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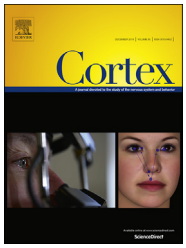

Research report

Expectations about person identity modulate the face-sensitive N170

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ABSTRACT

Identifying familiar faces is a fundamentally important aspect of social perception that requires the ability to assign very different (ambient) images of a face to a common identity. The current consensus is that the brain processes face identity at approximately 250–300 msec following stimulus onset, as indexed by the N250 event related potential. However, using two experiments we show compelling evidence that where experimental paradigms induce expectations about person identity, changes in famous face identity are in fact detected at an earlier latency corresponding to the face-sensitive N170. In Experiment 1, using a rapid periodic stimulation paradigm presenting highly variable ambient images, we demonstrate robust effects of low frequency, periodic face-identity changes in N170 amplitude. In Experiment 2, we added infrequent aperiodic identity changes to show that the N170 was larger to both infrequent periodic and infrequent aperiodic identity changes than to high frequency identities. Our use of ambient stimulus images makes it unlikely that these effects are due to adaptation of low-level stimulus features. In line with current ideas about predictive coding, we therefore suggest that when expectations about the identity of a face exist, the visual system is capable of detecting identity mismatches at a latency consistent with the N170.

1. Introduction

Recognizing familiar faces is essential for social interactions, where our behaviour is moderated by knowledge about an individual (Bruce & Young, 1986, 2012), and behavioural studies show significantly faster response to familiar than to unfamiliar faces (Ramon, Caharel, & Rossion, 2011). Yet the appearance of a face can be affected by a great many identity-irrelevant changes (e.g. lighting, pose, expression etc.). Jenkins, White, Van Montfort, and Burton (2011)

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introduced the idea of "ambient images" to encompass this natural everyday variability in the images of faces that confront us. Familiar face recognition is barely perturbed by this variability, whereas the recognition and perception of the identities of unfamiliar faces is highly image-dependent (Bruce, 1982; Hancock, Bruce, & Burton, 2001; Longmore, Liu, & Young, 2008). One recent study (Andrews, Burton, Schweinberger, & Wiese, 2016) appears to show that the brain can form stable representations even of unfamiliar faces on the basis of brief, incidental exposure to multiple different ambient images, so that different images of the same unfamiliar identities elicit a "recognition" response subsequently.

The hallmark of face recognition, then, is image-invariant recognition, but little is known about how the brain achieves this. This is partly because relatively few studies of neural responses involved in face recognition have used a sufficiently variable sample of familiar faces to demonstrate image invariance. However, one very informative approach that has been used to measure the rapid time course of neural responses to familiar faces is event related potentials (ERPs). Many studies have provided robust evidence that the N250 potential is sensitive to recognizing a familiar face (Andrews et al., 2016; Bentin & Deouell, 2000; Eimer, 2000; Schweinberger, 2011; Schweinberger & Neumann, 2016).

These findings are consistent with the view that the neural mechanisms essential to familiar face recognition are engaged within 250 msec. Evidence for any impact of face familiarity on earlier components of the ERP remains equivocal, although a recent study (Visconti di Oleggio Castello & Gobbini, 2015) found reliably accurate saccadic reaction times to familiar face targets against unfamiliar distractors averaged 191 msec post-stimulus suggesting that recognition processes may occur earlier. Here, we focus on the N170, the earliest of the ERP components to have been studied as an index of face-sensitive visual processes. Identified by Bentin and colleagues in 1996 (Bentin, Allison, Puce, Perez, & McCarthy, 1996), the N170 is a negativity occurring approximately 150–200 msec post-stimulus onset, across occipitotemporal regions (Luck, 2014). Larger N170 amplitudes to faces have been consistently found compared to other stimulus categories (Eimer, 2011; Rossion & Jacques, 2008). The N170 is the first component of the visual ERP to index aspects of higher order vision, as it is the earliest component to show sensitivity to stimulus category membership when low-level stimulus attributes are carefully controlled (Rossion & Caharel, 2011).

The face-sensitive N170 is generally believed to index processes relating to face detection (Eimer, 2011; Schweinberger, 2011; Schweinberger & Neumann, 2016), and is not usually reported to be sensitive to face *identity* (although see Rossion & Jacques, 2011 for a contrary view). Caharel, Ramon and Rossion (2014) found differential responses in EEG waveforms as early as 208 msec to personally familiar target faces, compared to unfamiliar distractor faces. Other studies by Caharel and colleagues have found intriguing pointers to possible identity-related N170 response using familiar (one's own and famous) versus unfamiliar faces (Caharel et al., 2002) and repetition adaptation effects of unfamiliar faces (Caharel, d'Arripe, Ramon, Jacques, & Rossion, 2009). But these studies have not made use of ambient images such as those we must recognize in daily interaction. More relevant to the present study, Andrews et al. (2016) reported no overall difference in ERP response at N170 (130–160 msec latency) between unfamiliar and newly familiar identities in participants exposed to multiple different ambient images of the faces in a previous sorting task, although they do report effects at an early (180–280 msec latency) and late (280–400 msec latency) N250 ERP. Nevertheless, very few studies of the N170 to date have been designed to test recognition of familiar face identities across multiple different ambient images.

An elegant "fast periodic stimulation" paradigm introduced by Rossion and colleagues (reviewed in Rossion, 2014), has offered tantalizing evidence that face identity may indeed modulate early ERP components. Dzhelyova and Rossion (2014) used a variant of this paradigm whereby a low frequency (1.18 Hz) periodic stimulus face was embedded within in a sequence comprised of a high frequency (5.88 Hz) periodically occurring image of a different face. They demonstrated that frequency-domain signals reflecting increased power synchronised with the occurrence of both the low and high frequency stimulus faces at occipitotemporal electrodes. This implies that activity reflecting the processing of each particular stimulus identity (the higher and low frequency face images) is indexed at these sites. The basic stimulation frequency (5.88 Hz) is occurring within a time latency consistent with the N170 (i.e., 1000 msec/5.88 = 170.1 msec).

Here, we performed two experiments building upon Rossion's recent work, using ambient images of famous, familiar faces to investigate whether the N170 component can be modulated by familiar face identity using ambient stimuli. We used a paradigm adapted from the fast periodic visual stimulation (FPVS) method introduced by Rossion (2014). Our modifications involved using a longer stimulus presentation time (500 msec), and hard stimulus onset transitions (i.e., abrupt changes between one image and the next, without any blank/fixation screen ISI). These modifications allowed us to generate traditional ERPs across the 0–500 msec stimulus presentation duration, by time-locking EEG epochs to the stimulus onset. We were confident that the N170 could be recorded in this way since Johnston, Molyneux, and Young (2015) showed a robust N170 response to the onsets of face stimuli in pop music videos containing abrupt transitions, and found a correlation between these data and N170 responses from a more traditional paradigm.

In Experiment 1, participants viewed an uninterrupted FPVS series of face images that were each presented for 500 msec, with a 0 msec ISI. The sequence was created from cycles of six images, involving five different images of a high frequency famous face identity, with the sixth image in every sequence being a single image of a different famous face identity (i.e. low frequency periodic). We used a set of five, highly varied ambient images of each famous (familiar) face identity, so that in each cycle of six images, each of the five distinct images of the high frequency identity occurred in a randomized order, followed by a randomly selected image of the low frequency identity. Thus, we ensured that any observed effects would not reflect adaptation to low-level stimulus characteristics, as all images in a cycle of six images were very different from each other. By counterbalancing