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Affective engagement for facial expressions and emotional scenes: The influence of social anxiety

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ABSTRACT

Pictures of emotional facial expressions or natural scenes are often used as cues in emotion research. We examined the extent to which these different stimuli engage emotion and attention, and whether the presence of social anxiety symptoms influences responding to facial cues. Sixty participants reporting high or low social anxiety viewed pictures of angry, neutral, and happy faces, as well as violent, neutral, and erotic scenes, while skin conductance and event-related potentials were recorded. Acoustic startle probes were presented throughout picture viewing, and blink magnitude, probe P3 and reaction time to the startle probe also were measured. Results indicated that viewing emotional scenes prompted strong reactions in autonomic, central, and reflex measures, whereas pictures of faces were generally weak elicitors of measurable emotional response. However, higher social anxiety was associated with modest electrodermal changes when viewing angry faces and mild startle potentiation when viewing either angry or smiling faces, compared to neutral. Taken together, pictures of facial expressions do not strongly engage fundamental affective reactions, but these cues appeared to be effective in distinguishing between high and low social anxiety participants, supporting their use in anxiety research.

1. Introduction

The study of emotion relies on the use of cues or contexts that reliably engage the bodily reactions that collectively have defined emotion for the psychophysiologist for over a century. Among the visual cues often used to investigate emotion are pictures of facial expressions (Ekman and Friesen, 1976; Hansen and Hansen, 1998; Gur et al., 2002; Lundqvist et al., 1998; Matsumoto and Ekman, 1988; Tottenham et al., 2009) and pictures of pleasant and unpleasant natural scenes (Lang et al., 2008). Previous studies, however, report small or null effects of emotional expression on autonomic measures of emotional reactivity (e.g., Alpers et al., 2011; Surcinelli and Codispoti, 2007). In fact, faces are more often utilized as affective cues in behavioral paradigms (e.g., dot-probe, Mogg and Bradley, 2002; Perez-Edgar et al., 2010; visual search, Frischen et al., 2008; Juth et al., 2005) or neuroscience investigations (e.g., Eimer and Holmes, 2007; Portois and Vuilleumier, 2006) in which emotional expressions can affect reaction time, ERPs or BOLD activity.

One possibility is that pictures of emotional expressions can influence attention and other cognitive processes, without necessarily strongly activating the autonomic and somatic reactions indicative of emotional engagement. Thus, in the current study, we measure emotional and attentional indices of processing for faces and scenes. In particular, we measure three different reactions to a startling acoustic probe presented during picture viewing: the blink reflex, the P3 component elicited by the startle probe, and speeded reaction time. Central questions concern whether emotional faces prompt affective modulation of the blink reflex, and whether concurrent measures of attention, including reaction time and the event-related potential (ERP) to the startle probe, will show evidence of heightened processing (or avoidance) of emotional expressions, particularly for participants reporting high social anxiety.

The blink component of the startle reflex is reliably potentiated when viewing aversive compared to neutral scenes, and is attenuated for pleasant scenes (e.g., Lang and Bradley, 2010); thus it is a useful measure of emotional reactivity during picture viewing (Vrana et al., 1988). Several previous studies have examined startle reflex modulation during affective face viewing, with some studies reporting modest startle potentiation when participants view unpleasant facial expressions (Anokhin and Golosheykin, 2010; Dunning et al., 2010; Grillon and Charney, 2011; Hess et al., 2007; Springer et al., 2007).

A number of paradigmatic specifications have been noted, however. For example, Anokhin and Golosheykin (2010) reported startle potentiation for angry and fearful faces that was only significant for female participants. In contrast, Springer et al. (2007) reported potentiated startle when participants viewed angry, but

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not fear, faces, regardless of gender. Hess et al. (2007) also reported startle potentiation specifically prompted by angry faces, but only for pictures depicting male expressors. Using angry faces only, Dunning et al. (2010) manipulated picture arousal by systematically morphing faces to display varying levels of intensity, and only found potentiation for angry faces rated as maximally intense. Studying fear faces specifically, Grillon and Charney (2011) reported startle potentiation when viewing fearful expressions, but only when participants were also under threat of shock (Grillon and Charney, 2011). Moreover, at least two studies have reported that startle magnitude is enhanced when participants view *either* happy or angry expressions compared to neutral faces (Alpers et al., 2011; Garner et al., 2011)—a different pattern of reflex modulation than observed when viewing arousing pleasant and unpleasant scenes. In the current study, we intermixed pictures depicting happy, angry, and neutral facial expressions with pictures of emotional and neutral natural scenes, which allowed a direct comparison of startle reflex modulation across picture type.

Assuming that startle potentiation will not be strong for facial expressions, however, our next question concerned possible differences in attention allocation to pictures of facial expressions. Previous studies in our laboratory and others (Cuthbert et al., 1998; Schupp et al., 1997; Bradley et al., 1999; Smith et al., 2005) have clearly indicated that the amplitude of the P3 component elicited to a startling probe presented during picture viewing serves as an accurate index of resource allocation: when people view emotional pictures, the probe P3 is attenuated throughout the viewing interval, suggesting fewer resources are available for processing the secondary probe when attention is captured by the affective foreground cue. Moreover, reaction time to startle probes is similarly affected, particularly shortly after picture onset, with slower reactions for emotional, compared to neutral, pictures (Bradley et al., 1999). In the current study, we measured both ERPs and speeded reaction time to startle probes presented when viewing faces or scenes, to gauge heightened attention allocation even in the absence of evidence of strong emotional engagement.

