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Face-specific event-related potential in humans is independent from facial expression

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Abstract

A face-specific brain EEG potential at approximately 160 ms after stimulus presentation has recently been described by various research groups. Most of these studies analysed this face-specific brain potential using smiling faces as stimuli. In electrophysiological studies, however, differences in amplitude due to the emotional valence of the stimuli were described as early as 100 ms after stimulus presentation. In order to investigate the effect of facial expressions with different emotional content on face-specific brain EEG potentials, event-related potentials (ERPs) to faces with sad, happy and neutral expressions were compared to ERPs elicited with buildings in 16 healthy subjects. A face-specific potential at vertex approximately 160 ms after stimulus presentation has been verified in the present study. No significant differences in latency or amplitude of this component were found for different facial expressions.
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1. Introduction

There is strong evidence from electrophysiological studies for a face-specific event-related potential, which indicates that faces are processed in different brain regions compared to control stimuli. This face-specific brain activity has been reported in the range between 120 (Linkenkaer Hansen et al., 1998) and 175 ms (Boetzel and Grusser, 1989) after the presentation of a face. However, differences in amplitude of brain electrical activity associated with the emotional valence of the stimuli were found as early as 100 ms after stimulus presentation (Pizzagalli et al., 1999).

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Furthermore, the processing of different facial expressions is supposed to start at approximately 180 ms post-stimulus (Streit et al., 1999). Most studies analysing the face-specific brain potential do not report the expression or emotional content of their face stimuli (Boetzel and Grusser, 1989; Eimer, 1998; Eimer and McCarthy, 1999; Linkenkaer Hansen et al., 1998) or they used smiling faces only (Boetzel et al., 1995; Debruille et al., 1998). Therefore, an influence of the emotional valence of the face stimuli on the face-specific brain potential cannot be ruled out. Only one study investigated the influence of different facial expressions and blurred faces on the event-related potentials (ERPs) and did not find any significant differences between conditions (Streit et al., 2000). However, this study failed to include non-facial control stimuli in order to identify the face-specific brain potential. The present study was therefore designed to clarify the issue as to whether the face-specific brain potential is modified by the emotional valence of the face stimuli presented.

2. Methods and materials

A total of 16 right-handed healthy volunteers took part in the study (eight women and eight men, age between 19 and 42 years, mean = 24.1; S.D. = 5.8). Stimulus material was taken from the set of pictures of facial affect of Ekman and Friesen (1976) and consisted of black and white slides of the faces of two female and male actors, each presenting a happy, a sad and a neutral face. In a pilot study, these 12 pictures of facial affect were correctly labelled in 91% of 36 healthy volunteers. Black and white photographs of four different buildings in three slightly different variations each were used as control stimuli. Buildings appear to be suitable control stimuli, as they are complex objects that, in contrast to e.g. front sides of cars, do not have similarities with faces. Each picture was of approximately the same size and brightness and each was repeated eight times, resulting in a total of 192 stimuli. Pictures were presented in a pseudo-randomised order in the centre of a computer monitor placed 100 cm from the subjects' eyes, with a visual horizontal angle of 4.6° and a vertical angle of 6.3°. The presentation time for each stimulus was 500 ms with a constant inter-stimulus interval of 2000 ms. The subjects were asked to silently classify every slide as a face or as a building. For control of attention, the subjects were asked after 6–12 stimuli to report the last classification.

The EEG was recorded at 21 scalp sites positioned according to the international 10–20 system, using gold-cup electrodes (Nicolet, 3-mm diameter). Linked mastoids with compensating resistors of 10 kΩ were used as reference electrodes. Three additional electrodes were placed at the outer canthi of both eyes and below the right eye to monitor eye blinks. The bandpass was set to 0.1–70 Hz and the EEG was sampled continuously at a rate of 256 Hz. Impedance values were kept at 5 kΩ or below. For recording, a 32-channel DC amplifier (Brain-Star System) and acquisition software (NEUROSCAN) were used. Trials affected by artifacts were automatically identified, marked by the software and rejected from further analyses, based on an artifact criterion of >98 μV of voltage in any one of the 24 channels at any point within the first 500 ms after stimulus presentation. The artifact-free trials were separately averaged off-line for each subject and for the facial affects happiness, sadness and neutral, and for buildings.

As the face-specific brain potential is most prominent at Cz, we just analysed the values derived from this electrode position. In order to determine time segments for analysis in a data-driven manner, the overall grand mean of the evoked potentials was calculated for the electrode location Cz. This curve revealed two minima and two maxima within the first 500 ms. The peaks preceding and following each of these four peaks were accepted as borders of the respective segments, resulting in time windows of 66.4–168.0 ms for the first negative component N1, 171.9–351.6 ms for the second negative component N2, 125.0–238.3 ms for the first positive (P2) and 242.2–500.0 ms for the second positive (P3) component. The peak amplitude and latency values for ERP elicited by faces and buildings were analysed using *t*-tests for dependent measures. To analyse the effect of different facial expressions, the peak amplitude measurements were entered into separate repeated-measures ANOVAs with the

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