Published in final edited form as:

Behav Res Ther. 2017 July ; 94: 71–80. doi:10.1016/j.brat.2017.05.001.

A prospective examination of risk factors in the development of intrusions following a trauma analog

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Abstract

Several factors have been linked to the severity of posttraumatic distress, although retrospective designs in much of the literature limit conclusions regarding the temporal relation between risk factors and corresponding symptoms. To address these concerns, the current project employed an analog trauma paradigm to assess the impact of background characteristics, stress response, and post-stressor affect regulation on subjective distress and intrusive memories experienced during the subsequent processing of emotional stimuli. University students ($N = 184$; 56% female, 42% White/Non-Hispanic) were shown graphic scenes of a televised suicide. Physiological activation was recorded during exposure with emotion ratings collected following the film. Participants then viewed a sadness- or humor-eliciting prime under instructions to inhibit or naturally express emotion. Intrusions experienced during the priming film and residual distress at study's conclusion were rated prior to debriefing. Hierarchical regression identified reductions in emotional valence as a robust predictor of intrusions and distress. Sympathetic activation and exposure to the sadness prime were associated with intrusion frequency, whereas attenuated parasympathetic response predicted intrusion intensity. Expressive inhibition demonstrated a unique association with residual distress. Results suggest peritraumatic processes and post-exposure factors may hold more prominent relations with immediate trauma-related distress as compared to pre-existing survivor characteristics.

Keywords

trauma; intrusions; PTSD; analog design; risk factors; physiological response

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Research over the past three decades has identified a number of factors demonstrating reliable associations with posttraumatic distress: background characteristics such as gender, trauma history, and pre-existing depression; peritraumatic responses involving emotional and physiological reactions during the event; and post-exposure factors including cued emotion and affect regulation (Cisler, Olatunji, Feldner, & Forsyth, 2010; Litz, Kaloupek, Orsillo, & Weathers, 2000; Ozer, Best, Lipsey, & Weiss, 2003). Despite progress in isolating correlates of posttraumatic stress, retrospective designs in much of this literature limit conclusions regarding the temporal relation between risk factors and corresponding symptoms. Analog trauma studies - protocols in which intrusive memories are elicited temporarily in non-clinical participants - have emerged as a flexible method for assessing prospective relations between risk factors and trauma-relevant outcomes (James et al., 2016). The goal of the current project was to examine the unique influence of background characteristics, stress response, and post-stressor affect manipulation on the development of intrusive memories and distress in participants exposed to an analog trauma.

Epidemiological research indicates that trauma exposure is exceedingly common, with 51–61% of the population experiencing one or more events over the course of their lifetime (Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Estimates of the lifetime prevalence of posttraumatic stress disorder (PTSD), by contrast, are considerably lower (4–8%; Pietrzak, Goldstein, Southwick, & Grant, 2011; Kessler, Berglund, Demler, Jin, & Walters, 2005), generating considerable interest in factors that may increase an individual's probability of developing disorder.

Several influential meta-analyses have examined aggregate data from the existing literature to isolate variables holding reliable associations with PTSD (e.g., Brewin, Andrews, & Valentine, 2000; Ozer et al., 2003). While meta-analytic procedures enhance precision in the estimation of relations between risk factors and symptoms, inferences drawn from these data remain limited. First, the majority of studies aggregated for analysis are cross-sectional, limiting strong conclusions regarding the temporal relation between risk factors and corresponding symptoms. Second, the emphasis on general associations with total symptom severity may obscure processes by which variables confer specific risk. For example, cross-sectional analyses have identified female gender as a consistent correlate of PTSD, but it remains unclear whether women are at greater risk for uniform symptom development, whether risk is limited to specific symptom domains, or whether increased vulnerability is attributable to post-exposure factors (e.g., lack of support, social blaming) unfolding in the weeks and months following the event.

Analog trauma studies are one approach used to address the limitations of cross-sectional designs. Analog paradigms involve presenting non-clinical participants with aversive film and/or photographic stimuli to elicit intrusive thoughts and images over a discrete period (e.g., Holmes & Bourne, 2008; James et al., 2016). Intrusive memories are believed to be a hallmark symptom of PTSD, with multiple theoretical models identifying intrusions as a specific mechanism in the development of disorder (e.g., Brewin, 2001; Ehlers & Clark, 2000; Foa, Steketee, & Rothbaum, 1989). Within the analog trauma paradigm, intrusive memories and corresponding distress are assessed in the laboratory shortly after exposure (e.g., Bomyea & Amir, 2012) and/or in the days following participation (e.g., Nixon, Cain,

Nehmy, & Seymour, 2009). Predictors of subsequent intrusions vary by study but typically include background characteristics, affective response to the analog trauma, and/or experimental manipulations targeting post-exposure processing (James et al., 2016).

Background Characteristics

Background characteristics including gender, prior trauma exposure, and depression are routinely identified as general risk factors of posttraumatic stress (e.g., Brewin et al., 2000; Ozer et al., 2003) although evidence of specific links to intrusive memories remains mixed. In a recent meta-analysis of 16 analog studies, both trauma history and participant gender failed to predict intrusive images occurring in the week following exposure (Clark, Mackay, & Holmes, 2015). Selected studies outside this review have observed more frequent intrusions and higher intrusion-related distress in women relative to men (Kamboj et al., 2014; Wessel, Overwijk, Verwoerd, & de Vrieze, 2008); however, strong evidence for trauma history and biological sex as specific risk factors for traumatic intrusions remains limited.

Pre-existing depression, by contrast, has been identified as a predictor of intrusive memories in several analog studies. Meta-analyses by Clark et al. (2015) found that lower depression scores were associated with a reduction in the odds of intrusions assessed at 1-week post-exposure. Laposa and Alden (2006) also noted prospective relations between depression and the frequency of subsequent film-related intrusions. Existing research suggests that rumination and associated cognitive biases may predispose individuals with active depression to develop more negative appraisals of the traumatic event, increasing the likelihood of unwanted memories (Angelakis & Nixon, 2015; Spinhoven, Penninx, Krempeniou, van Hemert, & Elzinga, 2015). Mental imagery has also been proposed as a common etiological factor for both depression and traumatic intrusions (Holmes, Blackwell, Heyes, Renner, & Raes, 2016). Within this framework, mental imagery is believed to serve as an “emotional amplifier” of negative autobiographical memory including reactions to potentially traumatic events (Holmes & Mathews, 2010).

Affective Response to the Analog Trauma

Subjective response to analog trauma stimuli has been shown to be a robust predictor of intrusive memories (Clark et al., 2015; James et al., 2016). Physiological monitoring in these designs also enables a direct assessment of the extent to which biological processes relate to subsequent intrusions. For example, Bryant and colleagues (2013) identified small effects of sympathetic change on intrusive memories in women presented with aversive images ($\beta = .15$). Chou, La Marca, Steptoe, and Brewin (2014) observed a similar relation between post-film sympathetic activation and the frequency of intrusions in a mixed-gender sample ($\beta = .17$). It is important to note that specific effects in these studies failed to reach formal criteria for statistical significance although the samples available for both analyses were limited ($N = 45$). Results are notable, however, given the paucity of research in this area and the concordance of effects with models positing a functional relation between increased arousal and the consolidation of traumatic memory (Brewin, Gregory, Lipton, & Burgess, 2010; Ehlers & Clark, 2000).

