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Expressive inhibition in response to stress: Implications for emotional processing following trauma

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Abstract

Expressive inhibition - the willful restriction of expressed emotion - is documented in individuals reporting trauma-related distress, but its impact on global affective functioning remains unclear. Theoretical models propose that chronic activation of negative emotion and deliberate restriction of affect operate synergistically to produce trauma-related emotional deficits. The current project examined the impact of these factors on subjective experience and physiological activation following exposure to an analog trauma. University students ($N = 192$; $M_{\text{age}} = 20$, 57% female, 42% White/Non-Hispanic) viewed a graphic film depicting scenes of a televised suicide. Participants then viewed either a sadness- or humor-eliciting film under instructions to inhibit [$n_{\text{sadness}} = 45$, $n_{\text{humor}} = 52$] or naturally express emotion [$n_{\text{sadness}} = 48$, $n_{\text{humor}} = 47$]. Expressive inhibition was associated with restricted amusement specifically among participants viewing the humor film. Inhibition also produced attenuated sympathetic and parasympathetic recovery, irrespective of film assignment. Evidence of disruptions in emotional processing supports models identifying inhibition as a possible mechanism in post-trauma affect dysregulation.

Keywords

Emotion regulation; Expressive inhibition; Trauma; PTSD

1. Implications for emotional processing following trauma

Emotional deficits associated with posttraumatic stress disorder (PTSD) have been identified as the most poorly conceptualized and least studied aspect of the disorder (Litz, 1992). This is problematically given that affective deficits, historically indicated as symptoms of emotional numbing (APA, 1980), demonstrate robust associations with negative outcomes including the prospective severity of PTSD (e.g., Harvey & Bryant, 1998), reduced quality of life (e.g., Lunney & Schnurr, 2007), interpersonal dysfunction (e.g., Kuhn, Blanchard, &

Hickling, 2003), and poor response to intervention (e.g., Jaycox & Foa, 1996; Taylor et al, 2001). Existing theory identifies both automatic and volitional processes as contributing to emotional dysregulation following trauma. The deliberate restriction of expressed emotion (i.e., expressive suppression) is one mechanism having received empirical attention (e.g., Roemer, Litz, Orsillo, & Wagner, 2001) although the impact of this behavior on global affective response and its relation to broader conceptualizations of post-trauma emotional functioning remains unclear. The goal of the current project was to evaluate the impact of deliberate expressive inhibition on subjective experience and physiological response following the activation of negative, trauma-related emotion networks. For this research, an analog paradigm was used to simulate trauma-relevant processes in a diverse, non-clinical sample.

1.1. Post-trauma affective deficits

The specific mechanisms contributing to symptoms of emotional restriction and detachment have received limited attention within prominent models of PTSD (e.g., Foa, Steketee, & Rothbaum, 1989; Horowitz, 1986; Resick & Schnicke, 1992). In response, Litz (1992) provides a comprehensive framework outlining processes believed to influence affective functioning in the aftermath of trauma. Contrasting models of global emotional restriction, Litz operationalizes affective deficits as a phasic reaction to trauma-related intrusions, characterized by a restricted response to positive emotional events. Although survivors retain *the capacity* for normal emotional processing, the likelihood of an adaptive response is reduced by the activation of trauma-related intrusions and distress. Three hierarchical systems are outlined in Litz' model.

1.1.1. Expressive-motor programs—Unlearned, expressive-motor programs are proposed to coordinate processing at the most basic level. These programs are activated involuntarily in the presence of emotionally relevant stimuli and organize universal affective processes (e.g., stereotyped expressive behavior, physiological response). Expressive-motor programs provide the capacity for basic emotional learning and remain unaltered following trauma exposure. Evidence of similarities in emotional processing across PTSD and non-PTSD groups in the absence of explicit trauma cues suggests that basic programs for adaptive emotional responding remain intact following exposure (e.g., Amdur, Larsen, & Liberzon, 2000; Phan, Britton, Taylor, Fig, & Liberzon, 2006).

1.1.2. Schematic processes—A higher-order schematic subsystem is proposed to organize networks that coordinate learned emotional reactions (Litz, 1992). As with other models (e.g., Foa & Rothbaum, 1998), trauma networks are thought to be characterized by their accessibility and by the intensity of cued emotional responding. Activation of trauma-relevant networks serves to decrease the threshold for negative affect while increasing the threshold for positive emotional experience. Research indicating cued deficits in expressive behavior, positive emotion, physiological activity, and defensive startle provides evidence of state-dependent processing anomalies in survivors with PTSD (Casada, Amdur, Larsen, & Liberzon, 1998; Litz, Orsillo, Kaloupek, & Weathers, 2000; Miller & Litz, 2004).

1.1.3. Conceptually driven deficits—Whereas schematic deficits in response to cued reactions are largely involuntary, processing in Litz's (1992) conceptual subsystem is both deliberate and effortful. The conceptual system enables volitional, top-down regulation and is influenced by an individual's expectations and attributional style. Deficits at the conceptual level are the result of deliberate regulatory strategies intended to restrict emotional response, particularly during the activation of trauma-relevant networks. Examination of conceptual-level processing has primarily targeted the willful inhibition of expressive behavior.² Research with combat survivors suggests those with PTSD deliberately restrict expressive response to positive and negative events to a greater degree than veterans with no diagnosable disorder (Roemer et al., 2001). Associations between inhibition and post-trauma symptoms also have been noted in student and community survivor samples (Marx & Sloan, 2002; Moore, Zoellner, & Mollenholt, 2008). Evidence of indiscriminant and habitual withholding in this literature is consistent with top-down conceptual processes believed to influence dysregulation in the aftermath of trauma (Litz, 1992).

