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

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ABSTRACT

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 board of the University of Würzburg approved the experimental procedure and all participants provided informed consent. All participants were free of any neurological or psychiatric disorder (self-report) and had normal or corrected-to-normal vision.

Stimulus materials

Thirty-six pictures (18 females) were selected from the Radboud Faces Database (Langner et al., 2010), all showing neutral facial expressions in frontal view. Pictures were selected based on normative ratings with regards to best percentage of agreement on emotion categorization and mean genuineness (Langner et al., 2010). Pictures were converted to gray-scale, and the contrast was approximated by calculating the variance, which was standardized across all the Radboud faces in order to minimize physical differences.

For the context stimuli, 36 sentences were created, varying in terms of valence (positive, neutral, and negative) and self-reference (self-related vs. other-related), resulting in 6 sentences per category (see Table S1 in the supplementary material). In order to minimize grammatical differences or differences in word length between sentences, all sentences were of the same grammatical structure. Moreover, each sentence of each category contained 6 words.

For a manipulation check, all the participants were asked to rate the sentences with regard to arousal and valence in a separate run after the main experiment (Table 1). Rating data of one participant was lost due to hard disk error. Repeated-measures ANOVAs containing the within-subjects factor self-reference (self-related vs. other-related) and valence (negative vs. neutral vs. positive) were run on valence and arousal ratings separately. As expected, a significant main effect of contextual valence was observed for valence ratings, $F(2,46) = 220.98$, $p < .001$, $\eta_p^2 = .17$, with negative sentences being rated as more negative compared to neutral and positive ones, $F(1,23) = 166.63$, $p < .001$, $\eta_p^2 = .88$, and $F(1,23) = 251.10$, $p < .001$, $\eta_p^2 = .92$. Also, positive sentences were rated as being more positive compared to neutral ones, $F(1,23) = 201.81$, $p < .001$, $\eta_p^2 = .91$. A significant interaction valence × self-reference, $F(2,46) = 25.90$, $p < .001$, $\eta_p^2 = .53$, indicated that this effect was modulated by self-reference. Post-hoc comparisons revealed that for negative sentences, self-related ones were rated as being more negative compared to other-related ones, $t(23) = 5.31$, $p < .001$, whereas positive self-related sentences were evaluated as being more positive compared to the respective other-related ones, $t(23) = 4.62$, $p < .001$. Interestingly, also neutral self-related sentences were rated as being more positive compared to neutral other-related ones, $t(23) = 3.10$, $p = .005$.

For arousal ratings of the sentences, significant main effects of valence and self-reference were observed, $F(2,46) = 51.76$, $p < .001$, $\eta_p^2 = .69$, and $F(2,46) = 35.85$, $p < .001$, $\eta_p^2 = .61$, with negative and positive sentences being rated as more arousing compared to neutral ones, $F(1,23) = 52.57$, $p < .001$, $\eta_p^2 = .70$, and $F(1,23) = 56.89$, $p < .001$, $\eta_p^2 = .71$, respectively. Moreover, the interaction of both factors was highly significant, $F(2,46) = 10.64$, $p < .001$, $\eta_p^2 = .32$. Post-hoc comparisons showed that all faces in emotional contexts (self- and other-related) were evaluated as more arousing compared to their neutral counterparts, all $ts(23) > 6.04$, $p < .001$, whereas faces in negative contexts did not differ from their counterparts in positive contexts, neither in self- nor in other-related contexts, $t(23) = 0.89$, $p = .382$, and $t(23) = 0.91$, $p = .374$, respectively. The differences between affective (negative and positive) and neutral contexts are larger in the self-related condition (see Table 1), as paired comparisons of the difference scores (negative-neutral and positive-neutral) further indicated, $t(23) = 1.39$, $p = .002$, and $t(23) = 1.41$, $p = .002$, respectively. Altogether, affective ratings revealed that manipulations of valence and self-reference yielded the expected results, and thus were applicable for the experiment.

Table 1
Mean affective ratings ± *SD* (valence and arousal) of sentences with self- vs. other-related contexts (negative, neutral, positive).

	Self-reference			
	Self		Other	
Contextual valence	Valence	Arousal	Valence	Arousal
Negative	2.66 (0.66)	4.88 (1.82)	3.26 (0.74)	3.50 (1.62)
Neutral	5.29 (0.44)	2.38 (1.52)	5.07 (0.29)	1.87 (1.11)
Positive	7.21 (0.70)	4.78 (1.85)	6.66 (0.71)	3.40 (1.43)

Procedure

Participants passively viewed sentences and neutral facial expressions according to the paradigm established by Kim et al. (2004) and modified by Schwarz et al. (2013). For an example of an experimental trial see Fig. 1.

