probability was used as the significance criterion for differences between ERPs of Different vs Same items during 600 ms. The motor response was similar in both cases, and presumably did not influence these findings.

The waveforms for matching/non-matching pairs of faces had short-lasting significant dissimilarities at 30 ms, 150 ms and 210-250 ms, however, large and widespread differences were seen in 300-520 ms. They were found mostly in anterior brain regions especially in the prefrontal areas, and more in the left hemisphere. For the posterior regions significant differences were found only in the left hemisphere for short periods.

The waveforms for matching/non-matching pairs of patterns had in some channels significant dissimilarities at 50-80 ms, 160-200 ms, 220-270 ms in the right hemisphere, and at 320-400 ms in some frontal sites.

4 Discussion

The non-matching face in the consecutive pair of stimuli elicits different electrical brain responses from those of the matching pairs. Components with peak latencies 350-400 ms have been described by other authors for non-matching items (faces or words). The brain responses on matching/non-matching faces showed more differences than those in pattern matching task: the waveform distinctions were larger and lasted longer, and had different scalp distribution. Thus, it cannot be just the same/different object effect, which explains the differences observed. It seems that the decision on the identity of a familiar person activates additional mechanisms involving widespread networks of bilateral frontal regions and left posterior areas.

References

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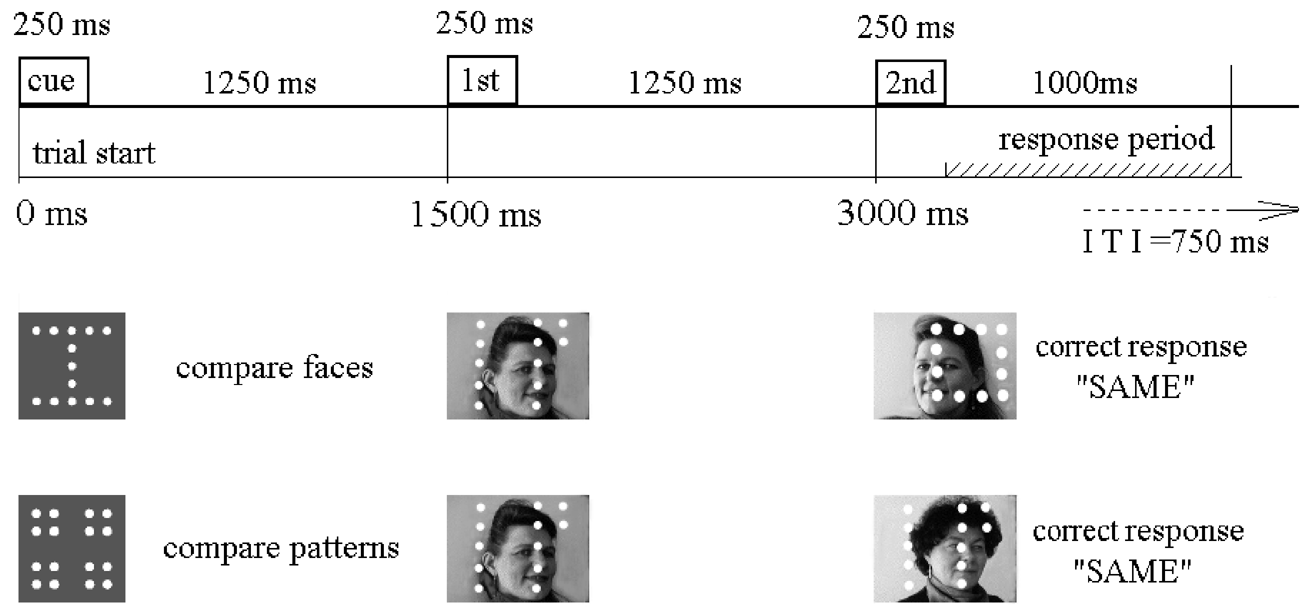

Figure 1. *The progression of a single trial is described as a timeline from 0 to 4000 ms. Both cues and samples of stimuli are presented with the instruction for cues and correct response.*