1.2. Consequences of expressive inhibition

Assuming survivors with PTSD routinely inhibit expression, what are the potential consequences of this behavior? Clearly, deliberate and pervasive inhibition could enhance the appearance of flattened affect characteristic of many individuals with PTSD. Inhibition may also selectively attenuate the experience of positive emotion. Gross and Levenson (1997) found that women instructed to inhibit expression during a humorous film reported less positive emotional experience than those permitted to naturally express. Inhibition in response to negative stimuli, by contrast, was unrelated to negative emotional experience. Whereas successful replication of these effects has been limited (i.e., Bonanno, Papa, Lalande, Westphal, & Coifman, 2004; Bush, Barr, McHugo, & Lanzetta, 1989; Davis, Senghas, Ochsner, 2009; Schmeichel, Volokhov, & Demaree, 2008; Zuckerman, Kiorman, Larrance, & Spiegel, 1981), the possibility of a targeted impact of inhibition on positive emotion - particularly during the activation of trauma-relevant networks - could account for conflicting symptoms of numbness and intense negative affect observed in survivors with PTSD (Amdur et al., 2000).

Data also suggest inhibition may impact elements of physiological response. Relative to natural expression, inhibition is shown to produce reliable elevations in sympathetic activity as indexed via skin conductance and other sympathetic-mediated indices (e.g., Gross & Levenson, 1993). Sympathetic dysregulation is proposed as a biological substrate for hyperarousal (Kolk, Greenberg, Boyd, & Krystal, 1985) which, in turn, demonstrates unique associations with posttraumatic numbing (e.g., Litz et al., 1997). The relation of post-trauma dysregulation with parasympathetic responding is less clear although some research provides evidence of parasympathetic nonresponse among individuals with PTSD (Cohen et al., 2000; Sahar, Shalev, & Porges, 2001). While preliminary, these effects are interesting in that parasympathetic reactivity is proposed to be instrumental to adaptive emotional

²*Expressive inhibition* as used in this research is synonymous with Gross and Levenson's (1993, 1997) conceptualization of *expressive suppression*. The term *expressive inhibition* is used to highlight the targeted regulation of expressive behavior as opposed to more general suppression of affective response (see Campbell-Sills, Barlow, Brown, & Hofmann, 2006).

functioning (Friedman, 2007; Porges, 1995). Research evaluating the impact of expressive regulation on parasympathetic activity remains equivocal (e.g., Demaree et al., 2006; Hagemann, Levenson, & Gross, 2006) although no study to date has examined these processes as they are likely to occur within the context of trauma-related distress.

1.3 Overview of the current research

Existing research indicates anomalies among trauma survivors at the schematic-level of processing, but studies examining the impact of conceptual-level regulation remain limited. The aim of the current project was to evaluate the consequences of expressive inhibition in a non-clinical sample following exposure to an analog trauma. Analog methodologies have proven useful for assessing a variety of trauma-relevant processes including memory coding, thought suppression, and the maintenance of intrusions (e.g., Brewin & Saunders, 2001; Davies & Clark, 1998; Krans, Näring, Holmes, & Becker, 2009). As Litz's (1992) model posits affective deficits to be a state-dependent reaction to negative emotional priming, the analog paradigm provides a unique opportunity to model trauma-relevant processes in a non-clinical sample.

University students in this study were shown a series of affectively valenced films. Upon establishing baseline levels of behavioral, subjective, and physiological response, participants viewed commercially available scenes of a televised suicide intended to prime trauma-relevant emotion networks. Finally, participants viewed either a sadness- or humor-eliciting film under instructions to inhibit or naturally express emotion. Inhibit instructions were designed to model deliberate regulatory processes thought to influence post-trauma emotional deficits. Expressive restriction was expected to uniquely produce attenuation in positive emotional experience while elevating measures of sympathetic response. Parasympathetic reactivity also was assessed although analyses were considered exploratory given conflicting effects within the trauma and expressive manipulation literatures (e.g., Cohen et al., 1998, 2000; Roberts, Levenson, & Gross, 2008).

2. Methods

2.1 Participants

Participants included 257 university students enrolled at a large southern university. Students identified through a mass testing procedure were contacted by email and invited to participate in a study about "how individuals respond to viewing unpleasant stimuli." Invitees were informed participation would involve viewing at least one graphic film depicting an actual suicide. Given the nature of this film and our intent to induce psychological distress, individuals involved in psychiatric treatment (i.e., counseling, medication), those reporting acute suicidal ideation, and those endorsing ongoing distress related to a potentially traumatic event were excluded from participation. Individuals having attempted suicide or those closely acquainted with someone who had attempted or completed suicide also were excluded.

Eligibility was determined through an in-person screening procedure administered prior to the experimental protocol. Treatment status and suicidal ideation were assessed using self-

report items. A checklist of potentially traumatic events (Blake et al., 1990) was used as an initial screen for potential trauma and/or prior exposure to suicide (self-attempts or relationships with close others having attempted/completed suicide). For those endorsing a potentially traumatic event, research staff administered follow-up questions to assess details of the event and to determine the presence of associated distress (e.g., *Do you continue to have unwanted and distressing memories of this event; Do you currently avoid situations or events that remind you of the event*). Individuals meeting eligibility requirements were permitted to continue with the experiment and received course credit. Those determined ineligible for participation were given partial credit and excused from the study. All experimental procedures were approved by relevant institutional review boards.

A total of 50 individuals were excluded given active trauma-related distress ($n = 37$), current psychiatric treatment ($n = 5$), acute suicidal ideation ($n = 1$), or reporting a previous suicide attempt/holding a close relationship with someone who had attempted or completed suicide ($n = 7$). Three cases were lost to equipment malfunction, two to experimenter error, and eight given failure to comply with experimental instructions (see Post ERQ). Two cases were removed given evidence of unreliable responding. Characteristics of the final sample ($N = 192$) are provided in Table 1.

2.2 Materials

2.2.1. Film stimuli

2.2.1.1. Neutral film: A silent, 64-s film of a standard television test-pattern was used to establish baseline levels of physiological and subjective response. Previous research provides evidence for the validity of this film as an affectively neutral stimulus (Gross & Levenson, 1995).