Each sentence (self-related/positive, self-related/negative, self-related/neutral other-related/positive, other-related/negative, and other-related/neutral) was presented six times, three times with a male personal pronoun and three times with a female personal pronoun beginning the sentence. Consequently, each individual face was shown six times within a context category with different sentences. One set of three male and three female faces was assigned to positive sentences, another set of three male and three female faces was assigned to negative sentences, and the last set of three male and three female faces was assigned to neutral sentences. This assignment of picture sets to specific context valences was counterbalanced across participants to ensure that differences in the ERPs were not caused by intrinsic features of the faces. Overall, per session 36 trials per condition were presented (3 male and 3 female faces repeated 6 times with the respective sentences) resulting in a total of 216 trials. In each trial, the sentence was presented for 2 s, after which with a gap of 500 ms a face was presented for 500 ms. After each trial, participants were asked to rate the respective face in terms of valence (-4 = very negative to $+4$ = very positive) and arousal (1 = not arousing at all to 9 = very arousing). The rating scales were presented on the screen and the participants were asked to key in the respective number on a keyboard in front of them. Note that the valence scale -4 to $+4$ was stored as values ranging from 1 to 9. There was no time limit for the rating response. The ITI in which a fixation cross was presented, randomly varied between 2000 and 3000 ms. Presentation of the stimuli was controlled by presentation software (Neurobehavioral Systems, Inc., Albany, CA, USA), the pictures were shown on a 21-inch CRT-monitor (60 Hz refresh rate) located approximately 100 cm in front of the participant. Participants were instructed to keep their eyes comfortably focused on the center of the screen and to simply view the sentences and pictures, and rate the faces afterwards.

EEG recording and data reduction

Brain and ocular scalp potentials were measured with a 128-channels geodesic sensor net (Electrical Geodesics, Inc., Eugene, OR, USA), on-line bandpass filtered from 0.1 to 100 Hz, and sampled at 250 Hz using Netstation acquisition software and EGI amplifiers. Electrode impedance was kept below 50 kΩ, as recommended for this type of high-impedance EEG amplifier. Data were recorded continuously with the vertex sensor as reference electrode. Continuous EEG data were low-pass filtered at 35 Hz using a zero-phase forward and reverse digital filter before stimulus-synchronized epochs were extracted from 200 ms pre-stimulus onset (face) to 800 ms post-stimulus onset and baseline-corrected (-100 ms). Preprocessing and artifact rejection were performed according to Junghöfer et al. (2000) using EMEGs software (Peyk et al., 2011). Off-line, data were re-referenced to an average reference. Afterwards, epochs were averaged for each participant and each experimental condition. ERP components were quantified on the basis of peak or mean amplitudes calculated over time windows defined on the basis of visual inspection and the literature (e.g., Wieser et al., 2010). The P100 component was analyzed as peak amplitude between

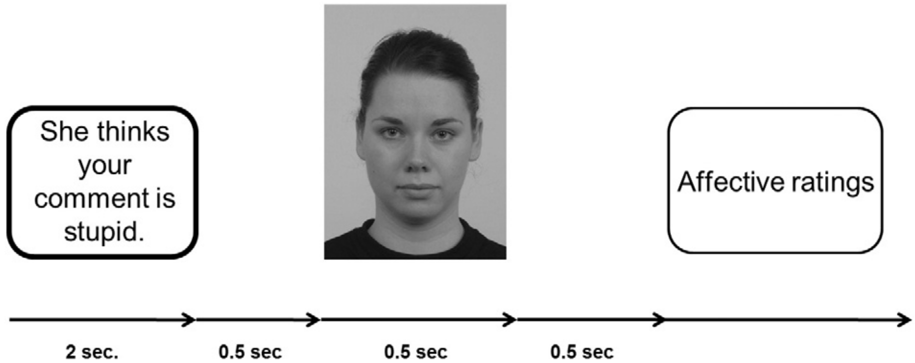

Fig. 1. Schematic of an experimental trial. A fixation cross was shown during intertrial interval (ITI), which lasted randomly 2 and 3 s.

80 and 120 ms over right and left occipital electrode clusters including electrode O1 (EGI sensors 69, 70, 73, 74) and electrode O2 (EGI sensors 82, 83, 88, 89). For the N170 component, which reflects the early perceptual encoding stage of face processing, the peak amplitude was quantified between 150 and 180 ms after picture onset at lateral temporo-occipital clusters including electrodes P7 (EGI sensors 57, 58, 59, 63, 64, 65, 68, 69) and P8 (EGI sensors: 89, 90, 91, 94, 95, 96, 99, 100). The EPN was analyzed as an index of selective attention processes. It was scored as mean activity from 220 to 300 ms from two temporo-occipital clusters including EGI sensors 57, 58, 59, 60, 63, 64, 65, 66, 68, 69, 70, 73, 74 (left) and 82, 83, 84, 85, 88, 89, 90, 91, 94, 95, 96, 99, 100 (right). The LPP was analyzed (mean activity from 400 to 600 ms after face onset) as an index of sustained motivated attention across bilateral fronto-central (EGI sensors, left: 12, 13, 19, 20, 24, 28, 29, right: 4, 5, 111, 112, 117, 118, 124) and centro-parietal (EGI sensors, left: 7, 30, 31, 36, 37, 42, 53, 54, 61, right: 7, 30, 31, 36, 37, 42, 53, 54, 61) clusters. A schematic

