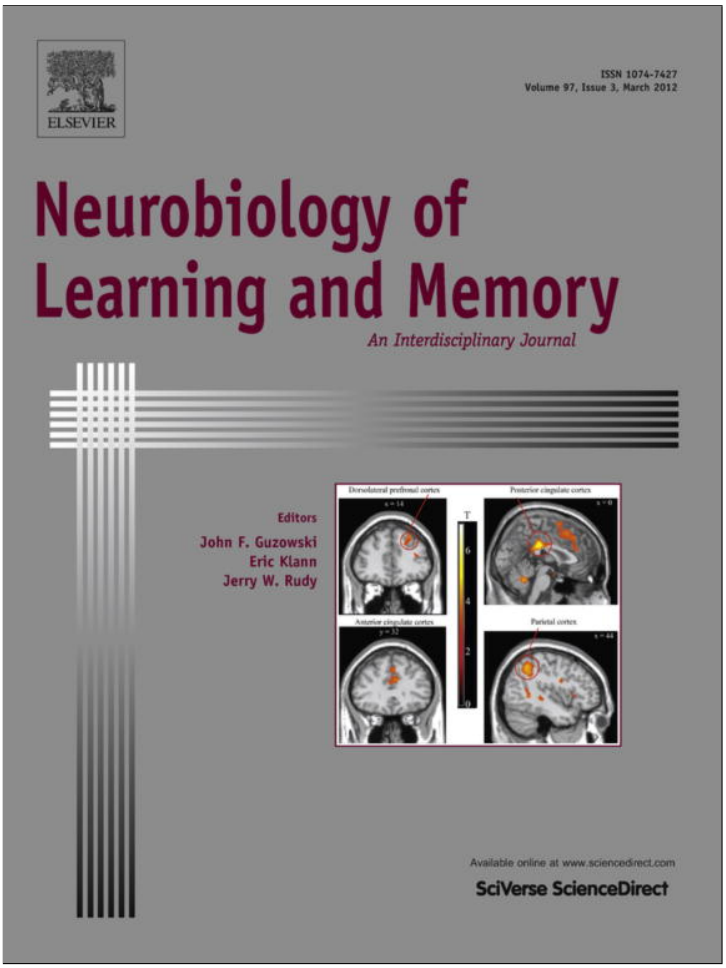

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Emotional information in body and background hampers recognition memory for faces

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ABSTRACT

Emotional influences on memory for events have long been documented yet surprisingly little is known about how emotional signals conveyed by contextual cues influence memory for face identity. This study investigated how positively and negatively valenced contextual emotion cues conveyed by body expressions or background scenes influence face memory. The results provide evidence of emotional context influence on face recognition memory and show that faces encoded in emotional (either fearful or happy) contexts (either the body or background scene) are less well recognized than faces encoded in neutral contexts and this effect is larger for body context than for scene context. The findings are compatible with the hypothesis that emotional signals in visual scenes trigger orienting responses which may lead to a less elaborate processing of featural details like the identity of a face, in turn resulting in a decreased facial recognition memory.

1. Introduction

A landmark study in psychological science has shown that emotionally laden events are remembered in great detail and with extreme vividness long after they have occurred and this phenomenon has been labeled 'flashbulb memories' (Brown & Kulik, 1977). Many studies since have shown that emotions influence memory processes and emotion effects on memory have been shown for different types of information, including faces (for reviews, see Kensinger, 2004; LaBar & Cabeza, 2006; Phelps, 2004). However, studies investigating the effect of emotional information on face memory have yielded inconsistent results, showing either enhanced or decreased memory for positively or negatively valenced emotional faces (e.g. D'Argembeau & Van der Linden, 2007; Johansson, Mecklinger, & Treese, 2004). So far, all the studies presented subjects with completely isolated and context-free face stimuli. However, in everyday life, faces are typically seen in the context of the whole body and against the backdrop of the surrounding scene. Recent studies have shown that emotional information conveyed by these contextual cues influence how facial expressions are perceived (Aviezer et al., 2008; Meeren, van Heijnsbergen, & de Gelder, 2005; Van den Stock, Righart, & de Gelder, 2007) (for reviews, see Belin, Fecteau, & Bedard, 2004; de Gelder & Van den Stock, 2011b; de Gelder et al., 2006). For example, a face on a fearful body is perceived as more fearful than the same face on a happy body (Van den Stock et al., 2007), and a happy face against a happy background is more often perceived as happy than the same face against a fearful background (Righart & de Gelder, 2008b). There is already evidence from ERP-studies that these emotional body and scene effects occur in an early processing stage, before 200 ms post stimulus onset (Meeren et al., 2005; Righart & de Gelder, 2006, 2008a). This indicates that these effects take place in the course of face perception and not in later stages devoted to elaboration of the primary percept by higher cognitive processes that are top-down, resource-dependent and slow in nature. Ultimately this may indicate that the face and the other non-face stimulus presented together with it are processed within the same time window and by face and scene processing routes that are possibly interactive as has been argued for facial expressions and emotional voices (see de Gelder & Bertelson, 2003; de Gelder & Van den Stock, 2011b for reviews).

