

## Emotion regulation and potentiated startle across affective picture and threat-of-shock paradigms

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### Abstract

Past studies beginning with Jackson et al. [Jackson, D.C., Malmstadt, J.R., Larson, C.L., Davidson, R.J., 2000. Suppression and enhancement of emotional responses to unpleasant pictures. *Psychophysiology* 37 (4), 515–522.] document increases and decreases in emotionally-potentiated startle by way of instructing participants to enhance or suppress their emotional responses to *symbolic* sources of threat (unpleasant pictures). The present study extends this line of work to a threat-of-shock paradigm to assess whether startle potentiation elicited by threat of *actual* danger or pain is subject to emotion regulation. Results point to successful volitional modulation for both *Affective-Picture* and *Threat-of-Shock* experiments with startle magnitudes from largest to smallest occurring in the enhance, maintain, and suppress conditions. Successful regulation of startle potentiation to the threat of shock found by the current study supports the external validity of the Jackson paradigm for assessment of regulation processes akin to those occurring in the day-to-day context in response to *real* elicitors of emotion.

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Emotionally-enhanced startle, referring to the potentiation of the startle reflex when the aversive motivational system is activated by an unpleasant or anxiogenic foreground (Bradley et al., 1990; Grillon et al., 1991; Vrana et al., 1988), has become a widely used objective index of negative emotion. More recently, volitional self-regulation of emotionally-enhanced startle has been demonstrated (Dillon and Labar, 2005; Jackson et al., 2000; Piper and Curtin, 2006). In these studies, participants displayed a complete reduction in startle potentiation elicited by unpleasant pictures from the International Affective Picture System (Lang et al., 1988) following the simple instruction to ‘suppress’ emotional responses. Because all applications of Jackson’s regulation paradigm to date employ emotional pictures representing *hypothetical* affective scenarios, a question remains regarding the efficacy of volitional suppression for neutralizing

fear-potentiated startle elicited by the threat of *actual* physical danger or pain. Given that the value of experimental paradigms testing emotion regulation lies in their ability to generate inferences regarding the workings of emotion regulation to *real* sources of emotion arising in the day-to-day context, it is necessary to establish whether effects from Jackson’s paradigm extend beyond regulation of symbolic sources of aversiveness to actual threat of danger.

One possibility is that negative emotion to actual physical threat will be less subject to willful suppression. Though emotion regulation is generally adaptive and considered an essential component of mental health (Gross and Munoz, 1995), down-regulation of negative emotion to potent and imminent danger may serve to prolong exposure and vulnerability to survival threats and may not have been naturally selected over the course of evolution. In turn, negative emotion elicited by actual physical threat or pain (i.e., electric shock) may be less subject to volitional suppression than that elicited by more hypothetical or symbolic sources of threat (i.e., unpleasant pictures).

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The notion that negative emotion generated by threat of shock may be more difficult to terminate via willful suppression derives support from data revealing more robust startle potentiation elicited during threat of shock relative to unpleasant pictures (Lissek et al., 2004), as well as findings that expression of fear-potentiated startle elicited by instructed (Baas et al., 2002), or conditioned threat of shock (Scaife et al., 2005), is difficult to reduce with anti-anxiety benzodiazepines (but see Bitsios et al., 1999; Graham et al., 2005; Riba et al., 2001). Additionally, because levels of startle modulation elicited by emotional pictures and threat of shock are uncorrelated (Greenwald et al., 1998) and because responses to negative pictures and threat of shock have been linked to dissociable neural substrata (Funayama et al., 2001), it is plausible that regulation of emotional responses to unpleasant pictures versus threat of shock involves separable processes and the ability to suppress emotion from the former may not necessarily indicate the ability to suppress emotion from the latter.

The aim of the current study was to replicate the findings of Jackson et al. (2000) using IAPS pictures and to extend this line of work to a *threat-of-shock* paradigm (Grillon et al., 1991) with the particular focus on whether startle potentiation elicited by genuine physical threat can be abolished through willful suppression. In addition to startle EMG data, both subjective reports of experienced difficulty to suppress/enhance and qualitative reports of regulation strategies were collected to further characterize potential differences in regulation across paradigms.