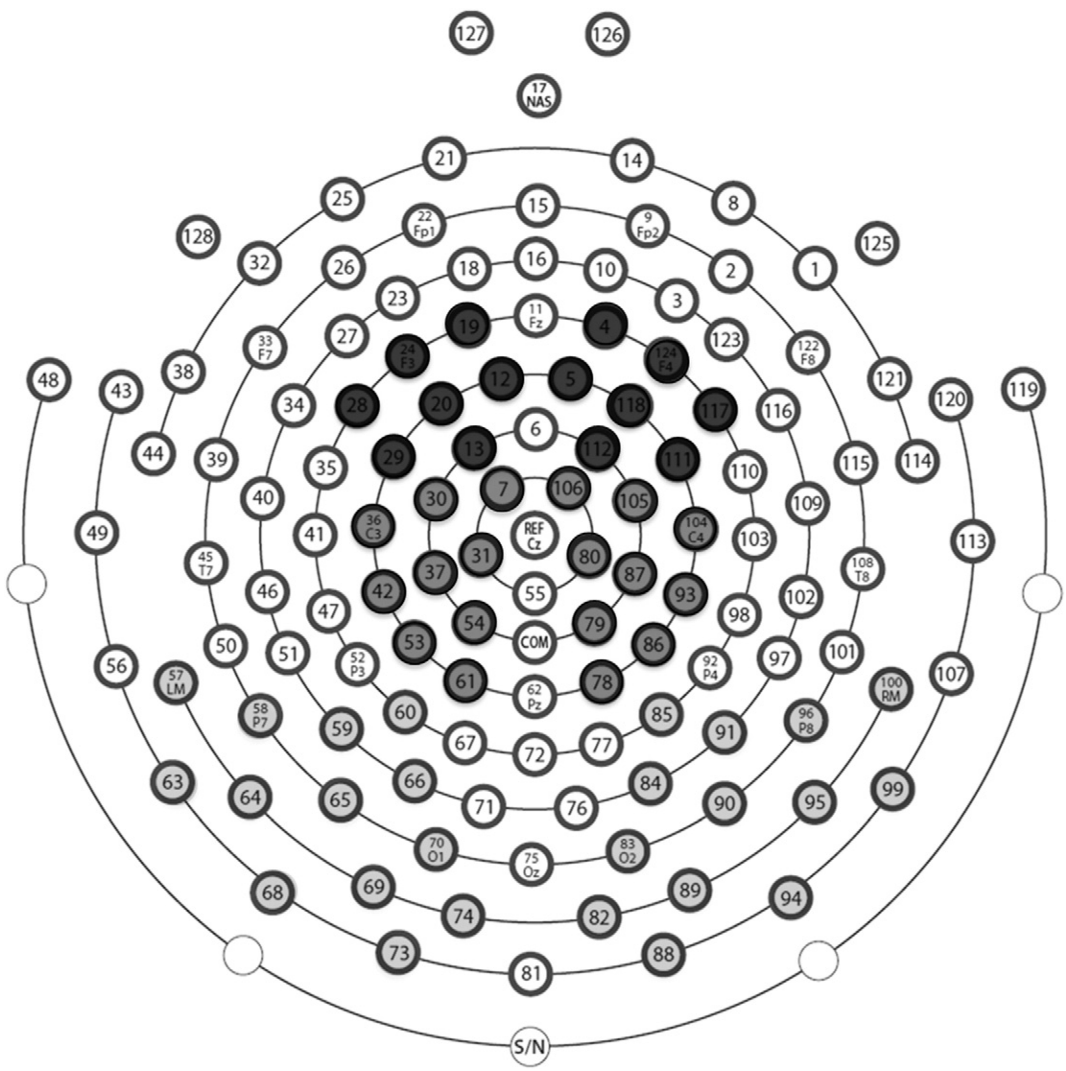

Fig. 2. Layout of the dense electrode array. Locations of the electrodes grouped for regional means for fronto-central LPPs are in dark-gray. Electrodes grouped for regional means for centro-parietal LPPs are in medium-gray. Bright-gray sensors were used for extracting the regional means for the EPN amplitudes across temporo-occipital sensor clusters.

of the electrode layout and clusters used for the extraction of regional means for the EPN and LPP is given in Fig. 2.

Statistical analysis

ERP measures as well as valence and arousal ratings were subjected to separate repeated-measures ANOVAs containing the within-subject factors contextual valence (negative vs. positive vs. neutral), and self-reference (self-related vs. other-related). ANOVAs for ERPs additionally contained the within-subjects factor hemisphere (left vs. right). Furthermore, assessment of the LPP additionally contained the within-subjects factor caudality (fronto-central vs. centro-parietal). If necessary, Greenhouse–Geisser correction of degrees of freedom (GG-ε) was applied. A significance level of .05 was used for all analyses. For all analyses, the uncorrected degrees of freedom, the corrected *p*-values, the GG-ε and the partial η^2 (η_p^2) are reported (Picton et al., 2000).

Results

Affective ratings

Highly significant main effects of contextual valence and self-reference were observed for arousal ratings of faces, $F(2,48) = 15.29$, $p < .001$, GG-ε = .62, $\eta_p^2 = .39$, and $F(1,24) = 27.04$, $p < .001$, $\eta_p^2 = .53$. As expected, faces in self-related contexts were evaluated as being more arousing than faces in other-related contexts (Fig. 3a). As post-hoc comparisons also revealed, faces in negative as well as positive contexts were rated as to be more arousing than faces in neutral contexts, $F(1,24) = 16.36$, $p < .001$, $\eta_p^2 = .41$, and $F(1,24) = 17.39$, $p < .001$, $\eta_p^2 = .42$. Furthermore, negatively contextualized faces were also rated to be more arousing than positively contextualized faces, $F(1,24) = 4.80$, $p = .038$, $\eta_p^2 = .17$.