Parasympathetic activation during exposure may also influence the development of psychopathology, but specific relations remain largely unexplored. Consistent with models identifying parasympathetic activation as a general resilience factor (Friedman, 2007), clinical studies have found PTSD symptom severity to be associated with lower resting parasympathetic activity as well as decreased response to experimental stressors (Agorastos et al., 2013; Norte et al., 2013). Analog studies have yet to test the degree to which parasympathetic reactivity may predict aspects of intrusive memories and corresponding distress.

Experimental Manipulations Targeting Post-Exposure Processing

A final set of factors involves the manipulation of emotional and regulatory processes following analog exposure. One area gaining recent attention involves the incorporation of positive mental imagery in the treatment of mood- and anxiety-related difficulties (Holmes et al., 2016; Tsai & McNally, 2014; Zbozinek, Holmes, & Craske, 2015). Modifications to the analog trauma paradigm in which aversive stimuli are replaced with positively valenced films suggests the presence of common mechanisms in the generation of involuntary positive and negative memory (Clark, Mackay, & Holmes, 2013; Davies, Malik, Pictet, Blackwell, & Holmes, 2012). Research exploring the effects of mood-congruent recall suggests that positive mood induction may enhance the accessibility of positive autobiographical memory in select individuals (e.g., Holmes et al., 2016; Joorman & Siemer, 2004). From this perspective, the deliberate activation of positive affect may serve to suppress or compete with the generation of negative mental imagery associated with PTSD and co-occurring disorders.

Strategies used to manage affective responding post-exposure may further influence the development of symptoms. Expressive suppression is a volitional regulatory strategy intended to inhibit the outward display of emotion (Gross, 1998). While trait-level suppression demonstrates robust associations with elevated depression, reduced emotional well-being, negative social relations, and greater posttrauma symptom severity (Gross & John, 2003; Moore, Zoellner, & Mollenholt, 2008), few studies have explored specific links to traumatic intrusions. Existing research suggests the intentional down-regulation of expressive emotion may be associated with increased rumination, producing greater risk for the development of intrusive memories (Gross & John, 2003; Moore et al. 2008). Expressive suppression may also facilitate the development of intrusions by disrupting verbal processing systems necessary for adaptive encoding of distressing events (Brewin, 2001). Richards and Gross (2000) note that the active monitoring and online correction of expressive behavior during episodes of suppression is cognitively taxing, producing specific deficits in verbal processing and memory. Existing research linking disruptions in verbal processing to an increase in the frequency of analog intrusions (Holmes, Brewin, & Hennessy, 2004) suggests that expressive suppression following the presentation of aversive film stimuli may enhance the development of intrusive imagery.

Current Study

Despite increased interest in analog trauma research, several factors relating to risk and resiliency remain unexplored. It is also relevant to note that existing studies typically target a single or small subset of factors, limiting knowledge of the interrelations between variables and their relative contribution to subsequent intrusions. Aims of the current project were to examine the unique influence of background characteristics, analog trauma response, and post-exposure affect regulation on both (a) intrusive memories experienced during the processing of subsequent emotional stimuli and (b) residual distress assessed at the study's conclusion. Data were collected as a part of a larger study targeting emotional regulation in response to an experimental stressor (Clapp, Patton, & Beck, 2015). Participants completed background measures prior to viewing a series of three films: a neutral stimulus, an analog stressor, and a final affective prime (humorous or sad). Sympathetic and parasympathetic response was collected during each film, with ratings of subjective emotion completed after each viewing period. Before presentation of the final affective prime, participants were instructed to either suppress all expressive behavior or to watch the film clip naturally. Participants then rated the frequency and intensity of intrusive memories experienced during the priming video. Ongoing distress in response to the analog trauma film was assessed at debriefing. The evaluation of intrusions experienced during a concurrent processing task is consistent with procedures used in previous research (e.g., Takarangi, Strange, & Lindsay, 2014) and was intended to examine unique influences on intrusive memories occurring in the course of valenced life events.

Based on existing research, female gender, prior Criterion-A trauma exposure, and greater severity of pre-existing depression were expected to demonstrate positive relations with all outcomes. Increased emotional and physiological reactivity during the analog trauma were also expected to predict elevations in intrusions and distress. Finally, participants viewing the positive prime and those permitted to naturally express emotion were expected to experience fewer analog symptom relative to those in the negative prime and suppression conditions.

Method

Participants

Participants included 257 undergraduates enrolled in introductory psychology courses at a large southern university. Students were contacted by email and invited to participate in a study exploring "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 the film, students receiving mental health services (i.e., counseling, medication), those reporting acute suicidal ideation, and those acknowledging ongoing distress related to a potentially traumatic event were excluded from participation. Individuals having attempted suicide or reporting a close relation with someone who had attempted or completed suicide also were excluded given the nature of the analog trauma.

Eligibility was determined through an in-person screening administered upon participants' arrival to the study. Treatment status and suicidal ideation were assessed using self-report

items. A checklist of potentially traumatic events served as an initial screen for previous trauma and/or exposure to suicide (i.e., personal-attempts and/or relationships with close others having attempted/completed suicide). For those endorsing possible trauma exposure, follow-up questions were administered by trained research staff to assess the presence of ongoing distress (e.g., *Do you continue to have unwanted and distressing memories of this event?*; *Do you currently avoid situations or activities that remind you of the event?*). Participants meeting eligibility requirements were permitted to continue with the protocol. Those identified as ineligible were given partial credit and excused. All screening and experimental procedures received institutional review board approval.

A total of 50 individuals were excluded given ongoing trauma-related distress ($n = 37$), current mental health treatment ($n = 5$), acute suicidal ideation ($n = 1$), or direct association with a suicide attempt/completion ($n = 7$). Three cases were lost to equipment malfunction, two to experimenter error, and ten due to participant failure to comply with experimental instructions. Seven individuals failed to complete relevant questionnaire measures, resulting in their exclusion from analysis. A final case was identified as a multivariate outlier given an implausible increase in sympathetic activation relative to scores in the larger sample ($z = 5.12$). Distributions in the final set of $N = 184$ participants (see Table 1) approached normality (skew $|-1.16|$; kurtosis $|-2.05|$; Tabachnick & Fidell, 2001) with no additional evidence of multivariate outliers. Little evidence of multicollinearity was noted across predictors in the final model (tolerance $|.86|$). Descriptive statistics and correlations between primary study variables are provided in Table 2.

Materials

Background characteristics—Participant characteristics were assessed using self-report measures and follow-up queries administered prior to the experimental protocol.

Demographics: Demographic information was collected via self-report. A screening item assessing current mental health treatment was also included on this measure.

Criterion-A trauma: Probable trauma history was evaluated using a screening device adapted from the Life Events Checklist (LEC; Gray, Litz, Hsu, & Lombardo, 2004). Participants indicated whether they had experienced, directly witnessed, or learned about the occurrence of 17 stressful and potentially traumatic events. Follow-up items were used to gather additional information (e.g., event description; age of occurrence; injury/physical harm; experienced fear, helplessness, horror) about the event(s) identified by respondents as the most distressing.

After reviewing responses, research staff administered a series of semi-structured queries to determine eligibility for the larger study. Students reporting ongoing distress as the result of probable trauma and/or direct exposure to suicide were excused. Individuals whose responses did not preclude them from participation were coded for the presence or absence of an experience consistent with Criterion-A trauma as outlined in *DSM-IV-TR* (APA, 2000). Approximately 30% ($n = 58$) of cases were randomly selected for independent review by a graduate supervisor with extensive training in trauma-focused assessment. Inter-rater reliability for Criterion-A status in this sample was excellent ($\kappa = .85$).

