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Toward an understanding of the emotion-modulated startle eyeblink reflex: The case of anger

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Abstract

Three studies investigated the effect of angering pictures on the startle eyeblink response, based on anger's unique identity as an approach-oriented negative affect. In Study 1, eyeblinks to startling noise probes during angering and neutral pictures did not differ, despite angering pictures being rated higher on arousal and anger and more negative in valence. Study 2 replicated Study 1; also, dysphoric participants exhibited potentiated eyeblinks to probes during angering pictures much like those to probes during fear/disgust stimuli. A follow-up study revealed that dysphoric participants rated angering pictures higher in fear. Study 3 again found that eyeblinks to probes during angering and neutral pictures did not differ. Taken together, these results suggest that probes during angering stimuli elicit eyeblinks much like those during neutral stimuli, perhaps due to the competing influences of arousal, valence, and motivation on the startle eyeblink reflex.

Descriptors: Startle eyeblink, Emotion, Motivation, Anger

The startle eyeblink response, a defensive reaction, traditionally follows a linear pattern during emotional stimuli. Specifically, startle eyeblinks to noise probes during fear/disgust or aversive stimuli are larger and startle eyeblinks to probes during pleasant or appetitive stimuli are smaller than ones that occur in response to probes during neutral stimuli[1] (Vrana, Spence, & Lang, 1988). Lang and colleagues (Bradley, Cuthbert, & Lang, 1990; Lang, Bradley, & Cuthbert, 1990) posited that the modulation of such startle responses depended on the match or mismatch of the emotional valence of the foreground with the startle probe. That is, because the startle probe is aversive, stimuli that also prompt an aversive or avoidant reaction elicit a larger response, whereas stimuli that prompt an appetitive reaction inhibit the reflexive aversive response to the startle probe. As such, the startle reflex will either be enhanced or inhibited, depending on whether the emotional valence of the stimuli and the probe match or mismatch. This hypothesis further states that stimuli higher in arousal, defined as the intensity of the appetitive or avoidant motivation, augment the response (Cuthbert, Bradley, & Lang, 1996). Thus, the stronger the motivation, the stronger the blink potentiation (negative stimuli) or inhibition (positive stimuli).

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1. In some research, the neutral condition is omitted and only comparisons between probes during unpleasant and pleasant stimuli are made. This paper focuses on the unpleasant-neutral comparison and, as such, only papers in which this comparison is made will be cited and discussed.

Methodology of Examining the Acoustic Startle Eyeblink

Most researchers investigating affective modulation of startle eyeblinks use pictures to elicit emotional states. In this paradigm, participants passively view pictures depicting blood and snakes to elicit negative affective states, pictures such as erotica and skydiving to elicit positive affective states, and pictures such as wicker baskets to elicit neutral affective states. Noticeably absent from this literature is research examining anger, a negative affect with appetitive qualities (for a review, see Carver & Harmon-Jones, 2009). Rather, negative affects such as disgust and fear, which are associated with avoidance motivation, prevail in these paradigms (Mikels et al., 2005).

Anger has been examined in a handful of startle studies, and these studies utilized text-prompted affective imagery rather than affective pictures. In these studies, probes during anger-related imagery elicited potentiated startle responses much like those observed in response to probes during other negative affective imagery such as fear (Cook, Hawk, Davis, & Stevenson, 1991; Gautier & Cook, 1997; Hawk, Stevenson, & Cook, 1992; Miller, Patrick, & Levenston, 2002) or disgust (Vrana, 1994). Only one very recent study on individuals with moderate to severe traumatic brain injury demonstrated inhibited eyeblinks to probes during angry imagery, and this effect was likely due to impairments in arousal (Neumann, Hammond, Norton, & Blumenthal, 2011). A concern with only examining anger in mental imagery paradigms is that the pattern of startle responses has been shown to differ between the standard picture and mental imagery paradigms. Whereas both paradigms result in potentiated blinks in response to probes during fear/disgust stimuli, blink inhibition in response to probes during arousing pleasant imagery has not been observed in paradigms using mental imagery (Cook et al., 1991; Hawk et al.,

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1992; Miller et al., 2002; Witvliet & Vrana, 1995). Rather, eyeblinks to probes during pleasant mental imagery are larger, similar to those in response to probes during aversive imagery scripts. This lack of a difference between aversive and pleasant imagery suggests that the affective modulated startle response found in mental imagery paradigms is assessing a different psychological process than the affective modulated startle response found in standard picture viewing paradigms. Within picture viewing paradigms, compared to neutral stimuli, affective pictures cause greater perceptual engagement, but within mental imagery paradigms, affective imagery causes greater "nonperceptual engagement (i.e., mental associative processing)" (Miller et al., 2002, p. 527). The potentiated startle response during both positive and negative affective imagery likely "reflects a basic function of the acoustic startle reflex, namely, the interruption of ongoing behavior" (Miller et al., 2002, p. 527), and this interruption of internally focused processes protects the organism by mobilizing it to respond to significant changes in the environment (Graham, 1979; Miller et al., 2002). Because affective imagery paradigms do not typically find differences between positive and negative imagery, the present research utilized affective pictures to elicit emotional states.

Anger and Approach Motivation

Such a discrepancy between picture and mental imagery paradigms may have implications for more than just responses to probes during pleasant stimuli. Despite anger's negative valence (e.g., Harmon-Jones, 2004), it differs from most negative affects in that it possesses approach-oriented motivational qualities also shared by some arousing positive affects (Harmon-Jones, 2003a; Harmon-Jones, Harmon-Jones, Abramson, & Peterson, 2009; see Carver & Harmon-Jones, 2009, for a review). That is, rather than causing an avoidant response seen in fear and disgust, anger frequently leads to approach tendencies such as aggression (e.g., Berkowitz, 1993), greater visual attention to rewards (Ford et al., 2010), increased motivation to obtain objects, particularly when paired with a potential reward (Aarts et al., 2010), and motor behavior aimed at distance reduction (Wilkowski & Meier, 2010). In fact, the link between anger and approach behaviors has been seen in humans as young as 7 months old (Kearney, 2004). Anger is also associated with traits such as assertiveness and competitiveness (Buss & Perry, 1992) and behavioral approach sensitivity (Carver, 2004; Harmon-Jones, 2003b).

Animal behavior research also supports the idea that anger is linked to approach motivation. For instance, mice with high exploratory temperament (documented by various behaviors) are more aggressive than low exploratory mice in the intruder test (Kazlauckas et al., 2005). In 4- to 9-year-old children, approach/positive anticipation and frustration/anger are directly correlated with each other and with overt aggression (Deater-Deckard et al., 2010).

Other evidence that anger shows similarities to approach-motivated positive states comes from research on determination. Determination is a positive, approach-motivated affect (Watson, Clark, & Tellegen, 1988). The word *determination* appears on Watson et al.'s (1988) Positive and Negative Affect Schedule (PANAS), so it correlates highly with ratings of other positive, approach-related states such as interested, enthusiastic, and excited. Determination is also reported when individuals are angry (Harmon-Jones, Harmon-Jones et al., 2009), and when positive approach motivation is activated (Harmon-Jones, Schmeichel, Mennitt, & Harmon-Jones, 2011; Harmon-Jones, Harmon-Jones, Fearn, Sigelman, & Johnson, 2008). In addition, perceivers confuse facial expressions intended to communicate determination with facial expressions intended to communicate anger. Furthermore, the intensity of perceived anger and determination are highly correlated: the more intense a determination expression is perceived, the more it appears anger-like (C. Harmon-Jones et al., 2011).

Anger's identity as an approach-related affect has been further supported with research on asymmetrical frontal cortical activity and emotion (for reviews, see Harmon-Jones, 2003a; Rutherford & Lindell, 2011). The left prefrontal cortex has been found to be involved in approach motivational processes; the right prefrontal cortex has been found to be involved in withdrawal motivational processes. Several studies have found that despite anger's negative valence, it is also associated with relative left frontal cortical activation (Harmon-Jones & Peterson, 2009; Harmon-Jones, Peterson, & Harris, 2009; Peterson, Gravens, & Harmon-Jones, 2011; Peterson, Shackman, & Harmon-Jones, 2008), further suggesting that anger is associated with approach motivation (for a review, see Harmon-Jones, Gable, & Peterson, 2010).

A recent study examined trait anger in relation to startle eyeblink responses (Amodio & Harmon-Jones, 2011) and found that trait anger, as well as the other approach-oriented emotions such as interest and enjoyment, were associated with startle eyeblink inhibition in response to probes during arousing positive stimuli.

The Anger-Modulated Startle Reflex

Previous research investigating startle eyeblinks in response to probes during angering stimuli has been inconclusive because mental imagery paradigms have not shown the expected startle eyeblink inhibition to probes during pleasant imagery, suggesting that some other processes may be preventing positive appetitive states from inhibiting the startle response. Consequently, it would be important to examine anger using affective pictures.

On the basis of past research on anger, three hypotheses were advanced. One prediction is that probes during angering stimuli should elicit inhibited eyeblink responses much like pleasant stimuli (motivation hypothesis). An alternative hypothesis is that probes during anger stimuli may evoke larger blinks because of anger's high levels of arousal and negativity, similar to fear and disgust (arousal/valence hypothesis). A third hypothesis suggests that while the motivational properties of anger will inhibit the eyeblink response, anger's high levels of arousal and negativity will augment the response. Because these influences will be competing against one another, the end result will be somewhere in the middle, much like a startle response to a probe during a neutral picture. In other words, according to this third hypothesis (valence/arousal/motivational direction hypothesis), the affect-modulated startle response is determined by valence, arousal, and motivational direction in combination.

Because anger is a negative-arousing affect associated with approach motivation (Carver & Harmon-Jones, 2009), all three hypotheses are necessary. That is, the motivation hypothesis posits that probes during angering and pleasant stimuli should cause smaller startle eyeblinks than probes during neutral stimuli, which should cause smaller startle eyeblinks than probes during fear and disgust stimuli (assuming all stimuli are high in arousal). The arousal/valence hypothesis posits that probes during arousing pleasant stimuli should cause smaller eyeblinks than neutral stimuli, which should cause smaller startle eyeblinks than probes during stimuli that evoke arousing anger, fear, and disgust. Finally, the valence/arousal/motivational direction hypothesis posits that

startle responses to probes during angering stimuli may be similar to those during neutral stimuli but differ from startle responses to probes during arousing pleasant and fear/disgust stimuli because anger is associated with approach motivation but also arousing and negative.

Three studies investigated these competing hypotheses. Study 1 used a paradigm much like that used in previous startle studies investigating the effect of emotional pictures on the eyeblink response. However, in addition to displaying pleasant, fear/disgust, and neutral pictures, Study 1 included racist pictures depicting, for example, Klansmen and Nazis, which were designed to make participants low in racial prejudice angry. These same pictures were used to successfully elicit anger in previous research (Harmon-Jones, Lueck, Fearn, & Harmon-Jones, 2006).

Study 2 tested whether the effects of Study 1 would replicate with different angering stimuli, that is, antipatriotic scenes. These pictures of flag burning and other antipatriotic scenes have been shown to cause anger in participants (Harmon-Jones, Harmon-Jones, Amodio, & Gable, 2011). Second, Study 2 tested whether individual differences in dysphoria, which has been characterized by increased avoidant emotional processes and decreased appetitive emotional processes (e.g., Fowles, 1988; Gray, 1994), would influence responses to probes during the angering stimuli. Study 3 examined the anger-modulated startle reflex as a function of trait and state approach motivation.