2.2.1.2. Analog trauma: Films used to simulate trauma-relevant processes in previous studies have typically involved presenting graphic or troubling scenes over an extended period (i.e., 9–29 min; Halligan, Clark, & Ehlers, 2002; Kindt & van den Hout, 2003; Laposa & Alden, 2006). The current study employed a brief, but shocking, film depicting scenes of an actual suicide, similar in duration to experimental stimuli presented at the final assessment period. In the video, a suited, middle-aged man is shown to extract a firearm from a large manila envelope and shoot himself during a televised press conference (Death Scenes II, 2003). The film was approximately 60 s in duration. Pilot testing identified the scene as effective in priming trauma-relevant emotions (e.g., fear, shock, horror) and inducing intrusive images over a discrete period. Presentation of the film also produced reductions in emotional valence, increases in emotional arousal, and heightened levels of sympathetic activation.³

2.2.1.3. Humor film: A 155-s clip from the motion picture *When Harry Met Sally* (Reiner, 1989) was used to elicit positive emotion. Validation research shown this film is shown to elicit moderate to high levels of discrete amusement (Gross & Levenson, 1995).

³Pilot data are available from the first author upon request.

2.2.1.4. Sorrow film: A 171-s clip from the motion picture *The Champ* (Lovell & Zeffirelli, 1979) was used to elicit negative emotion. This film is shown to reliably elicit moderate to high levels of discrete sadness in previous research (Gross & Levenson, 1995).

2.2.2. Self-report measures

2.2.2.1. Emotion regulation questionnaire (ERQ): The ERQ (Gross & John, 2003) was completed during the preliminary screening to assess baseline differences in two regulatory strategies. Expressive suppression is synonymous with expressive inhibition and refers to the deliberate restriction of expressive behavior (e.g., *I control my emotions by not expressing them*). Cognitive reappraisal involves modifying the construal of emotional events to alter their subjective impact (e.g., *I control my emotions by changing the way I think about the situation I'm in*). Suppression and reappraisal are calculated as the mean of scale items (1: *strongly disagree* to 7: *strongly agree*) with higher scores indicating greater regulation. Internal consistencies for suppression (4 items, $\alpha = .76$) and reappraisal (6 items, $\alpha = .80$) in this sample were adequate.

2.2.2.2. Emotion ratings: Subjective valence (0: *unhappy/very unpleasant* to 8: *happy/very happy*) and emotional arousal (0: *low/calm* to 8: *high/excited*) were rated on a 9-point Likert scale following the presentation of each film. A series of discrete emotion states also were assessed on a similar 9-point scale (0: *not at all* to 8: *most ever in my life*). Ratings of anger, disgust, fear, horror, shock, and tension were used to assess the efficacy of the trauma stressor. Ratings of sadness and amusement were used to evaluate the activation of specific emotion states targeted by the sorrow and humor films, respectively.

2.2.2.3. Post-film ERQ: Regulation strategies employed during presentation of the sorrow and humor films were assessed at the conclusion of the study using a modified version of the ERQ (see Butler, Lee, & Gross, 2007). Post-film ERQ scores were used to determine whether participants instructed to inhibit reported greater suppression than those allowed to freely express and to identify individuals instructed to express who nonetheless restricted expression. Post-film suppression scores ≥ 5.0 served to identify individuals who may have inadvertently withheld. This cut-off corresponds to a score 1.5 SD above published norms (Gross & John, 2003).

2.2.2.4. Intrusions: The frequency (1: *not at all* to 7: *constantly*) and intensity (1: *not at all* to 7: *extremely*) of intrusive memories experienced through the remainder of the protocol were assessed at debriefing to further determine the efficacy of the analog trauma film.

2.2.3. Physiological assessment—Skin conductance level (SCL) and respiratory sinus arrhythmia (RSA) were used as indices of sympathetic and parasympathetic activation, respectively (Kreibig, 2010). Autonomic measures were collected using a Coulbourn LabLinc V system. Signals were integrated through a Coulbourn Wingraph Port (VI9-02). Data were scored on-line and recorded using Win/Daq DI-720 series software.

2.2.3.1. SCL: SCL was collected using IVM (12.55 mm) Ag/AgCl surface electrodes applied to the medial phalanx of the palmar surface of the first two fingers of the non-

dominant hand. Electrode paste (.5% saline) specific to the collection of electrodermal measures (Discount Disposables TD-246 Electrode Paste) was applied to surface electrodes which were secured using adhesive collars and surgical tape. SCL was quantified by applying a constant .5 V across electrodes using a Coulbourn V71-23 isolated skin conductance coupler. Data were sampled at 15 Hz and screened for artifacts offline through visual inspection. SCL was calculated as the mean value in $\mu\text{Siemens}$ (μS) across each viewing period.

2.2.3.2. RSA: ECG waveforms were collected using disposable Cleartrace 1700 electrodes placed in a modified Lead II configuration. Active electrodes were applied below the midpoint of the right clavicle and on the inner surface of the left forearm. A second electrode on the left forearm, distal to the first, served as ground. R-waves and sequential R-R intervals were detected to the nearest ms and extracted offline using QRSTool Version 1.2.2 (Allen, Chambers, & Towers, 2007). Files containing artifacts precluding reliable identification of consecutive R-waves (3.9% of all film epochs) were edited using CardioEdit software (Brain-Body Center, University of Illinois at Chicago).