Current depression: The Beck Depression Inventory-II (Beck, Steer & Brown, 1996) was used as a screen for acute suicidal ideation and to index current levels of depression. Items are rated on a 0–3 Likert scale with total scores reflecting greater levels of symptom severity. The psychometric properties of the BDI-II are well documented (Beck et al., 1996). Scores in the current sample ranged from minimal (13) to severe (29 – 36) with evidence of good internal consistency ($\alpha = .86$).

Affective Response to the Analog Trauma—A pair of film stimuli were administered as an experimental analog of trauma exposure. Stress response was quantified as the relative change in emotional and physiological activation across films.

Film stimuli

Neutral film: Video of a standard television test pattern was administered to establish baseline levels of emotional and physiological responding. The film stimulus was 64-seconds in length and contained no sound. Previous research provides evidence for the validity of the test pattern film as an affectively neutral stimulus (Gross & Levenson, 1995).

Analog trauma: A 60-second clip depicting scenes of an actual televised suicide was used to elicit an acute stress response. In the video, a government official is seen to extract a firearm and shoot himself during a press conference (*Death Scenes II*, 2003). 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.

Subjective and physiological response

Subjective emotion: Ratings of subjective valence (0: *unhappy/very unpleasant* to 8: *happy/very happy*) and emotional arousal (1: *low/calm* to 9: *high/excited*) were collected at the conclusion of each film period.¹ Affective response to the analog trauma was calculated as the change in scores relative to neutral baseline.

Physiological reactivity: Skin conductance level (SCL) and respiratory sinus arrhythmia (RSA) were collected as indices of sympathetic and parasympathetic activation, respectively (Kreibig, 2010). Skin conductance is a measurement of sweat production on the palmar surface of the hands, which is driven primarily by sympathetic activation (Dawson, Schell, & Filion, 2007). RSA is a systematic variation in heart rate related to breathing, which has been proposed as a measure of pure parasympathetic activation (Porges, 2007). Physiological data were acquired using a Coulbourn LabLinc V system. Waveforms were integrated through a Coulbourn Wingraph Port (V19-02) and recorded using Win/Daq DI-720 series software.

SCL was collected using IVM (12.55mm) Ag/AgCl surface electrodes applied to the medial phalanx of the palmar surface of the first two fingers on the non-dominant hand. Electrodes were filled with 0.5% saline paste specific to the collection of electrodermal measures (Discount Disposables TD-246 Electrode Paste) and secured with adhesive collars and

¹Participants also provided ratings for several discrete affective states as part of the larger study (Clapp et al., 2015).

surgical tape. SCL was quantified by applying a constant 0.5V across electrodes using a Coulbourn V71-23 Isolated Skin Conductance coupler. Data were sampled at 15 Hz and visually screened for artifacts off-line. Sympathetic response to the analog trauma was calculated as the change in mean SCL (μS) relative to activity recorded during the Neutral film.

Electrocardiogram data used for the extraction of RSA was collected using disposable Cleartrace 1700 electrodes positioned 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. Inter-beat intervals were detected to the nearest *ms* and extracted offline using Allen, Chambers, and Towers' (2007) QRSTool (Version 1.2.2). Files with artifacts precluding reliable identification of consecutive R-waves at any point in the time series (4.8% of all film epochs) were scored 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). Parasympathetic response to the analog trauma was calculated as the change in mean RSA ($\ln \text{ms}^2$) relative to activity during neutral baseline.

Post-film experimental manipulation—Following presentation of the analog trauma, participants were randomly assigned to view a priming film intended to elicit a positive or negative emotional state.

Humor prime: Participants randomized to the positive mood induction condition were presented with a 155-second scene from the motion picture *When Harry Met Sally* (Reiner, 1989). Validation research has shown this film to elicit moderate to high levels of discrete amusement (Gross & Levenson, 1995).

Sadness prime: Participants randomized to the negative mood induction condition were presented with a 171-second clip from the motion picture *The Champ* (Lovell & Zeffirelli, 1979). This film is shown to reliably elicit moderate to high levels of discrete sadness in previous research (Gross & Levenson, 1995).

Outcome measures

Intrusion frequency: The frequency of intrusive memories experienced during the post-exposure viewing period was assessed using a single item measure (*How frequently did you experience thoughts, memories, or images of the suicide film while watching the last film?*) administered after participants completed emotion ratings for the final priming film. Responses were recorded on a seven-point Likert scale (1 = *not at all*, 4 = *occasionally*, 7 = *constantly*). The mean interval from the conclusion of the trauma stimulus to the completion of intrusion ratings was 10 min 09 sec ($SD = 1 \text{ min } 23 \text{ sec}$). Participants were not previously informed that intrusive memories would be assessed in this study.

Intrusion intensity: An additional item was used to determine the intensity of intrusive thoughts and images experienced during the affective prime (*How intense was the experience of these thoughts, memories, or images at this time?*). Responses were again recorded on a seven-point Likert scale (1 = *not at all*, 4 = *somewhat*, 7 = *extremely*).

Ongoing distress: Ongoing distress in response to the analog trauma was assessed at the conclusion of the study following the removal of physiological sensors and final debriefing. Specifically, research staff asked participants, “On a scale from 0 to 100, with 0 being not at all and 100 being the most you have ever been in your life, how distressed are you *right now* in response to the film?” The 0 to 100 rating for this assessment was selected to correspond with subjective units of distress scales (SUDS) commonly used in clinical research and practice.² The mean interval from the conclusion of the trauma stimulus to the collection of distress ratings was approximately 15 min 34 sec ($SD = 1$ min 53 sec).

Procedure

Participants were seated in a dimly lit, temperature-controlled room (2.4 x 2.2 m) upon arrival to the study. Following the provision of informed consent and initial screening, participants were instructed to wash their hands in preparation for physiological assessment. Students were then fitted with electrodes and given rating scales to be completed after each film. After sitting quietly for a 10-minute period to habituate to the physiological sensors, participants received a 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 baseline film was presented following a 1-minute post-instruction delay to offset immediate physiological response to the instruction stimulus. Film stimuli were displayed on an 81.3 cm television monitor positioned 2.1 m in front of the participant. At the end of the viewing period, participants received pre-recorded instructions to provide ratings of subjective emotion experienced during the film. The analog trauma was presented under identical procedures. Prior to administration of the final mood induction, participants were randomized to one of two regulation conditions. Individuals allowed to naturally express emotion during the final film received instructions identical to those preceding the first two viewing periods. Individuals selected to deliberately restrict emotional expression 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

²Ratings of ongoing distress following debriefing also were used to identify participants who may have experienced an adverse reaction to the experimental protocol.

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.

Viewing instructions were followed by a randomized Humor or Sadness prime (Humor-Express: $n = 45$; Humor-Inhibit: $n = 49$; Sadness-Express: $n = 46$; Sadness-Inhibit: $n = 44$).³ After rating subjective response to the final film, participants completed a final set of items assessing the frequency and intensity of intrusive thoughts experienced during the priming film. Research staff returned to assist with the removal of physiological sensors once all ratings were complete. Staff administered a final debriefing protocol that concluded with an assessment of ongoing distress. Students were thanked for their time and encouraged to contact the second author with questions or concerns regarding participation.

Analytic Approach

Hierarchical regression models were used to determine the respective contributions of background characteristics, affective response to the analog trauma, and post-film experimental manipulation to the prediction of intrusive memories (frequency, intensity) and residual distress. In Step 1 of each hierarchical model, background characteristics including sex, Criterion-A trauma exposure, and current depressive symptoms were entered. Step 2 included measures of affective response to the analog trauma (i.e., changes in valence, arousal, SCL, RSA). Finally, Step 3 included indicators for post-film manipulations (i.e., Film Prime: 0 = Sadness, 1 = Humor; Suppression: 0 = Express, 1 = Inhibit; Film*Suppression interaction). All predictors were mean-centered with variables at each step entered into the model simultaneously.

