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Abstract

DSM symptoms of emotional numbing appear to have a major impact on the course and outcome of posttraumatic stress disorder (PTSD), yet the construct definition of emotional numbing itself has not been clearly established. Two opposing conceptualizations of this construct have been proposed in the traumatic stress literature. One holds numbing to be a form of non-effortful emotional avoidance, akin to dissociation, that results in diminished responsiveness to emotional stimuli in general (Foa, Zinbarg, & Rothbaum, 1992; Foa & Hearst-Ikeda, 1996). The other suggests that numbing entails a deficit in responsiveness to positive emotional stimuli but not to negative emotional stimuli (Litz, Orsillo, Kaloupek, & Weathers, 2000; Litz & Gray, 2002). In fact, the latter conceptualization suggests that symptoms of emotional numbing are related to augmented responsiveness to negative emotional stimuli. Research to date has yet to establish whether DSM symptoms of emotional numbing are associated with either of these hypothesized emotional response patterns. The current study examined subjective, psychophysiological, and expressive-motor indices of emotional responses to a series of emotionally evocative visual stimuli in 52 adult female sexual assault victims seeking treatment for current PTSD. Results indicated there was little variation in affective responses associated with the degree of emotional numbing symptom severity endorsed by participants. Findings are discussed in terms of their implications for future research aimed at clarifying the construct of emotional numbing.

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The psychological aftermath of traumatic events encompasses an extensive and varied range of emotional sequelae. A majority of people exposed to trauma manage to cope with the events without developing severe and lasting impairment. However, it is estimated that 12% of the American population (approximately 34,000 people) have experienced lasting posttraumatic symptoms severe enough to warrant a diagnosis of PTSD at some point in their lives (Kessler, 2000). PTSD can have a devastating impact on individuals' ability to function in day-to-day life, maintain employment, and establish and sustain satisfying relationships. The high prevalence of PTSD and the often disabling nature of its associated symptoms have led to its growing recognition as a major public health issue (Brunello et al., 2001).

Evidence is accumulating to suggest that one subset of PTSD symptoms, those designated as 'emotional numbing' symptoms, may play an important role in the development and maintenance of posttrauma pathology. This subset includes symptoms of diminished interest or pleasure in important activities; feelings of detachment or estrangement from other people; and a restricted range of emotion (e.g., inability to experience feelings of love or happiness; American Psychiatric Association [APA], 2000). Emotional numbing symptoms have been found to serve as a better predictor of PTSD diagnostic status than any other symptom cluster (Foa et al., 1995a). Early symptoms of emotional numbing have been found to predict later development of PTSD, above and beyond the prediction afforded by depression and dissociation, factors commonly associated with negative posttraumatic adjustment (Feeny, Zoellner, Fitzgibbons, & Foa, 2000). Further, the presence of emotional numbing symptoms has been found to differentiate chronic and non-chronic groups of randomly selected adults with PTSD (Breslau & Davis, 1992), and to be strongly associated with chronicity of the disorder among Vietnam veterans (Marshall et al., 2006).

A variety of negative psychosocial outcomes have been suggested to follow in the wake of emotional numbing symptoms. Research among combat veterans has consistently found numbing symptoms to show a strong negative association with quality of family relationships and social support (e.g., Galovski & Lyons, 2004; Ruscio, Weathers, King, & King, 2002). Similar findings have also been reported among victims of road traffic collisions (Kuhn, Blanchard, & Hickling, 2003; Riggs, Byrne, Weathers, & Litz, 1998). In addition, the severity of emotional numbing has been shown to relate to higher levels of psychological distress, anxiety, hostility, stress-mediated physical complaints (Thompson et al., 2004) and somatization (Escalona, Achilles, Waitzkin, & Yager, 2003). Although not clearly causal, these relationships were found to emerge after accounting for variance explained by all other PTSD symptoms and controlling for factors such as prior trauma history, extent of combat exposure, and comorbid psychopathology, suggesting that emotional numbing symptoms are an important risk factor for poor posttraumatic adjustment.

Clinical accounts suggest that numbing “is one of the most intractable PTSD symptoms” and that “many people who stop suffering from intrusions of the trauma continue to feel unmotivated and dead to the world” (Davidson & van der Kolk, 1996, p.

515). However, there is a dearth of research concerning this issue. One of the earliest treatment outcome studies of PTSD reported that emotional numbing symptoms showed little improvement in response to exposure therapy (Keane, Fairbank, Caddell, & Zimering, 1989). Few studies have examined how the initial severity of numbing symptoms influences response to treatment for PTSD. Where this has been examined, it appears that more severe pretreatment numbing is associated with poorer treatment outcome (Taylor et al., 2001). Taken together, these findings suggest that greater research attention is sorely needed to help better understand and treat the phenomenon of emotional numbing. Yet, surprisingly, emotional numbing symptoms remain the least well-studied aspect of PTSD (Asmundson, Stapleton, & Taylor, 2004; Litz & Gray, 2002).

One of the greatest obstacles to research investigating emotional numbing is that there is a lack of clarity concerning the basic definition of the ‘emotional numbing’ construct. As Litz and Gray (2002) point out, the concept of emotional numbing is poorly operationalized in the DSM. In particular, the symptom of ‘restricted range of affect,’ is ambiguous as to the types of affect that are restricted. The examples of emotions that are “especially” affected (i.e., “those associated with intimacy, tenderness, and sexuality;” APA, 2000, p. 464) are positive emotions. However, terminology such as “numbing of general responsiveness” and “markedly diminished ability to feel emotions” implies that *all* kinds of emotions are constricted as a part of this symptom picture.

