Brief report

Affective modulation of the acoustic startle: Does sadness engage the defensive system?

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\textbf{Abstract}

It has been suggested that high arousal negative affective states, but not low arousal negative affective states, potentiate the startle response. Because sadness has generally been studied as a low arousal emotion, it remains unclear whether high arousal sadness would produce startle potentiation to a similar degree as high arousal fear. To address this issue, 32 participants viewed two sets of 10-min film clips selected to induce two affective states of high subjective arousal (fear, sadness) and a neutral state of low subjective arousal, while the eyeblink startle response associated with brief noise bursts was assessed using orbicularis oculi EMG. Larger blink magnitude was found for fearful than for sad or neutral clips. Implications for conceptualizing sadness are discussed.

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\section{1. Introduction}

Startle response magnitude (SRM) of the eyelblink reflex typically shows response potentiation during fear, anger, and disgust, but no change or response inhibition for low-arousal sadness (Cook et al., 1991; Hawk et al., 1992; Lee and Lang, 2009; Robinson et al., 2000; van Oyen Witvliet and Vrana, 1995; van Oyen Witvliet and Vrana, 2000). One interpretation is that defensive reflexes are amplified by concurrent negative affect (Lang et al., 1990), but only when arousal levels are high, where arousal is defined as the subjective experience of restlessness, excitation, and agitation (Bradley et al., 2001a,b; Bradley and Lang, 2000). An alternative interpretation is that sadness does not activate the defensive system. Whereas fear, anger, and disgust are elicited in the presence of something unwanted, such as a potentially harmful, obstructing, or distasteful object, sadness is elicited in the absence of something wanted, such as the separation from a valued person (Lazarus, 1991).

Although previous research has typically studied sadness as a representative of negative, low arousal emotions, high-arousal sadness is also possible (van Oyen Witvliet and Vrana, 1995). To examine whether sadness can activate the defensive system, we used films to elicit states of fear and sadness that were matched for levels of subjective arousal (Jansen and Frijda, 1994; Kaviani et al., 1999, 2004). The study reported here represents additional analyses of data from a study demonstrating autonomic, respiratory, and facial-expressive differences between fear- and sadness-inducing films (Kreibig et al., 2007).

\section{2. Method}

\subsection{2.1. Participants}

Participants were 37 college students, screened for good health, good hearing, and absence of psychological disorders. Of these, 32 (17 women; 6\% African-American, 33\% Asian-American, 58\% European-American (47\% non-Hispanic, 11\% Hispanic), and 3\% other) were included in analyses. 4 participants were excluded due to technical problems, and one did not comply with instructions. Mean age was 20.9 years (SD = 2.0). Participants gave written consent and received US $30 for participating.

\subsection{2.2. Materials}

Two sad, fearful, and neutral 10-min color film clips with soundtrack were used (for details, see Kreibig et al., 2007). The emotional material shows situations where people die or anticipate dying under two different conditions: a threat of physical integrity due to a persecutor (fear films); a threat of loss of a loved one due to physical illness (sadness films). Films were selected for their potential to elicit intense emotional feelings and expressions (e.g., tearfulness for sadness or gaze diversion for fear). Each clip was preceded by a 30\’s audio introduction. The background peak sound level of the film presentation was calibrated to 60 dB(A).

Startle was elicited with 50 ms bursts of 95 dB(A) white noise (20–20,000 Hz) with 0.1 ms rise/fall time (Lang, 1995), administered binaurally by HD 475
Sennheiser stereo headphones, with 60-s intertrial-interval (unpredictably varying). There were 10 stimuli per film and 3 per quiet-sitting period.

2.3. Procedure

Participants individually watched the films in one of six orders. Films were presented on a 20” television monitor at a viewing distance of 1.75 m in a dimly lit room, played from a computer-controlled video tape player. Participants were instrumented with sensors for autonomic, respiratory, and myographic measures and headphones. They learned that they would hear occasional bursts of noise through the headphones, to which they should give no special attention. During a 2-min habituation phase, 8 startle stimuli were administered at unpredictable intervals, averaging 13 s. Participants then watched the 6 films. Each film was preceded by a 3-min quiet sitting period. Participants rated their feelings immediately after each film.

2.4. Measures

Self-report was obtained for how participants “generally felt during the last film clip” for sadness (sad, tearful; α = .90), fear (afraid, nervous; α = .91), and arousal (activated (either energetic or agitated), alert, stimulated; α = .88) using visual analogue scales labeled 0 (not at all) to 10 (extremely) and for valence on a scale labeled −2 (very negative) to 2 (very positive).

Bipolar electromyogram (EMG) of the orbicularis oculi was recorded with pairs of 4 mm miniature Beckman Ag/AgCl electrodes filled with Oxford Instruments (Hawthorne, NY) Teca Gel placed under the right eye. Data were sampled at 1000 Hz using an SA Instruments (San Diego, CA) 12-channel bioamplifier interfaced with a Data Translation (Marlborough, MA) DT3001 PCI 12-bit 16-channel A/D conversion board to a Pentium PC.