This raises the question of how these early effects of one stimulus (the whole body, the surrounding context) on perceiving the face influences storage of the face identity in memory. This issue also has important practical relevance. For example, judicial eyewitness testimonies depend on trustworthy suspect identification in a line up. But since the encoding of the facial identity typically occurred in emotionally laden situations, it is important to know

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whether these emotional contexts like the scene of a car crash or the aggressive body posture of a robber influence memory for the face. How these emotional context effects influence face recognition memory remains unexplored to date.

There is evidence that emotional signals originating from sources other than the face turn attention away from the face, therefore hampering elaborate encoding of the facial identity (Calvo & Lang, 2004), which may result in reduced recognition. But an alternative hypothesis is that emotional bodies and background scenes result in a general arousal increase which may facilitate a deeper encoding of the total visual input, including facial identity, consistent with the flashbulb memory phenomenon (Brown & Kulik, 1977). Furthermore, emotional context effects might depend on the valence of the contextual emotion. Negatively valenced emotional context information may detract more attention from the face than positively valenced emotional context cues, because processing of threatening signals has priority over non-threatening signals.

In the present study, we examined whether positive and negatively valenced emotional information conveyed by bodies and scenes influences recognition memory for facial identities.

2. Method

2.1. Participants

Ninety-five participants volunteered for the experiment (17 male, mean (SD) age = 21.9 (3.4)) in exchange for course credits. None of the participants had a neurologic or psychiatric history and all had normal or corrected to normal vision. Informed consent was obtained according to the declaration of Helsinki.

2.2. Stimulus materials

2.2.1. Faces

Pictures of facial expressions were taken from the Karolinska Directed Emotional Faces set (Lundqvist, Flykt, & Öhman, 1998) and from our own database. In a pilot study, 591 faces were randomly presented one by one on a screen and participants ($N = 20$) were instructed to categorize the valence expressed in the face on a 7 point scale (1 = very negative; 2 = negative; 3 = slightly negative; 4 = neutral; 5 = slightly positive; 6 = positive; 7 = very positive). Based on these results, we selected 160 facial expressions (80 female), all categorized between 3 and 5 by at least 80% of the participants.

2.2.2. Bodies

Stimuli of whole body expressions were selected from our own database (de Gelder & Van den Stock, 2011a) on the basis of a similar pilot study. The selected stimuli displayed happy and fearful body postures and an instrumental action (pouring water in a glass). We used these instrumental actions as emotionally neutral stimuli, because like the emotional expressions, instrumental actions elicit movement and action representation and we wanted to control for these variables. Twenty fearful (10 female), 20 happy (10 female) and 20 neutral (10 female) body expressions were selected, all recognized accurately by at least 75% of the participants in the pilot study.

2.2.3. Scenes

Stimuli displaying neutral and emotional natural scenes from the International Affective Picture System (IAPS) (Lang, Bradley, & Cuthbert, 1999) added with landscapes downloaded from the internet were presented one by one in a pilot study to 15 participants. Instructions stated to categorize the emotion provoked by the scene in a 5 alternative forced-choice task (disgust, fear, happiness, neutral, sadness). None of the scenes contained images of faces or bodies. Twenty neutral, 20 happy and 20 fear-inducing scenes were selected, all correctly categorized by more than 60% of the participants.

2.2.4. Compound stimuli

2.2.4.1. Face-body. We created realistically looking face-body compounds. Each body was randomly paired with a face of the same gender. This resulted in 60 compound stimuli: 20 with a fearful body expression, 20 with a happy body expression and 20 with a neutral body expression. See Fig. 1 for stimulus examples.

2.2.4.2. Face-scene. We created face-scene compounds by placing the face in the middle of the scene. Additionally, we added a dark schematic upper torso under the face, in order to avoid the impression of a 'floating' face. Care was taken that the face or torso did not conceal essential parts of the scene. Sixty face-scene compounds were created: 20 with a fearful scene, 20 with a happy scene and 20 with a neutral scene. See Fig. 1 for stimulus examples.