Two main conceptual models have emerged to describe the nature and function of emotional numbing symptoms in PTSD. One describes emotional numbing as a form of noneffortful avoidance that takes place when other efforts at avoidance have failed to reduce the distress caused by intrusive and arousal symptoms (Foa & Hearst-Ikeda, 1996; Foa, Zinbarg, & Rothbaum, 1992). This model holds that emotional numbing is akin to dissociation and entails the shutting down of all affective experience, both positive and negative, as a defense against painful emotions. In contrast, Litz and colleagues (Litz, 1992; Litz & Gray, 2002; Litz, Orsillo, Kaloupek, & Weathers, 2000) challenge the idea that emotional numbing involves a dampening of negative emotions at all. They propose that emotional numbing consists of a selective processing deficit for *positive* emotional stimuli, a deficit caused by the draining of attentional resources when attention is allocated to perceptions of threat in the environment (Litz & Gray, 2002). Thus, they contend that the term “numbing” is a misnomer for what is actually a deficit in the experience and expression of positive emotions only.

The importance of emotional numbing symptoms to PTSD psychopathology underscores the need to develop a clearer understanding of the nature and underlying mechanisms behind these symptoms. The ability for research to further investigate this phenomenon, however, depends on having valid ways of measuring the construct under study. Valid measurement of the emotional numbing construct, in turn, depends on having a fundamentally agreed upon construct definition that specifies the types of emotional responses considered a part of the construct. The primary assessment tools for measuring emotional numbing symptoms rely on DSM symptom criteria, which are themselves the subject of debate. Thus, external validation of the emotional response parameters associated with DSM emotional numbing symptoms – i.e., whether these symptoms are associated with diminished responsiveness to positive emotional stimuli, negative emotional stimuli, or both – is needed. The present study aims to help resolve the debate over which emotional responses are 'numbed' as a part of emotional numbing, by examining patterns of emotional responsiveness to a range of emotional stimuli across individuals who report varying levels of emotional numbing symptom severity.

Theories of Emotional Numbing

Numbing as Non-Effortful Avoidance

The basic notion that emotional numbing serves the function of reducing exposure to painful affect has been a feature of etiological models of PTSD since the earliest efforts to account for the complex symptom patterns seen in this disorder. The majority of current cognitive behavioral approaches to treating PTSD are, in fact, based on models that accord an avoidance function to emotional numbing (Resick & Calhoun, 2001). The dominant conceptualization of emotional numbing derives from the work of Foa and colleagues (1992). This conceptualization holds that numbing is a form of dissociative response involving noneffortful avoidance of painful traumatic stimuli, a response that occurs when active efforts at avoidance fail at reducing intense negative affect (Foa et al., 1995a). The present discussion aims to provide an overview of key components of this conceptualization.

In keeping with earlier behavioral formulations (e.g., Keane, Fairbank, Cadell, Zimering, & Bender, 1985), Foa and colleagues' conceptualization of emotional numbing holds it to serve an avoidance function. Unlike earlier views, however, this conceptualization emphasizes a distinction between *effortful* and *noneffortful* forms of avoidance (Foa et al., 1992). Effortful avoidance encompasses overt behaviors, such as active avoidance of situations or places that resemble some aspect of the trauma, as well as efforts to avoid thoughts and feelings related to the trauma. Symptoms of emotional numbing, such as feelings of detachment and restricted range of affect, are conceptualized as forms of noneffortful avoidance. Foa and colleagues (1992) posit that effortful and noneffortful forms of avoidance are likely to involve different underlying mechanisms, one more conscious and strategic, the other, relatively automatic. Unlike cognitive avoidance or thought suppression, in which conscious efforts are aimed at avoiding aversive stimuli, numbing/dissociation may be learned in a manner that bypasses cognitive input. As Foa and colleagues (1995a) state, “Effortful avoidance…may be regulated by strategic psychological processes, whereas numbing may be mediated by more automatic (biological?) mechanisms resembling those underlying the freezing behavior in animals” (p. 119).

Foa and Riggs (1994) posited that numbing/dissociation in human PTSD develops as a reaction to intrusive memories and trauma-related cues that evoke a situation of uncontrollable, unpredictable stress. Efforts at active avoidance may serve to reduce exposure to contexts of perceived threat in the short term, but as an individual’s fear network becomes more and more generalized, many unidentifiable cues serve to prime the trauma memory, and efforts at active avoidance become less and less successful. As a result, high levels of tonic arousal develop, manifested in symptoms of PTSD hyperarousal. According to Foa and Riggs (1994), “When active avoidance strategies fail to reduce distress, one way for the victim to gain relief is to ‘shut down the system.’ This shutting down is expressed in the numbing symptoms of PTSD" (p. 143). Thus, the failure of effortful avoidance in reducing distress is conceptualized as responsible for both hyperarousal and numbing/dissociation in PTSD.

Numbing/dissociation during exposure therapy is thus seen as an obstacle to the efficacy of exposure-based treatments, as it reduces the individual's experiencing of trauma-related responses that are crucial to emotional processing. The blocking of emotional processing thought to be responsible for the reduced efficacy of exposure therapy is thought to operate on an everyday basis in the individual's life as well, interfering with natural recovery by preventing habituation to feared stimuli and the acquisition of new and more accurate information about safety and danger (Foa et al., 1995b).

Dissociation. In order to understand the nature of noneffortful avoidance processes as described by Foa and colleagues (c.f. especially Foa et al., 1992 and Foa & Hearst-Ikeda, 1996), it is important to address the use of the term *dissociation* in reference to numbing. Broadly speaking, the term dissociation encompasses any "disruption in the usually integrated functions of consciousness, memory, identity, or perception" (APA, 2000, p. 519) and includes experiences of depersonalization, derealization, dissociative amnesia, fugue states, and in its most extreme form, dissociative identity disorder. In listing dissociative experiences reported by trauma victims, Foa and Hearst-Ikeda (1996) include terms associated with emotional numbing symptoms, in addition to those typically associated with dissociative disorders. The list includes "amnesia, *emotional detachment*, feelings of depersonalization, out-of-body experiences, dreamlike recall of events, *feelings of estrangement*, flashbacks, and abreaction" (Foa & Hearst-Ikeda, 1996, p. 208, italics added).