Estimates of effect for within-subject contrasts are presented as Cohen's d (1988; small = .20; medium = .50; large = .80). Effect sizes for regression coefficients are reported as partial (pr) and squared semipartial correlations (sr^2). sr^2 coefficients are interpreted as the proportion of unique variability in an outcome attributable to the predictor. pr (small = .14; medium = .36; large = .51; Cohen, 1988) are used in the calculation of power and reflect the residual association between variables controlling for other predictors in the model. Sensitivity analyses (G*Power; Faul, 1992–2012) identified regression models as adequately powered to detect small effects of individual predictors ($f^2 = .04$; $pr = .20$) for two-tailed tests at $1-\beta = .80$.

Results

Efficacy of the Analog Trauma Procedure

Data supporting the efficacy of the analog trauma procedure is provided in Table 3. Participants evidenced substantial reductions in subjective valence, with the lower-limit of the 95% CI for d exceeding a 1 SD reduction in pleasantness ($p < .001$). The interval estimate for change in subjective arousal indicated a small to medium increase in emotional activation across films ($p < .001$). Point estimates of effect and corresponding intervals for change in SCL were generally consistent with large increases in sympathetic response ($p < .$

³Compliance with instructions to inhibit expression was verified through behavioral ratings of expressed emotion (Kring & Sloan, 2007) based on video data for the larger study (see Clapp et al., 2015).

001) although data failed to support a reliable change in RSA ($p = .583$). Participants reported experiencing intrusive images at moderate frequency and intensity (see Table 2). Average distress ratings at debriefing were relatively low, appropriate to the design.

Outcome Measures

Intrusion frequency—An initial hierarchical model was estimated to determine the unique effects of background characteristics, affective response to the analog trauma, and post-film experimental manipulation on intrusion frequency. Background characteristics entered in Step 1 failed to predict reliable variability in intrusion frequency ($p = .487$; see Table 4). Indicators of affective response in Step 2 produced a significant model ($p = .045$) owing to a reliable change in the model R^2 ($p = .018$). Reductions in emotional valence ($p = .048$) and increased sympathetic activation ($p = .028$) during the analog trauma were significant predictors of intrusion frequency. Post-film variables entered in Step 3 produced a marginal change in the overall R^2 ($p = .068$) with the final model reaching statistical significance ($R^2 = .115$, $p = .018$). Reductions in emotional valence ($\beta = -.168$, $p = .029$; $pr = -.165$, $CI_{90\%} [-.280, -.038]$) and greater sympathetic change ($\beta = .161$, $p = .039$; $pr = .156$, $CI_{90\%} [.026, .272]$) during the analog film continued to predict the frequency of intrusive memories. Priming condition also demonstrated a unique relation with intrusion frequency ($\beta = -.174$, $p = .017$; $pr = -.180$, $CI_{90\%} [-.294, -.056]$) with participants viewing the humor prime reporting less frequent intrusions ($M = 2.65$, $SD = 1.78$) than those viewing the sadness film ($M = 3.39$, $SD = 2.09$).

Intrusion intensity—Background characteristics entered in Step 1 failed to account for variability in intrusion intensity ($p = .071$; see Table 5) although an isolated effect for Criterion A exposure was noted ($p = .050$). Stress response variables in Step 2 produced a statistically reliable solution ($p = .001$) and an increase in the model R^2 ($p = .001$). Reductions in both emotional valence ($p = .001$) and parasympathetic reactivity ($p = .048$) emerged as reliable predictors of intrusion intensity. The model remained significant with the inclusion of predictors in Step 3 ($R^2 = .141$, $p = .003$) although post-film manipulation variables failed to contribute reliable variability to the overall solution ($R^2 = .011$, $p = .533$). Reductions in emotional valence ($\beta = -.260$, $p = .001$; $pr = -.254$, $CI_{90\%} [-.361, -.133]$) and parasympathetic activation ($\beta = -.144$, $p = .048$; $pr = -.149$, $CI_{90\%} [-.265, -.008]$) during the analog trauma remained unique predictors of intrusion intensity.

Subjective distress—Background characteristics in Step 1 failed to account for significant variability in residual distress ($p = .210$; see Table 6). Indicators of analog trauma response in Step 2, however, produced a reliable change in R^2 ($p = .001$). Reductions in valence ($p = .002$) again emerged as a significant predictor with a marginal effect for increased emotional arousal ($p = .054$). The final model accounted for significant variability in ratings of subjective distress ($R^2 = .156$, $p = .001$) although the contribution of post-film manipulation variables was minimal ($R^2 = .029$, $p = .116$). A significant effect of valence ($\beta = -.260$, $p = .001$; $pr = -.256$, $CI_{90\%} [-.363, -.135]$) was noted as was a marginal effect of increased emotional arousal ($\beta = .143$, $p = .051$; $pr = .148$, $CI_{90\%} [-.264, .000]$). Expressive suppression ($\beta = .165$, $p = .021$; $pr = .174$, $CI_{90\%} [.049, .288]$) was also identified as unique predictor of residual distress. Participants selected to inhibit expression

during the final priming film reported greater levels of subjective distress ($M = 33.51$, $SD = 26.75$) relative to those permitted to freely express emotion ($M = 25.57$, $SD = 24.81$).

Discussion

The aim of the current study was to evaluate unique predictors of intrusive memories and subjective distress following exposure to an analog trauma. Prospective relations of background characteristics, affective response to the analog trauma film, and post-exposure manipulation of emotion and expression were examined. For these data, the combined effect of participant sex, prior trauma, and concurrent depression failed to account for statistically significant variability in the frequency or intensity of intrusive images experienced during the final mood induction or in levels of general distress assessed at debriefing ($R^2 = .013 - .038$). Results are partially consistent with meta-analyses by Clark et al. (2015) indicating minimal effects of sex and prior trauma exposure on the development of intrusive memories in the context of analog trauma exposure. Interestingly, pre-existing depression also failed to demonstrate expected relations with intrusions and distress. Several factors may have contributed to the lack of support for depression as a reliable predictor in the current models. Variability in the timing (immediate vs. delayed) and method (rating scales vs. diary methods) of assessment could have masked effects noted in previous research. It is also possible that post-film manipulation of emotion and expression altered effects observed in variations of the analog paradigm or that the influence of background characteristics are more appropriately expressed through interactions with peri-traumatic and/or post-exposure processes. Continued research evaluating intrusions in the presence and absence of post-exposure manipulations, as well as clinical studies exploring the specific relation between survivor background and reexperiencing, are needed to clarify null effects observed in these data.

By contrast, emotional reactivity to the analog trauma demonstrated robust associations with both intrusions and residual distress ($R^2 = .064 - .102$). The prominence of stress response as a reliable predictor of intrusive imagery is generally consistent with theoretical models identifying emotional arousal as a specific mechanism in the encoding of intrusive memory (Brewin et al., 2010; Ehlers & Clark, 2000). Specifically, increased negative reaction to the analog trauma, as indicated by change in pleasantness from neutral baseline, was associated with elevations in intrusion frequency, intensity, and residual distress. Results of this study, combined with existing data from the analog trauma literature (e.g., Clark et al., 2015), suggest that increased risk of posttraumatic intrusions may represent a specific mechanism in the relation between peritraumatic affect and PTSD (e.g., Ozer et al., 2003).