RSA was extracted using CardioBatch software (Brain-Body Center, University of Illinois at Chicago) consistent with methods developed by Porges (1985). Porges' time series method is highly correlated with alternative metrics of heart-rate variability and demonstrates strong evidence as a valid and reliable measure of cardiac vagal control (Allen et al., 2007). RSA was scored as the mean value ($\ln \text{ms}^2$) across each viewing period.⁴

2.2.4. Behavioral response

2.2.4.1. Facial expressive coding system (FACES): Expressive behavior was coded using the FACES system (Kring & Sloan, 2007). Ratings of global expressive behavior (1: *low* to 5: *high*) were used to determine expressive response and compliance with instructions to inhibit. Experimental sessions were digitally recorded using a Sony EVID70 color video camera. Four cases were lost due to equipment malfunction and/or experimenter error leaving film data for 188 participants. Epochs corresponding to each viewing period ($N = 564$) were extracted for all participants. Behavioral coding of each epoch was conducted by the second author who was trained in FACES.⁵ Independent coding was provided by a graduate student trained to reliability ($\text{ICC} = .80$) using 75 epochs randomly selected from the full set of observations. Approximately 35% of the remaining epochs ($N = 180$) were chosen at random for review. Inter-rater reliability for this sample was excellent ($\text{ICC} = .93$).

2.3. Procedure

Participants were assigned to condition at enrollment through a stratified randomization procedure with strata defined by gender and minority status. A randomized list of condition assignments was generated for each strata using an online program (random.org).

⁴Methods used for the quantification of heart rate variability and the interpretation of these indices is a point of ongoing debate within the psychophysiology literature (e.g., Grossman & Taylor, 2007). Whereas some investigators support the correction of RSA using paced breathing procedures or statistical correction for respiration, existing research provides evidence of few differences across metrics within the context of routine psychological paradigms (Allen et al., 2007; Denver et al., 2007).

⁵Film epochs were assigned a unique identification number and rated without volume to mask coders to film and participant condition.

Individuals (whose gender and ethnic identity were recorded during the initial mass testing) were entered into the randomization list corresponding to their strata sequentially in order of enrollment.

Participants were seated in a dimly lit, temperature-controlled room (2.4×2.2 m) upon arrival to the scheduled appointment. They were reminded of the purpose of the study and that participation would involve viewing at least one graphic film depicting an actual suicide. After providing informed consent and completing initial screening procedures, those eligible for the study were instructed to wash their hands in preparation for physiological assessment. Students were fitted with transducers and given forms to be completed after each film. Participants were asked to sit quietly during a 10-min adaptation period but remained in contact with an experimenter through an open intercom system. Participants then received the following set of pre-recorded instructions taken from Gross and Levenson (1993):

We will now be showing you a short film clip. It is important to us that you watch the film clip carefully, but if you find the film too distressing, just say “stop”.

The Neutral film was presented following a 1-min post-instruction delay to minimize any immediate physiological response to the instruction stimulus. Films were displayed on an 81.3 cm television monitor positioned 2.1 m in front of the participant. Pre-recorded instructions to complete emotion ratings were administered at the conclusion of the film. The analog trauma film was then presented under identical procedures. Upon completing emotion ratings for this film, participants received one of two pre-recorded instruction sets. Express participants received instructions identical to those preceding the first two films. Inhibit participants received the following instructions, adapted from Gross and Levenson (1993):

In a moment we will be showing you another short film clip. It is important to us that you watch the film carefully, but if you find the film too distressing, just say “stop”. This time, if you have any feelings as you watch the clip, please try your best not to let those feelings show. In other words, as you watch the film clip and as you complete the questionnaires, try to behave in such a way that a person watching you would be unable to know that you are feeling anything at all. Watch the film clip and mark your responses carefully, but please try to behave in such a way that someone watching you would not know that you are feeling anything at all.

The assigned sorrow or humor film was presented following a 1-min post-instruction period. Upon conclusion of the protocol, participants completed the post-film ERQ and items assessing the frequency and intensity of intrusions. Students were thanked following debriefing and were encouraged to contact the first author with questions or ongoing distress associated with participation.

2.4. Analytic approach

Adequacy of randomization across individual difference characteristics was examined using ANOVA and chi-square models for continuous and categorical variables, respectively.

Paired-samples *t*-tests were used to evaluate the efficacy of the analog trauma as indicated by changes in subjective emotion, physiological activation, and expressive responding relative to the preceding Neutral film.

Potential differences in expressive, subjective, and physiological response to the neutral and trauma films across conditions were examined through a series of 2 (instruction: watch, inhibit) $\times$ 2 (film: humor, sorrow) $\times$ 2 (period: Time 1, Time 2) repeated-measures ANOVA models. Primary hypotheses were evaluated using an additional set of 2 (instruction) $\times$ 2 (film) $\times$ 2 (period: Time 2, Time 3) repeated-measures ANOVAs for each outcome. Assuming minimal evidence of differences in affective response prior to manipulation, these analyses provide a series of parsimonious models that preclude violations of sphericity in designs having three or more repeated assessments (Vasey & Thayer, 1987).

The magnitude of omnibus effects for repeated measures factors were calculated as partial eta squared (η_p^2). Effect sizes (*d*) and confidence intervals for repeated-measures contrasts were standardized using the variability of difference scores to permit calculation of intervals around point estimates of effect (Cumming & Finch, 2001).⁶ Between-group effects and corresponding confidence intervals are presented as Hedges *g* (Hedges, 1982). η_p^2 of .01, .06, and .14 were used as interpretive benchmarks for small, medium, and large effects, respectively; corresponding values for *d* and *g* are given as .20, .50, and .80 (Cohen, 1988).

3. Results

3.1. Randomization check

ANOVA models provided little evidence for reliable differences across condition (sorrow-express: *N* = 48; sorrow-inhibit: *N* = 45; humor-express: *N* = 47; humor-inhibit: *N* = 52) with regard to age, number of potentially traumatic events, expressive suppression, or cognitive reappraisal (p = .386; η_p^2 = .016). Chi square tests also failed to support statistically significant differences in gender and minority status across condition (p = .329; V = .134).