The equation of dissociation and numbing rests on a view of dissociative phenomena and numbing as functionally equivalent responses. In fact, Foa and Hearst-Ikeda (1996) use the terms "dissociation" and "numbing" interchangeably to refer to manifestations of noneffortful avoidance, as in "Dissociation or numbing, like avoidance, is a strategy to avert trauma-related distressing emotions" (Foa & Hearst-Ikeda,1996, p. 219). These authors suggest that a category termed "emotional dissociation" be used to refer to a broad class of behaviors including dissociation, numbing, and active avoidance that share a common function within PTSD – that is, behaviors that result in avoidance of distressing emotions, regardless of the level of intentionality or conscious awareness of the behavior (Foa & Hearst-Ikeda, 1996).

Stress-induced analgesia. Fundamental to Foa et al.'s (1992) conceptualization of noneffortful avoidance is that it involves temporary relief from aversive emotional states. This tenet derives much of its rationale from clinical experience as well as similarities between the experiences of humans exposed to trauma and the reactions of laboratory animals exposed to experimental shock (Foa et al., 1992). Animals exposed to unpredictable, uncontrollable stress have been observed to develop temporary analgesia (decreased pain sensitivity), as well as a variety of behaviors thought to parallel human posttraumatic stress reactions. Foa and colleagues (1992) suggested, "the stress-induced analgesia…observed in animals exposed to uncontrollable, unpredictable shock may be analogous to the numbing often seen in PTSD sufferers. Indeed, both stress-induced analgesia and PTSD numbing appear to be phasic[1] responses evoked by trauma-related stress" (p. 221).

Numbing/dissociation, like stress-induced analgesia, is thought to reduce an organism's awareness of painful stimulation when faced with inescapable suffering. In the context of uncontrollable, unpredictable shocks, stress-induced analgesia in animals occurs alongside of a more general *freeze* response, characterized by motor passivity, withdrawal, and cessation of appetitive behaviors such as grooming and eating. Such responses are suggested to have evolved to serve adaptive functions under circumstances of inescapable threat, by allowing the organism to preserve energy and divert attention and resources away from pain and injury. This response is suggested to be analogous to human reactions of withdrawal, passivity, and emotional detachment during a trauma (Foa et al;. 1992). Foa and Riggs (1994) draw a parallel between stress-induced analgesia in animals and "reports of 'numbing' experiences during which a victim ceases to feel physical and emotional pain while being brutalized" (p. 141).

Empirical evidence for numbing as non-effortful avoidance. The precise biological mechanisms that underlie noneffortful avoidance in humans are currently unknown. However, a frequently cited view is that blunting of responsiveness associated with PTSD numbing may be associated with anomalies in the endogenous opioid system. Foa and colleagues point out that under certain conditions, stress-induced analgesia is mediated by the release of endogenous opioids (1992). They cite studies demonstrating that when an

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[1] "Phasic" responses or symptoms are those that occur "only from time to time especially when they are evoked by some salient environmental event," in contrast to "tonic" symptoms that form part of an individual's baseline level of functioning (Pitman et al., 1990, p. 141).

opiate antagonist is administered to animals that were previously conditioned to respond to shocks or tones with stress-induced analgesia, the analgesic response does not occur. Thus, when opioids are blocked, the analgesia is blocked, suggesting that opioids are instrumental in producing the analgesic reaction.

Based on the phenomenological similarities between stress-induced analgesia in animals and numbing/dissociation in humans, Foa and colleagues suggested that numbing/dissociation may involve mediation by endogenous opioids as well (1992). Unfortunately, this hypothesis has so far received very little research attention. To this author's knowledge, the only study to address this question is a widely cited pilot investigation by Pitman and colleagues (1990). These researchers found experimental evidence of opioid-mediated analgesia following exposure to a combat film among Vietnam combat veterans with PTSD. Degree of analgesia following exposure to either neutral or combat film stimuli was measured via pain intensity ratings in response to a heat source applied to the forearm. On average, pain ratings showed a 30% reduction following exposure to the combat versus neutral film among the PTSD participants, whereas a control group of Vietnam combat veterans without PTSD did not demonstrate analgesia in reaction to the combat film. When an opiate antagonist (naloxone) was administered prior to film viewing, the analgesic reaction was inhibited (i.e., no reduction in pain responsiveness occurred). These results were interpreted to support the existence of opioid-mediated analgesia in response to conditioned trauma cues in humans.

The argument that emotional numbing is related to some form of abnormal activity in the opioid system has also been suggested by studies reporting lower pain thresholds (Perry et al., 1987), higher rates of chronic pain (Benedikt & Kolb, 1986) and lower beta-endorphin levels (Hoffman, Burges Watson, Wilson, & Montgomery, 1989) in PTSD patients compared to controls.

If one accepts the initial assumption that emotional numbing and dissociation are functionally equivalent constructs, a variety of evidence on the physiological and neurobiological correlates of dissociation can be viewed as support for an emotion-dampening role for emotional numbing symptoms. For example, research has revealed evidence of lower autonomic reactivity in response to trauma-related stimuli among trauma victims with high levels of dissociation (e.g., Griffin, Resick, & Mechanic, 1997; Lanius et al., 2001). Altered brain activation patterns indicative of reduced emotional processing have also been related to dissociation among trauma victims (Lanius et al., 2002; Rauch et al., 1996). However, given that the functional equivalence assumption rests on the notion that emotional numbing produces a reduction in negative emotion, such evidence can only be considered as support for the model if this initial assumption is validated in other ways.

The conceptual model of numbing as a form of noneffortful avoidance provides a compelling theoretical framework from which to understand diminished emotional reactivity in trauma-cued situations. The theory that noneffortful, relatively automatic avoidance processes are responsible for a lack of emotional arousal in emotion-laden contexts offers an apparent answer to the paradoxical symptom picture found in PTSD:

that of individuals who are both emotionally hyperreactive and hyporeactive to emotional stimuli at various times.

However, a significant and problematic component of Foa and colleagues' model is the basic tenet that emotional numbing and dissociation are functionally equivalent constructs. This tenet rests on the *a priori* assumption that both emotional numbing and dissociation produce relief from aversive states, and hence, acquire negative reinforcement value. While there is a growing body of research that suggests dissociation involves dampening of emotion, these studies have not measured the presence or severity of self-reported emotional numbing symptoms in conjunction with dissociation. Thus, emotional numbing symptoms cannot be presumed to reduce aversive emotional states on the basis of this type of evidence.