Physiological response to the trauma film also evidenced unique relations with intrusive memories during the final emotion manipulation. Those demonstrating increased sympathetic reactivity to the analog trauma evidenced more frequent intrusions, whereas those demonstrating parasympathetic withdrawal reported greater intrusion intensity. One possibility is that increased sympathetic activation, combined with parasympathetic withdrawal, may serve as a biological marker of emotional arousal contributing to the enhanced consolidation of involuntary memory (e.g., Ehlers & Clark, 2000). Behavioral models, by contrast, posit that physiological reactivity during exposure serves as a risk factor

for symptom development as a result of greater unconditioned response to the traumatic event (Foa et al, 1989). From this perspective, physiological reactivity is thought to facilitate perceptions of the event as more negative or fear-inducing (Cohen, 2008), which may enhance feelings of associated and/or continued threat. Effects of sympathetic activation in the current study were small but similar in magnitude to those noted in previous research (Bryant et al., 2013; Chou et al., 2014). Commonalities across these studies warrant continued efforts to clarify the unique relation of sympathetic and parasympathetic response with the development of posttraumatic intrusions.

Post-exposure manipulations contributed minimally to their respective models ($R^2 = .011-.037$) although specific effects of priming and expressive suppression were noted. The emotion prime evidenced a unique relation with intrusion frequency such that those exposed to the humor film reported less frequent intrusions during the positive mood induction. Short-term effects in these analyses may be attributable to competing processes involved in the encoding of positive emotional memory (Clark et al., 2013; Davies et al., 2012). Modest levels of overall depression in this sample further suggest the possibility of active mood repair in individuals viewing the humor prime (e.g., Joormann & Siemer, 2004).

Expressive suppression was also found to hold a unique relation with elevated distress at the conclusion of the study. Evidence of effects on distress, as opposed to involuntary memory, suggest the influence of processes associated with the potentiation of general negative affect. As noted, suppression is conceptualized as a broad risk factor of negative psychological outcomes, with research noting consistent relations with restricted positive emotion, increased rumination, and lower well-being (Gross & John, 2003, Gross & Levenson, 1997). Results of the current project suggest that even brief episodes of expressive suppression following exposure to aversive events may serve to maintain negative emotional reactions over the short term.

It is important to note that intrusions targeted in this project were those experienced during the processing of secondary emotional stimuli, with approximately half of participants engaged in a simultaneous regulation task. Similar studies incorporating lab-based monitoring protocols have examined the frequency of intrusive memories both at rest (e.g., Morina, Leibold, Ehring, 2013; Zetsche, Ehring, & Ehlers, 2009) and during the completion of various thought suppression and cognitive tasks (e.g., Holmes, James, Kilford, & Deeprose, 2010; Nixon et al., 2009). By contrast, diary methods used to monitor thoughts and images in the days following participation capture a mix of intrusions occurring at rest and during the completion of routine life events. Negative thoughts and images targeted in this study may be conceptualized as an analog of intrusions experienced in emotionally charged situations where survivors may elect to regulate the public display of emotion. Results suggest the emotional content of these situations and the extent to which survivors attempt to restrict expression may independently influence levels of intrusion and distress, although strong conclusions await replication.

Other elements of the design also warrant attention. First, the trauma stimulus in this study was relatively brief. Film stimuli in other studies are often longer in duration (e.g., 5–21 min; Holmes et al., 2010; Nixon et al., 2009), increasing the level of content to be

represented in subsequent intrusions. Effects observed in the current analyses may be strengthened through more prolonged exposure to the analog trauma.

Assessment of intrusive memories in the present study was also limited to single-item self-report scales. Research evaluating the reliability of self-reported intrusions suggests procedures involving probed-recording or real-time monitoring tasks (e.g., Takarangi et al., 2014; Wessel, Huntjens, & Verwoerd, 2010) may provide a more robust assessment of intrusion frequency. Other studies have incorporated standard training protocols, providing participants with specific instruction on how to monitor and report intrusions (e.g., Holmes et al., 2004). Augmented reporting methods were not available for the current project but should be considered in future research. It is also relevant to note that intrusive memories in this study were monitored only within the context of the experimental session. Continued tracking using daily diary or follow-up assessments would permit a more comprehensive assessment of the persistence of effects in the days following participation.

While the current models provide tests for a broad set of risk factors, variables in this study are by no means an exhaustive list of relevant predictors. Continued research would benefit from further evaluation of trait-level factors (e.g., anxiety sensitivity, experiential avoidance), stress response variables (e.g., cognitive appraisals, alterations in cortisol/HPA activity), and post-exposure processes (e.g., imagery training). Further attention to the interrelation of risk factors and their potential interactive effects is also needed. Several studies offer preliminary evidence for complex influences on the development of intrusive imagery. For instance, Chou et al. (2014) note that the relation between cortisol levels following analog trauma exposure and the frequency of subsequent intrusions may be strengthened by elevations in post-film sympathetic activation. Kamboj et al. (2014) report conditioned associations between intrusive memories and continuous measures of “femininity” in which femininity is related to increased intrusions in men with no associations in women. Related research by Joorman and Siemer (2004) found that presentation of a humorous film facilitated mood-congruent recall of positive autobiographic memories in nondysphoric individuals while failing to influence recall in participants reporting elevated depression. Similar factors may be at work in the present study, emphasizing the need to consider potential higher-order effects among target variables.

Finally, several factors influence the potential generalizability of effects in this research. Despite the strengths of the analog design, experimental procedures in the current study were intended only to approximate, not replicate, actual response to trauma. Debate continues in the literature as to what processes and symptoms can be reasonably modeled within the context of an analog design (Holmes & Bourne, 2008; James et al., 2016). The generalizability of effects to populations beyond college-aged adults is also unknown. Finally, ethical considerations necessitated the exclusion of participants demonstrating the greatest risk for trauma-related distress. As a consequence, effects in this study may provide a relatively conservative estimate of the relations between trauma-relevant factors and corresponding intrusions.

In conclusion, the present results offer support for the impact of emotional activation, physiological reactivity, expressive regulation, and post-exposure affective cues in the

development of intrusions and distress following exposure to an analog trauma stressor. Results are generally consistent with prior research indicating a strong influence of peritraumatic processes on the development of subsequent symptoms. However, data indicating potential effects of expressive suppression and negative emotional priming on post-exposure distress highlight the importance of addressing maladaptive coping strategies following traumatic exposure.

Acknowledgments

The authors would like to acknowledge Megan L. Avery for her assistance with the coding of Criterion A trauma for this project.

Funding: This work was supported by grants from the National Institute of Mental Health (F31 MH083385), the National Institute of General Medical Sciences (P20GM103432), and funds provided through the University of Memphis Lillian and Morrie Moss Chair of Excellence, held by Dr. Beck.

