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Discrimination of emotional facial expressions in a visual oddball task: an ERP study

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Abstract

Several ERP studies have shown an orienting complex, the N2/P3a, associated to the detection of stimulus novelty. Its role consists in preparing the organism to process and react to biologically prepotent stimuli. Whether this N2/P3a: (1) could be obtained with complex visual stimuli, such as with emotional facial expressions; and (2) could take part in a complex discrimination process has yet to be determined. To investigate this issue, event-related potentials were recorded in response to repetitions of a particular facial expression (e.g. sadness) and in response to two different deviant (rare) stimuli, one depicting the same emotion as the frequent stimulus, while the other depicted a different facial expression (e.g. fear). As expected, deviant stimuli evoked an N2/P3a complex of larger amplitude than frequent stimuli. But more interestingly, when the deviant stimulus depicted the same emotion as the frequent stimulus the N2/P3a was delayed compared to the response elicited by the different-emotion deviant. The N2/P3a was thus implicated in the detection of physical facial changes, with a higher sensitivity to changes related to a new different emotional content, perhaps leading to faster adaptive reactions.

Keywords: Event-related potential; Oddball; Facial expressions; Categorical perception; N2/P3a; Latency

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1. Introduction

Most event-related brain potential (ERP) studies have used an 'oddball paradigm', in which subjects have to detect, amongst a series of standard stimuli, an infrequent deviant one (Garcia-Larrea et al., 1992). The detection of stimulus change may play a role in turning attention to events of biological importance (Halgren and Marinkovic, 1995). This has been indexed by three main ERP components, in the auditory as well as in the visual modalities. First, when subjects are placed in inattentive conditions, deviant stimuli in a homogenous stimulus sequence elicit a specific negative deflection, called *mismatch negativity* (MMN) (Näätänen et al., 1978 for audition; Tales et al., 1999 for vision), which reflects an automatic (attention-independent) neural mechanism underlying the perception of stimulus change (Näätänen et al., 1993).[1] Second, when subjects are placed in attentive conditions, deviant stimuli evoke a series of field potentials, the *N2/P3a*, overlapping the MMN activity described above, and called by Halgren and Marinkovic (1995) the *orienting complex*, because it subserves attention. Indeed, the orienting complex is defined as the mobilization of cerebral and somatic resources in order to effectively cope with a biologically important event. Third, a *P3b* component, recorded maximally at parietal sites and functionally related to the conscious detection of change leading subjects to respond to deviant stimuli, has also been recorded (Bentin et al., 1999; Campanella et al., 2000).

In the present study, we employed a variation of the visual oddball paradigm[2] that did not manipulate attention. Our hypotheses were focused on the N2/P3a complex and the P3b component, given that the MMN is classically described in inattentive conditions. As suggested above, the N2/P3a complex could reflect the afferent (preparation-to-process) and efferent (preparation-to-respond) functions of the orienting complex (Halgren and Marinkovic, 1995), whereas the P3b component is possibly related to the conscious subjects' responses (Bentin et al., 1999). Therefore, it is plausible to think that: (1) similar N2/P3a and P3b components could be obtained in response to deviant complex visual stimuli, such as emotional facial expressions (due, for instance, to their high importance in social communication); and (2) these components could be modulated, in latency and/or in amplitude, by the categorical nature of frequent and deviant stimuli.

By using a morphing procedure, it is possible to generate continua of different morphed faces moving linearly from one facial expression (e.g. sadness) to another one (e.g. fear). Several studies have shown that two different morphed faces, perceived as sharing the same emotion (WITHIN-categorical differences), are harder to discriminate than two different morphed faces perceived as two different emotions (BETWEEN-categorical differences), *even if the physical distance inside*

[1] Note that if the auditory MMN is a well-established phenomenon, its visual analogue has only been demonstrated in a few studies (Tales et al., 1999).

[2] Classical oddball paradigms used one frequent and one deviant stimulus. For our purpose, one frequent and two deviant stimuli will be used in the present study.