Without the equation of numbing and dissociation, the evidentiary support for the model of numbing as a form of noneffortful avoidance is less robust. The single study that has reported opioid-mediated analgesia in humans, while an intriguing example of biologically mediated reduction of an aversive state, also fails to address the relationship with self-reported numbing symptoms. Such processes may or may not bear a relationship to the kinds of experiences trauma victims are referencing when they endorse difficulty experiencing the full range of emotions. Thus, without further research, this evidence cannot be appropriately marshaled in support of claims about emotional numbing. Similar limitations apply to neurobiological studies that have begun to identify brain regions implicated in dissociation. Without knowing if any of the variables examined in such laboratory paradigms show a correlation with self-reported numbing symptoms, in fact, it is unclear how any of the laboratory phenomena discussed thus far might relate to the literature on numbing symptoms assessed via self-report.

What is clear is that there is a growing body of evidence that supports the existence of a form of noneffortful avoidance. Research suggests that this form of avoidance may indeed occur relatively automatically and be biologically mediated. In addition, the functional role of this form of avoidance can be readily accounted for within Foa and colleagues' model of the factors that maintain PTSD. However, although the conclusions drawn from this research literature apply clearly to dissociation, it does not appear that a strong case exists for generalizing conclusions about dissociation to emotional numbing symptoms. Rather, the construct of emotional numbing is conflated with that of dissociation. What is needed, therefore, are efforts to investigate the phenomenological experience of emotional numbing and establish the parameters of this construct.

Numbing as a Selective Emotional Processing Deficit

In contrast to views that posit the emotional numbing symptoms of PTSD to be a form of avoidance, Litz and colleagues (Litz, 1992; Litz et al., 2000; Litz & Gray, 2002) have advanced a model that describes the emotional deficits in PTSD in quite a different manner. These authors refute the notion that numbing involves a dampening of emotional distress. In fact, given the intense emotional distress that forms a central feature of PTSD, these researchers argue that the term "numbing" is a misnomer for describing the emotional deficits in PTSD. The authors of this model contend that people with PTSD do not experience what might be described as generalized “emotional numbness.” Rather, individuals with PTSD are overly primed to experience *negative* affect as a result of a pervasive orientation to perceive and respond to threatening stimuli (i.e., hypervigilance). They suggest that what has been labeled “numbing” is more aptly viewed as a selective deficit in experiencing *positive* emotions. Thus, a major redefinition of the term “emotional numbing” is advocated, with the central feature being a restricted range of positive affect.

According to this model, deficits in experiencing positive emotions come about as a downstream effect of an information processing bias. The idea that individuals with PTSD, like other anxiety disorders, are vulnerable to an information processing bias involving selective attention to threat-related cues in the environment is well established. Litz and colleagues argue that this bias entails a devotion of attentional resources to the detection and processing of threat cues, and that this draining of resources leaves little room for elaboration of positive features of the environment. As a result, positive thoughts, feelings, and associations are less likely to be accessed and expressed. Such deficits in experiencing positive emotions are expected to be particularly salient in situations that prime trauma-related negative emotions, such as exposure to evocative trauma-related stimuli (Litz, 1992; Litz et al., 2000).

Within this theory, the ability to access and express the full range of emotions that were available prior to the trauma is not thought to be eliminated, as one interpretation of the term “emotionally numb” might suggest (Litz, 1992). Rather, the primacy of negative emotions makes positive emotions and responses less accessible. It is suggested that patients with PTSD have a higher threshold for detecting positive stimuli in the environment, and may require more intense, unambiguous, and sustained positive stimulation in order to access positive emotion networks (Litz & Gray, 2002). The analogy of a “signal-to-noise” ratio is used to explicate this phenomenon: ongoing background levels of physiological arousal and cognitive and emotional distraction are conceptualized as the “noise” against which a “signal” – a positive stimulus – must be detected. Thus, high levels of hyperarousal, as well as acute states of cued trauma-related emotions, can both be expected to create greater difficulty in detecting and responding to positive emotional stimuli (Litz & Gray, 2002).

Empirical evidence for numbing as a selective processing deficit. Based on this theory, Litz et al. (2000) predicted that individuals with PTSD who are exposed to trauma-related cues would subsequently display a selective emotional processing bias toward negatively valenced stimuli, while processing positive stimuli in a superficial manner. To test this prediction, the authors exposed two groups of Vietnam combat veterans (with and without PTSD; n = 32 and 29, respectively) to two priming conditions: a trauma-related prime (a video of combat sights and sounds) and a neutral prime (neutral comparison video). Immediately after each prime, participants viewed a series of photographs from the International Affective Picture System (IAPS; Center for the Study of Emotion and Attention, National Institute of Mental Health, 1990) varying in hedonic valence (neutral, positive, and negative). Their emotional responses were assessed across a variety of indices, including expressive-motor behavior, peripheral autonomic responses, and self-reported emotional reactions. Consistent with the authors' prediction, the PTSD group showed signs of a diminished emotional response to photographs depicting positive scenes after exposure to the combat prime, in comparison to their non-PTSD counterparts. Specifically, positive expressive-motor behavior (smiling) was significantly reduced under the combat prime condition in comparison to the control group. Interestingly, the facial-expressive behavior among the PTSD group following the combat prime was incongruent with self-report indices of positive emotion, i.e., PTSD participants reported positive feelings, but did not express these feelings facially. Contrary to expectation, the PTSD group did not show an augmented response to negative photographic stimuli, nor did their self-reported emotions or peripheral autonomic reactions to positive and negative images differ from those of control participants (although the PTSD group rated neutral images as less pleasant than their counterparts; Litz et al., 2000).

