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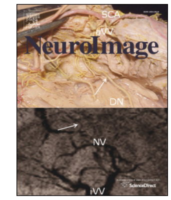

Not so harmless anymore: How context impacts the perception and electrocortical processing of neutral faces☆

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Our first impression of others is highly influenced by their facial appearance. However, the perception and evaluation of faces is not only guided by internal features such as facial expressions, but also highly dependent on contextual information such as secondhand information (verbal descriptions) about the target person. To investigate the time course of contextual influences on cortical face processing, event-related brain potentials were investigated in response to neutral faces, which were preceded by brief verbal descriptions containing cues of affective valence (negative, neutral, positive) and self-reference (self-related vs. other-related). ERP analysis demonstrated that early and late stages of face processing are enhanced by negative and positive as well as self-relevant descriptions, although faces per se did not differ perceptually. Affective ratings of the faces confirmed these findings. Altogether, these results demonstrate for the first time both on an electrocortical and behavioral level how contextual information modifies early visual perception in a top-down manner.

Introduction

What's in a face? This question has been raised many times since Darwin postulated that facial expressions are adaptive and important social communicative signals (Darwin, 1872). Most of the research in cognitive (neuro-)science so far has focused on single, static, context-less faces posing high intensity levels of emotional expressions. Based on results from these studies, it has been proposed that emotion recognition from faces is automatic, hard-wired, effortless and universal (Ekman, 1992). However, there is growing evidence now that faces do not always speak for themselves, but their perception can be highly dependent on contextual information (Barrett et al., 2011). As has been comprehensively reviewed recently, context cues may originate from within-face features such as eye gaze and facial dynamics, within-sender features such as affective prosody and body posture, external features from the environment surrounding the face such as visual scene, other faces, social situations, and within-perceiver features such as personality traits, affective learning processes and implicit processing biases (Wieser and Brosch, 2012).

Context clearly plays an even more important role when the emotional information from a face is ambiguous such as in surprised faces (Kim et al., 2004; Neta et al., 2011) or no emotional information is available such as in neutral faces (Schwarz et al., 2013). The evaluation of ambiguous faces is thought to be based on the two dimensions of valence and dominance when there is no affective information available at all (Todorov, 2011). However, when affective and other contextual variables are available one may assume that these guide the face perception in their direction. Indeed, previous encounters and the affective context can affect early stages of face processing. For example, it was shown that faces previously set in a negative emotional context (gossip) afterwards dominate in a binocular rivalry paradigm such that they gain perceptual dominance (Anderson et al., 2011). Moreover, Morel et al. (2012) showed in a study using magnet-encephalography (MEG) that faces previously paired only once with negative or positive contextual information, are processed differently: The brain discriminates neutral faces between 30 and 60 ms already post-face onset according to the type of emotional context previously associated with those faces. More precisely, the faces previously seen in a positive (happy) emotional context evoked a dissociated neural response as compared to those previously seen in either a negative (angry) or a neutral context. Source localization showed that two main brain regions were involved in this very early effect: the bilateral ventral, occipito-temporal, extrastriate regions and right anterior medial temporal regions. It is noteworthy to mention that in this study, the contextual influences are based on previous encounters, but the contextual information is not present at the time the face is seen again.

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The same holds true for affective or social learning processes. In social conditioning paradigms it has been demonstrated that formerly neutral faces gain affective valence (as indexed by ratings) based on the social unconditioned stimulus (verbal description, voices with negative valence) they were paired with during an acquisition phase (Davis et al., 2010; Iidaka et al., 2010). These effects were also accompanied by enhanced brain responses mainly in the amygdaloid complex underscoring the "new" affective valence and salience of previously neutral faces.

Important hints for the contextual modulation of brain responses to affective material come from studies in which preceding narratives were used to alter the meaning of subsequent neutral and emotional pictures (Foti and Hajcak, 2008; MacNamara et al., 2009, 2011). In these studies it was demonstrated that the late positive potential (LPP) of the event-related brain potential which is thought as an index for sustained perceptual processing is modified by picture-preceding narratives: The amplitude of the LPP was reduced for both neutral and unpleasant pictures described neutrally as compared with unpleasant pictures described negatively (Foti and Hajcak, 2008; MacNamara et al., 2009). Importantly, these effects were observed to be enduring, as pictures previously preceded by negative compared to neutral narratives were rated as more unpleasant and more emotionally arousing and elicited a larger LPP half an hour after they were presented together with the context cues (MacNamara et al., 2011). This line of research shows that neural responses to affective stimuli are effectively altered by preceding narrative contexts and suggests that context manipulations via verbal material may also change the electro-cortical processing of inherently neutral stimuli.