3.2. Analog trauma response

Data supporting the efficacy of the analog trauma film is provided in Table 2. Participants evidenced reliable increases in anger, disgust, fear, horror, shock, and tension relative to the Neutral film (all p < .001) with specific effects ranging from small to large (mean *d* = .96). Elevations also were noted in expressive behavior, emotional arousal, discrete sadness, and SCL (all p < .001). Additional reductions were observed for ratings of emotional valence and discrete amusement (all p < .001). RSA was unchanged across viewing periods (p = .768). Ratings for the frequency (M = 3.00, SD = 1.95) and intensity (M = 3.35, SD = 1.96) of distressing thoughts and images assessed at the conclusion of the study indicated moderate levels of intrusive memories, appropriate to the paradigm. Repeated-measures ANOVA

⁶As noted by Cumming and Finch (2001), the sampling distribution of *d* in repeated-measures designs using alternative standardizers (e.g., baseline variance; pooled variance at Time 1 & Time 2) is complex, precluding the exact estimation of confidence intervals. Raw means and standard deviations are provided to facilitate the independent calculation of alternative metrics.

models failed to support reliable differences in response across conditions prior to experimental manipulation ($p = .066$, $\eta_p^2 = .018$ for all effects at Time 1 & Time 2).

3.3. Primary analyses

3.3.1. Expressive behavior

3.3.1.1. FACES global expression: Analysis of global expression across the final two viewing periods revealed an instruction $\times$ period interaction ($F_{1,184} = 17.17$, $p < .001$; $\eta_p^2 = .085$) with greater expression in the express ($M = 2.47$, $SD = 1.17$) versus inhibit condition ($M = 1.73$, $SD = .86$; $p < .001$; $g = .72$, 95% CI [.43, 1.02]) at Time 3. Within-groups contrasts indicated decreased expressive behavior among inhibit participants ($\beta = -.50$, $SE = .13$, $p < .001$; $d = .38$, 95% CI [.17, .59]) with no change among those instructed to express ($\beta = .20$, $SE = .13$, $p = .125$; $d = .16$). A film $\times$ period interaction ($F_{1,184} = 28.05$, $p < .001$; $\eta_p^2 = .132$) also indicated greater expression during the humor ($M = 2.45$, $SD = 1.14$) versus the sorrow film ($M = 1.71$, $SD = .89$; $p < .001$; $g = .72$, 95% CI [.42, 1.01]). Relative to the analog trauma, expression increased during the humor film ($\beta = .29$, $SE = .13$, $p = .032$; $d = .22$, 95% CI [.02, .42]) but decreased during the sorrow film ($\beta = -.62$, $SE = .13$, $p < .001$; $d = .52$, 95% CI [.30, .73]).

3.3.2. Subjective emotion

3.3.2.1. Discrete amusement: A film $\times$ instruction $\times$ period effect was noted for discrete amusement ($F_{1,188} = 6.79$, $p = .010$; $\eta_p^2 = .035$; see Table 3). Between-group tests revealed those instructed to inhibit during the humor film evidenced less subjective amusement than those allowed to express ($p = .001$; $g = .69$, 95% CI [.28, 1.09]). Instruction was unrelated to amusement ratings among participants viewing the sorrow film ($p = .378$; $g = .18$). Within-group contrasts found increased amusement during the humor relative to the Trauma film for both express ($SE = .30$, $p < .001$; $d = 2.14$, 95% CI [1.61, 2.65]) and inhibit ($SE = .34$, $p < .001$; $d = 1.39$, 95% CI [1.01, 1.77]) conditions although confidence intervals for absolute change indicate greater elevations in amusement among those allowed to naturally express emotion (Cumming & Finch, 2005; see Fig. 2). Participants inhibiting expression during the sorrow film evidenced no change in amusement ($SE = .22$, $p = .129$; $d = .23$) although reductions were noted among individuals permitted to express ($SE = .24$, $p = .001$; $d = .51$, 95% CI [.21, .81]).

3.3.2.2. Discrete sadness: A film $\times$ period interaction was observed for discrete sadness ($F_{1,188} = 156.11$, $p < .001$, $\eta_p^2 = .454$) indicating greater sadness in response to the sorrow film ($M = 4.31$, $SD = 2.21$) relative to the humor film ($M = 1.14$, $SD = .43$, $p < .001$; $g = 2.66$, 95% CI [2.27, 3.05]). Within-group contrasts revealed increased sadness during the sorrow film ($\beta = 1.30$, $SE = .24$, $p < .001$; $d = .56$, 95% CI [.34, .78]) and decreased sadness during the humor film ($\beta = -2.78$, $SE = .22$, $p < .001$; $d = 1.28$, 95% CI [1.01, 1.54]).

3.3.2.3. Emotional valence: A film $\times$ period interaction was noted for emotional valence ($F_{1,188} = 223.70$, $p < .001$; $\eta_p^2 = .449$) with participants viewing the humor film ($M = 5.42$, $SD = 1.36$) demonstrating more pleasant emotion than those viewing the sorrow film ($M = 2.34$, $SD = 1.65$, $p < .001$; $g = 2.05$, 95% CI [1.70, 2.40]). Within-group contrasts indicated

increased valence across assessment periods for participants viewing the humor film ($\eta^2 = .282$, $SE = .19$, $p < .001$; $d = 1.47$, 95% CI [1.19, 1.77]). Valence was unchanged in those viewing the sorrow film ($\eta^2 = -.24$, $SE = .15$, $p = .117$; $d = .16$).

3.3.2.4. Emotional arousal: Emotional arousal evidenced a film $\times$ period interaction ($F_{1,188} = 9.12$, $p = .003$; $\eta_p^2 = .046$). Follow-up tests indicated greater arousal in response to the humor ($M = 3.94$, $SD = 1.72$) relative to the sorrow film ($M = 3.15$, $SD = 2.09$, $p = .005$; $g = .41$, 95% CI [.13, .70]). Within-group contrasts noted decreased arousal in participants viewing the sorrow film ($\eta^2 = -.11$, $SE = .05$, $p < .001$; $d = .57$, 95% CI [.34, .77]). Arousal remained unchanged relative to the analog trauma for participants viewing the humor film ($\eta^2 = -.20$, $SE = .23$, $p = .371$; $d = .09$).