These investigators interpreted the overall study results to suggest that individuals with PTSD may indeed fail to process positive emotional stimuli at a deep level, particularly when trauma-related negative affect has been primed (Litz et al., 2000). They suggest that although self-report of positive affect (which did not differ across groups) may be influenced by social desirability, the desynchronous facial responses observed in the PTSD group reflect a more objective index of reduced emotional processing. Applying Lang's (1985) information processing theory, the authors suggest that the PTSD participants in this study “were able to process the positive images to a sufficient degree allowing for an appraisal of stimulus content. The trauma priming, however, reduced patients’ capacity to access fully the positive emotional network, which when activated in quiescent states elicits full, synchronous emotional reactions” (Litz et al., 20000, p. 36).

As noted, the study also found patterns that were unexpected. The PTSD group did not evidence a greater degree of emotional processing for negative stimuli. This finding stands in contradiction to the authors’ theory that people with PTSD will show prejudicial processing of emotionally congruent (negative) stimuli when trauma-related material is primed (Litz, 1992; Litz et al., 2000). Of relevance for the conceptualization of emotional numbing, the study found no evidence of *reduced* negative emotional processing following the trauma prime either, as might be predicted by Foa and colleagues’ model of numbing/dissociation.

Of further note is a finding that the PTSD participants showed signs of greater autonomic activation (heart rate) across all stimulus conditions in the study in comparison to their non-PTSD counterparts. While this finding is not surprising, given the hyperarousal characteristic of PTSD, it may be important to understanding the context under which the study results occurred. The authors acknowledge that the greater physiologic arousal present among PTSD participants across conditions suggests that a state of hypervigilance to threatening stimuli may have been activated during the experiment as a whole. However, an interpretation problem arises from the fact that evidence of hyperarousal was present across priming *and* neutral conditions. Thus, it is difficult to disentangle the influence of the cued emotional state brought on by the combat prime from the underlying hyperarousal present throughout the experiment. The effectiveness of the experimental manipulation of emotional state was not formally evaluated; therefore, it is difficult to ascertain the degree to which exposure to the combat prime induced the intended state of cued negative arousal. Although a statistical main effect was reported for several indicators of emotionality in response to the combat prime, the absence of effect size data pertaining to these responses prevents a clearer understanding of how participants responded to the prime – that is, how intense was the induced state of negative emotional arousal? Given that the study's goal was to test the effect of a trauma-cued negative emotional state on subsequent emotional processing, it is unclear whether the obtained results represent a true test of this phenomenon, distinct from the effects of general hyperarousal. On the basis of Litz and colleagues' model, it could well be hypothesized that high levels of tonic hyperarousal could also lead to disruptions in processing of positive emotions.

Another limitation of the study is that it failed to report data on the phenomenon presumably of most interest to the study, emotional numbing symptoms. This omission is unfortunate in that it prevents conclusions from being drawn about the kind of emotional response patterns associated with symptom reports of emotional numbing as assessed via DSM criteria. Although the authors refute the notion of generalized emotional numbing implicit in DSM symptom criteria, reporting of evidence on the relationship between DSM numbing symptoms (as assessed via current criteria) and differential patterns of emotional processing would serve to help clarify the nature of the emotional deficits experienced by individuals who endorse emotional numbing symptoms.

Despite these limitations, the study provides an important step toward elucidating the nature of emotional numbing symptoms in PTSD. As an initial demonstration and test of the authors' model, the study incorporated a number of important methodological strengths. For instance, emotional responses were measured across multiple modalities, allowing for a more fine-grained analysis of emotional response parameters. This procedure allowed findings to emerge that would certainly have been missed had emotional responses been assessed using only one channel. The study's mixed results with regard to emotional reactions assessed via physiologic, self-report, and expressive-motor channels underscores the importance of multimodal assessment for exploring the nature of emotional processing in PTSD.

Ultimately, this study leaves a number of questions unanswered. Would a similar (or perhaps even more pronounced or pervasive) finding of emotional processing deficits have occurred in a sample that specifically reported high subjective levels of emotional numbing symptoms? Was the pattern of diminished expression of positive affect a consequence of a trauma-cued state, or of general hyperarousal? Although the findings do not lend themselves to simple interpretation, the study does provide an initial demonstration of a distinct pattern of emotional responsivity (or rather, lack thereof) that can emerge among PTSD participants subsequent to priming of traumatic material. As such, it provides a compelling basis for studying this phenomenon further in order to better understand the parameters of emotional processing in PTSD.

A similar study examined emotional responding among Vietnam combat veterans with PTSD (*n* = 17), combat veterans without PTSD (*n* = 11), and nontraumatized control participants (*n* = 14; Amdur, Larsen, & Liberzon, 2000). Like Litz and colleagues' study, this study employed self-report as well as expressive motor and physiological response measures to examine participants' reactions to standardized images from the IAPS. In addition to examining emotional responses in terms of arousal and valence, the study also included a measure of the intensity of specific self-rated emotions (Afraid, Angry, Ashamed, Calm, Disgusted, Pleased, Sad, and Surprised). Unlike Litz et al.'s study, this study examined participants' responses to the IAPS images without any prior manipulation of trauma-related or neutral primes, thus specifically allowing for an examination of emotional responsivity in the context of more general baseline functioning.

The study found few overall differences between the emotional response patterns of the three groups. No group differences emerged across self-reported arousal and valence ratings of the images, nor in skin conductance, heart rate, or facial EMG response patterns. Group differences did emerge when responses to a subset of emotionally evocative images were examined (images that were normatively identified as Distressing, Exciting, or Unattractive). Specifically, the PTSD group reported the highest intensity of particular negative emotions (Angry, Disgusted, Ashamed, and Sad) and the lowest intensity of positive emotions (Calm and Pleased) among the three groups in response to these images. The authors suggested these differences might have emerged only in response to more emotionally evocative stimuli because the inclusion of responses to neutral stimuli may cause differences to be “washed out” in data analysis (Amdur et al., 2000, p. 233).

Of further interest, the study found that while self-reported arousal and valence ratings were uncorrelated within each of the control groups (consistent with patterns found in nonclinical samples), these indices were negatively correlated within the PTSD group (Amdur et al., 2000). That is, the more negatively the PTSD group rated an image, the more arousal was reported; while the more positively an image was rated the less arousal was reported.