For valence ratings of faces, a highly significant main effect of contextual valence evolved, $F(2,48) = 39.77$, $p < .001$, GG-ε = .61, $\eta_p^2 = .62$. Furthermore, the interaction contextual valence × self-reference was highly significant, $F(2,48) = 10.72$, $p < .001$, $\eta_p^2 = .31$. Post-hoc pairwise comparisons revealed that faces in a self-relevant negative context were rated as more negative compared to faces in other-relevant negative contexts, $t(24) = 2.34$, $p = .028$, whereas faces in a self-relevant positive context were rated as more positive compared to faces in other-relevant positive contexts, $t(24) = 4.04$, $p < .001$ (Fig. 3b). No differences emerged between faces in self- and other-relevant neutral contexts.

Event-related brain potentials (ERPs)

P100

The P100 of the face-evoked ERP did not show any effects of contextual valence or self-reference. Also, no hemispheric differences were observed. Mean P100 amplitudes per condition are given in Table 2.

N170

The N170 amplitudes of the face-evoked ERP were significantly larger over the right temporo-occipital hemisphere, $F(1,24) = 4.63$, $p = .042$, $\eta_p^2 = .162$. However, no other modulations by contextual valence or self-reference were observed. Mean N170 amplitudes per condition are given in Table 3.

Early posterior negativity (EPN)

Cortical processing of neutral faces differed significantly in the EPN time window depending on verbal context presentation. For the mean EPN amplitudes (220–300 ms) a significant main effect of contextual valence was obtained, $F(2,48) = 3.33$, $p = .044$, $\eta_p^2 = .12$. Faces put in a negative context elicited an increased relative negativity as compared to faces put in neutral contexts, $F(1,24) = 4.99$, $p = .035$, $\eta_p^2 = .17$ (Fig. 4). The difference between faces in positive compared to neutral contexts did not reach statistical significance, $F(1,24) = 3.46$, $p = .075$, $\eta_p^2 = .13$. Furthermore, a significant main effect of self-reference emerged, $F(1,24) = 5.76$, $p = .025$, $\eta_p^2 = .19$., with a more pronounced EPN for faces in self-related compared to other-related contexts (Fig. 5).

Late positive potential (LPP)

The waveform analyses revealed highly significant modulations of the LPP as a function of self-reference in all sensor clusters (see Fig. 6). Overall, analysis of the LPP amplitudes revealed significantly higher LPPs over central compared to frontal clusters, $F(1,24) = 56.78$, $p < .001$, $\eta_p^2 = .70$, and over right compared to left electrode clusters, $F(1,24) = 10.85$, $p = .001$, $\eta_p^2 = .31$. Furthermore, LPPs for self-relevant compared to other-relevant faces were larger, $F(1,24) = 19.67$, $p < .001$, $\eta_p^2 = .45$. The interaction of caudality and hemisphere was also found to be significant, $F(1,24) = 5.18$, $p = .032$, $\eta_p^2 = .18$, which was due to larger differences between hemispheres for central electrodes (left $M = 1.17$ μV, $SD = 1.12$; right $M = 2.13$ μV, $SD = 1.18$), $t(24) = 3.82$, $p = .001$, compared to frontal electrode clusters (left $M = -1.69$ μV, $SD = 1.67$; right $M = -1.18$ μV, $SD = 1.81$), $t(24) = 2.18$, $p = .040$. As the significant interaction hemisphere × self-reference revealed, $F(1,24) = 5.71$, $p = .025$, $\eta_p^2 = .19$, self-compared to other-relevant faces elicited larger LPPs over the right

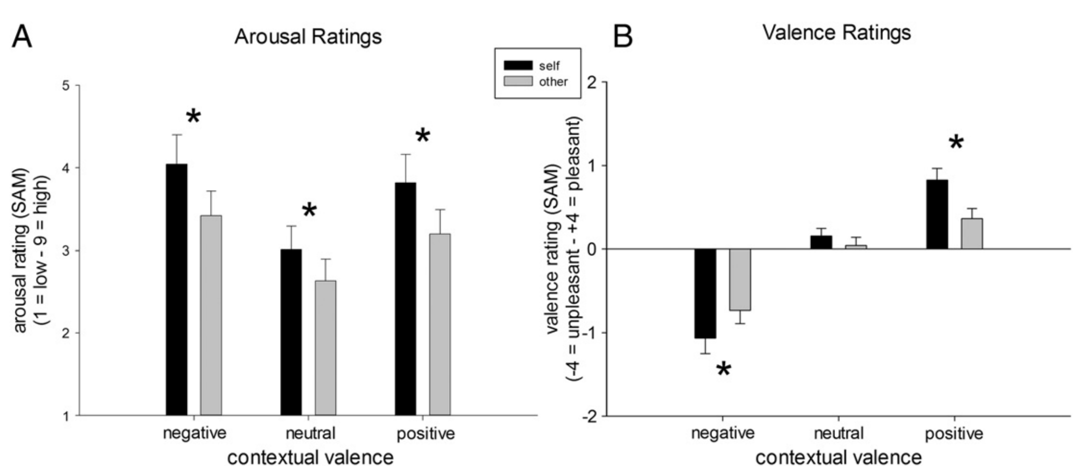

Fig. 3. A) Mean arousal (±SEM) ratings for the faces in self- vs. other-related, negative and positive contexts. B) Mean valence (±SEM) ratings for the faces in self- vs. other-related, negative and positive contexts. Note that the valence rating was obtained on a scale from −4 to 4, but stored and analyzed as values ranging from 1 to 9.

