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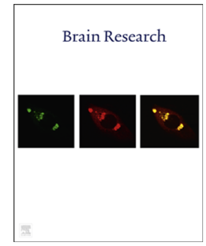


Research Report

# Configural and featural face processing are differently modulated by attentional resources at early stages: An event-related potential study with rapid serial visual presentation

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ARTICLE INFO

*Article history:*
Accepted 10 January 2015
Available online 16 January 2015

*Keywords:*
Face processing
P1
N170
Attentional resource
Event-related potential (ERP)

ABSTRACT

It is widely reported that face recognition relies on two dissociable mechanisms, the featural and the configural processing. However, it is unclear whether these two processing types involve different neural mechanisms and are differently modulated by attentional resources. Using the attentional blink (AB) paradigm, we aimed to investigate the effect of attentional resources on configural and featural face processing by recording event-related potentials (ERPs). The amount of attentional resources was manipulated as deficient or sufficient by presenting the second target (T2) in or out of the AB period, respectively. We found that in addition to a traditional P3 attention effect, the amplitude of N170/VPP to the T2 stimuli was also sensitive to attentional resources, suggesting that attention affects face processing at an earlier perceptual processing stage. More importantly, configural face processing elicited a larger posterior P1 compared to featural face processing, but only when the attentional resources were sufficient. In contrast, the anterior N1 was larger for configural relative to featural face processing only when the attentional resources were deficient. These results suggest that early stages of configural and featural face processing are differently modulated by attentional resources, possibly with different underlying mechanisms.



## 1. Introduction

Face recognition relies on two types of processing: featural processing focuses on the individual components of a face (e.g., the shape of the eyes or month), whereas configural processing considers the spatial interrelationships among the single facial components (e.g., the distance between the eyes, or between the mouth and nose) (Maurer et al., 2002). At the neural level, it was found that these featural and configural processes may rely on different brain regions (Maurer et al., 2007; Mercure et al., 2008; Renzi et al., 2013; Scott and Nelson, 2006; Yovel and Kanwisher, 2004). For example, Maurer et al. (2007) found that the right fusiform gyrus and right frontal cortex showed greater activity during the configural processing, whereas the left prefrontal activity increased for featural processing. Using rTMS, Renzi et al.

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http://dx.doi.org/10.1016/j.brainres.2015.01.017

(2013) found that TMS over the left middle frontal gyrus selectively disrupted featural processing, whereas TMS over the right inferior frontal gyrus selectively interfered with configural processing of faces.

However, it remains unclear whether configural and featural faces are dissociated on time course. Using event-related potentials (ERPs), it was found that human faces can evoke a negative potential at approximately 170 ms (N170) (Bentin et al., 1996), and a positive potential detected at the fronto-central electrode (VPP, vertex positive peak) with the same neural dipole as N170 (Jeffreys, 1996; Rossion et al., 1999; Itier and Taylor, 2002; Joyce and Rossion, 2005). Using the difference waveform between familiar and unfamiliar faces, Scott and Nelson (2006) found that the amplitude and the hemispheric lateralization of the N170 component are modulated by featural and configural changes in faces. Specifically, the right hemisphere N170 was significantly greater for configural processing relative to featural processing, whereas the left hemisphere N170 exhibited the opposite pattern. In contrast, Mercure et al. (2008) observed that N170 was not influenced by both featural and configural processing. In brief, it is unknown whether N170/VPP are sensitive to featural and configural face processing.

Moreover, it has been shown that attention can affect face perception in earlier studies. Using competition paradigm, Jacques and Rossion (2007) have found that the N170 in response to faces is modulated by spatial attention. Mohamed et al. (2009) also observed a dramatic reduction of the face N170 under high perceptual load conditions. On the contrary, several other studies suggested that face perception is automatic as little or no N170/VPP was modulated by attention. For example, Cauquil et al. (2000) observed that neither the latency nor the amplitude of N170/VPP was sensitive to the directed attention on faces. In brief, it is unknown whether the face processing, especially featural and configural face processing, is modulated by attention.