More recently, Spahic-Mihajlovic, Crayton, & Neafsey (2005) reported similar findings among a war refugee population. Employing the IAPS as stimuli, these authors examined self-reported emotional responses among a group of Bosnian refugees with PTSD (n = 21). Like Amdur et al. (2000), these researchers examined responses to the IAPS in the absence of any priming manipulation. Participants with diagnosable PTSD were found to show reduced responsivity to positive images and enhanced responsivity to negative images compared to the control group. Although the PTSD and control groups did not differ in their valence ratings, the PTSD group rated pleasant images as “almost completely non-arousing,” (Spahic-Mihajlovic et al., 2005, p. 383) while rating unpleasant images as more highly arousing than the control group. In contrast, control group participants gave high arousal ratings to both pleasant and unpleasant images, consistent with a curvilinear relationship.

In the only laboratory study thus far specifically designed to examine emotional numbing in women with PTSD (Orsillo, Batten, Plumb, Luterek, & Rossner, 2004), women with PTSD related to physical or sexual assault (*n* = 18) and women without a history of trauma or psychiatric disorder (*n* = 17) were exposed to film clips selected to elicit specific emotions of amusement, sadness, fear, anger, and contentment. Participants rated their subjective emotional responses to the film clips using the Positive and Negative Affect Scale (PANAS; Watson, Clark, & Tellegen, 1988). Videotapes of the women's facial expressions during the watching of film clips were coded for frequency of positive and negative facial expressions of emotion. In addition, participants were asked to write for 5 minutes about their feelings about the film clip, and their responses were coded for the presence of positive and negative emotional expression.

Women with PTSD were found to report more negative emotional activation on the PANAS across all film clips compared to controls (Orsillo et al., 2004). Similarly, the PTSD group used more negative emotion words on average in writing about the films compared to controls. However, the expected pattern of reduced positive emotional expression to positive film clips and enhanced negative emotional expression to negative film clips did not emerge. Facial expressions of positive and negative emotions while viewing film clips were not significantly different between PTSD and control groups, although the PTSD group reacted with more signs of negative emotion to both positive and negative film clips overall. The authors suggest that these findings may reflect a tendency for women with PTSD to experience more negative emotional activation across a range of emotional stimuli, but without registering this emotion in their facial expressions. However, it is also noted that the small sample size in this study may have limited findings (Orsillo et al., 2004).

Building on this research, Orsillo and colleagues (Orsillo, Theodore-Oklota, Luterek, & Plumb, 2007) developed the Emotional Reactivity and Numbing Scale (ERNS), a 62-item self-report instrument designed to provide a more fine-grained assessment of the parameters of emotional responses and deficits in PTSD. Items include both positive and negative (reverse-scored) statements describing the tendency to experience a range of emotions including happiness, sadness, anger, and fear in response to emotion-eliciting situations. Respondents rate the extent to which emotional responses apply to them on a 5-point Liker-type scale ranging from "Not at all typical of me" to "Entirely typical of me." Separate subscales measure reactivity to positive, sad, angry, and fearful emotion-laden contexts, as well as a subscale measuring endorsement of general emotional numbing (e.g., "There are certain emotions that I cannot feel").

In an initial validation study of the ERNS (Orsillo et al., 2007), the authors explored the relations between subscale scores on this measure and PTSD status among veterans with (n = 39) and without PTSD (n = 40) associated with the life event they identified as the "most distressing." PTSD status was assessed with the Distressing Event Questionnaire (DEQ; Kubany et al., 2000), and the single-item measure of emotional numbing on this instrument was used to assess convergent validity of the ERNS. Across

PTSD diagnostic status, positive and general numbing subscales were found to correlate strongly with the single-item measure of emotional numbing on the DEQ, whereas numbing of sadness, fear, and anger were uncorrelated with this item. The researchers found that participants with PTSD endorsed greater general emotional numbing as well as greater numbing of positive emotions compared to those without PTSD. Subscales measuring reactivity to anger and sadness cues showed the opposite pattern, with PTSD participants endorsing greater reactivity to these cues than those without PTSD.

Taken together, the results of these studies begin to offer convergent support for the presence of deficits in responding to positive emotional stimuli accompanied by augmented responsivity to negative stimuli in PTSD. Indices of diminished positive emotional responsivity include reduced facial zygomotor activity (Litz et al., 2000), reduced intensity of specific self-reported positive emotions (Amdur et al., 2000), reduced self-reported arousal in response to pleasant images (Amdur et al., 2000; Spahic-Mihajlovic et al., 2005). Evidence of augmented responsivity to negative stimuli includes higher self-reported feelings of specific negative emotions (Amdur et al., 2000) and higher self-reported arousal (Amdur et al., 2000; Spahic-Mihajlovic et al., 2005) in response to evocative visual imagery, and greater negative emotional expression in response to film clips (Orsillo et al., 2004).

Less clear are the conditions under which such responses may be expected to occur. Whereas Litz and colleagues (2000) reported deficits in positive facial responding only in the context of a trauma-primed state, the extent to which this priming condition was instrumental in producing the observed deficits is unclear. Litz and Gray (2002) note that baseline (tonic) hyperarousal, as well as the potential for increased vigilance associated with performing an ambiguous laboratory task, could also serve to prime threat-related emotional response patterns in PTSD participants. This explanation may account for the findings of reduced positive emotional responses and augmented negative emotional responses under non-trauma-primed conditions in two of the three studies.

Unfortunately, a number of methodological limitations exist with these studies as a whole, including small sample sizes, selection of control and comparison groups on the basis of PTSD diagnostic status (rather than severity of emotional numbing symptoms), and high levels of psychiatric comorbidity within PTSD groups. Thus, questions remain as to the relationship between the patterns of emotional responses observed in these studies and the construct of emotional numbing as codified in DSM symptom criteria for PTSD. Finally, control groups have thus far been similarly comprised of individuals with an absence of Axis I psychopathology. Although this methodology is common in initial efforts to decrease sample heterogeneity and simplify between-group comparisons, it creates a number of confounds as well. Explicit measurement of emotional numbing symptoms and use of further comparison groups to include traumatized and nontraumatized controls, as well as psychiatric control groups, would facilitate conclusions about the specificity of the observed findings to PTSD and to emotional numbing symptoms in particular.