The EMG was filtered using 500 Hz anti-aliasing hardware and 28–500 Hz digital bandpass filters (Van Boxtel, 2001), full-wave rectified, and smoothed using a 10 ms time constant. Startle eyeblink response magnitude (SRM, in μV) was quantified as the difference from pre-startle baseline amplitude to peak amplitude of the EMG response associated with the sudden blink of the eyelids within 20–120 ms of startle probe onset (Wilhelm and Peyk, 2005). Invalid blinks occurred to 9.4% and non-response associated with the sudden blink of the eyelids within 20–120 ms of startle probe onset (Wilhelm and Peyk, 2005). Invalid blinks occurred to 9.4% and non-response associated with the sudden blink of the eyelids within 20–120 ms of startle probe onset (Wilhelm and Peyk, 2005).

Effects were tested with a 2 (gender) × 2 (film set) × 3 (film type) mixed-model analysis of variance (ANOVA), applying Greenhouse-Geisser correction where appropriate, and Tukey’s Honestly Significant Difference tests for post-hoc comparisons.

3. Results

3.1. Manipulation check

Films elicited the expected feeling self-reports (Table 1). Sad films elicited higher sadness ratings than fearful and neutral films, which did not differ. A gender × film-type effect, F(2,60) = 4.98, p < .05, indicated that women showed higher sadness ratings for sad films (M = 6.17, SE = 0.37) than men (M = 4.50, SE = 0.35), p < .001. Fearful films elicited higher fear ratings than sad and neutral films. Unexpectedly, fear ratings were also higher for sad1 than for neutral films. Results for valence and arousal ratings (Table 1) showed that sad and fearful films were comparable on valence and arousal, and were rated as more negative and more arousing than neutral films2.

3.2. Startle responses

Analysis of SRM showed a film-type effect (Table 1). Post-hoc tests indicated that SRM was significantly lower for sad and neutral than for fearful films, p < .001, and that SRM did not differ between sad and neutral films, p = .99.

4. Discussion

To test whether sadness can activate the defensive response system, we compared high-arousal fear and sadness. Successful elicitation of emotions was indicated by self-report. In line with previous research, our results indicated increased SRM in the fearful compared to the neutral condition. Although sad and fearful conditions were comparable in subjective valence and arousal, SRM was lower in sad than in the fearful condition, and responses during the sad condition did not differ from those in the neutral condition.

This finding is noteworthy in light of mild co-activation of fear in the sad condition indicated by self-report. Whereas this circumstance might have favored startle potentiation, our results do not indicate startle potentiation in the sad condition. A two-process model of reciprocal effects of emotion and attention (Bradley et al., 2006) might suggest that startle-inhibiting effects of attention could have caused the absence of startle potentiation for the sad condition, i.e., if attention were higher in the sad than fearful condition. However, a film-type effect on self-rated attention (attentive, involved; α = .85), F(2,60) = 32.46, p < .001, ε = .758, indicated higher attention for the emotional than neutral conditions (M = 4.51, SE = 0.25), p’s < .001, but no difference between sad (M = 6.67, SE = 0.24) and fearful conditions (M = 6.24, SE = 0.25), p = .53.

Our results show that sadness does not potentiate SRM, suggesting that sadness does not engage the defensive system. Future research needs to address if, instead, sadness engages the appetitive system, as sadness may be characterized by approach motivation toward an unattainable affiliation goal (Carver, 2004).

The current study has several limitations. First, because we limited our participants to healthy young adults in order to study basic emotional processes as a state variable, we do not know whether our results apply to clinical populations. Second, we studied sadness only in comparison to fear, as fear has been demonstrated to reliably activate the defensive system. Future research should compare sadness to other negative high arousal (anger, disgust) and low arousal (embarrassment, shame) emotions to address the specificity of our findings. Third, our results are based on a relatively

1 This effect was qualified by a film-set × film-type effect, F(2,60) = 5.32, p < .05, with higher fear ratings for the set 2 sad film (M = 2.42, SE = 0.34) than for the set 1 sad film (M = 1.58, SE = 0.30), p < .05.

2 A recent study involving this material replicated these results.
small number of stimuli for each emotion category and our material was not standardized for physical characteristics [Jansen and Frijda, 1994; Kaviani et al., 1999]. Finally, following past research, we defined arousal based on subjective experience. Previous analyses of our data (Kreibig et al., 2007) suggest no difference between sadness and fear on various physiological measures of arousal (including often-used electrodermal and cardiovascular measures), but very specific myocardial β-adrenergic and respiratory differences. Future research might benefit from a multi-level definition of arousal, integrating subjective experience, physiological activity, and action tendencies.

References