Study 1

Method

Participants. One hundred fifty (53 male) introductory psychology students participated in exchange for extra credit. For startle eyeblinks, data from eight participants were excluded due to equipment failure, leaving 142 participants for analyses. For self-reported emotions, data from three participants were unusable due to incomplete ratings. Of the 142 participants, 3 identified as African American, 17 identified as Asian, 113 were Caucasian, 1 was Caucasian/Hispanic, and 8 identified as other ethnicities. All participants were students at the University of Wisconsin–Madison, which has a student body low in racial prejudice (see below) who should become angry to pictures of racist imagery.

Materials. Sixty-four pictures were presented in randomized order. Sixteen consisted of racist imagery (e.g., Ku Klux Klan, German Nazis) and were found on the Internet; the remaining images were 16 selected from each of the fear/disgust (e.g., snake, bloody hand), neutral (e.g., spoon, rolling pin), and pleasant (e.g., windsailing, partially nude couple) types of the International Affective Picture System (IAPS; Lang, Bradley, & Cuthbert, 2008)[2]. Three neutral picture practice trials, with startle probes, preceded the 64 pictures. Each picture trial consisted of a fixation cross, which was presented for 1 s, a picture presented for 6 s, and an intertrial interval (ITI) of 14–19 s.

The startle probe was a 50 ms, 102 dB burst of white noise presented through stereo headphones. Probes were presented during 75% of trials and occurred 3.5 or 4.5 s after picture onset. Probes were also occasionally presented during the ITI (1 s after picture termination). These probe times were used to prevent the individual from learning when the probe would occur, and the ones occurring during the picture viewing were combined for analyses, as is commonly done in startle probe affective picture research (e.g., Patrick, Bradley, & Lang, 1993). Only startle eyeblinks to probes presented during affective pictures were considered.

Because the angering pictures were associated with racial prejudice, we assessed participants' reported prejudice toward Blacks using the 20-item Attitude Toward Blacks scale (Brigham, 1993). Items on the instrument were rated on a scale from 1 (*strongly disagree*) to 7 (*strongly agree*). Examples of items are: "If a Black were put in charge of me, I would not mind taking advice or direction from him or her," and "I enjoy a funny racial joke, even if some people might find it offensive" (reverse coded).

Procedure. After informed consent was obtained, participants completed the Attitude Toward Blacks scale, and electrodes were affixed to participants' faces. They then viewed pictures in randomized order while the electromyographic (EMG) signal over the left inferior orbicularis oculi (startle eyeblink) was recorded. Participants were told to ignore the intermittent noises they would hear through the headphones, as was done in most past startle eyeblink research. After the first picture viewing, participants viewed the pictures a second time and rated each on arousal (1 = *calm*, 9 = *excited*), valence (1 = *negative*, 9 = *positive*), and anger (1 = *not at all angry*, 9 = *very angry*).

Data collection and reduction. To record startle eyeblinks, 4 mm Ag/AgCl electrodes (In Vivo Metric, Healdsburg, CA) were placed over the left inferior orbicularis oculi below the inner and outer canthi, as suggested by van Boxtel, Boelhouwer, and Bos (1998). Impedance levels were 10 kΩ or below. The EMG signal was amplified, and frequencies below 30 Hz and above 500 Hz were filtered online (Contact Precision Instruments Bio II, Cambridge, MA). Signals were digitally sampled at 1000 Hz. Offline, EMG activity was rectified and then smoothed. The peak magnitude 20–120 ms following noise onset was determined. Individual trials were standardized within individuals to create z scores,[3] which were then averaged by picture type.

Eyeblinks were visually inspected, and trials in which there was excessive noise in the signal, or in which a spontaneous blink occurred either immediately preceding stimulus onset or in the interval between stimulus onset and the minimal blink onset latency, were rejected (Blumenthal et al., 2005). Double blinks, characterized by the presence of two peaks in immediate succession within the 20–120 ms window, were also cause for rejection. For this sample, 12.4% of all trials were rejected.

2. IAPS picture numbers: 1050, 1090, 1200, 1300, 2190, 2200, 2240, 2440, 2480, 2500, 2620, 2850, 2880, 3060, 3150, 3400, 3550, 4672, 4608, 4611, 4641, 4653, 4658, 4659, 4670, 5470, 5500, 5621, 5626, 5731, 6230, 7000, 7004, 7006, 7010, 7020, 7031, 7080, 7175, 7270, 7380, 8080, 8170, 8190, 8370, 9250, 9300, 9405, 9500, 9620, and 9630. The pictures depicting racism were selected because we suspected they might evoke anger in this sample, which is generally low in racial prejudice. This sample from UW-Madison has lower racial prejudice on the Attitudes toward Blacks scale ($M = 5.60$) than a sample from Michigan State University ($M = 4.22$), which is also a suburban, public university in the northern midwest of the United States with a student body population similar in size to UW-Madison (lower scores indicate more prejudice; Navarrete, Fessler, Fleischman, & Geyer, 2009).

3. In Studies 1 and 2, startle responses to ITI probes were included during z-score standardization, resulting in skewed distributions with deviations that do not add to zero. In Study 2, no difference in raw startle responses during ITIs was found between dysphoric and nondysphoric participants, $t(24) = 0.31$, $p > .76$. Event codes were not included for ITI probes in Study 3, and as such they were not included in z-score standardization, resulting in a normal distribution with deviations that add to zero.

Table 1. *Mean (SD) Picture Ratings for Participants in Study 1*

	Picture type			
Rating type	Angering	Pleasant	Neutral	Fear/disgust
Valence	1.86 (1.04)$_a$	5.94 (1.37)$_b$	4.00 (1.54)$_c$	1.78 (0.80)$_a$
Arousal	3.35 (2.16)$_a$	4.78 (1.57)$_b$	1.85 (1.01)$_c$	3.79 (2.27)$_d$
Anger	5.44 (2.02)$_a$	1.25 (0.50)$_b$	1.23 (0.38)$_b$	3.56 (1.76)$_c$

Notes. Within each rating type, means with significant differences ($p < .05$) are denoted by different subscripts.

Statistical analyses. All statistical analyses described in this paper were conducted using Statistica 7.1 (StatSoft, Inc., Tulsa, OK). Repeated measures and mixed-model analyses of variance (ANOVAs) were used to examine the influences of picture type and group (in Studies 2 and 3) on startle eyeblink responses and picture ratings. Post hoc comparisons were done using the Neuman-Keuls range test.

Results

Picture ratings. In light of a significant 4 (Picture Type) × 3 (Rating Type: valence, arousal, anger) interaction, $F(6,828) = 456.20$, $p < .001$, participants' ratings of the pictures were examined using a four-way (picture type) repeated measures ANOVA for each rating type.

The main effect of picture type was significant for ratings of valence, arousal, and anger, $F(3,414)$s = 617.87, 189.34, and 375.71, ps < .001, respectively. Ratings of valence and arousal for pleasant, neutral, and fear/disgust pictures were consistent with past research. Angering pictures were rated as more angering than all other picture types, and fear/disgust pictures were rated as more angering than neutral and pleasant pictures. Ratings of anger for pleasant and neutral pictures were low and did not differ, $p > .87$. Angering pictures were rated as more negative and more arousing than neutral pictures, whereas angering pictures were rated more negative but less arousing than pleasant pictures. In addition, angering and fear/disgust pictures were rated equally negative ($p > .51$), but the fear/disgust pictures were rated as more arousing than the angering pictures. See Table 1 for means, standard deviations, and follow-up comparison results for all picture ratings.

Startle eyeblinks. The four-way (picture type: angering, pleasant, neutral, fear/disgust) repeated measures ANOVA revealed a main effect of picture type, $F(3,423) = 51.35$, $p < .001$. Startle eyeblinks were greater to probes during fear/disgust pictures ($M = 0.22$, $SD = 0.39$) compared to probes during angering pictures ($M = –0.06$, $SD = 0.28$), pleasant pictures ($M = –0.23$, $SD = 0.30$), and neutral pictures ($M = –0.04$, $SD = 0.28$), ps < .001. Eyeblinks to probes during pleasant pictures were smaller than eyeblinks to probes during neutral and angering pictures, ps < .001. Eyeblinks to probes during angering pictures did not differ from eyeblinks to probes during neutral pictures, $p > .56$.

Attitude Toward Blacks. Attitude Toward Blacks scores were very close to the positive end point of the scale ($M = 5.60$, $SD = 0.81$), suggesting that the participants were relatively low in racial prejudice (in this study, higher scores indicate lower racial prejudice). Attitude Toward Blacks scores were not significantly correlated with startle eyeblink magnitudes (ps > .32). However, Attitude Toward Blacks scores did relate to the picture ratings. To examine these relationships, difference scores were created by subtracting ratings of neutral pictures from ratings of affective pictures. Participants with more positive attitudes toward Blacks rated the angering pictures as being more angering ($r = .35$, $p < .001$) and more negative ($r = –.20$, $p < .05$). These results suggest that the reported anger evoked by the angering pictures was likely due to more than just experimenter demand. No other significant relationships were found, ps > .09.

Discussion

Study 1 replicated much previous work in line with the emotional valence/arousal hypothesis (Lang, Bradley, & Cuthbert, 1990) showing that startle probes presented during fear/disgust pictures elicited larger eyeblink responses than probes presented during neutral pictures, which elicited larger eyeblink response than probes presented during pleasant pictures. Ratings of valence and arousal indicated that pleasant pictures were perceived as more positive and more arousing than neutral and fear/disgust pictures, whereas fear/disgust pictures were more arousing and more negative than neutral pictures.

New to the present research is that no discernible differences were found between startle eyeblinks to probes during angering and neutral pictures, despite the angering pictures being rated higher on anger and arousal and more negative in valence. In fact, the angering and fear/disgust pictures were rated equally negative, yet probes during fear/disgust pictures elicited larger blinks. The emotion valence/arousal hypothesis predicted that such a negative emotional response the angering pictures should cause potentiated eyeblinks much like those to probes during fear/disgust pictures. It is possible that the greater arousal of the fear/disgust stimuli compared to the anger stimuli contributed to the potentiated eyeblinks. However, if that were the case, probes during the more arousing angering pictures should have elicited larger eyeblinks than those during the less arousing neutral pictures, and this was not the case.

Another hypothesis predicted that, given their approach motivational quality, probes during angering pictures should cause inhibited eyeblinks like those in response to probes during pleasant pictures. This was also not supported as probes presented during angering pictures elicited larger eyeblinks than did those presented during pleasant pictures. Again, the arousal of the pleasant stimuli might have caused relatively greater eyeblink inhibition, but that does not explain why reactivity to probes during neutral and angering pictures did not differ.

The hypothesis that received the most support is the third, which predicted that the competing influences of arousal, valence, and motivational direction would cause eyeblinks in response to probes during angering pictures to resemble those to probes during neutral pictures. That is, even though angering pictures are more negative in valence and higher in arousal than neutral pictures, which would predict potentiated eyeblinks, the influence of anger's approach motivational qualities that tend to inhibit eyeblinks cancels out the former. As such, the resulting response resembles that to probes during neutral pictures.