2.3. Procedure

Participants were randomly assigned to one of four conditions, using a 2 emotion (fearful and happy) $\times$ 2 category (body and scene) factorial design. In each of the four conditions, 20 emotional and 20 neutral compound stimuli were presented. For example, in the fearful body condition, participants were shown 20 fearful face-body compounds and 20 neutral face-body compounds. This design allows making within-subject comparisons between neutral and emotional context influences. There was no overlap between the identities in the neutral and emotional tasks. See Fig. 1 for a schematic presentation of the procedure and stimulus examples. The study consisted of an encoding block and a recognition block. In the encoding block, participants were randomly presented one by one all 40 compound stimuli for 1000 ms, separated by an ISI of 3000 ms during which a dark screen was presented. The instructions stated to memorize the identity of the face in order to recognize it in a later phase of the experiment. The participants were explicitly instructed that they were to remember the face and only the face, regardless of any other contextual information. After all 40 compound stimuli were presented once, a second encoding run followed with the same stimuli and instructions. We used two encoding runs, because we wanted 20 emotional (and 20 neutral) trials per condition and aimed at an average correct recognition performance above 70%.

The recognition block followed the encoding block. A trial consisted of simultaneous presentation of two isolated faces of which one was presented during the encoding block. Both faces were cropped so outer non-face features like the hair were mostly concealed and the 'new' face was matched with the 'old' regarding gender and hair color. Participants were instructed to indicate which of the two faces they recognized by pressing the left or right response button, indicating their choice for the corresponding face. The two faces were presented until response, after which a dark screen was presented for 1500 ms.

3. Results

Accuracies in the recognition block were computed as a function of emotional valence (fear, happy or neutral) and category (body or scene) in the encoding block. The results are displayed in Fig. 2. We additionally calculated the median reaction times (RT) of the correct trials. For every condition, we compared the neutral with the emotional accuracy rates and RT, using paired

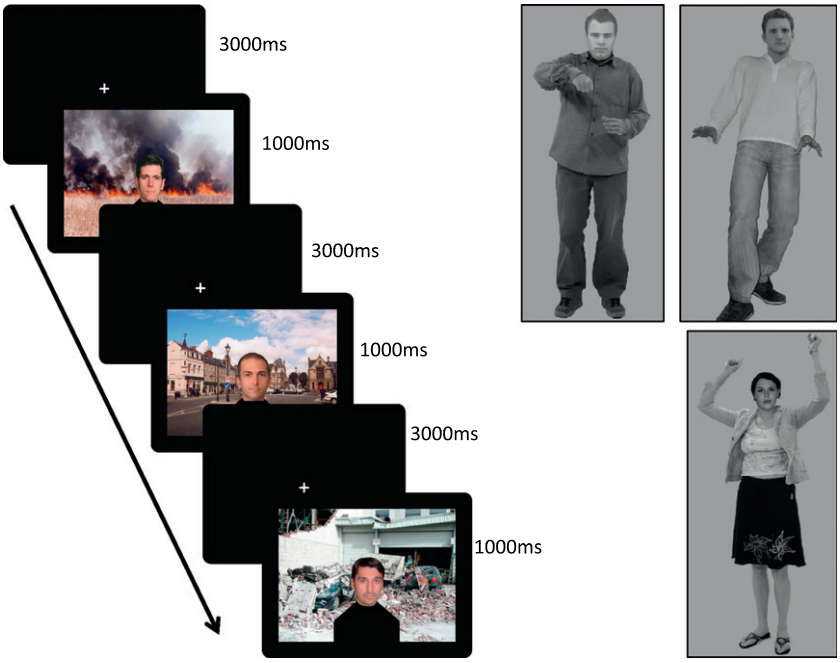

Fig. 1. Left: schematic presentation of the procedure in the encoding block. Stimuli were presented for 1000 ms with a 3000 ms inter stimulus interval. The stimuli display a neutral face in a (from top to bottom) fearful, neutral and fearful scene. Right: Stimulus examples of face-body compounds showing a fearful body on the top right, a neutral body on the top left and a happy body on the bottom right.