The Current Study

To date, studies that have examined aspects of Litz and colleagues (2000; 2002) model of emotional numbing have produced converging evidence of reduced processing of positive emotions in PTSD as well as some support for augmented processing of negative emotions. However, these studies have been limited to examining differences in emotional responses between comparison groups divided on the basis of meeting or not meeting diagnostic criteria for PTSD. The primary goal of the present study was therefore to examine patterns of emotional response to standardized evocative stimuli in relation to severity of emotional numbing symptoms. Given that the more proximal factor thought to account for the emotional response patterns predicted by Litz and colleagues' theory is not PTSD diagnostic status, but rather, emotional numbing symptoms, it was expected that using severity of emotional numbing symptoms as an independent variable would allow a stronger relationship with these response patterns to be detected.

An additional goal in designing the present study was to include a range of emotional response channels (i.e., physiological, expressive motor) in addition to self-report. Previous studies have found conflicting results depending on the emotional response channels examined. As yet, there is no single indicator thought to represent the 'best' index of emotional experiencing. Thus, a combination of emotional response indicators was selected to replicate as great a range of response modalities as feasible[2],

[2] Initially, both corrugator and zygomatic facial muscle responses were planned to be measured as part of the current study. However, due to considerations of participant burden, the number of physiological measures was reduced. Corrugator EMG activity was selected for measurement as it has been shown to be a reliable correlate of negative emotional responses even when incongruent autonomic responses are found (Dimberg, 1990).

with the rationale that the convergence of indicators from multiple methodologies offers both a greater likelihood of detecting emotional response patterns if they are to be found, and a chance to add to the accumulation of data on the nature of the emotional response parameters associated with emotional numbing.

Of interest in the present study was to see if the emotional response patterns predicted by Litz and colleagues' theory could be further replicated under non-trauma-cued conditions. Although this theory predicts that priming of trauma-related memories is likely to produce stronger emotional response deficits, it also holds that high tonic levels of hyperarousal can be sufficient to produce these deficits. Consistent findings of a unique association between hyperarousal and numbing symptoms also suggests that priming of trauma memories may not be necessary to activate emotional numbing in people with PTSD. Further, the construct of emotional numbing as codified in the DSM carries the connotation of a pervasive tendency that is not necessarily brought on by trauma reminders. The question of whether individuals with PTSD experience emotional numbing as a tonic phenomenon, however, requires further study.

The current study also aims to contribute to the knowledge base on patterns of PTSD symptom expression among women. Although PTSD is estimated to be twice as prevalent among women than men (Kessler et al., 1995), PTSD constructs have historically been developed on the basis of male combat veteran samples, only later being applied to women (APA, 2007; Cusack, Falsetti, & de Arellano, 2002). This practice has resulted in far less data on women's responses to trauma and on prototypically female forms of trauma, such as sexual assault (Gavranidou & Rosner, 2003). The imbalance in our knowledge of women's and men's responses to trauma is particularly acute with regard to physiological dimensions of emotional experience (Peirce, Newton, Buckley, & Keane, 2002). Thus, the current study was designed to examine physiological correlates of emotional numbing in women with PTSD.

The issue of how to measure severity of emotional numbing, given that symptom measures of emotional numbing are based on a disputed conceptualization of the construct, is a difficult one. It is clear that some operational definition must serve as a means of capturing variation on the emotional numbing construct, even if that operational definition is an imperfect one. The use of DSM symptom criteria to assess emotional numbing provides a standard reference point against which hypothesized emotional response patterns can be compared. With the publication of the ERNS, a further tool for evaluating the extent of emotional numbing is now available. Despite the greater range of information captured by the ERNS, most research findings on emotional numbing relate to DSM symptom measures. Therefore, in order to relate results to the broader literature, emotional numbing symptom measures are the focus of the primary hypotheses in this study. However, responses to the ERNS are explored in supplementary analyses to assess the convergence of these measures.

A further consideration in measuring emotional numbing is the selection of which DSM symptom or symptoms ought to represent 'emotional numbing.' While this term is typically applied to the constellation of symptoms labeled 'numbing of general responsiveness' in the DSM (i.e., diminished interest or pleasure in activities, detachment from others, and restricted range of affect), it is also often used to specifically denote the symptom of restricted range of affect. The emotional response patterns that form the focus of Litz and colleagues' model are most directly related to the symptom of restricted range of affect. Thus, it might be expected that emotional response variables such as diminished arousal in response to positive emotional stimuli would be more directly related to severity of this particular symptom than to the set of emotional numbing symptoms as a whole. However, the body of research linking severity of emotional numbing symptoms to negative psychosocial outcomes has been based on inclusion of all three symptoms. Thus, it is of clinical interest to examine the nature of emotional response patterns experienced by individuals who endorse high levels of these three symptoms, as these are the individuals presumably at risk for poor adjustment as a function of their emotional numbing symptoms.

Finally, two additional measures related to the construct of emotional numbing are included in the present study: a measure of depressive symptoms and a measure of dissociative experiences. The conceptualization of emotional numbing symptoms as a manifestation of reduced processing of positive emotional stimuli yields a construct that has considerable conceptual overlap with the construct of anhedonia characteristic of depression. Thus, some degree of positive correlation between depression and emotional numbing is expected. In contrast, if Litz and colleagues' conceptualization of emotional numbing is accurate, there is no such conceptual link between emotional numbing symptomatology and experiences of dissociation, as there would be in Foa and colleagues' model. Thus, a comparison of the degree of relationship between these two measures and severity of emotional numbing was included as an additional method of examining the nomothetic network surrounding emotional numbing.