3.3.3. Physiological response

3.3.3.1. SCL: SCL evidenced an instruction $\times$ period interaction ($F_{1,188} = 11.33$, $p = .001$; $\eta_p^2 = .057$). Between-group comparisons indicated no difference in SCL across inhibit ($M = 3.99$, $SD = 2.12$) and express ($M = 4.02$, $SD = 2.22$) conditions at the final viewing period ($p = .935$; $g = .01$). Within-group contrasts revealed reductions in SCL for both inhibit ($\eta^2 = -.17$, $SE = .06$, $p = .003$; $d = .31$, 95% CI [.10, .51]) and express ($\eta^2 = -.44$, $SE = .05$, $p < .001$; $d = .88$, 95% CI [.64, 1.12]) participants although confidence intervals for absolute change suggest greater reductions in those permitted to freely express emotion (see Fig. 1).

3.3.3.2. RSA: RSA also evidenced an instruction $\times$ period interaction ($F_{1,188} = 7.02$, $p = .013$; $\eta_p^2 = .036$). Between-group comparisons again indicated no difference in RSA across inhibit ($M = 6.78$, $SD = 1.09$) and express ($M = 6.59$, $SD = 1.20$) conditions ($p = .262$; $g = .16$). Within-group contrasts revealed modest decreases in RSA among individuals permitted to express ($\eta^2 = -.12$, $SE = .05$, $p = .028$; $d = .23$, 95% CI [.02, .43]) with no reliable change in those instructed to inhibit ($\eta^2 = .12$, $SE = .07$, $p = .106$; $d = .17$; see Fig. 1).

3.3.4. Mechanisms of regulation—Post-film ERQ scores collected at the conclusion of the study were examined using 2 (film) $\times$ 2 (instruction) ANOVA models to identify strategies used to modulate expressive behavior during the final viewing period. Data indicated a main effect of instruction ($F_{1,187} = 115.81$, $p < .001$; $\eta_p^2 = .386$) whereby participants instructed to inhibit reported greater expressive suppression ($M = 4.64$, $SD = 1.39$) than participants allowed to naturally express ($M = 2.75$, $SD = 1.05$; $g = 1.53$, 95% CI [1.20, 1.85]).⁷ An additional effect of film was observed ($F_{1,187} = 6.87$, $p = .010$; $\eta_p^2 = .036$) such that individuals viewing the sorrow film reported greater suppression ($M = 3.90$, $SD = 1.52$) than those viewing the humor film ($M = 3.52$, $SD = 1.57$; $g = .25$, 95% CI [-.04, .54]). An instruction effect also was noted with respect to post-film ERQ reappraisal ($F_{1,187} = 10.96$, $p = .001$; $\eta_p^2 = .056$) such that inhibit participants endorsed greater reappraisal ($M = 4.16$, $SD = 1.51$) than those permitted to express ($M = 3.49$, $SD = 1.34$; $g = .47$, 95% CI [.18, .76]). Despite elevations in both regulation strategies among participants in the inhibit condition, effects sizes and corresponding confidence intervals suggest

⁷Four participants failed to complete the post-ERQ measure at the conclusion of the study.

expressive suppression was the primary method of restricting behavioral display in these data.⁸

4. Discussion

Multiple studies suggest that trauma survivors who experience psychological distress may willfully inhibit the behavioral expression of emotion (Litz et al., 2000; Marx & Sloan, 2002; Roemer et al., 2001). The aim of the current project was to examine the impact of deliberate expressive inhibition on basic affective processes as they are believed to operate following trauma. Litz's (1992) model of affective processing identifies trauma-related triggers as a causal factor in the attenuation of positive emotional response. For the purpose of this research, negative affect and intrusive memories were temporarily induced in non-clinical volunteers through exposure to an analog trauma. Activation of trauma-relevant affect in this analog sample was necessary to approximate dysregulation occurring at both the schematic and conceptual levels of processing.

4.1. Consequences for emotional experience

Affective response under instructions to express or inhibit emotion evidenced anomalies consistent with Litz's (1992) model. Among participants viewing the humor-eliciting stimulus, those restricting expression demonstrated less subjective amusement than those permitted to naturally express. Confidence intervals around effect sizes for absolute change further indicated a reliable attenuation of positive response among participants instructed to inhibit (Cumming & Finch, 2005). Amusement ratings for participants viewing the sorrow film provided no evidence of differences across instruction condition. Within-group contrasts noted reductions in amusement among express participants although intervals for absolute change failed to support a reliable difference across students randomized to sorrow-express and sorrow-inhibit groups.

Failure to detect similar effects in emotional valence could be attributable to incongruences between the underlying conceptual model and the dimensional assessment of emotion. Litz (1992) identifies innate expressive-motor programs as the basic building blocks of affect, consistent with discrete theories of emotion (e.g., Ekman, 1992). Given this model, generalized valance - which subsumes a number of individual expressive-motor programs (e.g., enjoyment, surprise) - may provide a less sensitive index of the specific effects of inhibition. It is relevant to note that studies evaluating the consequences of inhibiting positive expression generally have failed to detect an impact on dimensional emotion (e.g., Bonanno et al., 2004; Davis et al., 2009; Gross & Levenson, 1997; Schmeichel et al., 2008; Zuckerman et al., 1981).

In sum, results suggest that chronic inhibition following exposure to significant trauma may inadvertently attenuate positive emotion while maintaining the full spectrum of negative affect. Consequences associated with the willful down-regulation of expression are likely to

⁸Effects from supplementary 2 (film) $\times$ 2 (instruction) $\times$ 2 (assessment) ANCOVA models controlling for post-film reappraisal scores were consistent with results presented in the text.

be most pronounced for stimulus-specific affect although additional research is needed to determine the impact on other positive emotion states (e.g., happiness, love, contentment).

