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Startle eye-blink modulation by facial self-resemblance and current mood

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ABSTRACT

Although salient stimuli are known to modulate startle eye-blink responses, and one's own face is considered of particular salience, effects of facial self-resemblance on startle responsiveness have not been systematically investigated. For the present study, pictures from the FACES database (rated as neutral) were digitally morphed to resemble the participants' (N = 37) faces to varying degrees (25–50–75%). Perceptually matched geometrical shapes served as a control condition. At SOAs of either 300 ms or 3000 ms after picture onset, startle responses were elicited by white noise (50 ms, 105 dB), and recorded at the orbicularis oculi via EMG. Prior to the experiment, self-reported mood was assessed by means of the PANAS. Relative to non-face stimuli, the presentation of faces reduced startle magnitude at short, but not long, lead intervals. Furthermore, for probes presented at a SOA of 300 ms, a linear decrease in startle magnitude with higher levels of self-resemblance was observed, presumably reflecting higher salience of the self-face. The startle modulating effect of self-resembling faces during longer lead intervals was moderated by the participants' current mood: negative affect predicted stronger patterns of attenuation, which might be interpreted as an increase in self-focus resulting from more negative mood.

1. Introduction

Face recognition can be considered a prerequisite for our sense of personal identity, which might even explain why human faces, by contrast with other traits, evolved to show increased phenotypic variation (Sheehan and Nachman, 2014). In line with the notion of their special biological and social significance, faces tend to capture attention on an automatic, 'exogenous' level, when compared to other categories of objects, as indexed by resistance to change blindness (Ro et al., 2001) as well as enhanced inhibition of return (Theeuwes and van der Stigchel, 2006). While the salience of faces as a perceptual category is rarely open to doubt, the status of one's own face, however, has been a point of recent debate. Specifically, both behavioral and neurophysiological evidences indicate that the self-face benefits from a processing advantage at the stage of encoding (Tong and Nakayama, 1999; Keyes et al., 2010), and interferes with attentionally demanding tasks when presented as a distractor (Brédart et al., 2006). However, whether these effects do indeed reflect prioritized perceptual processing has been challenged. Instead, it has been advocated that the attention-grabbing capacity of the self-face relies on top-down control processes preventing disengagement of attention (Devue and Brédart, 2008). A related objection could be based on the assumption that allocation of selective attention is likely to precede recognition of facial identity (Ro et al., 2001). Nonetheless, perceiving your own face has been shown to modulate early event-related potentials (like the N170, commonly thought to involve pre-attentive structural encoding; Keyes et al., 2010), even under conditions of subliminal presentation (Geng et al., 2012). Importantly, these effects proved independent of mere familiarity. So far, however, little is known about the impact of various degrees of similarity on the attentional bias toward faces: if the processing advantage reported for self-face pictures can be found to extend to self-resembling faces in general, this would provide further evidence for the automaticity of self-face recognition.

In order to disentangle automatic from more controlled processes associated with the perception of self-resemblance, the current study took a somewhat novel approach, making use of startle modification as an index of face processing. Startle eye-blink responsiveness is known to be modulated by a variety of psychological parameters, including the concurrent presentation of visual foreground stimuli. Depending on the latency of the startle-eliciting probe relative to picture onset, either prepulse inhibition [PPI] or affective modulation of startle can be observed (Bradley et al., 1993). At long lead intervals (usually in the range of several seconds), the match or mismatch between the emotional valence of the stimulus and the defensive system underlying startle results either in potentiation due to unpleasant/negative pictures

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or in decreased startle in the presence of pleasant/positive content (Bradley et al., 1990). However, startle magnitude is also strongly affected by perceptual and attentional factors (Anthony and Graham, 1985; Blumenthal, 2001). When acoustic stimuli are used as prepulses, startle responses are inhibited at SOAs ranging from about 15 to 400 ms, and this inhibition (peaking at around 120 ms) seems to rely mostly on pre-attentive mechanisms serving to protect the processing of the preceding stimulus from interference (Blumenthal, 2008). Regarding the deployment of complex pictures as foreground stimuli, however, a somewhat different pattern emerges, with initial facilitation (at 50 ms) and maximum inhibition at onset delays of 300 ms (Bradley et al., 2006). Notably, differential effects of picture content on startle magnitude were found not to arise earlier than 300 ms after picture onset. Since PPI and affective modulation are probably uncorrelated within individuals (Hawk and Cook, 2000), startle responsiveness can be considered a promising measure of both the amount of attention drawn by the picture of a face (when probed at short lead intervals) and the affective value attached to it (when probed at long lead intervals). Although this approach might not always and unequivocally discern between affect and attention (e.g., see Blumenthal, 2001, for effects of continuous attention in startle modification), it seems nevertheless well suited to disentangle more automatic allocation of attention from affective factors in face processing. Important additional advantages of startle methodology include its low susceptibility to demand characteristics, its high signal-to-noise ratio, and comparatively little long-term habituation. This seems especially decisive when there are natural constraints as to the number of stimulus repetitions (which is obviously the case with a highly restricted class of stimuli, such as faces identical and/or similar to one's own).

