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Embodying approach motivation: Body posture influences startle eyeblink and event-related potential responses to appetitive stimuli

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ABSTRACT

Past research suggested that the motivational significance of images influences reflexive and electrocortical responses to those images (Briggs and Martin, 2009; Gard et al., 2007; Schupp et al., 2004), with erotica often exerting the largest effects for appetitive pictures (Grillon and Baas, 2003; Weinberg and Hajcak, 2010). This research paradigm, however, compares responses to different types of images (e.g., erotica vs. exciting sports scenes). This past motivational interpretation, therefore, would be further supported by experiments wherein appetitive picture content is held constant and motivational states are manipulated with a different method. In the present experiment, we tested the hypothesis that changes in physical postures associated with approach motivation influences reflexive and electrocortical responses to appetitive stimuli. Past research has suggested that bodily manipulations (e.g., facial expressions) play a role in emotion- and motivation-related physiology (Ekman and Davidson, 1993; Levenson et al., 1990). Extending these results, leaning forward (associated with a heightened urge to approach stimuli) relative to reclining (associated with less of an urge to approach stimuli) caused participants to have smaller startle eyeblink responses during appetitive, but not neutral, picture viewing. Leaning relative to reclining also caused participants to have larger LPPs to appetitive but not neutral pictures, and influenced ERPs as early as 100 ms into stimulus viewing. This evidence suggests that body postures associated with approach motivation causally influence basic reflexive and electrocortical reactions to appetitive emotive stimuli.

1. Introduction

Two of the most widely used psychophysiological measures of responses to affective stimuli are the startle eyeblink response and the late positive potential (LPP) of the event-related potential (ERP). Both appear responsive to the motivational significance of affective stimuli. That is, arousing affective stimuli exert the largest effects on the startle eyeblink response and LPP. And arousal has been posited to be a proxy for motivational significance (Bradley and Lang, 2007). For instance, highly arousing appetitive pictures have been found to influence startle responses (Gard et al., 2007; Grillon and Baas, 2003) and the LPP (Briggs and Martin, 2009; Schupp et al., 2004; Weinberg and Hajcak, 2010) more than less arousing appetitive pictures. Although these results do indeed suggest that motivational significance influences the startle eyeblink and LPP responses, more causal evidence for this postulate could come from a manipulation of motivational intensity that held the appetitive stimulus content constant. The present research was designed to provide this evidence.

1.1. Motivational modulation of the startle eyeblink response

The startle reflex causes the orbicularis oculi muscle around the eye to contract to sudden aversive events, protecting the eye from potential harm. In the lab, the startle response is typically induced by loud (100 db) bursts of white noise with instantaneous rise time (Blumenthal et al., 2005). When startle probes are presented early into picture viewing (e.g., 300 ms following picture onset; Grillon and Baas, 2003), startle eyeblinks have been found to be modulated primarily by attentional processes (Bradley et al., 1993, 2006). Consistent with this notion, behavioral research suggested that both unpleasant and pleasant pictures receive equal attention at an early processing stage (Calvo and Lang, 2004). For startle stimuli presented later into picture viewing, however, the startle eyeblink response has been found to be reliably modulated by the emotive significance of stimuli (Bradley et al., 2001; Lang et al., 1990; Vrana et al., 1988). This emotive modulation of the startle reflex occurs even when the same picture is presented 30 times in a row

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(Ferrari et al., 2011). The magnitude of startle eyeblinks is potentiated by arousing negative pictures and attenuated by arousing positive pictures. This effect is explained by the response-matching hypothesis, which postulates that the startle eyeblink is a basic defensive reaction that is responsive to the presence of affective cues. Aversive cues, such as arousing negative pictures, exacerbate the congruent avoidant motivation elicited by the startling sound and lead to larger startle blinks. Appetitive cues, such as arousing positive pictures, contrast the avoidant motivation of the startling sound and these inconsistent motivational states lead to smaller startle blinks. Animal research has found that nuclei within the amygdala play a critical role in the affective modulation of the startle response (Davis, 2006).

Consistent with the response-matching hypothesis, the startle response has been linked with motivation. High trait behavioral approach system (BAS) sensitivity, measured with Carver and White's (1994) scale, is correlated with smaller startle responses during arousing positive pictures (Hawk and Kowmas, 2003). Furthermore, trait emotions associated with approach motivation (e.g., anger, enjoyment, surprise) are correlated with smaller startle responses during arousing positive pictures (Amodio and Harmon-Jones, 2011). In addition, positive pictures associated with approach motivation (e.g., erotic images) attenuate startle responses more than positive pictures less associated with basic motivational impulses (e.g., sports scenes; Gard et al., 2007).