4.2. Consequences for physiological activation

Assessment of physiological response suggests a broad attenuation of autonomic recovery among individuals instructed to inhibit. Whereas SCL evidenced reductions in both instruction conditions, the effect for sympathetic recovery among express participants was nearly 200% greater than for inhibit participants. Confidence intervals for estimates of absolute change provide additional evidence of poorer sympathetic recovery as a result of inhibition. Similarly, RSA demonstrated significant reductions across viewing periods in the express condition whereas inhibit participants failed to evidence similar parasympathetic withdrawal. Confidence intervals around RSA change verify reliable differences across within-group effects.

Evidence of restricted autonomic recovery is consistent with contemporary models linking adaptive emotional response to physiological flexibility (Friedman, 2007; Porges, 1995). Attenuated reductions in SCL are consistent with research identifying sympathetic activation as a consequence of expressive inhibition (e.g., Gross & Levenson, 1993, 1997). Data suggest chronic inhibition of emotional reactions may be one of several mechanisms contributing to elevated sympathetic response associated with PTSD (Bremner, Southwick, & Charney, 1999).

Whereas research evaluating the relation of trauma to parasympathetic functioning continues to evolve, multiple studies have observed limited parasympathetic reactivity to psychological stressors/emotional challenge in individuals with PTSD (e.g., Cohen et al., 2000; Sahar et al., 2001; but see Woodward, Kaloupek, Schaer, Martinez, & Eliez, 2008). Similar effects are noted in the depression literature where lack of parasympathetic withdrawal during emotional challenge is shown to predict the maintenance of depression in both children and adults (Gentzler, Santucci, Kovacs, & Fox, 2009; Rottenberg, Salomon, Gross, & Gotlib, 2005). The current study is one of the first to identify differential parasympathetic responding as a consequence of expressive inhibition. Whereas strong conclusions await replication in clinical samples, these data suggest expressive inhibition among trauma survivors may undermine physiological responses associated with adaptive emotional processing.

4.3. Clinical implications

Although the current study provides evidence of processing anomalies as a result of expressive inhibition, data do not address the underlying function of this behavior as it relates to trauma. Litz (1992) proposed down-regulation of emotion at the conceptual-level of processing is attributable to maladaptive belief structures developed following exposure. Support for this hypothesis is provided by Clapp et al. (2014) who found inhibition to be uniquely related to mistrust and fear of exploitation among women with abuse-related PTSD. In this context, inhibit instructions employed for the present study can be viewed as a minimal manipulation (Prentice & Miller, 1992) given that participants (presumably) did not engender maladaptive beliefs similar to those observed in survivors with PTSD. Continued

research with clinical samples, namely individuals presenting with established deficits in schematic and conceptual processing, may demonstrate increasingly robust effects of willful inhibition.

4.4. Limitations and future directions

Interpretation of these data should be made within the context of the study's strengths and limitations. Analog paradigms demonstrate considerable utility in evaluating basic psychological processes using diverse and adequately powered samples. The current study provides evidence for the disruption of affective response under minimal expressive manipulation; however, strong interpretation of effects awaits replication in clinical samples. On one hand, participants in this research - many of whom endorsed trauma exposure with little evidence of ongoing distress - could be viewed as exceptionally hardy, providing a relatively conservative test for the effects of posttraumatic inhibition. On the other hand, experimental procedures employed here were only intended to simulate, not replicate, an actual traumatic experience. Moderate activation of trauma-relevant emotions and intrusive memories provide evidence for the internal validity of the paradigm, but it is unclear whether these reactions accurately reflect emotional processes occurring in individuals with PTSD. Continued research with individuals endorsing active post-trauma symptoms may provide a more plausible estimate for the true magnitude of effects.

An additional concern in this analog design is the potential for demand characteristics in response to the expressive manipulation. Failure of previous studies to detect widespread demand characteristics (e.g., Davis et al., 2009; Schertau, Dalgleish, & Dunn, 2009) as well as evidence of effects in response to covert expressive manipulation (e.g., Stepper & Strack, 1993) suggest the role of experimental bias in withholding paradigms is limited. Validation checks used in the development of the current protocol also failed to provide support for participant awareness of specific study hypotheses.⁹ Although we are unable to rule out the possibility of demand characteristics in all volunteers, evidence from the existing literature provides reasonable assurance that participant biases are unlikely to account for the observed effects.

The targeted approach to psychophysiological assessment limits conclusions regarding more global consequences of inhibition. SCL and RSA were selected as primary outcomes given their status as unique indicators of sympathetic and parasympathetic response. However, these measures index autonomic activation within separate organ systems and provide only limited insight into the gestalt of physiological response as a result of inhibition. A more inclusive assessment of physiological activation would strengthen continued research with this paradigm.

Finally, the impact of inhibition was assessed only in response to amusement- and sadness-eliciting stimuli. Elicitation of other emotion states (e.g., happiness, pride, satisfaction) in future research is needed to determine the range of emotions for which expressive inhibition

⁹A small pilot study provided volunteers ($N = 28$) with a step-by-step description of all study procedures. Respondents were asked to identify the investigators' hypotheses and to respond to self-report measures as if they had completed the study (Kazdin, 2003). Results provided no evidence of expectations consistent with the hypothesized effects. Speculation on the actual purpose of the study typically involved person-specific reactions to the analog trauma film.

may attenuate experience. Furthermore, elicitation of subjective amusement and sadness was achieved through the use of a single affective stimulus. Inclusion of multiple stimuli for each target emotion would allow investigators to systematically vary affective intensity and evaluate the impact on subsequent emotional processing.