Study 2

We thought it important to conduct another study to test whether this pattern of startle responses would replicate using a different set of angering pictures. Specifically, we employed angering stimuli portraying anti-U.S. imagery such as flag burning and the attack on the World Trade Center.

A second aim to the experiment was to examine whether probes during angering pictures would produce larger eyeblink responses in individuals who may respond with less approach motivation and more avoidance motivation toward angering pictures. One group that may show such responses toward angering stimuli might be individuals with mild depressive tendencies (dysphoria). Individuals with mild depression lack sensitivity to appetitive stimuli and show heightened sensitivity to aversive stimuli (e.g., Fowles, 1988). For instance, one study found that individuals with dysphoria responded to an anger-evoking communication with greater relative right frontal cortical activity (which is associated with greater avoidance motivation; Harmon-Jones et al., 2002). Other research has found that mildly depressed individuals demonstrate exaggerated startle eyeblink responses to probes during aversive stimuli[4] (Cook et al., 1991).

As such, in Study 2, angering, pleasant, neutral, and fear/disgust stimuli were viewed by individuals with subclinical depressive symptoms ("dysphoria"[5]) as well as individuals without dysphoria. These two groups of individuals were compared to examine whether they would differ in their startle eyeblink responses to probes during affective pictures, particularly angering pictures.

Method

Participants. Participants were part of a larger group of introductory psychology students who completed the Beck Depression Inventory–II (BDI-II; Beck, Steer, & Brown, 1996) prior to the experiment and were eligible to participate in the study if their scores were in the bottom (below 2) and top (above 9) quartiles. Quartiles were used to select extreme groups; more stringent cutoffs were not used to insure that we could get a sufficient number of participants. A total of 38 (12 male) students participated in the experiment; three participants did not fully complete the study, data from six participants were excluded due to equipment failure, leaving 29 participants (dysphoric: $n = 14$; nondysphoric: $n = 15$).

Materials. Sixty-four pictures were presented in randomized order. Sixteen consisted of antipatriotic/anti-U.S. imagery (e.g., flag burning, Osama bin Laden) and were found on the Internet; the remaining images were those used in Study 1. Startle probe parameters were the same as in Study 1. In this and the next study, all participants were students at Texas A&M University, which has a student body that is more politically conservative than most universities ("Top 10 Most Socially Conservative Colleges," 2012). The university also provides more commissioned officers to the U.S. Armed Forces than any other school except the service academies ("Texas A&M University," 2012). These characteristics should make this sample likely to become angry to anti-U.S. pictures.

The BDI-II (Beck et al., 1996) was administered to assess dysphoria. The BDI-II was also administered during the experiment. To capture dysphoric tendencies over time (i.e., trait dysphoria), current scores were averaged with participants' previous scores, and a median split determined group assignment[6] (dysphoric: $M = 12.39$, $SD = 2.76$; nondysphoric: $M = 1.85$, $SD = 2.02$; $t(24) = 10.76$, $p < .001$).

Because the angering pictures likely evoke anger because of their link to patriotism, it was important to assess whether the dysphoria groups differed in patriotism. To do so, Schatz, Staub, and Lavine's (1999) 19-item Patriotism questionnaire was administered to assess individual differences in blind and constructive patriotism. Blind patriotism, measured with 12 items (e.g., "People who do not wholeheartedly support America should live somewhere else" and "The United States is virtually always right"), has been shown to relate to political disengagement and perceptions of foreign threat. In contrast, seven items assessing constructive patriotism (e.g., "If I criticize the United States, I do so out of love for my country" and "I express my love for America by supporting efforts at positive change") have been associated with political involvement.[7]

Procedure. After informed consent was obtained, participants completed the BDI-II and Patriotism questionnaires. Other procedures were identical to those used in Study 1.

Data collection and reduction. To record startle eyeblinks, two 9-mm tin electrodes (Electro-Cap International, Eaton, OH) were placed over the left inferior orbicularis oculi below the inner and outer canthi. Impedance levels were 10 kΩ or below. The EMG signal was amplified online with Neuroscan Synamps (El Paso, TX), band-pass filtered (0.1 to 500 Hz; 60 Hz notch filter enabled), and digitized at 2000 Hz. Offline, frequencies below 30 Hz and above 500 Hz were filtered (24 dB rolloff). EMG activity then was rectified and smoothed using a 30 Hz (24 dB rolloff), low-pass analog simulation (one-pass [forward] Butterworth) filter (as in Dvorak-Bertsch, Curtin, Rubenstein, & Newman, 2009) prior to baseline correction. The peak magnitude 20–120 ms following onset was determined.

The remaining procedures to process startle eyeblinks were identical to those used in Study 1. Two individuals who did not show any responses were classified as nonresponders (Blumenthal et al., 2005) and were not included in analyses. Data from one additional participant were not used due to more than half of trials in a given picture type being rejected, leaving a final sample of 26

4. Some research found flattened startle responses among depressed individuals or no differences from controls (Dichter, Tomarken, Shelton, & Sutton, 2004; Forbes, Miller, Cohn, Fox, & Kovacs, 2005). Severity of depressive symptoms may be a factor, as more flattened startle responses were seen in participants with a greater number of lifetime depressive episodes (Kaviani et al., 2004), suggesting that individuals with mild depression may show exaggerated responses to stimuli as in Cook et al. (1991).

5. The terms "dysphoria" and "dysphoric" are used in this research in light of the fact that this is not a true clinical sample. No clinical interviews were conducted to make a diagnosis of depression, and the scores obtained for the dysphoric group are below clinical cutoffs for a major depressive episode.

6. Only one participant switched groups (dysphoric to nondysphoric) as a result of this strategy. S/he went from 11 to 4 on the BDI-II. When the startle results were reanalyzed without this one participant, the results were essentially the same. The interaction of dysphoria group and picture type (neutral, anger, fear/disgust, positive) was $F(3,69) = 2.21$, $p < .10$. The interaction of dysphoria group and picture type, subtracting affective from neutral picture responses, was $F(2,46) = 3.86$, $p < .05$.

7. Scores on the Patriotism questionnaire support the notion that students at Texas A&M University tend to be high in patriotism. In our samples (totaling 278 participants), the mean for constructive patriotism was 3.31, which is over the halfway point of the scale. We were unable to locate means for any comparison samples that were matched to our sample in terms of geographic region, date of completion, and other sample characteristics (i.e., most published studies using this questionnaire only report correlations and not mean levels of patriotism).

participants for data analyses (dysphoric: $n = 13$; nondysphoric: $n = 13$). For these 26 participants, 10% of all trials were rejected.

Results

Picture ratings. Participants' ratings of the pictures were examined using a Group × Picture Type repeated measures ANOVA for each rating type (valence, arousal, anger), as done in Study 1.

For valence, the main effects of group and picture type were significant, $F(1,24) = 14.21$ and $F(3,72) = 39.65$, ps < .001. Across all participants, neutral and pleasant pictures were rated more positively than fear/disgust and angering pictures. Ratings of valence did not differ between neutral and pleasant pictures, $p > .95$, or between angering and fear/disgust pictures, $p > .95$. Dysphoric participants perceived the pictures in general as more negative, $p < .001$. The Group × Picture Type interaction was not significant, $F = 1.52$, $p > .21$.

For arousal, only the main effect of picture type was significant, $F(3,72) = 19.97$, $p < .001$, which indicated that, across all participants, angering, fear/disgust, and pleasant pictures did not differ from each other (ps > .21), but were all more arousing than neutral pictures (ps < .001). The main effect of group and Group × Picture Type interaction were not significant, Fs < 2.00, ps > .17.

For anger, only the main effect of picture type was significant, $F(3,72) = 33.93$, $p < .001$. Angering pictures were perceived as being more angering than fear/disgust, pleasant, and neutral pictures. Fear/disgust pictures were more angering than pleasant and neutral pictures; the latter did not differ, $p > .53$. The main effect of group and Group × Picture Type interaction were not significant, Fs < 0.80, ps > .37. See Table 2 for means, standard deviations, and follow-up comparison results for all picture ratings.

Startle eyeblinks. A 2 (Group: nondysphoric, dysphoric) × 4 (Picture Type: angering, pleasant, neutral, fear/disgust) ANOVA revealed a main effect of picture type replicating Study 1, $F(3,72) = 12.32$, $p < .001$. Across all participants, startle eyeblinks to probes during fear/disgust pictures ($M = 0.32$, $SD = 0.29$) were larger than eyeblinks to probes during all other picture types (ps < .02). Eyeblinks to probes during pleasant pictures ($M = –0.21$, $SD = 0.31$) were smaller than eyeblinks to probes during neutral ($M = 0.06$, $SD = 0.39$) and angering ($M = 0.11$, $SD = 0.36$) pictures, ps < .01. Eyeblinks to probes during angering pictures did not differ from eyeblinks to probes during neutral pictures, $p > .63$.

The Group × Picture Type interaction approached significance, $F(3,73) = 2.51$, $p < .07$. For nondysphoric participants, probes during fear/disgust pictures ($M = 0.30$, $SD = .32$) elicited larger eyeblinks than did probes during angering ($M = –0.07$, $SD = 0.24$) and pleasant ($M = –0.18$, $SD = 0.25$) pictures (ps < .02). Probes during fear/disgust pictures elicited marginally greater eyeblinks compared to those during neutral pictures[8] ($M = 0.09$, $SD = 0.49$), whereas probes during pleasant pictures elicited marginally smaller eyeblinks compared to those during neutral pictures, ps = .11. Importantly, eyeblinks in response to probes during angering pictures did not differ from those during pleasant and neutral pictures, ps > .21.

A different pattern emerged for dysphoric participants. Probes during fear/disgust pictures ($M = 0.33$, $SD = 0.27$) elicited larger eyeblinks than did probes during pleasant pictures ($M = –0.24$, $SD = 0.37$; $p < .001$) and neutral pictures ($M = 0.03$, $SD = .027$; $p < .05$), but did not differ from eyeblinks to probes during angering pictures ($M = 0.28$, $SD = 0.39$; $p = .64$). Eyeblinks to probes during angering pictures were larger than those during neutral pictures ($p < .05$) and pleasant pictures ($p < .001$), and eyeblinks to probes during neutral pictures were larger than those during pleasant pictures ($p < .05$). Importantly, only eyeblinks in response to probes during angering pictures differed between groups, so that dysphoric participants showed larger eyeblinks than nondysphoric participants, $p < .05$ (all other ps > .61).

Because of our interest in assessing the effects of dysphoria on startle reactivity to probes presented during angering stimuli in particular, we created affective picture type minus neutral picture startle reactivity to probes scores and subjected these difference scores to an ANOVA. The main effect of picture type was significant, $F(2,48) = 25.09$, $p < .001$, revealing a linear pattern of eyeblinks, with the largest eyeblinks to probes during fear/disgust pictures ($M = 0.25$, $SD = 0.50$), followed by angering pictures ($M = 0.04$, $SD = 0.53$), and then pleasant pictures ($M = –0.27$, $SD = 0.48$), ps < .01.

