Early Stages of Emotional Face Processing and Attention Performance: An ERP Study

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INTRODUCTION

An increasing body of evidence shows that rapidly occurring emotional processes strongly influence the allocation of attention (Seipp, 1991; Burt, Zembar & Niederehe, 1995). For example, emotional stimuli like human faces attract and hold attention more strongly than neutral stimuli within only a few hundred milliseconds (Eger et al., 2003) – particularly, faces that are related to threat or danger such as fearful faces.

In the present study, event-related brain potentials (ERPs) in response to emotional distracters were measured as markers for the recruitment of cognitive control (specifically the N200). However, two questions remain unclear: first, whether very early stages of emotional processing (within 400 ms) are differentially sensitive to distinct negative emotions such as fear and sadness (Derryberry & Rothbart, 1997); and second, how these early stages of emotional processing influence subsequent attention performance.

Predictions:

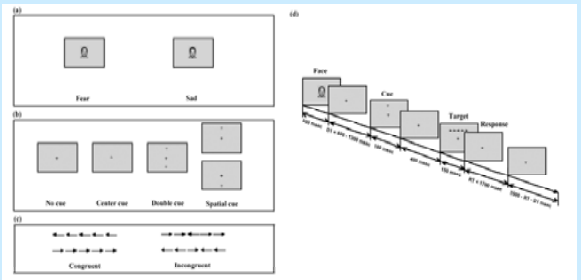
1) Viewing fearful versus sad faces might recruit greater processing resources, which then interferes with subsequent attention performance. In particular, if emotional information is distracting, prefrontal-mediated cognitive control resources may be recruited to inhibit attention; this may in turn have a negative impact on executive attention performance, which is also linked to activity of the prefrontal cortex.
2) Rapid recruitment of attentional resources is necessary if emotions are to serve the adaptive function of quickly alerting the individual to potential harm (Desimone, 1999). ERP responses would be related to decrements in subsequent attentional performance, but this may depend on attention system: alerting, orienting, and executive attention.

METHOD

Participants.
50 non-disordered adults, aged 17-51.

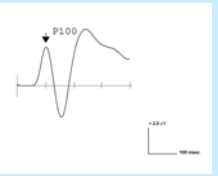
Emotional Faces
This study adapted 36 black-and-white photographs of fearful and sad faces (Tottenham et al., 2002).

The Attention Network Task (Fan et al., 2002).
This task is a combination of a cued reaction time (RT) and a flanker task that requires the subject to determine whether a central arrow points to the left or right. Each trial lasts 4000 ms plus the 500 ms inter-trial face.
Alerting (RT no cues – double cues), **Orienting** (RT center cues – spatial cues), **Executive attention** (RT incongruent – congruent flankers), and a higher score (conflict) indicates *decreased* executive attention efficiency.

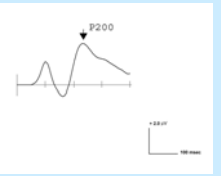


ERP recording and analysis

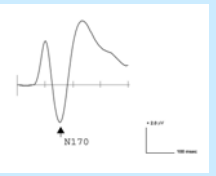
EEG activity was recorded via BioSemi 64 Ag/AgCl scalp electrodes, sampled at 512 Hz. Data were filtered with a low-cutoff frequency of .1 Hz and a high-cutoff frequency of 30 Hz. Stimulus-locked data was segmented into epochs from 200 ms before to 400 ms after stimulus onset (BESA 5.1; MEGIS Software GmbH, Munich, Germany). ERPs (peak to peak) were generated to faces:



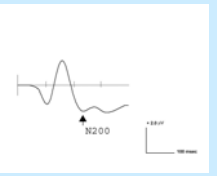
P100 (maximal between 80 - 120ms) – relatively automatic attention and inhibition



P200 (maximal between 210 – 250ms) – emotional and visual attention processing



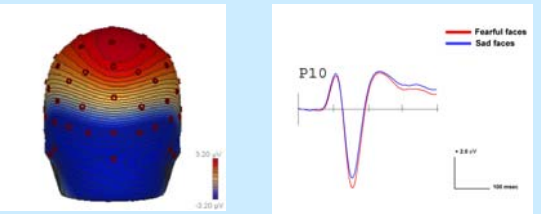
N170 (maximal between 130 – 170ms) – face-specific processing



N200 (maximal between 210 – 250 ms) – recruitment of cognitive control

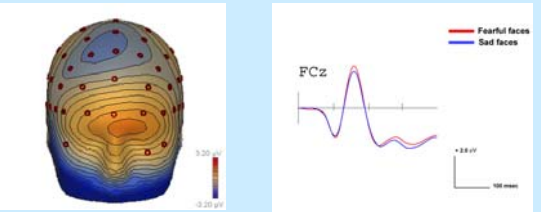
RESULTS

Figure 1. N170 was enhanced following fearful faces.



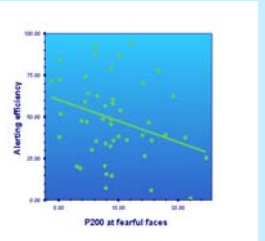
Right temporal sites (P10) comparable to the N170 at maximal peak between 130 and 170 ms , particularly following fearful (M = 8.50, SD = 4.58) versus sad faces (M = 8.00, SD = 4.32, $t(49) = 2.29$, $p < .05$).

Figure 2. N2 was enhanced following fearful faces.

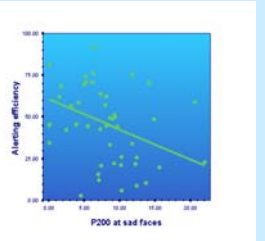


Frontocentral site (FCz) comparable to the N2 at maximal peak between 210 to 250 ms following fearful (M = 6.08, SD = 3.32) versus sad faces (M = 5.72, SD = 3.07, $t(49) = 2.09$, $p < .05$).

Figure 3. As P200 following fear and sad faces increased, alerting decreased.



r = -.35, p <.05



r = -.38, p <.01

ERP responses were not significantly correlated with orienting and executive attention.

SUMMARY

1) Posterior N170 and medial frontal N200 were sensitive to distinct negative emotional face types. In particular, early stages of emotional face processing were enhanced following fearful versus sad faces.
2) Enhanced P200 was linked to reduced alerting. This implies that early emotional face processing modulated not only ERP responses but also subsequent attention performance.
3) Future research will focus on whether effects of ERP responses on executive attention differ depending on individual differences in mood; and the clinical implications of the emotional capture of attention and links between specific ERP responses and distinct domains of attention.

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