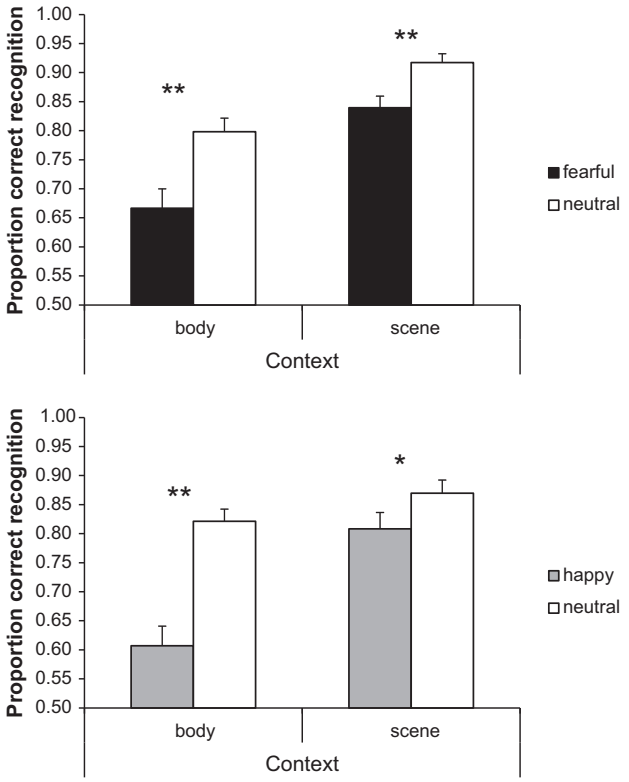

Fig. 2. Proportion correct face identity recognition as a function of context emotion in the encoding block. Error bars represent 1 SEM. ** = $p < 0.001$; * = $p < 0.05$.

samples t-tests and this revealed significantly higher accuracy ($t(26) = 5.132$, $p < 0.001$) and lower median RTs ($t(26) = 2.24$, $p < 0.034$) for faces that were encoded with a neutral body compared to a fearful body; a higher accuracy for faces encoded with a neutral than a fearful scene ($t(28) = 4.31$, $p < 0.001$). There was no significant difference in the response time data ($p < 0.30$). The accuracy was significantly higher ($t(20) = 8.771$, $p < 0.001$) for faces that were encoded with a neutral body compared to a happy body. There was no significant difference between median reactions times ($p < 0.44$). Finally, accuracies for faces encoded with a neutral scene were higher than faces encoded with a happy scene ($t(17) = 2404$, $p < 0.028$). There was no significant difference in the response time data ($p < 0.33$).

To compare body and scene context effects and positive with negative emotional context effects, we calculated for every condition the difference between the emotional and neutral accuracy data and submitted the results to a 2 category (body and scene) $\times$ 2 emotion (fearful and happy) ANOVA. The results revealed a significant main effect of category ($F(1,91) = 19.06$, $p < .001$) and category x emotion interaction ($F(1,91) = 4.38$, $p < .039$). The proportional difference between the emotional bodies and neutral bodies (.17) was larger than the proportional difference between the emotional scenes and neutral scenes (.07). Post-hoc independent samples *t*-test showed that the difference between fearful body contexts and neutral body contexts was significantly smaller than the difference between happy body contexts and neutral body contexts ($t(46) = 2.288$, $p < .027$), whereas there was no difference between the happy and the fearful scene effect ($p < .590$).

4. Discussion

Our results provide clear evidence that the emotional value of the context in which a face is encountered determines how well it is remembered. This strong emotion effect of subsequent memory for the identity of the face obtains even if participants are explicitly instructed to memorize the face and the face only. Our results show that facial identity is less well recognized when the face is seen with an emotional body expression or against an emotional background scene, compared to a neutral body or a neutral background scene. Furthermore, the emotional context effect on face memory obtains for contextual cues displaying a negative as well as a positive valence.

These findings are compatible with the hypothesis that emotionally salient events occurring outside the focus of attention (involuntarily) confiscate more cognitive resources than emotionally neutral contextual information (Vuilleumier, 2005). Emotional signals may trigger orienting responses in order to detect the source of potential danger. This may lead to a less elaborate encoding and analysis of feature details (Kensinger, Garoff-Eaton, & Schacter, 2007) like the identity of a face, in turn resulting in a decreased facial recognition memory.

An alternative explanation to consider is that emotional context affects memory at the stage of retrieving instead of encoding face identity information. For example, one could hypothesize that the encoding of a face identity in an emotional context is entirely comparable to the encoding of the same face in a neutral context. However, at the moment of encountering the face in the subsequent memory task, the emotional overtone associated with the stored face identity influences non-consciously the retrieving of that record, thereby hampering recognition performance. This explanation entails that the target face stimulus and the non-target body or scene stimulus are encoded separately and only subsequently linked together by another mechanism. The putative mechanism could be source memory. In any case, a supplementary mechanism needs to be postulated that links on a one to one basis the face and the scene or context in which it is originally encountered. At this stage, interactive processing of the target face and the non-target stimulus seems a plausible alternative. Furthermore, we believe that emotional context effects occurring at the retrieving phase would primarily obtain during active reproduction tasks, whereas in the current study the recognition task consisted of indicating which of the two presented faces also occurred in the encoding blocks. This format was designed to allow simple matching between perceived and stored face identity and hence limit active reproduction processing, minimizing susceptibility to emotion effects occurring post-encoding.