In line with the current approach, there is evidence that viewing pictures containing one's own face results in reduced startle responses relative to both neutral and emotionally arousing (negative/positive) stimuli (Buck et al., 2004).[1] Interestingly, a similar effect was also found with regard to faces bearing more subtle signs of self-resemblance, when presented in the context of erotic cues (Lass-Hennemann et al., 2011). Using long lead intervals only, Buck et al. (2004) nevertheless account for their findings in terms of an attentional bias toward the self, which is assumed to boost the startle attenuation driven by the affective value of the self-face. Similarly, in a study reported by Guerra et al. (2012), trials involving familiar faces (belonging to parents and romantic partners) were associated with substantially less startle reactivity than pictures of unknown faces. This finding raises the question whether the main mechanism behind the startle-attenuating effect of the self-face is a difference in attention, as suggested by Buck et al. (2004), or rather the face's subjective valence, i.e., some kind of positivity-bias. So far, previous studies have employed solely long lead intervals (ranging from 2 to 10 s), making it difficult to clearly distinguish between affective processes and other potential causes, such as more controlled allocation of attention. However, if the processing of self-related facial features exhibits a high degree of automaticity, it should be expected to impact startle responses elicited at very short latencies to the foreground picture as well, even faces with only partial similarity to the self. In order to address this hypothesis, the present study used morphed pictures, varying in resemblance to the participant's face, which were probed after both short (300 ms) and long (3000 ms) lead intervals. The timing of the short interval was based on evidence that the earliest differential impact of picture content on startle can be observed at onset delays of 300 ms (Bradley et al., 2006). It was also chosen because this latency corresponds roughly to the time course of face processing as described in previous studies (with the N250 being the first electrophysiological index of recognizing familiar faces; e.g., Schweinberger et al., 2004). Moreover, to exclude the possibility that rapid processing of emotional cues (such as facial expressions) would confound startle responses both at long and short onset delays (Duval et al., 2013), special care was taken only to include stimulus materials as affectively neutral as possible (i.e., neutral facial expression, no hair or clothing, etc.).

For exploratory reasons, we also tested the hypothesis that exteroceptive perception of self-referential stimuli might be facilitated by concurrent interoceptive signals, because previous research had indicated a close interplay of external and internal self-referential processing, for example, in the case of multisensory (visuo-tactile) stimulation potentially inducing alterations in the threshold for visual self-recognition (Tsakiris, 2008; Sforza et al., 2010). The finding that the accuracy of counting one's heartbeat can be improved by simultaneous presentation of one's own face (as well as through exposure to self-related words; Ainley et al., 2013) also points to an intrinsic connection between the processing of bodily signals, on the one hand, and self-face recognition, on the other. Therefore, we made use of naturally occurring changes in afferent baroreceptor activity as a model of intraindividual alterations in visceral sensations, by presenting pictorial stimuli locked to different phases of the cardiac cycle. Although the available evidence as to whether baroreceptor activation is able to modulate the subjective appraisal of affective pictures is still inconclusive (Nyklíček et al., 2005; Gray et al., 2012), there is growing support for the assumption that not only somatosensory processing (Edwards et al., 2009), but also genuinely cognitive functions, such as stimulus evaluation and motor response times, are affected by the cardiac cycle (Schulz et al., 2009). In addition to the impact of baro-afferent feedback, we were interested in potential interactions with the participants' subjective mood, because several theoretical models derived both from research in personality/social psychology and from clinical observations posit a close, possibly reciprocal relationship between negative affect and attention directed toward the self (see Mor and Winquist, 2002). Moreover, previous studies on attentional modulation of startle point to the possibility that the association between startle reactivity and self-focused attention may be a complex one, possibly moderated by negative emotional states such as anxiety (Panayiotou and Vrana, 1998). In order not to interfere with the experimental procedure itself, we opted for assessing the participants' current mood by means of self-report prior to the startle modulation paradigm.

Summing up, the present study aimed at investigating whether viewing faces, relative to non-face pictures, causes attenuation of startle and whether this effect increases with higher levels of similarity to the self. Moreover, by employing different lead intervals, we tried to elucidate the main mechanism underlying this phenomenon, i.e., the contribution of attentional vs. emotional factors. In addition, the effect of the cardiac cycle on the processing of self-resemblance was assessed by presenting pictures either locked to the systole or diastole.

2. Methods

2.1. Participants

Forty-one undergraduate students (22 women) from the University of Trier and the local University of Applied Science ('Hochschule Trier') participated for partial course credit or a small monetary recompense (25 €). After rejecting the data from non-responders ($N = 3$) and participants whose average heart-rate did not allow stimulus-locking to the diastolic phase ($N = 1$) (see Section 2.4.2 below), the final sample consisted of 19 women and 18 men; mean age was 23.0 ($SD = 2.5$).

All participants reported normal or corrected-to-normal vision. Participation was limited to individuals neither wearing beards nor facial piercings (except earrings). Further exclusion criteria, which were checked beforehand by means of a short diagnostic interview, included

[1] A more recent dissertational study (Taylor, 2011), investigating the impact of one's body image on affective reactions, found a comparable pattern of results. Specifically, both women scoring low and high in weight concern exhibited diminished acoustic startle responses when presented with pictures showing their own body or face, compared with neutral pictures (from the IAPS database).