



Research report

Neural correlates of priming and adaptation in familiar face perception

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ABSTRACT

Priming (PR) and adaptation-related aftereffects (AEs) are two phenomena when recent perceptual experiences alter face perception. While AEs are often reflected in contrastive perceptual biases, PR typically leads to behavioural facilitation. Previous research suggests that both phenomena modulate broadly similar components of the event-related potentials (ERPs). To disentangle the underlying neural mechanisms of PR and AE, we induced both effects within the same subjects and paradigm. We presented pairs of stimuli, where the first (S1) was a famous face (identity A, B or C), a morph between two famous faces (50/50% A/B), or a Fourier phase randomized face (as a control stimulus matched for low-level visual information) and the second (S2) was a face drawn from morph continua between identity A and B. Participants' performance in matching S2s to either A or B revealed contrastive aftereffects for *ambiguous* S2 faces, which were more likely perceived as identity B following the presentation of A and vice versa. *Unambiguous* S2 faces, however, showed PR, with significantly shorter response times, as well as higher classification performance, for identity-congruent than for incongruent S1–S2 pairs. Analyses of the simultaneously recorded ERPs revealed clear categorical adaptation at around 155–205 msec post-stimulus onset. We also found amplitude modulations for *unambiguous* S2 faces following identity-congruent S1 faces, related to PR, starting at 90 msec and being the most pronounced at around 205–255 msec. For *ambiguous* S2 faces, we also observed an ERP effect at around 205–255 msec that was correlated with behavioural AEs. Our results show that face PR and AEs are present simultaneously within a single paradigm, depending on the ambiguity of S2 faces and/or on the similarity of S1 and S2, and suggest that exclusive mechanisms might underlie both PR and AEs and that object-category and identity processing might run in parallel during face processing.

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1. Introduction

Human faces contain a large variety of socially relevant information – amongst them a person's identity, emotional state, gender, or age. However, rather than being exclusively determined by information in the stimulus, the perception of a certain face also depends on its specific perceptual history, or, its temporal context, as suggested in several previous studies.

A whole tradition of research has focused on repetition priming (PR). PR is typically associated with faster and/or more accurate responses when a face is preceded by the same face, both in immediate and long-term repetition contexts. Ellis et al. (1987) showed that participants classified faces being familiar/unfamiliar faster when these faces have been encountered previously. This effect was also observed in immediate repetition contexts (Schweinberger et al., 2002b). Schweinberger and colleagues reported faster response times (RTs) for familiar test faces (S2) following the same image (primed same) or a different image of the same person (primed different) when compared to S2s following the image of a different person (unprimed). Additionally, the primed same condition exhibited faster RTs than the primed different condition, suggesting some image specificity of the effect (as also found by Ellis et al., 1987). Finally, event-related potential (ERP) recording techniques revealed PR-related modulations of the occipito-temporal N250r ERP component, as well as of later components (Schweinberger et al., 2002b).

In other paradigms, prolonged exposure to faces leads to robust adaptation-related aftereffects (AEs; Leopold et al., 2001; Rhodes et al., 2003; Webster et al., 2004; Webster and MacLin, 1999; Yamashita et al., 2005). The behavioural consequences of these effects are of contrastive nature and typically observed as biases in the perception of faces that were ambiguous with respect to the adapted dimension. For example, Webster and MacLin (1999) showed that after adaptation to distorted faces, undistorted faces were perceived as distorted in the direction opposite to the adaptors, while adaptation to undistorted faces did not induce any bias to the perception of test faces. AEs were also reported in the perception of socially relevant information such as face gender (Kloth et al., 2010; Kovács et al., 2006, 2007; Webster et al., 2004), ethnicity, expressions (Webster et al., 2004), age (Schweinberger et al., 2010), gaze (Jenkins et al., 2006; Kloth and Schweinberger, 2008), and identity (Hills et al., 2010; Leopold et al., 2001; Rhodes et al., 2007). Unlike adaptation effects to basic, low-level visual dimensions – i.e., motion, orientation, spatial frequency, or texture (for review see Anstis et al., 1998; Clifford, 2002; Durgin and Proffitt, 1996; Frisby, 1979), facial adaptation is associated with high-level brain areas, containing face-selective neurons.

In a study on face identity aftereffects, Hills et al. (2010) quantified face identity aftereffects to different types of adaptors for familiar faces. After an adaptation period, participants allocated morphs between two identities (identities 1 and 2), each of which was preceded by a top-up adaptor, to either identity 1 or 2. Hills et al. found strong aftereffects in the form of a shift of identity thresholds towards the adapted identity relative to a baseline. For example following

adaptation to identity 2, participants were more likely to classify a morphed test face as identity 1. In a series of experiments, the authors found that this effect was the most pronounced if the adaptor and test stimuli were identical images, but it also could be observed for different adaptor and test image pairs. Additionally, Hills et al. (2010) reported face identity aftereffects following adaptation to written names, voices, faces of associated identities, as well as imagined faces and caricatures, the latter showing the strongest effects over all experiments.

Although the behavioural aspects of both repetition PR and AEs are very different, there are some functional properties they seem to share. High-level aftereffects were reported to be independent of size (Zhao and Chubb, 2001), viewpoint (Jiang et al., 2006), and retinal position (for review see Zimmer and Kovács, 2011a) to a certain extent. It has also been reported that both face distortion and identity AEs are reduced for different as compared to same image adaptors (Carbon and Ditye, 2012; Carbon et al., 2007; Hills et al., 2010), and that face distortion AEs can be even observed after 24 h (Carbon et al., 2007) or even as long as 7 days (Carbon and Ditye, 2011) between adaptation and test. Interestingly, repetition PR was also reported for even very long S1–S2 delays (cf. Cave, 1997 for an example in object recognition), and found to be insensitive to physical differences between S1 and S2, such as size, position and mirror reversal (Brooks et al., 2002), as well as geometrical distortions (Bindemann et al., 2008). In the latter study, the authors also reported reduced PR effects when S1 and S2 were different images belonging to the same identity, as also observed in other studies (Schweinberger et al., 2002b, 2004).

Because there are differences, but also similarities, in the behavioural correlates of repetition PR and AEs, the degree to which the two repetition-related phenomena share the same neural mechanisms is currently under heavy discussion. One line of experiments studies the suppression of the blood oxygen level dependent (BOLD) signal during stimulus repetition, measured by functional magnetic resonance imaging (fMRI) and termed fMRI adaptation (fMRIa; for reviews see Grill-Spector et al., 2006; Krekelberg et al., 2006). fMRIa was previously observed in both adaptation (Cziraki et al., 2010; Kovács et al., 2008) and PR experiments (Davies-Thompson et al., 2009; for examples on word and object recognition, see Grill-Spector et al., 2006; Henson, 2003) in various cortical structures such as the fusiform face area (FFA; Kanwisher et al., 1997) or the occipital face area (OFA; Gauthier et al., 2000) and other cortical areas.

In electrophysiological studies, correlates of AEs have been reported as early as 140–200 msec post-stimulus onset (N170 time window). Kovács et al. (2006) observed attenuations of the N170 component for S2s following adaptation to category-congruent S1s (see also Kloth et al., 2010), while N170 AEs to identity-congruent S1s seem small or absent (see also Amihai et al., 2011). The electrophysiological correlates of PR are less clear as yet. While some studies found early ERP effects of PR (e.g., Jemel et al., 2005) or of categorical perception of facial identity (Campanella et al., 2000), other studies suggested that the N170 is insensitive to short-term repetition PR of familiar faces (Amihai et al., 2011; Schweinberger et al., 2002a, 2002b).

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