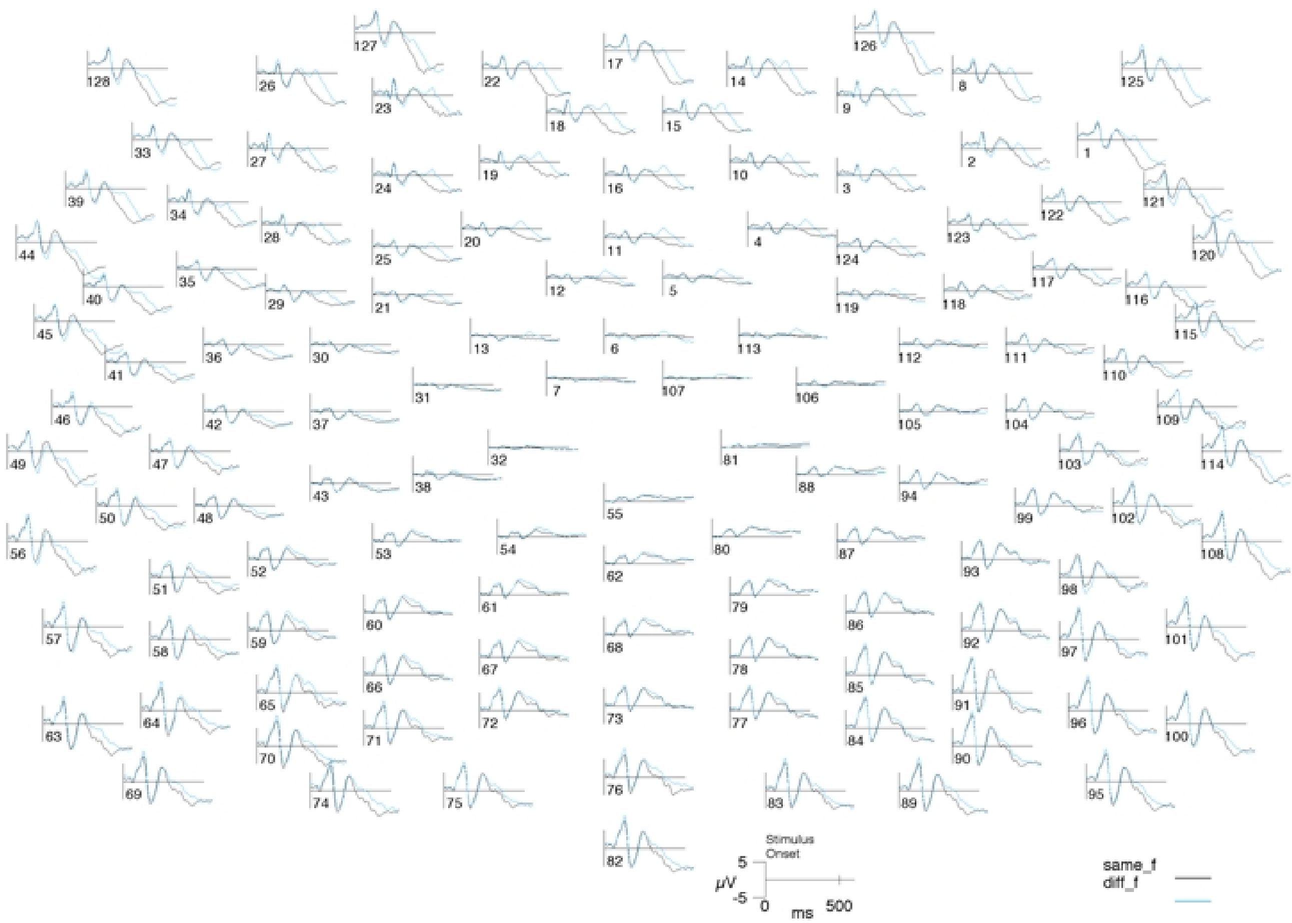

Figure 2. *128 channel grand averaged ERPs (19 subjects) plotted for the time period of 600 ms from the stimulus onset. The black line is for Same Face condition and the cyan one is for Different Face condition.*