References

- Agorastos A, Boel JA, Heppner PS, Hager T, Moeller-Bertram T, Haji U, Stiedl O. Diminished vagal activity and blunted diurnal variation of heart rate dynamics in posttraumatic stress disorder. *Stress: The International Journal on the Biology of Stress*. 2013; 16:300–310.
- Allen JB, Chambers AS, Towers DN. The many metrics of cardiac chronotropy: A pragmatic primer and a brief comparison of metrics. *Biological Psychology*. 2007; 74:243–262. [PubMed: 17070982]
- American Psychiatric Association. Diagnostic and statistical manual of mental disorders: DSM-IV-TR. Washington, DC: American Psychiatric Association; 2000.
- Angelakis S, Nixon RV. The comorbidity of PTSD and MDD: Implications for clinical practice and future research. *Behaviour Change*. 2015; 32:1–25.
- Beck, AT., Steer, RA., Brown, G. Manual for the Beck Depression Inventory II. (BDI-II). San Antonio, TX: Psychology Cooperation; 1996.
- Bomyea J, Amir N. Disgust propensity as a predictor of intrusive cognitions following a distressing film. *Cognitive Therapy and Research*. 2012; 36:190–198. [PubMed: 22661795]
- Brewin CR. A cognitive neuroscience account of posttraumatic stress disorder and its treatment. *Behaviour Research and Therapy*. 2001; 39:373–393. [PubMed: 11280338]
- Brewin CR, Andrews B, Valentine JD. Meta-analysis of risk factors for posttraumatic stress disorder in trauma-exposed adults. *Journal of Consulting and Clinical Psychology*. 2000; 68:748–766. [PubMed: 11068961]
- Brewin CR, Gregory JD, Lipton M, Burgess N. Intrusive images in psychological disorders: Characteristics, neural mechanisms, and treatment implications. *Psychological Review*. 2010; 117:210–232. [PubMed: 20063969]
- Bryant RA, McGrath C, Felmingham KL. The roles of noradrenergic and glucocorticoid activation in the development of intrusive memories. *PloS one*. 2013; 8:e62675. [PubMed: 23658640]
- Chou C, La Marca R, Steptoe A, Brewin CR. Biological responses to trauma and the development of intrusive memories: An analog study with the trauma film paradigm. *Biological Psychology*. 2014; 103:135–143. [PubMed: 25150464]
- Cisler JM, Olatunji BO, Feldner MT, Forsyth JP. Emotion regulation and the anxiety disorders: An integrative review. *Journal of Psychopathology and Behavioral Assessment*. 2010; 32:68–82. [PubMed: 20622981]
- Clapp JD, Patton SC, Beck JG. Expressive inhibition in response to stress: Implications for emotional processing following trauma. *Journal of Anxiety Disorders*. 2015; 29:109–118. [PubMed: 25576773]
- Clark IA, Mackay CE, Holmes EA. Positive involuntary autobiographical memories: You first have to live them. *Consciousness and Cognition: An International Journal*. 2013; 22:402–406.

- Clark IA, Mackay CE, Holmes EA. Low emotional response to traumatic footage is associated with an absence of analogue flashbacks: An individual participant data meta-analysis of 16 trauma film paradigm experiments. *Cognition and Emotion*. 2015; 29:702–713. [PubMed: 24920083]
- Cohen, J. Statistical power analysis for the behavioral sciences. 2. Hillsdale, NJ: Lawrence Erlbaum Associates, Inc; 1988.
- Cohen MA. The two-stage model of emotion and the interpretive structure of the mind. *Journal of Mind and Behavior*. 2008; 29:291–320.
- Davies C, Malik A, Pictet A, Blackwell SE, Holmes EA. Involuntary memories after a positive film are dampened by a visuospatial task: Unhelpful in depression but helpful in mania? *Clinical Psychology & Psychotherapy*. 2012; 19:341–351. [PubMed: 22570062]
- Dawson, ME., Schell, AM., Filion, DL. The electrodermal system. In: Cacioppo, JT, Tassinary, LG., Berntson, GG., editors. *Handbook of psychophysiology*. 3. New York: Cambridge University Press; 2007. p. 159–181.
- Death Scenes [Motion Picture]. United States: Anthem Pictures. 2003
- Ehlers A, Clark DM. A cognitive model of posttraumatic stress disorder. *Behaviour Research and Therapy*. 2000; 38:319–345. [PubMed: 10761279]
- Foa EB, Steketee G, Rothbaum BO. Behavioral/cognitive conceptualizations of post-traumatic stress disorder. *Behavior Therapy*. 1989; 20:155–176.
- Friedman BH. An autonomic flexibility-neurovisceral integration model of anxiety and cardiac vagal tone. *Biological Psychology*. 2007; 74:185–199. [PubMed: 17069959]
- Gray MJ, Litz BT, Hsu JL, Lombardo TW. Psychometric Properties of the Life Events Checklist. *Assessment*. 2004; 11:330–341. [PubMed: 15486169]
- Gross JJ, John OP. Individual differences in two emotion regulation processes: Implications for affect, relationships, and well-being. *Journal of Personality and Social Psychology*. 2003; 85:348–362. [PubMed: 12916575]
- Gross JJ, Levenson RW. Emotional suppression: Physiology, self-report, and expressive behavior. *Journal of Personality and Social Psychology*. 1993; 64:970–986. [PubMed: 8326473]
- Gross JJ, Levenson RW. Emotion elicitation using films. *Cognition and Emotion*. 1995; 9:87–108.
- Gross JJ, Levenson RW. Hiding feelings: The acute effects of inhibiting negative and positive emotion. *Journal of Abnormal Psychology*. 1997; 106:95–103. [PubMed: 9103721]
- Gross JJ. The emerging field of emotion regulation: An integrative review. *Review of General Psychology*. 1998; 2:271–299.
- Holmes EA, Blackwell SE, Heyes SB, Renner F, Raes F. Mental imagery in depression: Phenomenology, potential mechanisms, and treatment implications. *Annual Review of Clinical Psychology*. 2016; 12:249–280.
- Holmes EA, Bourne C. Inducing and modulating intrusive emotional memories: A review of the trauma film paradigm. *Acta Psychologica*. 2008; 127:553–566. [PubMed: 18234153]
- Holmes EA, Brewin CR, Hennessy RG. Trauma films, information processing, and intrusive memory development. *Journal of Experimental Psychology: General*. 2004; 133:3–22. [PubMed: 14979748]
- Holmes EA, James EL, Kilford EJ, Deeprose C. Key steps in developing a cognitive vaccine against traumatic flashbacks: Visuospatial Tetris versus verbal Pub Quiz. *Plos ONE*. 2010; 5.
- Holmes EA, Mathews A. Mental imagery in emotion and emotional disorders. *Clinical Psychology Review*. 2010; 30:349–362. [PubMed: 20116915]
- James EL, Lau-Zhu A, Clark IA, Visser RM, Hagenars MA, Holmes EA. The trauma film paradigm as an experimental psychopathology model of psychological trauma: Intrusive memories and beyond. *Clinical Psychology Review*. 2016; 47:106–142. [PubMed: 27289421]
- Joormann J, Siemer M. Memory Accessibility, Mood regulation, and dysphoria: Difficulties in repairing sad mood with happy memories? *Journal of Abnormal Psychology*. 2004; 113:179–188. [PubMed: 15122938]
- Kamboj SK, Oldfield L, Loewenberger A, Das RK, Bisby J, Brewin CR. Voluntary and involuntary emotional memory following an analogue traumatic stressor: The differential effects of