Moreover, previous research suggests that socially anxious individuals may particularly exhibit enhanced attentional and emotional processing when viewing emotional faces, and information processing theories of social phobia propose that symptoms may be maintained, in part, by a face-specific attentional bias (e.g., Heinrichs and Hofmann, 2001). For example, social phobia patients, compared to controls, have shown increased selective attention to angry faces in a variety of behavioral task paradigms (e.g., Mogg and Bradley, 2002; Juth et al., 2005; Putman et al., 2004). High social anxiety has also been associated with faster visual orienting to emotional faces (happy or angry) in eye-tracking research (e.g., Garner et al., 2006; Wieser et al., 2009), and with enhanced ongoing visual attention to emotional faces in ERP paradigms (McTeague et al., 2011; Mühlberger et al., 2009). Thus, an additional aim of the current study is to assess the extent to which reports of heightened social anxiety are associated with greater affective reactivity to emotional faces.

1.1. The current study

The present research examines affective and attentional engagement when participants view intermixed sets of (1) standardized happy, neutral, and angry facial expressions, and (2) pictures of emotional and neutral natural scenes. Face cues were selected from the Karolinska Directed Emotional Faces set (KDEF; Lundqvist et al., 1998). These images are more naturalistic than exaggerated or posed collections (i.e., Ekman and Friesen, 1976; Tottenham et al., 2009) and have been controlled for perceptual variables that might impact ERP measures.

Emotional scenes were selected from the International Affective Picture System (Lang et al., 2008) and included erotic and violent pictures. It is well-known that the visual scenes that strongly elicit responses in autonomic and somatic systems indicative of emotion are those that are rated as highly arousing (Balaban and Taussig, 1994; Bernat et al., 2006; Bradley et al., 2001; Codispoti et al., 2001; De Cesarei and Codispoti, 2010; Lang et al., 1993). In a systematic investigation of the effects of rated arousal and semantic content on psychophysiological reactivity, we found that pictures of erotica and violence most reliably engage emotional reactions, whereas contents rated lower in arousal, such as babies, pollution, and illness are more similar to neutral in their affective profile (Bradley et al., 2001). In the current study, therefore, we included pictures of erotica and violence as high arousal anchors for evaluating reactivity to facial expressions, but expected these scenes to generate strong emotional reactions compared to facial expressions, based on previous findings that emotional faces are rated relatively low in arousal and do not strongly elicit emotional reactions (Alpers et al., 2011; Lang et al., 2008; Surcinelli and Codispoti, 2007). Of major interest was whether pictures of facial expressions would differ from a set of neutral natural scenes also included in the stimulus set.

In addition to three responses to the startle probe, including speeded reaction time, the reflexive startle blink, and the amplitude of the P3 component of the ERP, the measurement array included continuous recording of skin conductance and picture-related ERPs. This array provides a profile of emotional and attentional engagement across the viewing interval: initial attention capture is reflected by slowed RT to startle probes; patterns of appetitive and defensive response mobilization are distinguished by startle reflex attenuation and potentiation, respectively; and probe P3 amplitude indexes continued attention capture across the viewing interval. Skin conductance tracks sympathetic activity associated with response mobilization, and the amplitude of the late positive potential provides a brain-based index that a cue is "significant"—activating appetitive or defensive motivational systems (Bradley, 2009).

2. Method

2.1. Participants and screening measures

Sixty (30 female) participants from University of Florida introductory psychology classes received course credit for participation. Participants were selected based on their total score on the Liebowitz Social Anxiety Scale—Self Report Version (LSAS-SR; Fresco et al., 2001), which was administered in an initial online prescreening session. The LSAS-SR is a 24-item questionnaire assessing dimensional severity of social anxiety symptoms. A total score of 60 has been established as the cutoff for significant symptoms of generalized social phobia (Rytwinksi et al., 2009), so to ensure recruitment of high- and low-anxiety participants, those with pre-screening LSAS total scores of 60 or greater, or lower than 40, were invited to participate.

The LSAS was re-administered at the laboratory session, and participants were assigned to either a high or low socially anxious group according to a median split on LSAS total score. The high anxiety group ($n = 30$, 21 male) reported an average total score of 67.8 (*s.d.* = 19.1) and the low anxiety group ($n = 30$, 11 male) reported an average total score of 23.7 (*s.d.* = 9.0).

2.2. Materials and design

Participants viewed 108 affective pictures representing pleasant, neutral, and unpleasant content, half depicting standard emotional facial expressions (54 pictures), and half depicting natural scenes (54 pictures). Emotional facial expressions were selected from the KDEF set (Lundqvist et al., 1998) and natural scenes from the IAPS (Lang et al., 2008). Specific contents portrayed scenes of human violence, neutral people in everyday situations, and erotic couples, and male and female facial expressions of anger, neutrality, and happiness. Mean (*s.d.*) normative arousal ratings for erotic, neutral, and violent scenes were 6.1(0.5), 3.4(0.5), and 6.3(0.5) (Lang et al., 2008), and for happy, neutral, and angry faces were 3.6 (0.3), 2.5(0.3), and 3.8(0.6) (Goeloeven et al., 2008).