As seen in Figure 1, the Group × Picture Type interaction was significant, $F(2,48) = 4.20$, $p < .05$. For nondysphoric participants, eyeblinks to probes during fear/disgust pictures were larger than

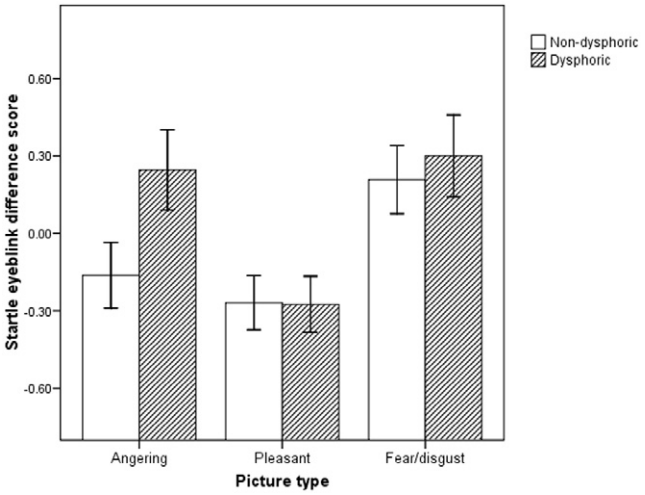

Figure 1. Startle eyeblink difference scores (affective—neutral z scores) to probes during angering, pleasant, and fear/disgust pictures for dysphoric and nondysphoric participants (Study 2). Error bars indicate 95% confidence intervals.

Table 2. *Mean (*SD*) Picture Ratings for Participants in Study 2 (Lab Experiment)*

	Picture type			
Rating type	Angering	Pleasant	Neutral	Fear/disgust
Valence	$3.64\ (1.76)_a$	$6.96\ (1.63)_b$	$6.76\ (1.86)_b$	$3.67\ (1.37)_a$
Arousal	$3.20\ (2.19)_a$	$3.67\ (1.75)_a$	$1.54\ (1.04)_b$	$3.23\ (1.80)_a$
Anger	$4.61\ (2.10)_a$	$1.52\ (1.01)_b$	$1.29\ (0.57)_b$	$3.11\ (1.82)_c$

Notes. Within each rating type, means with significant differences ($p < .05$) are denoted by different subscripts.

8. The predicted linear effect of startles to probes during fear/disgust pictures > startles to probes during neutral pictures > startles to probes during pleasant pictures is significant using a less conservative test (Fisher's LSD).

those during angering and pleasant pictures, *p*s < .001. Eyeblinks to probes during angering and pleasant pictures did not differ, $p > .29$. For dysphoric participants, eyeblinks were smallest to probes during pleasant pictures, *p*s < .001. Eyeblinks to probes during angering and fear/disgust pictures did not differ, $p > .63$.

Blind and constructive patriotism. Neither blind nor constructive patriotism differed between dysphoric (blind: $M = 2.60$, $SD = 0.56$; constructive: $M = 3.27$, $SD = 0.44$) and nondysphoric participants (blind: $M = 2.72$, $SD = 0.56$; constructive: $M = 3.37$, $SD = 0.31$), *t*s < 0.66, *p*s > .51. As such, it is unlikely that any group differences in patriotism contributed to differences in dysphoric reactions to the (antipatriotic) angering pictures.

Zero-order correlations revealed that constructive patriotism was associated with inhibited eyeblinks to probes during angering pictures, $r = -.42$, $p < .05$ (not controlling for eyeblinks during neutral pictures). Patriotism did not relate to other eyeblink responses, *r*s < .33, *p*s > .11.

Zero-order correlations also examined relationships between blind and constructive patriotism and picture ratings. To control for ratings to neutral pictures, difference scores were created by subtracting the neutral picture rating from the affective picture rating. Participants high in blind patriotism rated the pleasant pictures as being more negative, $r = -.45$, $p < .05$. Participants high in constructive patriotism also tended to rate the pleasant pictures as more anger-provoking, $r = .38$, $p < .07$. There were no other significant relationships between patriotism and picture ratings, *r*s < −.31, *p*s > .14.

Discussion

Replicating Study 1, Study 2 showed a linear pattern of eyeblinks to probes during affective pictures across all participants, with eyeblinks being greatest to probes during fear/disgust pictures, followed by neutral, and then pleasant pictures. Also like Study 1, startle eyeblinks to probes during angering pictures did not differ from eyeblinks to probes during neutral pictures, despite being rated higher in arousal and anger and more negative in valence. In Study 2, angering pictures were rated as arousing as fear/disgust pictures. Additionally, anger-related eyeblink inhibition was associated with constructive patriotism, perhaps suggesting that participants high in constructive patriotism were higher in approach motivation..

When participants were separated into groups based on dysphoria, however, a different pattern emerged. For nondysphoric participants, eyeblinks in response to probes during angering pictures did not differ from those in response to probes during pleasant and neutral pictures but were smaller than eyeblinks to probes during fear/disgust pictures. On the other hand, dysphoric participants evidenced eyeblinks to probes during angering pictures much like eyeblinks to probes during fear/disgust pictures. While this equality is consistent with the Valence × Arousal hypothesis proposed by Lang et al. (1990), given that both the angering and fear/disgust stimuli were arousing and negative in valence, it is also consistent with the motivation hypothesis assuming that the angering pictures evoked avoidance. However, there was no evidence that dysphoric participants rated the angering pictures any differently on valence, arousal, or anger relative to nondysphoric participants. If dysphoric participants did not perceive the angering pictures any differently on those dimensions, why did they show potentiated eyeblinks suggestive of a more avoidant reaction to them?

To examine why dysphoric participants showed startle eyeblinks during angering pictures similar to those during fear/disgust pictures, we collected additional data from a new set of 196 participants (52 male) who rated each of the same 64 pictures as described above and on additional variables: fear, disgust, joy, sadness, and anxiety. Data from nine were excluded because they did not complete the BDI-II, and data from three more were excluded because more than 95% of fear/disgust and pleasant photos were rated more than 2.5 standard deviations from the picture valence mean, leaving 184 participants. Using the same BDI-II cutoff derived from the median split in Study 2, there were 114 participants in the nondysphoric condition and 70 in the dysphoric condition. After viewing and rating all images, participants completed the Patriotism questionnaire and BDI-II (nondysphoric: $M = 2.42$, $SD = 2.37$; dysphoric: $M = 15.44$, $SD = 7.96$; $t(182) = 16.34$, $p < .001$). Neither blind nor constructive patriotism differed between dysphoric (blind: $M = 2.75$, $SD = 0.57$; constructive: $M = 3.16$, $SD = 0.61$) and nondysphoric participants (blind: $M = 2.87$, $SD = 0.59$; constructive: $M = 3.22$, $SD = 0.58$), *t*s < 1.31, *p*s > .19.

Because results for valence, arousal, and anger replicated those reported above, we focus on the other ratings, particularly fear where several important results emerged. For fear ratings, the main effects of group, $F(1,182) = 14.96$, $p < .001$, and picture type, $F(3,546) = 426.70$, $p < .001$, were significant. Across all participants, fear/disgust pictures elicited more fear than all other picture types. Angering pictures caused more fear than neutral and pleasant pictures, whereas neutral pictures caused less fear than pleasant pictures. Dysphoric participants rated all pictures higher on fear than nondysphoric participants, $p < .01$.

The Group × Picture Type interaction was also significant, $F(3,546) = 3.83$, $p < .01$. Dysphoric participants rated the angering pictures ($M = 5.41$, $SD = 2.15$) and fear/disgust pictures ($M = 5.47$, $SD = 1.87$) as more fearful than did the nondysphoric participants (angering: $M = 4.29$, $SD = 2.29$; fear/disgust: $M = 4.70$, $SD = 1.96$), *p*s < .05. Fear ratings of the other picture types did not differ between groups, *p*s > .17. Notably, for dysphoric participants, ratings of fear for angering pictures did not differ from ratings for fear/disgust pictures, $p > .73$, suggesting that they perceived the angering pictures to be as fear-provoking as the fear/disgust pictures. For nondysphoric participants, ratings of fear for angering pictures were lower than ratings of fear for fear/disgust pictures, $p < .05$. There were no significant Group × Picture Type interactions for the remaining indexes, *p*s > .11. See Table 3 for means, standard deviations, and follow-up comparison results of picture ratings across all participants.

Table 3. *Mean (*SD*) Picture Ratings for Participants in Study 2 (Online Follow-Up Study)*

	Picture type			
Rating type	Angering	Pleasant	Neutral	Fear/disgust
Valence	2.59 (1.35)$_a$	7.33 (1.08)$_b$	6.25 (1.30)$_c$	2.79 (1.31)$_a$
Arousal	4.64 (2.21)$_a$	4.61 (1.69)$_a$	1.85 (0.93)$_b$	4.79 (2.06)$_a$
Anger	6.23 (2.07)$_a$	1.24 (0.56)$_b$	1.24 (0.54)$_b$	3.09 (1.76)$_c$
Fear	4.71 (2.30)$_a$	1.85 (0.81)$_b$	1.39 (0.58)$_c$	4.99 (1.96)$_d$
Disgust	6.06 (2.11)$_a$	1.58 (0.84)$_b$	1.29 (0.57)$_c$	5.68 (1.61)$_d$
Joy	1.20 (0.35)$_a$	4.37 (1.73)$_b$	1.85 (0.92)$_c$	1.16 (0.32)$_a$
Sadness	4.95 (2.03)$_a$	1.31 (0.56)$_b$	1.72 (0.79)$_c$	3.64 (1.51)$_d$
Anxiety	4.37 (2.19)$_a$	1.50 (0.75)$_b$	2.45 (1.33)$_c$	4.55 (1.91)$_a$

Notes. Within each rating type, means with significant differences ($p < .05$) are denoted by different subscripts.

Study 3

Together, Studies 1 and 2 suggest that the competing influences of motivation, arousal, and valence influence the anger-modulated startle eyeblink reflex both in normal populations and in dysphoric individuals. Study 3 was designed to examine the reflex in individuals with heightened approach sensitivity.

In addition, Study 3 tested whether increases in state approach motivation would influence startle responses to probes during angering pictures. Previous research has shown that increasing the personal relevance of angering stimuli evokes greater approach motivation as measured by startle eyeblink (Neumann et al., 2011) and relative left frontal cortical activation (Harmon-Jones et al., 2006). As such, to ensure that the angering stimuli engage the behavioral approach system as much as possible, the relevance of the antipatriotic pictures was primed using the Patriotism questionnaire (Schatz et al., 1999), as was done in Study 2. In addition, half of participants were told they would have an opportunity to write an essay about why antipatriotic acts or attitudes are bad, and that their essay would be used in future research aimed at fostering patriotism (Harmon-Jones et al., 2006). These individuals were predicted to exhibit increased approached motivation as evidenced in inhibited startle eyeblinks to probes during angering pictures, relative to participants who did not have the expectancy to act against antipatriotism.

Method

Participants and design. Eighty-two (47 female) undergraduate students participated in exchange for partial course credit. Data from nine participants were excluded: two participants chose to stop the experiment before completion, six participants did not complete the experiment due to equipment failure, and physiological data from one participant were lost after completion. The design was a 2 between-subjects (Essay Expectation: expect, not expect) × 4 within-subjects (Picture Type: angering, pleasant, neutral, fear/disgust) design. There were 36 participants in the essay expectation condition and 37 participants in the no-essay expectation condition.