Besides explicit emotional contextual information another context variable is the self-reference of a given stimulus. As has been demonstrated before, self-reference dramatically changes the perception of affective stimuli. For example, the cortical processing of affective words is enhanced when self-reference is manipulated by a self-possessive pronoun (e.g., my pain vs. his pain, Herbert et al., 2011b). This is also reflected in enhanced amygdala activity for pleasant words when related to the self (Herbert et al., 2011a). Moreover, active emotion regulation conditions during which participants self-evaluated their responses to emotional stimuli compared to an evaluation of the emotional state of the central figure in the affective photo showed enhanced brain responses in emotion-related brain areas (e.g., Ochsner et al., 2004). In this line of research, the self-reference was manipulated to change or modify the meaning of inherently affective stimuli, though. In contrast, a recent fMRI study demonstrated that even neutral stimuli (faces) rendered self-relevant were associated with larger activity in frontal brain areas (involved in self-referential processing), but also in sensory areas devoted to face perception (fusiform gyrus) (Schwarz et al., 2013). Moreover, self-relevant faces were also rated as more arousing and more emotional depending on the affective valence of the context.

These findings indicate that self-reference acts as a strong context together with affective context variables in modulating both neural and behavioral responses to neutral faces. Interestingly, not only brain areas involved in self-referential processing, but also areas related to core face perception such as the FFA were modulated. Taken together, self-reference has been demonstrated to alter processing of inherently affective stimuli, while modulations of the processing of neutral faces have been found by affective context variables given beforehand. The interaction of these variables on neutral face processing has been only investigated in one fMRI study, which precludes inferences about the stages at which face processing is influenced by these context variables. While early sensory processes in response to this kind of information have been investigated either separately or with verbal material only, it has not been investigated yet when this information is integrated in the perception of neutral stimuli when this information is given in advance. More specifically, it remains unclear if this information is integrated at very early stages of face processing or if it is encoded separately and integrated at later stages of visual processing.

In this light, event-related brain potentials (ERPs) are best suited for investigating the time course of such influences and the integration of different kinds of contextual information on face processing. Early ERP component of interest are the occipital P100 and the face-specific occipito-temporal N170. The P100 has been found to be modulated by facial expressions (e.g., Wieser et al., 2012b), presumably reflecting enhanced attention to emotional compared to neutral facial expressions. Furthermore, the N170 which is implicated in structural encoding of faces (Bentin et al., 1996), is also presumably modified by their emotional content (for reviews, see Eimer, 2011; Vuilleumier and Righart, 2011), although the empirical evidence for an emotional modulation of the N170 is mixed and remains an issue of debate. Of greater relevance for the current research questions are the subsequent emotion-sensitive components such as the early posterior negativity (EPN), and the late positive potential (LPP). Both of these are enhanced in response to emotional faces (e.g., Mühlberger et al., 2009; Wieser et al., 2012a, 2012b), and index relatively early (EPN) and sustained (LPP) motivated attention to salient stimuli (Schupp et al., 2004; Wieser et al., 2010, 2012a, 2012b). As has been mentioned above, the LPP is also strongly modulated by preceding narratives which makes it a candidate component for the investigation of the effects of preceding verbal context information on subsequent face processing. Using this method, we sought to clarify at which stages of stimulus processing affective contexts may alter face processing. More specifically, we investigated whether these contexts already modify early attentional brain responses and the structural encoding of faces and whether possible modulations are relatively later at stages where normally emotional information is selectively processed, most likely due to influences stemming both from top-down and bottom-up bias signals. It is important to note that EPN and LPP modulations are mostly found when inherently affective stimuli are presented. In this study, however, the potential emotional meaning only comes from the preceding sentences and is not present at the time the face is presented. Modulations of the face-evoked potentials would therefore demonstrate for the first time that the brain also discriminates emotional meaning in faces stemming from secondhand information.

Based on the literature as mentioned above, we aimed at elucidating the time course of two contextual factors on face processing, namely self-reference and contextual valence. Most importantly, the possible interaction of both factors was a key target of the present study, as it has not been investigated before whether self-reference and contextual valence already interact on early levels of face processing. We hypothesized that neutral faces put in an affective context by preceding brief verbal descriptions would elicit stronger EPN and LPPs amplitudes compared to faces put in neutral context. Moreover, we assumed that self-reference would also enhance electro-cortical processing of neutral faces, and probably even interact with contextual valence. Furthermore, we expected these influences also to be present in affective ratings of neutral faces. As the modulation of the P100 and N170 by facial expressions is inconsistent, no clear a priori-hypotheses were formulated. However, both components were analyzed to identify whether preceding contextual information would alter early attentional processes as indexed by the occipital P100 or even the structural encoding of the faces (N170). If contextual modulation and particularly self-reference enhanced attention to faces in general, one would expect larger P100 amplitudes for faces in self-related compared to other-related contexts. If contexts altered structural encoding of faces, enhanced N170 amplitudes should be found.

Methods

Participants

Participants were 27 healthy adults (20 females) who received course credits for participation. Two participants had to be excluded from data analysis because of excessive eye movements and artifact-contaminated EEG data (2 females). The remaining 25 participants were between 20 and 27 years of age ($M = 22.4$ years, $SD = 5.12$). The institutional review

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