- communality in men and women. *Journal of Behavior Therapy and Experimental Psychiatry*. 2014; 45:421–426. [PubMed: 24929781]
- Kessler RC, Berglund P, Demler O, Jin R, Merikangas KR, Walters EE. 'Lifetime prevalence and age-of-onset distributions of DSM-IV disorders in the National Comorbidity Survey replication': Erratum. *Archives of General Psychiatry*. 2005; 62:768.
- Kessler RC, Sonnega A, Bromet E, Hughes M, Nelson CB. Posttraumatic stress disorder in the National Comorbidity Survey. *Archives of General Psychiatry*. 1995; 52:1048–1060. [PubMed: 7492257]
- Kreibig SD. Autonomic nervous system activity in emotion: A review. *Biological Psychology*. 2010; 84:394–421. [PubMed: 20371374]
- Kring AM, Sloan DM. The Facial Expression Coding System (FACES): Development, validation, and utility. *Psychological Assessment*. 2007; 19:210–224. [PubMed: 17563202]
- Laposa JM, Alden LE. An analogue study of intrusions. *Behaviour Research and Therapy*. 2006; 44:925–946. [PubMed: 16125135]
- Litz BT, Orsillo SM, Kaloupek D, Weathers F. Emotional processing in posttraumatic stress disorder. *Journal of Abnormal Psychology*. 2000; 109:26–39. [PubMed: 10740933]
- Lovell, D., Zeffirelli, F. *The Champ* [Motion Picture]. United States: MGM/Path Home Video; 1979. (Producer) (Director)
- Moore SA, Zoellner LA, Mollenholt N. Are expressive suppression and cognitive reappraisal associated with stress-related symptoms? *Behaviour Research and Therapy*. 2008; 46:993–1000. [PubMed: 18687419]
- Morina N, Leibold E, Ehring T. Vividness of general mental imagery is associated with the occurrence of intrusive memories. *Journal of Behavior Therapy and Experimental Psychiatry*. 2013; 44:221–226. [PubMed: 23228560]
- Nixon RV, Cain N, Nehmy T, Seymour M. The influence of thought suppression and cognitive load on intrusions and memory processes following an analogue stressor. *Behavior Therapy*. 2009; 40:368–379. [PubMed: 19892082]
- Norte CE, Souza GL, Vilete L, Marques-Portella C, Coutinho EF, Figueira I, Volchan E. They know their trauma by heart: An assessment of psychophysiological failure to recover in PTSD. *Journal of Affective Disorders*. 2013; 150:136–141. [PubMed: 23273551]
- Ozer EJ, Best SR, Lipsey TL, Weiss DS. Predictors of posttraumatic stress disorder and symptoms in adults: A meta-analysis. *Psychological Bulletin*. 2003; 129:52–73. [PubMed: 12555794]
- Pietrzak RH, Goldstein RB, Southwick SM, Grant BF. Prevalence and Axis I comorbidity of full and partial posttraumatic stress disorder in the United States: Results from wave 2 of the National Epidemiologic Survey on Alcohol and Related Conditions. *Journal of Anxiety Disorders*. 2011; 25:456–465. [PubMed: 21168991]
- Porges, SW. Method and apparatus for evaluating rhythmic oscillations in aperiodic physiological response systems. United States Patent number: 4,510,944. 1985.
- Porges SW. The polyvagal perspective. *Biological Psychology*. 2007; 74:116–143. [PubMed: 17049418]
- Reiner, R., Scheinman, A., Stolt, J., Nicolaidis, S. *When Harry Met Sally* [Motion Picture]. United States: New Line Home Video; 1989. (Producer, Director) (Producers)
- Richards JM, Gross JJ. Emotion regulation and memory: The cognitive costs of keeping one's cool. *Journal of Personality and Social Psychology*. 2000; 79:410–424. [PubMed: 10981843]
- Spinhoven P, Penninx BW, Krempeniou A, van Hemert AM, Elzinga B. Trait rumination predicts onset of Post-Traumatic Stress Disorder through trauma-related cognitive appraisals: A 4-year longitudinal study. *Behaviour Research & Therapy*. 2015; 71:101–109. [PubMed: 26093467]
- Tabachnick, BG., Fidell, LS. *Using multivariate statistics*. Boston: Pearson/Allyn & Bacon; 2001.
- Takarangi MT, Strange D, Lindsay DS. Self-report may underestimate trauma intrusions. *Consciousness and Cognition: An International Journal*. 2014; 27:297–305.
- Tsai J, Harpaz-Rotem H, Armour C, Southwick SM, Krystal JH, Pietrzak RH. Dimensional Structure of DSM-5 posttraumatic stress disorder symptoms: Results from the National Health and Resilience in Veterans Study. *The Journal of Clinical Psychiatry*. 2015; 76:546–553. [PubMed: 25562376]

- Wessel I, Huntjens RC, Verwoerd JL. Cognitive control and suppression of memories of an emotional film. *Journal of Behavior Therapy and Experimental Psychiatry*. 2010; 41:83–89. [PubMed: 19896117]
- Wessel I, Overwijk S, Verwoerd J, de Vrieze N. Pre-stressor cognitive control is related to intrusive cognition of a stressful film. *Behaviour Research and Therapy*. 2008; 46:496–513. [PubMed: 18328465]
- Zetsche U, Ehring T, Ehlers A. The effects of rumination on mood and intrusive memories after exposure to traumatic material: An experimental study. *Journal of Behavior Therapy and Experimental Psychiatry*. 2009; 40:499–514. [PubMed: 19665693]
- Zbozinek TD, Holmes EA, Craske MG. The effect of positive mood induction on reducing reinstatement fear: Relevance for long term outcomes of exposure therapy. *Behaviour Research and Therapy*. 2015; 71:65–75. [PubMed: 26073498]

Highlights

- Data examine factors related to risk for analog intrusions and distress.
- Peritraumatic emotion predicts intrusion frequency, intensity, and distress.
- Physiological reactivity predicts intrusion frequency and intensity.
- Affective priming and regulation predict intrusion frequency and distress.

Table 1**Participant Characteristics (N = 184)**

Age	19.9 (3.55)
Sex (% female)	55.7%
Race/Ethnicity	
Caucasian	41.8%
African American	37.5%
Hispanic	7.6%
Asian	6.0%
Other	7.1%
Criterion-A Trauma (% yes) ^a	44.0%
Natural Disaster	20.9%
Transportation Accident	61.4%
Accidents (Other)	15.2%
Threatened Harm	29.1%
Physical Assault	22.2%
Sexual Assault	8.2%
Combat	2.5%
Violent/Unexpected Death	2.5%

^aReflects the percentage of individuals coded as having one or more experiences consistent with DSM-IV Criterion-A trauma; categories reflect the percentage of individuals reporting having directly experienced each event on the initial checklist

Table 2

Correlations and descriptive statistics for primary study variables

	1	2	3	4	5	6	7	8	9	10	11	12
1. Intrusion Frequency	–											
2. Intrusion Intensity	.705	–										
3. Subjective Distress	.397	.368	–									
4. Sex	–.038	–.118	–.079	–								
5. Criterion-A	.112	.151	.144	–.125	–							
6. BDI-II	.033	–.032	.020	–.222	.130	–						
7. Valence	–.196	–.287	–.267	.155	–.022	.088	–					
8. Arousal	.008	.008	.174	–.014	.058	–.010	–.020	–				
9. SCL	.215	.128	.155	–.150	.075	.093	–.282	.155	–			
10. RSA	.007	–.136	–.100	.001	–.017	.022	–.013	–.155	.065	–		
11. Film Prime	–.189	–.121	–.081	.035	–.074	.021	.001	–.061	–.085	.064	–	
12. Suppression	.028	–.041	.153	–.042	.023	.079	.066	–.011	–.033	–.115	.032	–
<i>M</i>	3.01	3.36	29.58	–	–	8.27	–2.62	1.03	.61	–.03	–	–
<i>SD</i>	1.97	1.97	26.04	–	–	6.32	1.92	2.44	.67	.72	–	–

Note: Sex = [0 – female, 1 – male]; BDI-II = Beck Depression Inventory-II; Valence = change in emotional valence [ValenceTrauma – ValenceNeutral]; Arousal = change in emotional arousal [ArousalTrauma – ArousalNeutral]; SCL = skin conductance level reactivity [SCLTrauma – SCLNeutral]; RSA = respiratory sinus arrhythmia reactivity [RSATrauma – RSANeutral]; Film Prime = [0 – Sadness, 1 – Humor]; Suppression = [0 – Express, 1 – Inhibit]; Bolded figures statistically significant at $p < .05$; Bold underlined figures statistically significant at $p < .01$

Table 3

Descriptive statistics, effect sizes, and confidence intervals of effect for response to analog trauma^a

	Neutral	Trauma	t	d	95% CI
Valence	5.21 (1.52)	2.59 (1.71)	18.50	1.36	[1.16, 1.56]
Arousal	3.19 (2.12)	4.22 (1.90)	5.71	.43	[0.27, 0.57]
SCL	3.64 (2.18)	4.24 (2.20)	12.26	.90	[0.73, 1.07]
RSA	6.72 (1.16)	6.70 (1.15)	0.55	.04	[−0.10, 0.19]

Note: *t*-scores represent the difference in responding between the Neutral and Trauma films.

