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Research report

The activation of visual memory for facial identity is task-dependent: Evidence from human electrophysiology

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ABSTRACT

The question whether the recognition of individual faces is mandatory or task-dependent is still controversial. We employed the N250r component of the event-related potential as a marker of the activation of representations of facial identity in visual memory, in order to find out whether identity-related information from faces is encoded and maintained even when facial identity is task-irrelevant. Pairs of faces appeared in rapid succession, and the N250r was measured in response to repetitions of the same individual face, as compared to presentations of two different faces. In Experiment 1, an N250r was present in an identity matching task where identity information was relevant, but not when participants had to detect infrequent targets (inverted faces), and facial identity was task-irrelevant. This was the case not only for unfamiliar faces, but also for famous faces, suggesting that even famous face recognition is not as automatic as is often assumed. In Experiment 2, an N250r was triggered by repetitions of non-famous faces in a task where participants had to match the view of each face pair, and facial identity had to be ignored. This shows that when facial features have to be maintained in visual memory for a subsequent comparison, identity-related information is retained as well, even when it is irrelevant. Our results suggest that individual face recognition is neither fully mandatory nor completely task-dependent. Facial identity is encoded and maintained in tasks that involve visual memory for individual faces, regardless of the to-be-remembered feature. In tasks without this memory component, irrelevant visual identity information can be completely ignored.

1. Introduction

Are face perception and recognition fully automatic processes or can they be modulated by attention and top-down task sets? This question has been studied intensively (see Palermo & Rhodes, 2007; for a review), and the answer may depend on which aspects of face processing are being investigated. While the detection of facial configurations may be pre-attentive (e.g., Suzuki & Cavanagh, 1995; Vuilleumier, 2000), it is often

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assumed that recognizing the identity of individuals requires selective attention to those invariant facial cues that define identity (e.g., Palermo & Rhodes, 2002). If this is correct, individual faces may not be recognized automatically, but only in contexts where facial identity is task-relevant. However, results from behavioural repetition priming experiments suggest that the identity of familiar faces is encoded and maintained irrespective of whether or not observers are required to recognize these faces (Ellis, Young, & Flude, 1990). In these experiments, participants first performed familiarity, expression, or gender judgements on a set of familiar or unfamiliar faces. During a second phase, explicit familiarity judgements were required. The recognition of previously seen familiar faces was faster than the recognition of novel faces. Critically, these repetition priming effects were not only observed when faces had to be identified during the initial encounter, but also when gender or expression discriminations were required instead. Based on these results, Ellis et al. (1990) argued that the identity of familiar faces is impossible to ignore, and is encoded and retained in a task-independent mandatory fashion.

Interestingly, no such repetition priming effects were found for unfamiliar faces (Ellis et al., 1990), suggesting that identity-related visual cues from novel faces were not encoded or maintained when they were not task-relevant (but see Goshen-Gottstein & Ganel, 2000; for a demonstration of repetition priming effects with unfamiliar faces). This apparent difference between familiar and unfamiliar face recognition may be linked to the nature of the underlying representations in visual face memory. Representations of famous or personally familiar faces have been formed across time on the basis of numerous previous perceptual episodes, and are thus likely to be well established in visual memory, and easy to maintain and activate when the same individual face is encountered again. In contrast, memory traces of unfamiliar faces are based on a very limited number of prior encounters, and may therefore be more transient and harder to maintain and re-activate. Such differences in the memory representation of familiar as compared to unfamiliar faces may be responsible for the discrepancy between our excellent recognition memory for familiar faces and our poor ability to individuate unfamiliar faces (see Burton & Jenkins, 2011; for review). They may also result in systematic differences in the degree to which identity-related face processing is mandatory: Familiar faces may be recognized regardless of current task demands, whereas identity-relevant information from unfamiliar faces may be processed only when this is relevant for the task at hand.

The aim of the present study was to use event-related brain potential (ERP) measures of face processing to obtain new insights into the question whether face recognition is mandatory or task-set dependent, and to what degree this depends on whether a face is familiar or unfamiliar. Most ERP investigations of face processing have focused on the face-sensitive N170 component, which is triggered at lateral posterior electrodes 150–190 msec after stimulus onset. N170 amplitudes are typically unaffected by face familiarity (Eimer, 2000; Bentin & Deouell, 2000) or face identity repetition (Schweinberger, Pickering, Burton, & Kaufmann, 2002), which suggests that they reflect early stages of face perception that precede the explicit recognition of individual faces (Rossion et al., 2000; see also Eimer, 2011; Rossion & Jacques, 2011; for recent reviews). ERP components sensitive to identity-related face processing are usually found at latencies beyond 200 msec post-stimulus. In experiments where pairs of faces are presented successively, the repeated presentation of the face of the same individual triggers an enhanced negativity at inferior occipito-temporal electrodes, relative to trials where faces of two different individuals are shown. This N250r component is usually maximal between 220 msec and 280 msec and is accompanied by a broadly distributed anterior positivity (e.g., Schweinberger, Pfütze, & Sommer, 1995; Begleiter, Porjesz, & Wang, 1995; Schweinberger et al., 2002; Schweinberger, Huddy, & Burton, 2004). N250r components can be observed for repetitions of familiar as well as unfamiliar faces (e.g., Herzmann, Schweinberger, Sommer, & Jentzsch, 2004; Itier & Taylor, 2004), although this component is often smaller with unfamiliar faces (Pfütze, Sommer, & Schweinberger, 2002).

Importantly, N250r components are not just elicited in response to repetitions of physically identical face stimuli, but also when two different images of the same famous individual are presented (e.g., Bindemann, Burton, Leuthold, & Schweinberger, 2008). This image-independence of the N250r, which has also been demonstrated for repetitions of unfamiliar faces (Kaufmann, Schweinberger, & Burton, 2009; Caharel, d'Arripe, Ramon, Jacques, & Rossion, 2009; Zimmermann & Eimer, 2013), demonstrates that this component does not simply reflect repetitions of low-level perceptual features, but is instead related to the processing of facial identity. The N250r component is assumed to be triggered when the representation of a specific individual face in visual memory is activated by a match with the perceptual representation of a currently seen face (Schweinberger & Burton, 2003). In other words, the N250r is interpreted as an electrophysiological marker for the activation of view-independent face recognition units (FRUs; Bruce & Young, 1986; see Kaufmann et al., 2009). This interpretation is supported by the fact that N250 components are not only elicited in face repetition experiments, but have also been observed in response to participants' own faces (Tanaka, Curran, Porterfield, & Collins, 2006) and to previously known famous faces (Gosling & Eimer, 2011). The time course and scalp topography of these N250 components is very similar to the repetition-induced N250r (see Schweinberger, 2011; for a review), suggesting that both may be linked to analogous processes involved in the activation of visual memories of individual faces.

If N250r components reflect an early stage of face recognition where representations in visual face memory are activated by current perceptual input, they can be employed as a tool to investigate whether identity-related visual cues are encoded and retained in a mandatory fashion or only in contexts where facial identity is explicitly task-relevant, and whether this differs as a function of an observer's prior familiarity with an individual face. In an earlier study by Trenner, Schweinberger, Jentzsch, and Sommer (2004), N250r components to repetitions of famous faces were measured during an identity matching task (direct task) and during a different indirect task where participants had to classify the second face in each pair as actor or singer, and the identity of