Although these studies provide support for the idea that the startle response is influenced by the motivational significance of stimuli, more work is needed. For example, pictures of erotica and exciting sports scenes differ in variables other than approach motivational intensity; for instance, they differ in content (e.g., sport scenes are more likely outdoors than erotic scenes). In the present experiment, we manipulated motivational states by changing physical posture (i.e., leaning forward vs. reclining backward) while keeping the image content of appetitive stimuli constant across posture. Based on past research as well as associations between posture and approach motivation, we predicted that leaning forward would cause greater approach motivation than reclining backward.

Our ideas about the body posture manipulation are consistent with past research demonstrating that bodily manipulations influence emotion- and motivation-related physiology. For example, different facial expressions have been linked to different patterns of autonomic nervous system activity (Levenson et al., 1990). In addition, genuine smiles with Duchenne's marker (activation of zygomatic major and orbicularis muscle regions) as compared to less genuine smiles have been found to cause greater relative left frontal cortical activity, a neural correlate of approach motivation (Ekman and Davidson, 1993; for other emotional facial expression evidence, see Coan et al., 2001). Similarly, in response to appetitive stimuli, reclining backward has been found to cause lesser relative left frontal cortical activity as compared to sitting upright (Harmon-Jones and Peterson, 2009) and leaning forward (Harmon-Jones et al., 2011). In addition, slumped or helpless postures have been found to cause less task persistence as compared to upright and expansive postures (Riskind and Gotay, 1982). This past work, however, did not address if changes in physical posture influence more basic, reflexive physiological responses. In the present experiment, we tested whether changes in physical posture would influence the magnitude of the emotion-modulated startle eyeblink reflex.

1.2. Motivational modulation of the LPP

In addition, we investigated whether physical posture influences the LPP, an ERP starting 300 ms after stimulus onset and lasting for several 100 ms over central–parietal regions. The LPP has been found to be reliably influenced by the emotive significance of stimuli (Hajcak et al., 2012). For example, LPPs are larger to erotic pictures compared to positive pictures less associated with basic motivational impulses, such as exciting sports scenes (Briggs and Martin, 2009; Weinberg and Hajcak, 2010). In addition, mothers have larger LPPs to pictures of their own children's faces relative to pictures of familiar children, unfamiliar children, familiar adults, and unfamiliar adults (Grasso et al., 2009). Individuals who are currently in love with another person, furthermore, evince larger LPPs to pictures of that person relative to pictures of a friend or a beautiful but unknown person of the opposite sex (Langeslag et al., 2007). LPPs are also larger to scenes of mutilation and threat compared to scenes of contamination and loss (Schupp et al., 2004). Functional magnetic resonance imagining (fMRI) and electroencephalography (EEG) studies have revealed multiple neural generators of the LPP, such as the occipitotemporal and parietal cortex (Keil et al., 2002; Sabatinelli et al., 2007).

Similar to work with the emotion-modulated startle response, however, the idea that the LPP is responsive to motivational significance would be further supported if manipulated changes in motivational states were found to influence the LPP to identical pictures. To our knowledge, no work has examined if manipulating motivational states via body posture influences startle and LPP responses to emotive stimuli that are otherwise held constant. In addition, no work has examined if whole body manipulations influence fast responses such as the startle eyeblink and LPP. However, the possibility exists that bodily manipulations might influence even faster ERP responses.

1.3. Motivational modulation of early ERP components

Several earlier visual components of the ERP have also been found to be modulated by emotive as compared to neutral stimuli, though they produce less consistent effects (see review by Olofsson et al., 2008). In contrast to the LPP, whether these earlier ERP components differ between emotive and neutral stimuli depends on reference scheme and type of analyses used (Hajcak et al., 2012, for review). Early ERP components that occasionally differ between emotive and neutral pictures are the N1, which is a negative-going wave that peaks between 100 and 200 ms following stimulus onset (Foti et al., 2009; Keil et al., 2001); the P1, which is a positive-going wave that peaks between 100 and 200 ms following stimulus onset (Bernat et al., 2001; Pourtois et al., 2005; Santesso et al., 2008); and the early posterior negativity (EPN), a relative negative-going wave that peaks between 200 and 300 ms following stimulus onset (Dunning et al., 2011; Olofsson et al., 2008; Schupp et al., 2003).

1.4. The present experiment

To investigate if postures varying in approach motivation influence these physiological responses, we had participants recline backward or lean forward in a fully counterbalanced within-subjects design. Leaning often occurs in approach behavior and reclining often occurs when individuals are satiated; thus, these two postures reflect extremes in approach motivation (in a chair). While in these postures, participants viewed sexual scenes involving pairs of men and women (erotic images) and scenes of pairs of individuals talking or walking (neutral images). Based on prior research, we predicted that startle eyeblinks would be smaller during erotic images than neutral images, and moreover, that startle eyeblinks during erotic images would be smaller when viewed in the high approach leaning as compared to the low approach reclining posture. Posture, however, was not predicted to influence startle responses during neutral images.

In addition, we predicted that LPPs would be larger to erotic images than neutral images, and moreover, that the LPPs to erotic images would be larger when viewed in the high approach leaning