Materials

Personality measures. The Differential Emotions Scale, 4th ed. (DES-IV) (Izard, Libero, Putnam, & Haynes, 1993) was used to assess participants' trait emotional experiences. Due to limitations in time, only items pertaining to interest, enjoyment, sadness, anger, disgust, and fear were administered. The anger subscale of Buss and Perry's (1992) Aggression questionnaire was used to assess participants' trait anger.

Carver and White's (1994) 20-question Behavioral Inhibition System/Behavioral Activation System (BIS/BAS) scale was administered to assess individual differences in BIS and BAS sensitivity. It is comprised of four scales: BIS, which measures reactions to the expectation of punishment; BAS drive, which measures goal pursuit; BAS reward responsiveness, which assesses positive responses to anticipated reward; and BAS fun seeking, which measures one's desire for and willingness to approach new rewards.

The 15-item version of the Hypomanic Personality scale (Eckblad & Chapman, 1986; Klein, Lewinsohn, & Seeley, 1996) was used to assess proneness to hypomania. The dominance scale from the Personality Assessment Inventory (Morey, 1991) was used to assess characteristics of dominant personality. The BDI-II (Beck et al., 1996; described in Study 2) and the Center for Epidemiologic Studies Depression scale (CES-D; Radloff, 1977) were administered to assess depressive tendencies. The CES-D is used widely to assess depressive symptomatology in the general population. Participants were asked to rate how often they had experienced each feeling or behavior during the past week.

As in Study 2, the Patriotism questionnaire (Schatz et al., 1999) was administered to assess individual differences in blind and constructive patriotism as well as to make the antipatriotism of the anger pictures more salient.

Affective pictures. The same pictures used in Study 2 were used. Pictures were presented in two blocks; each block contained 32 pictures (8 of each picture type), and within each block, all picture types were presented. Other details were identical to Studies 1 and 2.

Startle probe. The startle probe was a 50 ms, 102 dB burst of white noise presented through stereo headphones. Probes were presented either 4 or 5 s after picture onset (32 trials), randomly during the ITI (16 trials), or not at all (16 trials). Each probe type was equally distributed across blocks, sets, and picture types.

Procedure and data collection and reduction. Procedures were identical to those in Studies 1 and 2, with the exception of condition assignment, which the experimenter determined randomly by drawing a slip of paper from an envelope.

The procedures used to collect and reduce startle eyeblinks were identical to those used in the above studies, with the exception of *z*-score transformation, which did not include startle responses during ITI trials (see Footnote 3). Data from three participants were excluded due to fewer than half of trials in a given picture type having a good startle response, leaving a total of 70 participants ($n = 35$ per condition) for data analyses involving startle eyeblinks. For these 70 participants, 7.5% of all trials were rejected.

Results

Responses to pictures as a function of essay expectation

Ratings. Participants' ratings of the pictures were examined using an Essay Expectation × Picture Type repeated measures ANOVA for each rating type (valence, arousal, anger, fear, disgust, joy, sadness). As can be seen in Table 4, the results were fairly consistent with the results from previous studies. For each rating, main effects of picture type emerged: valence, $F(3,210) = 187.88$, $p < .001$; arousal, $F(3,210) = 80.72$, $p < .001$;

Table 4. *Mean* (SD) *Picture Ratings for Participants in Study 3*

	Picture type			
Rating type	Angering	Pleasant	Neutral	Fear/disgust
Valence	2.97 (1.29)$_a$	6.12 (1.21)$_b$	4.95 (1.08)$_c$	3.01 (1.32)$_a$
Arousal	2.62 (1.68)$_a$	4.29 (1.66)$_b$	1.97 (1.15)$_c$	2.91 (1.96)$_a$
Anger	4.99 (2.14)$_a$	1.38 (0.79)$_b$	1.43 (0.89)$_b$	2.77 (1.81)$_c$
Fear	3.13 (1.99)$_a$	1.53 (0.74)$_b$	1.50 (0.92)$_b$	3.84 (2.00)$_c$
Disgust	5.04 (2.26)$_a$	1.54 (0.86)$_b$	1.43 (0.89)$_b$	4.89 (1.73)$_a$
Joy	1.56 (0.82)$_a$	4.59 (1.80)$_b$	2.67 (1.45)$_c$	1.52 (0.78)$_a$
Sadness	4.07 (1.97)$_a$	1.38 (0.77)$_b$	1.81 (1.12)$_c$	3.06 (1.63)$_d$

Notes. Within each rating type, means with significant differences ($p < .05$) are denoted by different subscripts.

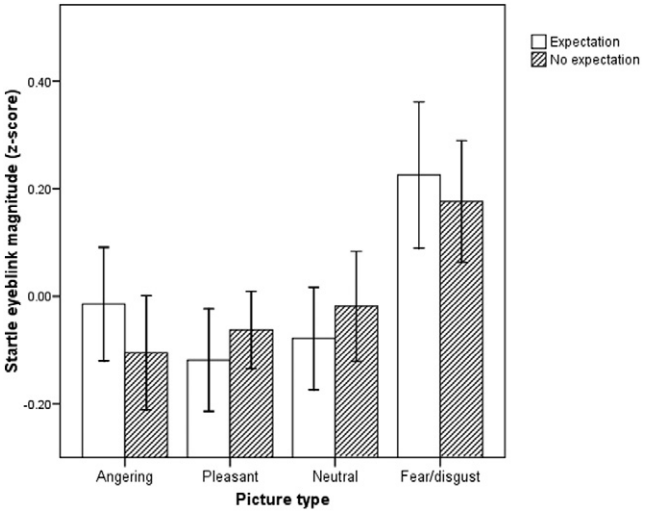

Figure 2. Mean startle eyeblink magnitude (*z* score transformed) to probes during all picture types as a function of essay expectation (Study 3). Error bars indicate 95% confidence intervals.

anger, $F(3,210) = 150.71$, $p < .001$; fear, $F(3,210) = 81.86$, $p < .001$; disgust, $F(3,210) = 203.03$, $p < .001$; joy, $F(3,210) = 173.66$, $p < .001$; sadness, $F(3,210) = 95.51$, $p < .001$. The essay expectation manipulation produced no main or interactive effects on picture ratings. See Table 4 for means, standard deviations, and follow-up comparison results for all picture ratings.

Startle eyeblinks. A 2 (Essay Expectation: expect, not expect) × 4 (Picture Type: angering, pleasant, neutral, fear/disgust) ANOVA revealed a main effect of picture type on startle eyeblink responses, $F(3,204) = 10.31$, $p < .001$. Across all participants, startle eyeblinks to probes during fear/disgust pictures ($M = 0.20$, $SD = 0.37$) were larger than eyeblinks to probes during all other picture types (ps < .001). Eyeblinks to probes during pleasant pictures ($M = –0.09$, $SD = 0.24$), neutral pictures ($M = –0.05$, $SD = 0.29$), and angering pictures ($M = –0.06$, $SD = 0.31$) did not differ from one another, ps > .60. The main effect of essay expectation and the Essay Expectation × Picture Type interaction were not significant (ps > .24). The null interaction can be seen visually in Figure 2.

Testing individuals with primarily anger experiences to the angering pictures. To examine how differences in ratings of the angering pictures might have influenced eyeblink responses, participants who were above the median on ratings of anger but below the median on ratings of fear (first group; $n = 8$) or sadness (second group; $n = 8$) were identified. A third group consisting of high anger/low disgust contained only four participants and was deemed too small for analysis.

For the high anger/low fear group, the repeated measures ANOVA was significant, $F(3,21) = 3.01$, $p < .05$. Eyeblinks to probes during fear/disgust pictures ($M = 0.38$, $SD = 0.48$) were greater than eyeblinks to probes during pleasant pictures ($M = –0.18$, $SD = .30$), $p < .05$, and were marginally greater than eyeblinks to probes during neutral pictures ($M = –0.14$, $SD = 0.35$) and angering pictures ($M = 0.01$, $SD = 0.28$), ps < .10. Eyeblinks in response to probes during angering, pleasant, and neutral pictures were the same, ps > .45.

The ANOVA for the high anger/low sadness group was also significant, $F(3,21) = 2.98$, $p < .05$. Eyeblinks to probes during fear/disgust pictures ($M = 0.32$, $SD = 0.40$) were greater than eyeblinks to startle probes during angering pictures ($M = –0.14$, $SD = 0.22$), $p < .05$, and were marginally greater than eyeblinks in response to probes during neutral pictures ($M = –0.01$, $SD = 0.26$) and pleasant pictures ($M = –0.11$, $SD = 0.28$), ps < .07. Eyeblinks to probes during angering, pleasant, and neutral pictures were the same, ps > .56.

Relationships between personality variables and responses to angering pictures.[9] We tested whether high approach personality traits (e.g., BAS, aggression, anger, hypomania, patriotism) would be associated with a pattern of responses to probes during angering pictures similar to responses to probes during pleasant pictures (i.e., inhibited eyeblinks), whereas low approach personality traits (e.g., depression, sadness) would show the opposite pattern of responses. Furthermore, although the manipulation of essay expectancy alone did not affect startle eyeblinks in response to affective pictures, it was thought that these personality variables might interact with the expectation (or lack of) to influence startle responses to probes during angering pictures.

To test these hypotheses, regression analyses were conducted in which essay expectation condition (effect coded as −1 [no expectation] and 1 [expectation]), the personality variable of interest (centered), and their interaction served as predictors for the startle response to probes during angering pictures. In these analyses, the dependent variable was a difference score created by subtracting the eyeblink response to probes during neutral pictures from the response to probes during angering pictures; this was done to reduce variance associated with responses to the probes during pictures in general rather than the affective content. If a significant Essay Expectation × Personality interaction was found, within-condition correlations were conducted to further examine the exact nature of the interaction.

Essay expectation did not interact with personality to significantly predict eyeblink responses to probes during angering pictures.

Consistent with predictions and replicating Study 2, participants who reported high constructive patriotism tended to evidence inhibited eyeblinks to probes during angering pictures, $\beta = –.19$, $p < .10$ (zero-order correlation: $r = –.31$, $p < .01$). Also consistent with Study 2, relationships with depressive traits (i.e., CES-D, BDI-II) trended in the expected direction but were not significant by conventional standards, CES-D: $\beta = .22$, $p < .07$; BDI-II: $\beta = .22$, $p < .08$ (zero-order correlations: CES-D: $r = .18$, $p > .13$; BDI-II: $r = .17$, $p > .16$).[10]

Blind and constructive patriotism and picture ratings. Zero-order correlations examined relationships between blind patriotism ($M = 2.66$, $SD = 0.61$) and constructive patriotism ($M = 3.41$, $SD = 0.50$) and picture ratings (controlling for ratings to neutral pictures, as in the above studies). Participants high in blind

9. Although the focus of this study was on the anger-modulated startle eyeblink, we also tested to see if individual differences in approach/avoidance motivation related to startle eyeblinks to probes during fear/disgust pictures. Zero-order correlations revealed that only trait anger related to inhibited eyeblinks to probes during fear/disgust pictures, $r = –.25$, $p < .05$ (other ps > .10).