One sign of the temporal characteristics of attention is attentional blink (AB). The AB refers to the fact that the identification of the second targets (T2) is severely impaired if it is presented approximately 200–500 ms after the first target (T1) under the rapid serial visual presentation (RSVP) paradigm (Raymond et al., 1992). The AB was attributed to the depletion of capacity-limited attentional resources by T1 processing, leaving too few resources available in the AB period to be applied to T2 (Raymond et al., 1992). Previous behavioral studies also observed the AB effect when T1 and T2 stimuli were faces (Awh et al., 2004; Landau and Bentin, 2008). Thus, we utilized the AB effect to investigate the role of attentional resources on face processing by comparing ERP components elicited by stimuli in the AB period (i.e., when attentional resources are deficient) with those out of the AB period (i.e., when attentional resources are sufficient).

In the present study, we analyzed that ERP components responded to T2 face stimuli by manipulating the stimuli onset asynchrony (SOA) between the two targets (240 ms vs. 720 ms) to achieve the following goals. The first goal was to investigate which ERP components are sensitive to configural and featural faces. If early ERP components, such as P1 and N170, were sensitive to configural and featural faces, we would expect to see the difference between featural and configural faces on these components. The second goal was to examine which ERP components are modulated by attentional resources in the AB effect. Previous studies revealed that P3 reflecting the *post-perceptual* processing was suppressed when attentional resources were deficient (Sergent et al., 2005; Vogel et al., 1998). Thus, if the N170 showed a similar pattern as P3, we would predict that face *perceptual* processing was also modulated by attentional resources, as the N170 reflects the pre-categorical structural encoding of face stimuli rather than identity recognition (Bentin and Deouell, 2000; Eimer, 2000). More importantly, we would explore the relationship between attentional resources and face processing type (featural and configural). Previous ERP researches have suggested that configural and featural face processing types are influenced by familiarity (Scott and Nelson, 2006), but it is unknown whether attentional resources have the same effect on featural and configural face processing. If it had, an interaction between attention and face processing type would be observed. Specifically, we would like to explore whether there is a difference between featural and configural face processing when attentional resources are deficient (in the AB period) and when attentional resources are sufficient (outside the AB period), respectively.

## 2. Result

### 2.1. Behavioral performance

When T1 and T2 were presented, we found that T2 response accuracy was significantly affected by the Lag and T2 processing type ($F_{1,28}=25.06$, $P<.001$; $F_{1,28}=5.69$, $P<.024$, respectively) (Fig. 2). Specifically, the participants performed better in lag 6 than in lag 2 conditions (73.4% vs. 69.2%). The accuracy for configural faces was higher than that for featural faces (74% vs. 68.6%). There was a significant interaction between T2 and T1 processing type ($F_{1,28}=6.55$, $P<.016$). Post-hoc analysis showed that the accuracy of configural faces was higher than that of featural faces when T1 was configural faces (79% vs. 67.9%), but no difference between them when T1 was featural faces (69.3% vs. 68.9%). No other significant interaction effect was found for the response accuracy. In addition, when only T2 are presented, no accuracy difference was observed for configural and featural face processing (75.9% vs. 78.7%), indicating that the result was not contaminated by task difficulty.

### 2.2. ERP data analysis

#### 2.2.1. Anterior N1

N1 amplitudes showed significant main effects of T2 processing type, Lag, and Hemisphere ($F_{1,28}=4.24$, $P<.049$; $F_{1,28}=7.77$, $P<.009$; and $F_{2,56}=10.37$, $P<.001$, respectively). The amplitude for configural face processing was significantly larger than for featural face processing ($-3.33$ vs. $-2.76$ μV). The amplitude elicited by lag 2 was larger than that by lag 6 conditions ($-3.44$ vs. $-2.65$ μV). Additionally, more negative amplitudes were found in the midline electrode than in the left and right hemisphere ($-3.26$, $-2.99$, and $-2.89$ μV, respectively). There