Table 2
Mean P100 amplitudes (±*SD*) averaged across left and right electrode clusters are given per experimental condition.

	Self reference			
	Self		Other	
Contextual valence	Left	Right	Left	Right
Negative	5.59 (3.26)	6.01 (3.18)	5.58 (3.22)	5.73 (2.38)
Neutral	5.80 (2.47)	6.18 (2.76)	6.05 (3.10)	6.38 (2.95)
Positive	5.75 (2.73)	5.79 (2.63)	5.76 (2.70)	6.10 (2.65)

hemisphere, $t(24) = 4.48$, $p < .001$, whereas this difference was not as large for the left hemisphere albeit still significant, $t(24) = 2.90$, $p = .008$ (Fig. 7).

Discussion

How is the time course of face processing influenced by preceding contextual information? The present study investigated the influence of affective and self-related context features on the evaluation and electro-cortical processing of neutral human faces. To this end, participants viewed neutral facial expressions preceded by sentences conveying contextual information about affective valence and self-reference, while ERPs in response to the face stimuli were recorded and affective ratings of these faces were obtained.

Results revealed main effects of contextual valence and self-reference, but no interaction of these factors on relatively early as well as later stages of electro-cortical affective stimulus processing (as indexed by EPN and LPP). Self- compared to other-related faces were associated with enhanced EPN as well as LPP amplitudes indicating early selective motivated attention to neutral faces which were put in self-related contexts, which is also sustained in later stages of more elaborated stimulus processing. Interestingly, negative affective context was also associated with preferential early processing (EPN), which was however not found at later stages anymore. Affective ratings basically support these ERP findings, with higher arousal ratings for negative and positive compared to neutral as well as self-related compared to other-related contextualized faces. However, an interaction of self-reference and affective valence was observed such that faces put in a negative-self-related context were rated as to be more negative, whereas faces in a positively rated context were rated as to be more positive.

The present study corroborates with findings showing that perception and evaluation of faces is substantially influenced by contextual information such as second-hand information, i.e. what people are told about other people as opposed to what people see in others' appearance (Ames et al., 2011). The effects found here show that affective context as well as self-reference lead to enhanced early and late cortical processing of faces which do not carry themselves any informational value with regard to emotion and self-reference.

A recent study employing the same paradigm, albeit modified for fMRI, showed that neutral self-compared to other-related faces were associated with stronger activations in prefrontal and fusiform gyrus brain areas (Schwarz et al., 2013), which supports the notion that medial prefrontal areas are involved in impression formation (Mitchell et al., 2005), but also points at top-down effects on visual processing itself. Moreover, faces which were paired previously only once with negative or positive contextual information, are already differentially processed between 30 and 60 ms post-face onset (Morel et al., 2012). In this study, source localization revealed two main brain regions involved in this very early effect: bilateral ventral, occipito-temporal, extrastriate regions and the right anterior medial temporal regions. In another study, faces were first shown together with neutral, negative, or positive gossip (and then presented alone in a binocular rivalry paradigm), only the faces previously paired with negative (but not positive or neutral) information dominated longer in conscious visual perception (Anderson et al., 2011).

Altogether, these findings demonstrate that contextual information as provided by verbal descriptions (so-called secondhand information) can influence face processing in a completely top-down manner, independent of the basic structural features of a face. This is also reflected in the present study as ERPs which are more likely modulated by facial features (P100 and N170) were not influenced by context information, whereas later components (EPN and LPP) which have been previously been shown to be modulated by preceding narratives (MacNamara et al., 2009, 2011), were modified depending on self-reference and affective valence of the preceding sentence. In addition, the present findings contribute to the notion that self-reference plays a pivotal role for the processing of social stimuli such as faces. As the effects of self-reference were also observed for later stages of face processing (LPP) in contrast to the influence of contextual valence, one may conclude that self-reference plays an even more important role than affective context variables. Interestingly, the effects of contextual valence were only observed for negative valence and only for the EPN. This is in contrast to findings where both negative and positive faces elicited larger EPN and LPP amplitudes (e.g., Schupp et al., 2004; Wieser et al., 2012a). However, one has to bear in mind that the reliable affective modulation of these ERPs was only found for inherently affective stimuli, but not for stimuli which acquired affective valence through information given beforehand and not present during face processing anymore. As these effects are naturally less robust, this may explain that only partial modulation of the ERPs has been found in the present study. As it was demonstrated that narratives can change the processing of neutral faces, an interesting next step would be to investigate these effects on affective faces. This would also allow for stronger conclusions whether self-reference and contextual valence are only active for faces in which no affective information is present or whether this effect is also found for inherently affective faces.