10. Because participants were not recruited on the basis of BDI-II scores, as was the case in Study 2, exact replication of the influence of dysphoria on anger-modulated startle eyeblink was not possible.

patriotism rated the angering pictures as being more anger-provoking ($r = .30$, $p < .05$) and more disgusting ($r = .31$, $p < .01$). These results suggest that the reported anger evoked by the angering pictures was likely due to more than just experimenter demand. Participants high in blind patriotism also rated the pleasant pictures as being more positive ($r = .32$, $p < .01$), more arousing ($r = .38$, $p < .01$), and more joyful ($r = .29$, $p < .05$). There was a trend for participants high in constructive patriotism to rate the fear/disgust pictures as less fear-provoking, $r = -.21$, $p < .08$. There were no other relationships between patriotism and picture ratings, rs < .19, ps > .12.

Discussion

Study 3 was designed to replicate the pattern of startle eyeblinks from Studies 1 and 2. This replication occurred in that no difference between eyeblinks to probes during angering and neutral pictures was found. Furthermore, eyeblinks were greatest to probes during fear/disgust pictures compared to all other picture types. Eyeblink inhibition to probes during pleasant pictures was not found, consistent with some past research (Grillon & Baas, 2003; Jackson, Malmstadt, Larson, & Davidson, 2000).

Study 3 also examined the influences of state and trait approach motivation on the anger-modulated startle reflex. We tested whether high approach traits would be associated with inhibited eyeblinks to probes during anger and low approach traits (i.e., sadness, disgust) would show the opposite pattern. Replicating Study 2, constructive patriotism was associated with inhibited anger-evoked startle eyeblinks. Eyeblink inhibition to probes during pleasant pictures was also associated with constructive patriotism; these relationships may have been due to individuals high in constructive patriotism being sensitive to appetitive processes. Supportive of this idea, constructive patriotism was related to more BAS (BAS–total, $r = .35$, $p = .003$; BAS–reward responsiveness, $r = .25$, $p < .05$; BAS–drive, $r = .33$, $p < .01$; BAS–fun seeking, $r = .22$, $p < .07$), and trait dominance ($r = .32$, $p < .01$). In contrast, blind patriotism was not significantly associated with BAS or dominance. No other relationships between personality characteristics and eyeblink magnitude of any type were found.

Manipulating approach motivation did not impact eyeblink responses or picture ratings, suggesting that the pictures were perceived similarly regardless of essay expectation condition. It is possible that participants in both conditions had a desire to act on the anger evoked by the antipatriotic images, given that all participants were primed by the Patriotism questionnaire. Another possibility is that participants in both conditions believed it to be impossible to act on their anger, thus reducing approach motivation (Harmon-Jones et al., 2006). It is difficult to discern the exact reason for the manipulation failure.

General Conclusions

Three studies investigated the anger-modulated startle eyeblink reflex. These studies provide evidence for the concurrent roles of valence, arousal, and motivation in the effect of emotion on the startle eyeblink response. Startle eyeblinks to probes during angering stimuli did not differ from eyeblinks to probes during neutral stimuli, despite being rated as more angering, arousing, and negative. Only once did differences emerge between startle eyeblinks to probes during angering and to probes during neutral pictures: In Study 2, dysphoric individuals evidenced potentiated eyeblinks to probes during angering stimuli much like reactions to probes during fear/disgust stimuli. Follow-up research revealed that dysphoric individuals rated the angering pictures as more fear-provoking than did nondysphoric participants. Dysphoric individuals may have responded to the angering pictures with a fear-like response because of deficits in appetitive motivation and increased sensitivity to negative emotional stimuli (e.g., Fowles, 1988; Gray, 1994; Harmon-Jones et al., 2002).

Individual Differences Relating to Emotion-Modulated Startle Responses

Several tests were conducted to examine whether approach motivation would relate to inhibited startles during angering pictures. Only one set of results provided some support for this idea. That is, individuals high in constructive patriotism, who scored high in approach motivation, had inhibited eyeblinks to probes during angering pictures in Studies 2 and 3. Although the correlation between constructive patriotism and eyeblinks to probes during angering pictures may not remain significant when corrections for multiple tests are implemented, we note that the correlation was predicted and that it replicated across two studies, suggesting that it is a true relationship and is not occurring by chance.

Other predicted relationships between individual differences in approach and avoidant personality traits and the emotion modulated startle eyeblink were not found. This is not entirely inconsistent with the literature. For example, greater blink inhibition to probes during pleasant stimuli has been found in individuals high in trait anger and enjoyment (Amodio & Harmon-Jones, 2011) and BAS sensitivity (Gros, 2011; Hawk & Kowmas, 2003). However, other research did not find relationships between approach traits and eyeblink inhibition (Larson, Ruffalo, Nietert, & Davidson, 2000). It is possible that detection of these relationships requires use of a sample with more extreme approach motivation scores (Gros, 2011).

Additionally, the majority of research investigating individual differences in the emotion modulated startle eyeblink focuses on responses to probes during fear/disgust stimuli. Potentiated eyeblinks to probes during fear/disgust stimuli have been found among individuals high in avoidant traits such as sensitivity to punishment (Caseras et al., 2006), harm avoidance (Corr et al., 1995), and fear (Cook et al., 1991). These effects have also been found in individuals with anxiety disorders such as phobias and post-traumatic stress disorder (PTSD) (see Grillon & Baas, 2003, for a review). Conversely, inhibited fear/disgust-evoked eyeblinks occur in individuals with psychopathic traits, suggesting deficits in processing of aversive stimuli (Patrick et al., 1993; but see Justus & Finn, 2007). However, other research found that avoidant traits such as anxious apprehension and anxious arousal (Nitschke et al., 2002), PANAS negative affect (Larson et al., 2000), and depression (Dichter, Tomarken, Shelton, & Sutton, 2004) did not moderate a potentiated startle response to probes during aversive pictures.

In any event, a large number of correlational tests were undertaken to examine whether individual differences in approach and avoidance related to startle eyeblink responses and generally nonsignificant correlations were observed. These null results suggest that the motivational hypothesis for the relationship between anger and startle eyeblink response was not supported. In addition, null results were observed for correlations between individual differences in avoidance-related traits and startle eyeblink responses to probes during fear/disgust pictures (see Footnote 9). These latter results are inconsistent with all three hypotheses regarding how emotion, motivation, and arousal influence startle eyeblink

responses. The present results coupled with past results that failed to find associations between traits of approach/avoidance and affective-modulated startle responses suggest that these associations are likely more complex than previously conceptualized and may be influenced by other variables.

Approach/Avoidance Motivation and the Startle Reflex

Lang (1995) described the startle eyeblink as a reflex specific to defensive motivation elicited by stimuli negative in affective valence (this formulation includes anger as part of defensive motivation). One interpretation is that eyeblink potentiation may be fear- or threat-specific, because direct threat of physical harm activates defensive motivation most intensely (Bradley, Cuthbert, & Lang, 1999). In support of this idea, one study found that probes during fear scenes elicited larger eyeblinks compared to probes during disgust scenes, despite being rated equally arousing (Balaban & Taussig, 1994). However, Yartz and Hawk (2002) failed to replicate this result, instead finding that potentiation occurred in response to probes during negative emotion pictures regardless of the specific aversive content. Furthermore, probes during arousing unpleasant stimuli depicting human attack, animal attack, and contamination elicited equally potentiated eyeblink responses, despite only the first two picture types being classified as most threatening to survival (Bradley, Codispoti, Cuthbert, & Lang, 2001).

The results of the present research suggest a more complex model encompassing the aggregate influences of three different factors—motivation, arousal, and valence—on startle eyeblink responses. In light of anger's identity as a negative affect with approach motivational properties similar to certain positive affects, anger was well qualified to test this multidimensional model of the startle reflex. According to the arousal/valence hypothesis, the anger-evoked startle eyeblink should be potentiated similar to eyeblinks to probes during fear/disgust, because anger is similar to fear/disgust in being high in arousal and negative in valence. The results did not support this hypothesis. The prediction that probes during angering stimuli would evoke inhibited eyeblink responses, much like probes during pleasant stimuli, due to activation of appetitive motivation was also not supported. Rather, it is more likely that the competing influences of all three factors produced an anger-related eyeblink undifferentiated from that evoked by probes during neutral stimuli, suggesting that a multidimensional model of the emotion-modulated startle eyeblink is most accurate. In other words, visual stimuli likely need to evoke an approach-motivated positive affective state to cause an inhibited startle eyeblink response, and they need to evoke a withdrawal-motivated negative affective state to cause a potentiated startle eyeblink response. This interpretation would also be consistent with the idea that affective stimuli that cause larger startle responses to probes need to activate defensive motivation, and anger is not a part of that system, contrary to what has been posited (Lang & Bradley, 2010). As revealed in the present experiments, probes during an approach-motivated negative affective state of anger cause startle eyeblink responses that are similar in magnitude to those caused by probes during neutral stimuli.

Limitations

A limitation to the present research is that the "angering" pictures likely elicited other emotions in addition to anger, such as fear, in some individuals. Analyses in Study 3 revealed that individuals who had primarily subjective anger to the angering pictures continued to show similar levels of startle eyeblinks to probes during angering and neutral pictures. However, the smaller sample size makes it important to conduct additional research to assess the replicability of this result.

In addition, one construct that was not measured in these studies is attention. Research has demonstrated that increased attentional processing in one modality (e.g., visual) can cause a reduction in the startle response in a different modality (e.g., auditory) (e.g., Filion, Dawson, & Schell, 1998). One possibility is that probes during the angering pictures would have caused blinks similar to probes during fear/disgust pictures but the angering pictures were more visually engaging and thus decreased the blink magnitude. However, attentional processes correlate highly with arousal (Lang, Bradley, & Cuthbert, 1998), and the present results suggest that angering pictures were equal in arousal to the fear/disgust pictures. Also, research suggests that fear/disgust pictures engage as much attention as positive pictures in nonclinical samples (Bradley, Greenwald, Petry, & Lang, 1992; Lang, Greenwald, Bradley, & Hamm, 1993). In addition, recent research suggests that affective modulation of the startle response maintains over repeated presentations of the same affective category (presented up to 30 times in a row), suggesting that attention does not completely explain the affective modulation of the startle response (Ferrari, Bradley, Codispoti, & Lang, 2011). In other words, while attention may be involved, it is unlikely to be the sole factor causing the angering picture startle eyeblinks to be equivalent to the neutral picture startle eyeblinks.

Another limitation is the null statistical test or absence of evidence of a difference between startle eyeblinks to probes during angering versus neutral stimuli. We believe it is important to note, however, that the "absence of evidence" in the present studies is not the same "absence" often encountered. Some of the most common explanations for null effects are: lack of a sensitive measure, low statistical power, and failure to manipulate the constructs of interest (Harmon-Jones, 1999). The startle eyeblink response is a sensitive measure as revealed by the effect of arousing positive and fear/disgust stimuli on reactions to startle probes in the present studies. Adequate statistical power existed in the present studies as revealed by the replications of the effect of arousing positive and fear/disgust stimuli on reactions to startle probes. Finally, the self-reported ratings of the angering stimuli suggested that valence, arousal, and anger were most likely appropriately manipulated in the present studies. Still, null effects are notoriously difficult to interpret, and this limitation applies to the current studies.