Our results further indicate that the emotional context effects are larger for bodies than for scenes. It is obviously difficult to directly compare the effect of bodies and scenes given the many differences between these two stimulus categories. Following the principle of transfer appropriate processing, retrieval cues will be more effective the more closely they match the studied representation (Rugg, Johnson, Park, & Uncapher, 2008), and the body and scene conditions differ remarkably in how closely they match the retrieval cues. Specifically, the retrieval cues were faces presented in isolation (i.e., as disembodied heads), as were the faces in the scene condition (disembodied heads superimposed on scenes), but this was not the case for the body condition (heads realistically configured on bodies). Thus, it is difficult to interpret any effects of context category (body vs. scene) without knowing the contribution of the effect of encoding-retrieval overlap in the stimuli. Our results provide a first indication for future studies addressing the interaction between contextual emotional memory effects and encoding-retrieval overlap.

Face-context interactions have so far only been investigated in one direction (namely the effect of the context on the face) at the perception stage. An interesting question for future studies concerns the effect of the facial expression on how the emotional significance of the context is seen. One can reason that superimposing faces on neutral or emotional scene stimuli does not radically change the interpretation of the scene. It seems unlikely that a neutral face would influence raters to categorize a negatively valenced scene as neutral or positive. But the same may not hold for face-body stimulus conjunctions. An interesting question for future studies therefore lies in investigating how facial expressions influence emotion perception of context cues.

To our knowledge, this has only been investigated at the memory stage. A recent study investigated the effects of face expression on memory for context. Neutral and emotional faces were presented but all against a neutral background and the results showed that when participants label the facial expression during encoding, contexts are remembered better when they contained an emotional face compared to a neutral face (Barrett & Kensinger, 2010). This result is also compatible with the hypothesis that emotional signals, either conveyed by a face or a scene, boosts encoding of the global visual input and not of features like facial identity.

The emotional context effect on memory may be specific for faces, since studies investigating emotional contextual influences on object memory showed partly opposite results. Objects encoded in a positive context are better remembered than in a neutral context, whereas no differences have been reported between object memory in neutral and negative contexts (Smith, Dolan, & Rugg, 2004; Smith, Henson, Dolan, & Rugg, 2004). Possibly, the discrepant results may relate to differences in face vs. object memory, although there are significant methodological differences between our study and both studies by Smith and colleagues. For instance, in our study only 40 faces had to be recognized after 2 encoding events whereas in both studies by Smith and colleagues 180 objects had to be recognized after only 1 encoding event. Although recognition rates were very high (around 80%), the latter design may lead to an overload of the memory capacity and an overshoot in task difficulty may trigger different memory processes at different time intervals.

Our findings have important practical implications for the value of eyewitness testimonies. The data show that recognition memory of unfamiliar persons encountered during emotional situations (which is usually the case in judicial practice) may be questioned, especially if the person displayed emotional signals in body language.

At the neural level, there is evidence that emotional memory effects are associated with the amygdala (for reviews, see Kensinger, 2004; LaBar & Cabeza, 2006; Phelps, 2004). However, generally emotion effects on non-face memory typically shows enhancement for emotional memories, whereas we observe a clear decrease for emotional context effects on face memory. An explanation may be that faces by themselves also activate amygdala and when presented together with emotional signals displayed by contextual cues, this may result in a competition situation between faces and contextual emotion signals. So the decrease in memory for faces encoded in emotional contexts may result from interference by the contextual cues on amygdala activation. The finding that emotional context effects are larger for bodies than for scenes is compatible with this explanation, since previous studies have shown that bodily expressions also activate the amygdala (for a review, see de Gelder et al., 2010).

An interesting question for future studies concerns how emotional contexts influence memory not for neutral faces as used here but for facial expressions (see also Barrett & Kensinger, 2010). Our study focused on emotional context influence on memory for neutral faces and therefore does not allow to assess congruency effects between affective information of the face and that of the context. Furthermore, we investigated contextual emotion effects on short term recognition memory, but these influences may differ from emotion effects on long term face memory, for example several weeks after encoding when consolidation processing has occurred (Hamann, 2001).

5. Conclusion

The present findings clearly show that memory for facial identity is hampered when faces are encoded in positively or negatively valenced emotional contexts as provided by bodies and scenes. This may be explained by interference of the emotional contexts on activation of amygdala.

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