It has been suggested that potential feedback-projections from prefrontal as well as from sub-cortical regions may drive the effects in earlier and late visual processing as the EPN as well as the LPP is associated with activity in extrastriate visual cortices and subcortical emotion-related structures like the amygdala (Liu et al., 2012; Sabatinelli et al., 2013). Notably, particularly the LPP seems to reflect widespread and concurrent activity across the visual system, and not the action of a single localized structure (Sabatinelli et al., 2013). Particularly the enhanced processing

Table 3
Mean N170 amplitudes (±*SD*) averaged across left and right electrode clusters are given per experimental condition.

	Self reference			
	Self		Other	
Contextual valence	Left	Right	Left	Right
Negative	−4.45 (3.93)	−5.36 (3.98)	−4.43 (3.91)	−5.42 (4.06)
Neutral	−4.06 (3.72)	−5.35 (4.27)	−4.10 (4.03)	−5.24 (4.29)
Positive	−4.48 (4.07)	−5.52 (4.33)	−3.69 (3.40)	−5.24 (3.99)

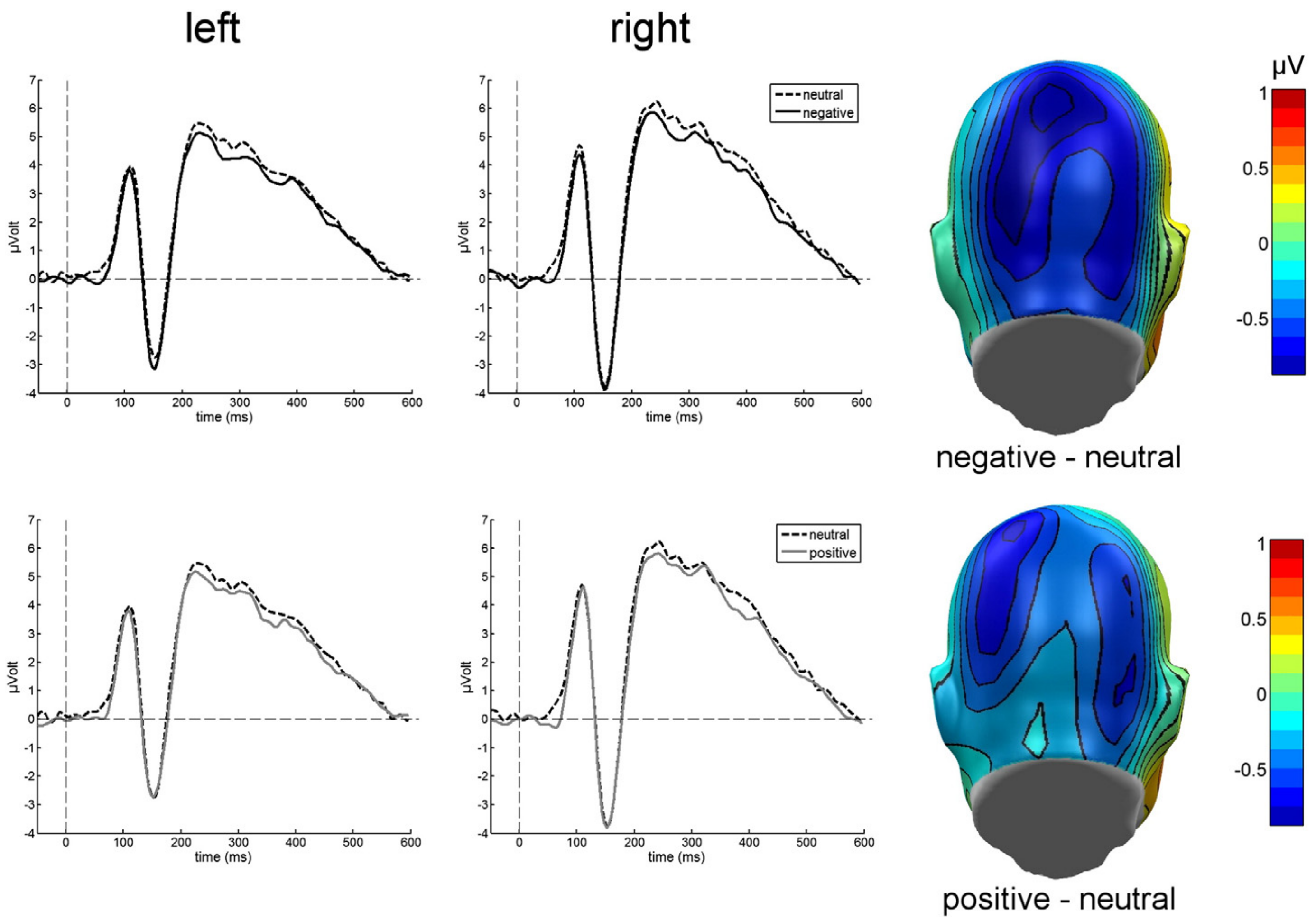

Fig. 4. Illustration of the EPN component (220–300 ms) averaged across left and right temporo-occipital electrode clusters for A) negative and B) positive contextualized faces. On the right panel the scalp potential maps of the difference waves "negative–neutral" and "positive–neutral", are given (back view of the model head).