Most of the obtained evidence has suggested that anger is associated with approach motivation (see review by Carver & Harmon-Jones, 2009). However, anger may occasionally not be accompanied by approach motivation (Kelley, Hortensius, & Harmon-Jones, in press; Zinner, Brodish, Devine, & Harmon-Jones, 2008). Both situational variables and individual differences may influence motivational responses to angering stimuli. Indeed, Study 2 suggests that depressive traits are associated with an avoidant response to anger, whereas both Studies 2 and 3 suggest that constructive patriotism relates to a more approach-oriented response. However, it is important to note that most emotions may have less-than-perfect associations with motivational direction. That is, passive viewing of erotic stimuli may not invariably evoke appetitive motivation, and passive viewing of fearful stimuli may not invariably evoke avoidance motivation. In any event, during passive viewing of these stimuli, startle eyeblinks are modulated for most individuals. Thus, we believe the our studies make an important point: passive viewing of angering stimuli that are rated high in negativity and arousal do not cause the same startle

eyeblink modulation caused by other stimuli, particularly fear/disgust stimuli that are also rated high in negativity and arousal. The present data with angering stimuli suggest that something other than the arousing negative valence of stimuli underlies the effect of certain affective stimuli on increased startle eyeblinks.

Conclusion

In paradigms investigating emotional processes, motivational properties of emotion are often shadowed by valence and arousal. Research utilizing the startle eyeblink, one of the most widely used physiological indexes of emotion for the last 20 years, is not an exception, as most investigators use paradigms that confound valence and arousal with motivational direction. The present results, which suggest that startle probes during anger, a negative-arousing affective state, do not cause startle eyeblink potentiation, support the notion that other emotive properties besides arousing negative valence are responsible for startle eyeblink potentiation. Based on these results, investigators should take into consideration the simultaneous influences of motivation, arousal, and valence on physiological responses to affective stimuli.

References

Aarts, H., Ruys, K. I., Veling, H., Renes, R. A., de Groot, J. H. B., van Nunen, A. M., & Geertjes, S. (2010). The art of anger: Reward context turns avoidance responses to anger-related objects into approach. *Psychological Science*, *21*, 1406–1410. doi: 10.1177/0956797610384152

Amodio, D. M., & Harmon-Jones, E. (2011). Trait emotions and affective modulation of the startle eyeblink: On the unique relationship of trait anger. *Emotion*, *11*, 47–51. doi: 10.1037/a0021238

Balaban, M. T., & Taussig, H. N. (1994). Salience of fear/threat in the affective modulation of the human startle blink. *Biological Psychology*, *38*, 117–131. doi: 10.1016/0301-0511(94)90033-7

Beck, A. T., Steer, R. A., & Brown, G. K. (1996). *The manual for the BDI-II*. San Antonio, TX: The Psychological Corp.

Berkowitz, L. (1993). Pain and aggression: Some findings and implications. *Motivation and Emotion*, *17*, 277–293. doi: 10.1007/BF00992223

Blumenthal, T. D., Cuthbert, B. N., Filion, D. L., Hackley, S., Lipp, O. V., & van Boxtel, A. (2005). Committee report: Guidelines for human startle eyeblink electromyographic studies. *Psychophysiology*, *42*, 1–15. doi: 10.1111/j.1469-8986.2005.00271.x

Bradley, M. M., Codispoti, M., Cuthbert, B. N., & Lang, P. J. (2001). Emotion and motivation I: Defensive and appetitive reactions in picture processing. *Emotion*, *1*, 276–298. doi: 10.1037/1528-3542.1.3.276

Bradley, M. M., Cuthbert, B. N., & Lang, P. J. (1990). Startle reflex modification: Emotion or attention? *Psychophysiology*, *27*, 513–522. doi: 10.1111/j.1469-8986.1990.tb01966.x

Bradley, M. M., Cuthbert, B. N., & Lang, P. J. (1999). Affect and the startle reflex. In M. E. Dawson, A. M. Schell, & A. H. Bohmelt (Eds.), *Startle modification: Implications for neuroscience, cognitive science, and clinical science* (pp. 157–183). New York, NY: Cambridge University Press.

Bradley, M. M., Greenwald, M. K., Petry, M., & Lang, P. J. (1992). Remembering pictures: Pleasure and arousal in memory. *Journal of Experimental Psychology: Learning, Memory, and Cognition*, *18*, 379–390. doi: 10.1037/0278-7393.18.2.379

Brigham, J. C. (1993). College students' racial attitudes. *Journal of Applied and Social Psychology*, *23*, 1933–1967. doi: 10.1111/j.1559-1816.1993.tb01074.x

Buss, A. H., & Perry, B. (1992). The Aggression questionnaire. *Journal of Personality and Social Psychology*, *63*, 452–459. doi: 10.1037/0022-3514.63.3.452

Carver, C. S. (2004). Negative affects deriving from the behavioral approach system. *Emotion*, *4*, 3–22. doi: 10.1037/1528-3542.4.1.3

Carver, C. S., & Harmon-Jones, E. (2009). Anger is an approach-related affect: Evidence and implications. *Psychological Bulletin*, *135*, 183–204. doi: 10.1037/a0013965

Carver, C. S., & White, T. L. (1994). Behavioral inhibition, behavioral activation, and affective responses to impending reward and punishment: The BIS/BAS scales. *Journal of Personality and Social Psychology*, *67*, 319–333. doi: 10.1037/0022-3514.67.2.319

Caseras, F. X., Fullana, M. A., Riba, J., Barbanoj, M. J., Aluja, A., & Torrubia, R. (2006). Influence of individual differences in the behavioral inhibition system and stimulus content (fear versus blood-disgust) on affective startle reflex modulation. *Biological Psychology*, *72*, 251–256. doi: 10.1016/j.biopsycho.2005.10.009

Cook, E. W., III, Hawk, L. W., Davis, T. L., & Stevenson, V. E. (1991). Affective individual differences and startle reflex modulation. *Journal of Abnormal Psychology*, *100*, 5–13. doi: 10.1037/0021-843X.100.1.5

Corr, P. J., Wilson, G. D., Fotiadou, M., Kumari, V., Gray, N. S., Checkley, S., & Gray, J. A. (1995). Personality and affective modulation of the startle reflex. *Personality and Individual Differences*, *19*, 543–553. doi: 10.1016/0191-8869(95)00059-F

Cuthbert, B. N., Bradley, M. M., & Lang, P. J. (1996). Probing picture perception: Activation and emotion. *Psychophysiology*, *33*, 103–111. doi: 10.1111/j.1469-8986.1996.tb02114.x

Deater-Deckard, K., Beekman, C., Wang, Z., Kim, J., Petrill, S. A., Thompson, L. A., & DeThorne, L. S. (2010). Approach/positive anticipation, frustration/anger, and overt aggression in childhood. *Journal of Personality*, *78*, 991–1010. doi: 10.1111/j.1467-6494.2010.00640.x

Dichter, G. S., Tomarken, A. J., Shelton, R. C., & Sutton, S. K. (2004). Early- and late-onset startle modulation in unipolar depression. *Psychophysiology*, *41*, 433–440. doi: 10.1111/j.1469-8986.00162.x

Dvorak-Bertsch, J. D., Curtin, J. J., Rubinstein, T. J., & Newman, J. P. (2009). Psychopathic traits moderate the interaction between cognitive and affective processing. *Psychophysiology*, *46*, 913–921. doi: 10.1111/j.1469-8986.2009.00833.x

Eckblad, M., & Chapman, L. J. (1986). Development and validation of a scale for hypomanic personality. *Journal of Abnormal Psychology*, *95*, 214–222. doi: 10.1037/0021-843X.95.3.214

Ferrari, V., Bradley, M. M., Codispoti, M., & Lang, P. J. (2011). Repetitive exposure: Brain and reflex measures of emotion and attention. *Psychophysiology*, *48*, 515–522. doi: 10.1111/j.1469-8986.2010.01083.x

Filion, D. L., Dawson, M. E., & Schell, A. M. (1998). The psychological significance of human startle eyeblink modification: A review. *Biological Psychology*, *47*, 1–43. doi: 10.1016/S0301-0511(97)00020-3

Forbes, E. E., Miller, A., Cohn, J. F., Fox, N. A., & Kovacs, M. (2005). Affect-modulated startle in adults with childhood-onset depression: Relations to bipolar course and number of lifetime depressive episodes. *Psychiatry Research*, *134*, 11–25. doi: 10.1016/j.psychres.2005.01.001

Ford, B. Q., Tamir, M., Brunye, T. T., Shirer, W. R., Mahoney, C. R., & Taylor, H. A. (2010). Keeping your eyes on the prize: Anger and visual attention to threats and rewards. *Psychological Science*, *21*, 1098–1105. doi: 10.1177/0956797610375450

Fowles, D. C. (1988). Psychophysiology and psychopathology: A motivational approach. *Psychophysiology*, *25*, 373–391. doi: 10.1111/j.1469-8986.1988.tb01873.x

Gautier, C. H., & Cook, E. W., III. (1997). Relationships between startle and cardiovascular reactivity. *Psychophysiology*, *34*, 97–96. doi: 10.1111/j.1469-8986.1997.tb02419.x

Graham, F. K. (1979). Distinguishing among orienting, defense, and startle reflexes. In H. D. Kimmel, E. H. van Olst, & J. F. Orlebeke (Eds.), *The orienting reflex in humans* (pp. 137–167). Hillsdale, NJ: Erlbaum.

Gray, J. A. (1994). Framework for a taxonomy of psychiatric disorder. In S. H. M. Van Goozen, N. E. Van de Poll, & J. A. Sergeant (Eds.), *Emotions: Essays on emotion theory* (pp. 29–59). Hillsdale, NJ: Lawrence Erlbaum.

Grillon, C., & Baas, J. (2003). A review of the modulation of the startle reflex by affective states and its application in psychiatry. *Clinical Neurophysiology*, *114*, 1557–1579. doi: 10.1016/S1388-2457(03)00202-5

Gros, D. E. (2011). Startle inhibition to positive-activated compared to neutral stimuli: Variations in self-reported behavioral approach. *Journal of Psychopathology and Behavioral Assessment*, *33*, 308–314. doi: 10.1007/s10862-011-9240-y

Harmon-Jones, C., Schmeichel, B. J., Mennitt, E., & Harmon-Jones, E. (2011). The expression of determination: Similarities between anger

and approach-related positive affect. *Journal of Personality and Social Psychology*, *100*, 172–181. doi: 10.1037/a0020966

Harmon-Jones, E. (1999). Toward an understanding of the motivation underlying dissonance processes: Is feeling personally responsible for the production of aversive consequences necessary to cause dissonance effects? In E. Harmon-Jones & J. Mills (Eds.), *Cognitive dissonance: Perspectives on a pivotal theory in social psychology* (pp. 71–99). Washington, DC: American Psychological Association.