4.5. Conclusions

Despite evidence as one of the more robust predictors of negative psychosocial outcomes, evaluation of specific mechanisms contributing to post-trauma affect dysregulation has been limited. The current study advances a small but growing literature proposing that down-regulation of emotional responding could play a role in the development and maintenance of trauma-related symptoms (e.g., Clapp et al., 2014; Marx & Sloan, 2002; Roemer et al., 2001). Specifically, results suggest the deliberate restriction of expressive behavior may contribute to reductions in positive emotional experience as well as attenuation of adaptive physiological response. Continued research is needed to determine the extent to which inhibition impacts affective functioning among individuals reporting active trauma symptoms, but the effortful nature of this behavior suggests that it may be well suited as a target for cognitive-behavioral intervention.

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Fig. 1.

Change in amusement following the analog trauma and associated 95% confidence intervals.

Note: change in discrete amusement and associated standard errors were 4.40 (.30), 3.44 (.34), -.85 (.24), and -.33 (.22) for humor-express, humor-inhibit, sorrow-express, and sorrow-inhibit conditions, respectively.

Fig. 2.

Changes in skin conductance level and RSA following the analog trauma and associated 95% confidence intervals. *Note:* SCL = skin conductance level; RSA = respiratory sinus arrhythmia; Change in skin conductance level and associated standard errors were $-0.44 (.05)$ and $-0.17 (.06)$ for express and inhibit conditions, respectively. Change in RSA and associated standard errors for express and inhibit conditions were $-0.12 (.05)$ and $0.12 (.07)$.

Table 1Sample characteristics ($N = 192$).

Age	19.9 (3.5)
Gender (% female)	56.8%
Years in college	1.6 (1.1)
Race/Ethnicity	
White/Non-Hispanic	41.7%
Black	37.0%
Hispanic/Latino	7.8%
Asian	6.8%
Multiracial	6.8%
Potential trauma (% personally experienced)	77.6%
Number of potentially traumatic events	1.8 (1.7)

Table 2

Means, standard deviations, standard error of change, and effect sizes for response to Neutral and Trauma films.

	Neutral (<i>M, SD</i>)	Trauma (<i>M, SD</i>)	<i>SE</i>	<i>p</i>	<i>d</i>	95% <i>CI d</i>
Trauma-specific emotion						
Anger	.53 (1.23)	.91 (1.52)	.117	.001	.23	[0.09, 0.38]
Disgust	.29 (.84)	3.71 (2.39)	.175	<.001	1.42	[1.22, 1.62]
Fear	.73 (1.41)	1.44 (1.91)	.145	<.001	.35	[0.20, 0.50]
Horror	.32 (1.01)	3.53 (2.59)	.189	<.001	1.22	[1.04, 1.41]
Shock	.40 (1.04)	4.70 (2.33)	.171	<.001	1.82	[1.59, 2.05]
Tension	1.32 (1.83)	3.03 (2.40)	.170	<.001	.72	[0.56, 0.88]
Outcome variables						
Expression	1.50 (.70)	2.25 (1.12)	.082	<.001	.67	[0.51, 0.83]
Valence	5.18 (1.55)	2.59 (1.73)	.142	<.001	1.32	[1.13, 1.51]
Arousal	3.15 (2.13)	4.20 (1.90)	.180	<.001	.42	[0.27, 0.57]
Sadness	.30 (.86)	2.96 (2.32)	.168	<.001	.26	[0.12, 0.41]
Amusement	1.96 (2.06)	1.08 (1.81)	.174	<.001	.57	[0.42, 0.72]
SCL	3.66 (2.20)	4.31 (2.25)	.054	<.001	.86	[0.69, 1.03]
RSA	6.70 (1.15)	6.68 (1.15)	.051	.768	.02	[-0.12, 0.16]

Note: SCL = skin conductance level (μ S); RSA = respiratory sinus arrhythmia ($\ln \text{ms}^2$).

Table 3

Means and standard deviations for affective response to the analog trauma and emotion films.

	Sorrow-express (N = 48)		Sorrow-inhibit (N = 45)		Humor-express (N = 47)		Humor-inhibit (N = 52)	
	Trauma	Emotion	Trauma	Emotion	Trauma	Emotion	Trauma	Emotion
Expression	2.38 (1.18)	1.96 (1.04)	2.31 (1.16)	1.45 (0.59)	2.21 (1.06)	2.98 (1.07)	2.16 (1.08)	1.96 (0.98)
Amusement	1.44 (1.90)	0.58 (1.11)	0.73 (1.60)	0.40 (0.86)	1.11 (1.84)	5.51 (1.40)	1.04 (1.84)	4.48 (1.58)
Sadness	2.83 (2.25)	4.40 (2.07)	3.20 (2.66)	4.22 (2.36)	2.55 (2.08)	0.06 (0.25)	3.25 (2.27)	0.21 (0.54)
Valence	2.48 (1.74)	2.21 (1.61)	2.69 (1.89)	2.49 (1.69)	2.27 (1.70)	5.62 (1.38)	2.50 (1.63)	5.25 (1.33)
Arousal	4.56 (1.76)	3.69 (2.20)	3.93 (1.94)	2.58 (1.80)	4.00 (1.88)	4.04 (1.91)	4.27 (1.99)	3.85 (1.54)
SCL	4.67 (2.33)	4.18 (2.28)	4.10 (2.28)	3.90 (2.16)	4.23 (2.32)	3.85 (2.18)	4.22 (2.11)	4.07 (2.09)
RSA	6.70 (1.28)	6.63 (1.27)	6.72 (1.18)	6.90 (1.17)	6.71 (1.12)	6.54 (1.14)	6.60 (1.05)	6.67 (1.02)

Note: Trauma = trauma analog film; Emotion = emotion film (i.e., sorrow, humor); Expression = facial activation coding system global expression rating; SCL = skin conductance level (μS); RSA = respiratory sinus arrhythmia ($\ln \text{ms}^2$).