of self-compared to other-related faces observed in the LPP time range may also be partly due to larger activity in face-related visual areas in the fusiform gyrus (Schwarz et al., 2013). Activity in these areas however might be slow and thus not be able to modify the early N170 response (thought to originate in the fusiform gyrus, Eimer, 2011). Whereas these LPP and EPN differences are normally observed in response to stimuli carrying affective information, it is important to note that in the present study these ERP differences were obtained in response to neutral faces only, where the affective information was not perceptually present at the same time, but given before. Thus, affective information acts as a source of attention in the brain which may directly and indirectly modulate cortical excitability in visual cortex via numerous pathways (for

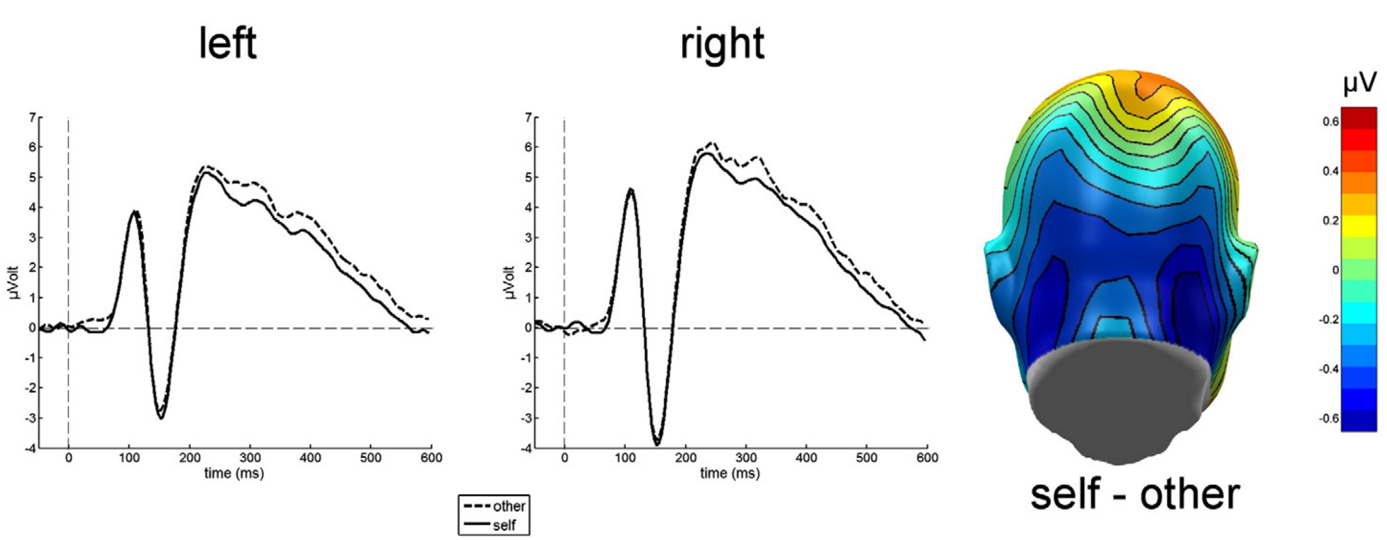

Fig. 5. Illustration of the EPN component (220–300 ms) averaged across left and right temporo-occipital electrode clusters for self- versus other-related faces. On a back view of the model head the scalp potential map of the difference wave "self–other" is given.