Harmon-Jones, E. (2003a). Clarifying the emotive functions of asymmetrical frontal cortical activity. *Psychophysiology*, *40*, 838–848. doi: 10.1111/1469-8986.00121

Harmon-Jones, E. (2003b). Anger and the behavioral approach system. *Personality and Individual Differences*, *35*, 995–1005. doi: 10.1016/S0191-8869(02)00313-6

Harmon-Jones, E. (2004). On the relationship of frontal brain activity and anger: Examining the role of attitude toward anger. *Cognition and Emotion*, *18*, 337–361. doi: 10.1080/02699930341000059

Harmon-Jones, E., Abramson, L. Y., Sigelman, J., Bohlig, A., Hogan, M. E., & Harmon-Jones, C. (2002). Proneness to hypomania/mania symptoms or depression symptoms and asymmetrical frontal cortical responses to an anger-evoking event. *Journal of Personality and Social Psychology*, *82*, 610–618. doi: 10.1037//0022-3514.82.4.610

Harmon-Jones, E., Gable, P. A., & Peterson, C. K. (2010). The role of asymmetric frontal cortical activity in emotion-related phenomena: A review and update. *Biological Psychology*, *84*, 451–462. doi: 10.1016/j.biopsycho.2009.08.010

Harmon-Jones, E., Harmon-Jones, C., Abramson, L. Y., & Peterson, C. K. (2009). PANAS positive activation is associated with anger. *Emotion*, *9*, 183–196. doi: 10.1037/a0014959

Harmon-Jones, E., Harmon-Jones, C., Amodio, D. M, & Gable, P. A. (2011). Attitudes toward emotions. *Journal of Personality and Social Psychology*, *101*, 1332–1350. doi: 10.1037/a0024951

Harmon-Jones, E., Harmon-Jones, C., Fearn, M., Sigelman, J. D., & Johnson, P. (2008). Left frontal cortical activation and spreading of alternatives: Tests of the action-based model of cognitive dissonance. *Journal of Personality and Social Psychology*, *94*, 1–15. doi: 10.1037/0022-3514.94.1.1

Harmon-Jones, E., Lueck, L., Fearn, M., & Harmon-Jones, C. (2006). The effect of personal relevance and approach-related action expectation on relative left frontal cortical activity. *Psychological Science*, *17*, 434–440. doi: 10.1111/j.1467-9280.2006.01724.x

Harmon-Jones, E., & Peterson, C. K. (2009). Supine body position reduces neural response to anger evocation. *Psychological Science*, *20*, 1209–1210. doi: 10.1111/j.1467-9280.2009.02416.x

Harmon-Jones, E., Peterson, C. K., & Harris, C. R. (2009). Jealousy: Novel methods and neural correlates. *Emotion*, *9*, 113–117. doi: 10.1037/a0014117

Hawk, L. W., & Kowmas, A. D. (2003). Affective modulation and prepulse inhibition of startle among undergraduates high and low in behavioral inhibition and approach. *Psychophysiology*, *40*, 131–138. doi: 10.1111/1469-8986.00013

Hawk, L. W., Stevenson, V. E., & Cook, E. W., III. (1992). The effects of eyelid closure on affective imagery and eyeblink startle. *Journal of Psychophysiology*, *6*, 299–310.

Izard, C. E., Libero, D. Z., Putnam, P., & Haynes, O. M. (1993). Stability of emotion experiences and their relations to trait personality. *Journal of Personality and Social Psychology*, *64*, 847–860. doi: 10.1037/0022-3514.64.5.847

Jackson, D. C., Malmstadt, J. R., Larson, C. L., & Davidson, R. J. (2000). Suppression and enhancement of emotional responses to unpleasant pictures. *Psychophysiology*, *37*, 515–522. doi: 10.1111/1469-8986.3740515

Justus, A. N., & Finn, P. R. (2007). Startle modulation in non-incarcerated men and women with psychopathic traits. *Personality and Individual Differences*, *43*, 2057–2071. doi: 10.1016/j.paid.2007.06.020

Kaviani, H., Gray, J. A., Checkley, S. A., Raven, P. W., Wilson, G. D., & Kumari, V. (2004). Affective modulation of the startle response in depression: Influence of the severity of depression, anhedonia, and anxiety. *Journal of Affective Disorders*, *83*, 21–31. doi: 10.1016/j.jad.2004.04.007

Kazlauckas, V., Schuh, J., Dall'Igna, O. P., Pereira, G. S., Bonan, C. D., & Lara, D. R. (2005). Behavioral and cognitive profile of mice with high and low exploratory phenotypes. *Behavioral Brain Research*, *162*, 272–278. doi: 10.1016/j.bbr.2005.03.021

Kearney, J. A. (2004). Early reactions to frustration: Developmental trends in anger, individual response styles, and caregiving risk implications in infancy. *Journal of Child and Adolescent Psychiatric Nursing*, *17*, 105–112. doi: 10.1111/j.1744-6171.2004.tb00004.x

Kelley, N. J., Hortensius, R., & Harmon-Jones, E. (in press). When anger leads to rumination: Induction of relative right frontal cortical activity with transcranial direct current stimulation increases anger-related rumination. *Psychological Science*.

Klein, D. N., Lewinsohn, P. M., & Seeley, J. R. (1996). Hypomanic personality traits in a community sample of adolescents. *Journal of Affective Disorders*, *38*, 135–143. doi: 10.1016/0165-0327(96)00005-5

Lang, P. J. (1995). The emotion probe: Studies of motivation and attention. *American Psychologist*, *50*, 372–385. doi: 10.1037/0003-066X.50.5.372

Lang, P. J., & Bradley, M. M. (2010). Emotion and the motivational brain. *Biological Psychology*, *84*, 437–450. doi: 10.1016/j.biopsycho.2009.10.007

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1990). Emotion, attention, and the startle reflex. *Psychological Review*, *97*, 377–398. doi: 10.1037/0033-295X.97.3.377

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (1998). Emotion, motivation, and anxiety: Brain mechanisms and psychophysiology. *Biological Psychiatry*, *44*, 1248–1263. doi: 10.1016/S0006-3223(98)00275-3

Lang, P. J., Bradley, M. M., & Cuthbert, B. N. (2008). International affective picture system (IAPS): Affective ratings of pictures and instruction manual. Technical Report A-8. University of Florida, Gainesville, FL.

Lang, P. J., Greenwald, M. K., Bradley, M. M., & Hamm, A. O. (1993). Looking at pictures: Affective, facial, visceral and behavioral reactions. *Psychophysiology*, *30*, 261–273. doi: 10.1111/j.1469-8986.1993.tb03352.x

Larson, C. L., Ruffalo, D., Nietert, J. Y., & Davidson, R. J. (2000). Temporal stability of the emotion-modulated startle response. *Psychophysiology*, *37*, 92–101. doi: 10.1111/1469-8986.3710092

Mikels, J. A., Fredrickson, B. L., Larkin, G. R., Lindberg, C. M., Maglio, S. J., & Reuter-Lorenz, P. A. (2005). Emotional category data on images from the International Affective Picture System. *Behavior Research Methods*, *37*, 626–630. doi: 10.3758/BF03192732

Miller, M. W., Patrick, C. J., & Levenston, G. K. (2002). Affective imagery and the startle response: Probing mechanisms of modulation during pleasant scenes, personal experiences, and discrete negative emotions. *Psychophysiology*, *39*, 519–529. doi: 10.1017/S0048577202394095

Morey, L. C. (1991). *The personality assessment inventory: Professional manual*. Odessa, FL: Psychological Assessment Resources.

Navarrete, C. D., Fessler, D. M. T., Fleischman, D. S., & Geyer, J. (2009). Race bias tracks conception risk across the menstrual cycle. *Psychological Science*, *20*, 661–665. doi: 10.1111/j.1467-9280.2009.02352.x

Neumann, D. R., Hammond, F., Norton, J., & Blumenthal, T. (2011). Using startle to objectively measure anger and other emotional responses after traumatic brain injury: A pilot study. *Journal of Head Trauma Rehabilitation*, *26*, 375–383. doi: 10.1097/HTR.0b013e3181f8d52d

Nitschke, J. B., Larson, C. L., Smoller, M. J., Navin, S. D., Pederson, A. J. C., Ruffalo D., . . . Davidson, R. J. (2002). Startle potentiation in aversive anticipation: Evidence for state but not trait effects. *Psychophysiology*, *39*, 254–258. doi: 10.1111/1469-8986.3920254

Patrick, C. J., Bradley, M. M., & Lang, P. J. (1993). Emotion in the criminal psychopath: Startle reflex modulation. *Journal of Abnormal Psychology*, *102*, 82–92. doi: 10.1037/0021-843X.102.1.82

Peterson, C. K., Gravens, L. C., & Harmon-Jones, E. (2011). Asymmetric frontal cortical activity and negative affective responses to ostracism. *Social, Cognitive, and Affective Neuroscience*, *6*, 277–285. doi: 10.1093/scan/nsq027

Peterson, C. K., Shackman, A. J., & Harmon-Jones, E. (2008). The role of asymmetrical frontal cortical activity in aggression. *Psychophysiology*, *45*, 86–92. doi: 10.1111/j.1469-8986.2007.00597.x

Radloff, L. S. (1977). The CES-D scale: A self-report depression scale for research in the general population. *Applied Psychological Measurement*, *1*, 385–401. doi: 10.1177/014662167700100306

Rutherford, H. J. V., & Lindell, A. K. (2011). Thriving and surviving: Approach and avoidance motivation and lateralization. *Emotion Review*, *3*, 333–343. doi: 10.1177/1754073911402392

Schatz, R. T., Staub, E., & Lavine, H. (1999). On the varieties of national attachment: Blind versus constructive patriotism. *Political Psychology*, *20*, 151–174. doi: 10.1111/0162-895X.00140

Texas A&M University. (n.d.). In *Wikipedia*. Retrieved May 27, 2012, from http://en.wikipedia.org/wiki/Texas_A&M_University.

Top 10 Most Socially Conservative Colleges. (n.d.). In *Microsoft Encarta*. Archived from the original on October 31, 2009. Retrieved from http://www.webcitation.org/5kwpYqjoQ

van Boxtel, A., Boelhouwer, A. J. W., & Bos, A. R. (1998). Optimal EMG signal bandwidth and interelectrode distance for the recording of acoustic, electrocutaneous and photic blink reflexes. *Psychophysiology*, *35*, 690–697. doi: 10.1111/1469-8986.3560690

Vrana, S. R. (1994). Startle reflex response during sensory modality specific disgust, anger, and neutral imagery. *Journal of Psychophysiology*, *8*, 221–218.

Vrana, S. R., Spence, E. L., & Lang, P. J. (1988). The startle probe response: A new measure of emotion? *Journal of Abnormal Psychology*, *97*, 487–491. doi: 10.1037/0021-843X.97.4.487

Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS. *Journal of Personality and Social Psychology*, *54*, 1063–1070. doi: 10.1037/0022-3514.54.6.1063

Wilkowski, B. M., & Meier, B. P. (2010). Bring it on: Angry facial expressions potentiate approach-motivated motor behavior. *Journal of Personality and Social Psychology*, *98*, 201–210. doi: 10.1037/a0017992

Witvliet, C. V. O., & Vrana, S. R. (1995). Psychophysiological responses as indices of affective dimensions. *Psychophysiology*, *32*, 436–443. doi: 10.1111/j.1469-8986.1995.tb02094.x

Yartz, A. R., & Hawk, L. W. (2002). Addressing the specificity of affective startle modulation: Fear versus disgust. *Biological Psychology*, *59*, 55–68. doi: 10.1016/S0301-0511(01)00121-1

Zinner, L., Brodish, A., Devine, P. G., & Harmon-Jones, E. (2008). Anger and asymmetrical frontal cortical activity: Evidence for an anger-withdrawal relationship. *Cognition and Emotion*, *22*, 1081–1093. doi: 10.1080/02699930701622961

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