Though suppression effects in the Threat paradigm were a primary focus, comparing levels of enhancement across paradigms was of additional interest. Given findings of greater state anxiety during the Threat versus Picture paradigm (Lissek et al., 2004) and the documented positive relationship between state anxiety and escalation or catastrophizing of negative emotion (e.g., Granot and Goldstein-Ferber, 2005), it logically follows that negative emotion to threat of shock might be more subject to willful enhancement. Additionally, the ability to enhance startle potentiation to threat of shock was of interest given concerns that threat of shock may elicit ‘ceiling’ magnitudes of startle (Bradley et al., 2005; Grillon et al., 2006; Grillon and Baas, 2003). For example, the lack of differentiation between anxiety patients and healthy controls found in several studies assessing startle potentiation to discrete, threat-of-shock cues (Grillon and Morgan, 1999; Grillon et al., 1998; Pole et al., 2003) could be attributable to ceiling effects producing maximal outputs in the startle system among all participants, leaving little room for elevations in startle magnitudes among patients versus controls. Testing whether startle magnitudes elicited during threat of shock can be increased through voluntary attempts to enhance negative emotion, will provide evidence for or against the possibility of such a ceiling effect.

A final aim of the current effort was to further assess differences in the magnitude of unregulated emotionally-potentiated startle across instructed threat-of-shock and unpleasant pictures. Though stronger potentiation to instructed threat-of-shock versus unpleasant pictures might be expected

given the greater aversive salience of the former (Lissek et al., 2004), the only study to date assessing startle modulation within both an instructed threat-of-shock and picture paradigm found startle potentiation of equal magnitudes to threat-of-shock and unpleasant pictures (Bradley et al., 2005). In that study, shock electrodes remained attached during assessment of startle potentiation to unpleasant pictures. Given that startle is potentiated by the simple presence versus absence of shock electrodes (Grillon and Ameli, 1998), startle increases to negative pictures may have been influenced by the presence of shock electrodes. As such, in the present study shock electrodes were attached during the Threat but not Picture experiment so as to assess magnitudes of potentiation to unpleasant pictures independent of potentiation associated with the presence of shock electrodes.

In sum, the current study was undertaken to test predictions that (1) startle potentiation elicited by threat of shock versus unpleasant pictures would be less subject to volitional suppression but more subject to enhancement, (2) subjective reports of task difficulty would reveal greater ease of suppressing in the Picture paradigm and greater ease of enhancing in the Threat paradigm, (3) distinct regulation strategies would be used for modulating emotion in the Picture and Threat runs, and (4) potentiation of the startle reflex during threat of shock would be stronger than that elicited by unpleasant pictures.

## 1. Methods

### 1.1. Participants

Fifty healthy participants (19 males, 31 females) with a mean age of 27.59 (S.D. = 8.94), and average state and trait anxiety scores of 32.10 (S.D. = 8.91) and 34.16 (S.D. = 8.92), respectively (State and Trait Anxiety Inventory; Spielberger et al., 1983) were recruited from the community via newspaper advertisement and reimbursed for their time. Prior to participation, participants gave written informed consent that had been approved by the NIMH Human Institutional Review Board. Inclusion criteria included: (1) no past or current Axis-I psychiatric disorder as per Structured Clinical Interview for DSM-IV, (SCID-I/NP; First et al., 2001) administered by a staff psychologist, (2) no medical condition (i.e., cardiovascular, endocrine, or neurological diseases; current or past history of malignancies) or treatment for such conditions that interfered with the objectives of the study as determined by a staff physician during a physical exam, (3) no current use of psychoactive medications or other drugs altering central nervous system function, and (4) no current use of illicit drugs as per self-report and confirmed with a urine test.

### 1.2. Physiological apparatus

Stimulation and recording were controlled by a commercial system (Contact Precision Instruments). Startle-blink EMG was recorded with two 6-mm tin cup electrodes placed under the right eye and amplifier band width was set to 30–500 Hz.

Startle was elicited by a 40-ms duration, 102 dB(A) burst of white-noise with a near instantaneous rise time presented binaurally through headphones.

### 1.3. Stimuli

International Affective Picture System images (IAPS; Lang et al., 2005) used in the picture viewing paradigm were 28 unpleasant (valence = 2.61, arousal = 6.43, dominance = 3.46) and 14 neutral pictures (valence = 4.86, arousal = 2.89, dominance = 5.92) from the picture set employed by Jackson

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