^aEffect sizes and confidence intervals for repeated-measures contrasts were standardized using the variability of difference scores to permit the calculation of intervals around point estimates of effect (Cumming& Finch, 2001).

Table 4

Hierarchical Regression – Intrusion Frequency

	Step 1: Background				Step 2: Affective Response				Step 3: Post-Film Manipulation			
	<i>b</i>	<i>SE</i>	β	<i>pr</i>	<i>b</i>	<i>SE</i>	β	<i>pr</i>	<i>b</i>	<i>SE</i>	β	<i>pr</i>
Frequency												
Sex	-.086	.302	-.022	-.021	.112	.301	.028	.028	.161	.298	.041	.041
BDI-II	.004	.024	.014	.014	.007	.024	.024	.024	.011	.023	.034	.034
Trauma	.426	.297	.108	.106	.387	.291	.098	.100	.356	.288	.090	.093
Valence					-.157	.079	-.153*	-.148	-.172	.078	-.168*	-.165
Arousal					-.023	.060	-.028	-.029	-.016	.060	-.020	-.021
SCL					.503	.227	.172*	.165	.470	.226	.161*	.156
RSA					-.025	.202	-.009	-.009	.022	.201	.008	.008
Film Prime									-.684	.284	-.174*	-.180
Suppress									.186	.285	.047	.050
Film*Supp.									-.614	.576	-.078	-.081
	$R^2 = .013$				$R^2 = .077^*$		$R^2 = .064^*$		$R^2 = .115^*$		$R^2 = .037$	
	$F_{(3, 180)} = 0.82$				$F_{(7, 176)} = 2.11$		$F_{(4, 176)} = 3.05$		$F_{(10, 173)} = 2.24$		$F_{(3, 173)} = 2.42$	

* *p* .05

Note: Sex = [0 – female, 1 – male]; BDI-II = Beck Depression Inventory-II; Valence = change in emotional valence [ValenceTrauma – ValenceNeutral]; Arousal = change in emotional arousal [ArousalTrauma – ArousalNeutral]; SCL = skin conductance level reactivity [SCLTrauma – SCLNeutral]; RSA = respiratory sinus arrhythmia reactivity [RSATrauma – RSANeutral]; Film Prime = [0 – Sadness, 1 – Humor]; Suppress = [0 – Express, 1 – Inhibit].

Table 5

Hierarchical Regression – Intrusion Intensity

	Step 1: Background				Step 2: Affective Response				Step 3: Post-Film Manipulation			
	<i>b</i>	<i>SE</i>	β	<i>pr</i>	<i>b</i>	<i>SE</i>	β	<i>Pr</i>	<i>b</i>	<i>SE</i>	β	<i>pr</i>
Frequency												
Sex	-.460	.297	-.117	.013	-.245	.292	-.062	-.063	-.236	.293	-.060	-.061
BDI-II	-.024	.023	-.077	.006	-.014	.023	-.044	-.045	-.011	.023	-.036	-.036
Trauma	.576	.292	.146*	.021	.546	.282	.138†	.145	.526	.284	.133	.140
Valence					-.263	.076	-.257***	-.251	-.266	.077	-.260***	-.254
Arousal					-.030	.058	-.037	-.039	-.031	.059	-.039	-.040
SCL					.161	.221	.055	.055	.136	.222	.047	.047
RSA					-.397	.196	-.145*	-.151	-.394	.198	-.144*	-.149
Film Prime									-.375	.279	-.096	-.101
Suppress									-.152	.280	-.039	-.041
Film*Supp.									-.117	.566	-.015	-.016
	$R^2 = .038$				$R^2 = .130$ ***		$R^2 = .092$ ***		$R^2 = .141$ **		$R^2 = .011$	
	$F_{(3, 180)} = 2.38$				$F_{(7, 176)} = 3.75$		$F_{(4, 176)} = 4.64$		$F_{(10, 173)} = 2.83$		$F_{(3, 173)} = 0.73$	

† *p* .054,* *p* < .05** *p* < .01*** *p* < .001

Note: Sex = [0 – female, 1 – male]; BDI-II = Beck Depression Inventory-II; Valence = change in emotional valence [ValenceTrauma – ValenceNeutral]; Arousal = change in emotional arousal [ArousalTrauma – ArousalNeutral]; SCL = skin conductance level reactivity [SCLTrauma – SCLNeutral]; RSA = respiratory sinus arrhythmia reactivity [RSATrauma – RSANeutral]; Film Prime = [0 – Sadness, 1 – Humor]; Suppress = [0 – Express, 1 – Inhibit].

Table 6

Hierarchical Regression – Subjective Distress

	Step 1: Background				Step 2: Affective Response				Step 3: Post-Film Manipulation			
	<i>b</i>	<i>SE</i>	β	<i>pr</i>	<i>b</i>	<i>SE</i>	β	<i>pr</i>	<i>b</i>	<i>SE</i>	β	<i>pr</i>
Frequency												
Sex	−3.379	3.970	−.065	−.063	.004	−.527	3.874	−.010	−.010	.000	−.098	3.855
BDI-II	−.052	.313	−.013	−.012	.000	.089	.304	.022	.022	.000	.055	.303
Trauma	7.221	3.904	.138	.137	.018	6.345	3.746	.121	.127	.014	6.036	3.730
Valence						−3.357	1.014	−.248***	−.242	.054	−3.520	1.012
Arousal						1.500	.773	.141 [†]	.145	.019	1.529	.777
SCL						2.160	2.929	.056	.055	.003	2.067	2.917
RSA						−3.041	2.601	−.084	−.088	.007	−2.194	2.603
Film Prime											−3.170	3.670
Suppress											8.546	3.680
Film*Supp.											−.292	7.443
	$R^2 = .025$					$R^2 = .126$ ***		$R^2 = .102$ ***		$R^2 = .156$ ***		
	$F_{(3, 180)} = 1.53$					$F_{(7, 176)} = 3.64$		$F_{(4, 176)} = 5.12$		$F_{(10, 173)} = 3.19$		$F_{(3, 173)} = 2.00$

[†] $p < .054$,* $p < .05$ ** $p < .01$ *** $p < .001$

Note: Sex = [0 – female, 1 – male]; BDI-II = Beck Depression Inventory-II; Valence = change in emotional valence [ValenceTrauma – ValenceNeutral]; Arousal = change in emotional arousal [ArousalTrauma – ArousalNeutral]; SCL = skin conductance level reactivity [SCLTrauma – SCLNeutral]; RSA = respiratory sinus arrhythmia reactivity [RSATrauma – RSANeutral]; Film Prime = [0 – Sadness, 1 – Humor]; Suppress = [0 – Express, 1 – Inhibit].