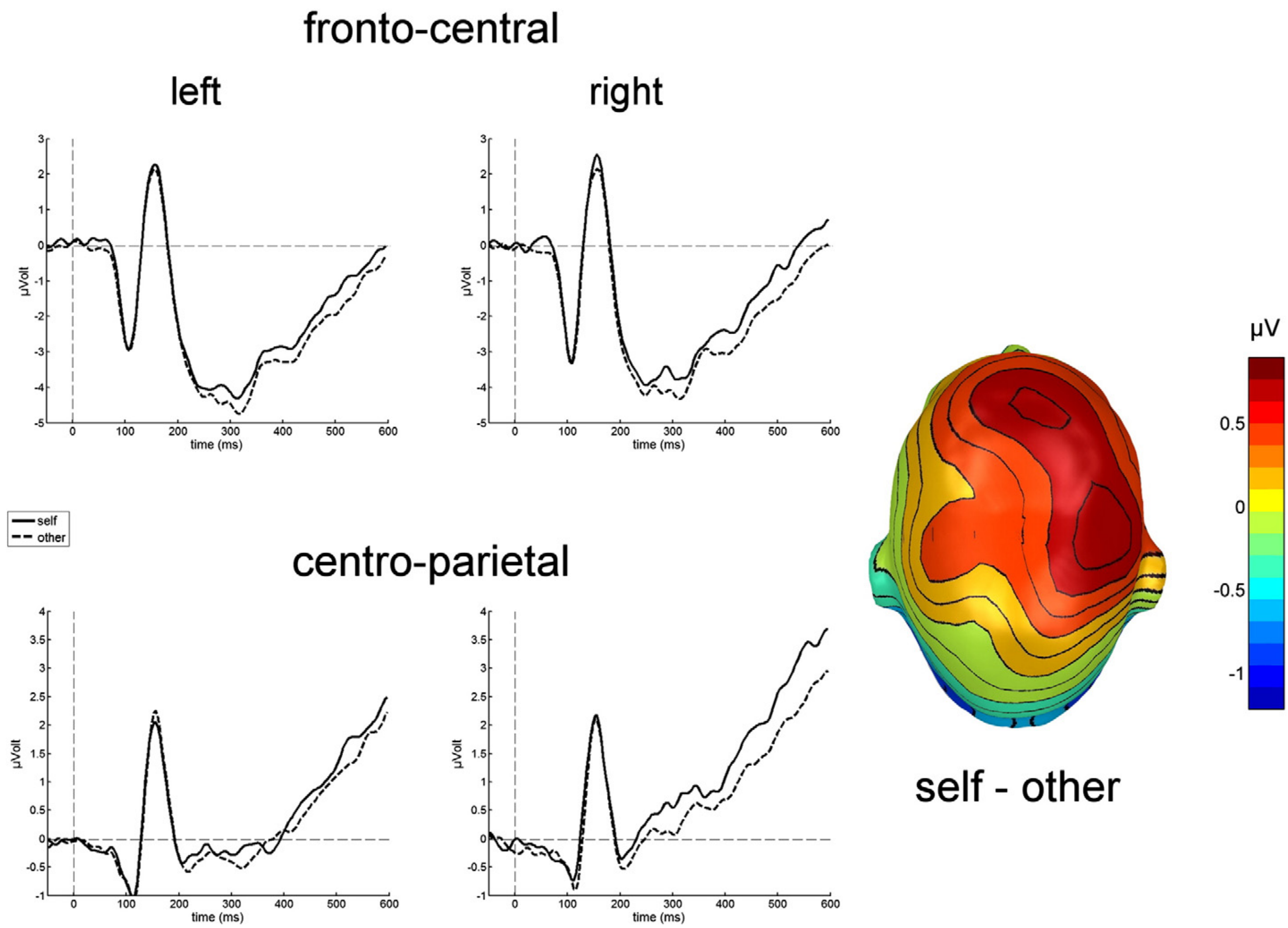

Fig. 6. Illustration of the LPP component showing left and right frontal (upper row) and central (lower row) sensor clusters for self- versus other-related faces. A scalp potential map of the difference wave 'self–other' for the LPP component is given on a top view of the model head.

reviews, see Pessoa and Adolphs, 2010; Pourtois et al., 2013). Based on current neurocognitive models of face processing, this also indicates that contextual information may influence activities in the extended neural network of face processing and thus alter the perception and evaluation of faces (Wieser and Brosch, 2012). Noteworthy, self-reference and contextual valence seem to exert rather independent influences on face

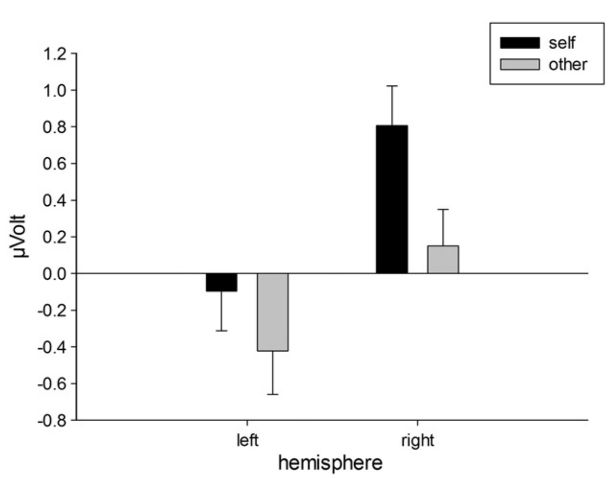

Fig. 7. Mean amplitudes (±SEM) for the LPP evoked by self- versus other-related faces for left and right hemispheric clusters, averaged across front-central and centro-parietal clusters.

perception. As the ERP measures indicate, the self-reference might also have stronger and longer lasting effects, such that enhanced elaborated processing occurs only for self-compared to other-related faces.

No effects of self-reference or contextual valence were found for early ERP components P100 and N170. This is to some part in contrast to earlier studies showing affective modulation of these ERPs in response to facial expressions (e.g., Batty and Taylor, 2003; Blau et al., 2007; Pourtois et al., 2004; Wronka and Walentowska, 2011). Again it has to be noted that both components reflect early processes in visual processing which are mainly driven by the visual features of the stimuli. As in the present study only neutral faces were used which did not differ in basic facial features, one may conclude that emotional modulations in these early components are most likely driven by differences in facial features between facial expressions, while affective value gained through secondhand information is only active for relatively later components such as the EPN and LPP. This is in contrast to Morel et al.'s findings (2012), which found context-related modulation of faces as early as 30–80 ms after face presentation. Notably, the very early modulations of context in the paper by Morel were found using MEG, which is much more sensitive to small differences compared to the EEG due to the much better signal-to-noise ratio and less susceptibility to artifacts.

Rather intriguing, the present results demonstrate for the first time that perceptually completely comparable stimuli (faces) are processed differentially on a cortical level depending on in which context they are presented. Importantly, our findings rule out alternative explanations with regard to inconsistent visual properties of the faces. Consequently, verbal descriptions as contextual information seem to constitute potent means to change the visual salience of a neutral face, which results in enhanced motivated attention to the face. Our results support the view that top-down (affective) information acquired through secondhand information influences our perception of others such that what we seem to know about someone influences not only the emotional response to them and our impression formation, but foremost our early visual perception of someone. In a word, it's not the facial appearance alone that forms our first impressions.

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Conflict of interest

The authors declare no conflict of interest.

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