Hypotheses

Overall, it was hypothesized that individuals with higher levels of emotional numbing symptoms would show evidence of reduced emotional reactivity to positively valenced visual images and augmented emotional reactivity to negatively valenced images compared to individuals with lower emotional numbing symptoms. Specifically, it was hypothesized that individuals who endorse high versus low levels of emotional numbing (EN) symptoms would show a pattern of differential responses to a series of standardized emotionally evocative photographs, such that:

1. Individuals with high EN would rate their feelings in response to both pleasant and unpleasant images as lower in valence, indicating lower happiness/ greater unhappiness, compared to individuals with low EN (a main effect of EN severity on subjective valence ratings)
2. Individuals with high EN would rate their arousal level in response to pleasant images as less intense than their arousal in response to unpleasant images (an interaction of EN severity and image type on subjective arousal ratings)
3. Individuals with high EN would show lower heart rate (HR) reactivity in response to pleasant than unpleasant images (an interaction of EN severity and image type on HR change)

4. Individuals with high EN would show lower skin conductance responses (SCR) to pleasant than unpleasant images (an interaction of EN severity and image type on SCR)
5. Individuals with high EN would show greater facial expression of negative affect (corrugator EMG) in response to unpleasant images compared to those with low EN (an interaction of EN severity and image type on EMG)
6. Individuals with high EN would show a negative correlation between subjective arousal and valence ratings, whereas these ratings would be uncorrelated in those with low EN
7. EN severity would be more highly correlated with depressive symptoms than with dissociative experiences.

Power Analysis

To determine the estimated sample size needed to detect differences between high and low EN groups across subjective, physiological, and expressive motor channels, results from studies that have analyzed these response variables were examined.

Arousal and valence. Three studies have measured subjective arousal and valence in trauma victims in response to normatively defined pleasant, neutral, and unpleasant images from the IAPS. The first (Litz et al., 2000) examined these measures in a group of 61 veterans with combat trauma following either a combat or neutral prime. Valence of neutral images was rated significantly lower by participants with PTSD (n = 32) versus without PTSD (n =29) following the combat prime condition, but not following the neutral prime condition. A significant simple main effect of prime condition was also found among the PTSD participants, such that valence of positive and neutral images were rated as less pleasant in the combat prime condition but not in the neutral prime condition. Unfortunately, an exact effect size estimate is not possible to extrapolate from the data reported in this study due to the complexity of the design. In addition, the extent to which the combat prime condition was responsible for the effects obtained is unclear due to the absence of effect size data. However, the findings provide a preliminary basis for expecting that differences on these measures can be detectable at an approximate sample size of 60.

A second study (Amdur et al., 2000) failed to find significant differences in subjective arousal or valence ratings between participants with combat-related PTSD (n = 17), a combat control group (n = 11), and a control group without combat exposure (n = 14). Unfortunately, the complexity of this study design precludes the calculation of an effect size estimate for these comparisons as well. A third study involving Bosnian refugees with and without PTSD (ns = 21; Spahic-Mihajlovic et al., 2005) failed to find a difference in valence ratings between groups. However, subjective arousal was rated significantly lower by PTSD versus control groups in response to neutral images, and significantly higher in response to unpleasant images. Again, exact effect size estimates are not possible to extrapolate from the data reported in this study. However, the ability to detect a significant difference on arousal in an even smaller sample (N = 42) supports the expectation of being able to detect such differences in a sample size of 50-60 participants.

One further hypothesis regarding subjective arousal and valence is also being put forward: that these two measures are expected to show a significant negative linear relationship among individuals with high EN. There is reason to expect a medium to large effect size for this effect: Amdur et al. (2000) found a medium effect (Pearson's $r = -.27$) among PTSD subjects, while Spahic-Mihajlovic et al. (2005) found a very large effect for this relationship (Pearson's $r = -.95$, an almost perfect negative linear relationship). G*Power software (Faul, Erdfelder, Lang, & Buechner, 2007) was used to estimate the sample size needed to detect the hypothesized effect. To detect a medium effect ($r = -.30$) at power of .80, a sample size of 67 participants would be needed, whereas a medium to large effect of $r = -.40$ would require a sample size of only 37 participants. Therefore, it was expected that a sample size of 50-60 participants would be sufficient to detect a medium to large effect but may be low-powered to detect a smaller effect.

Each of these studies examined differences between groups defined by PTSD diagnostic status. In contrast, the current study will be examining groups defined by severity of emotional numbing. This factor is theoretically more proximal to the dependent variables of interest in the study (i.e., dependent variables are thought to represent affective and physiological manifestations of emotional numbing, rather than manifestations of PTSD more generally). Therefore, it was expected that the present study would offer a more sensitive test of potential differences in these response variables. Despite this expectation, it is nevertheless clear from past research that considerable variability has been found with regard to the likelihood of detecting significant differences on the variety of dependent variables tapping different components of emotional responding. Therefore, a sample size equivalent to the larger of these three studies was deemed important to achieving adequate power.

Physiological and expressive motor responses. Two of the three studies noted above (Litz et al., 2000 and Amdur et al., 2000) also examined physiological and expressive motor responses (HR, SC, and EMG activity) to IAPS images. Neither study detected a significant difference on measures of HR or SC changes in response to the images. Amdur et al. (2000) examined frontalis EMG activity, a marker of negative emotional response, and failed to detect any significant differences between PTSD and control groups. However, Litz et al. (2000) examined zygomatic activity, a marker of positive emotional response, and found a significantly lower mean response to positive images in PTSD versus control participants. This finding occurred only in response to the combat prime manipulation, however. Despite these largely null findings, it was of interest in the present study to determine whether the presumably more proximal factor of EN severity might provide a more sensitive test of potential differences in these facets of emotional responding.

Method

Participants

Participants in the study were drawn from a treatment-seeking sample of adult women with PTSD who were assessed for inclusion in a treatment outcome trial of cognitive processing therapy conducted at the Center for Trauma Recovery at the University of Missouri-St. Louis. Participants were recruited for the parent study through newspaper advertisements and flyers posted in the community, in addition to referrals from local victim service agencies, shelters, and health care providers. Individuals were eligible for the current study if they met criteria for enrollment in the treatment outcome study and endorsed a lifetime history of sexual assault or sexual abuse. Inclusion criteria for the treatment outcome study required that the participant have current PTSD resulting from an interpersonal trauma and endorse symptomatic levels of trauma-related sleep disruption. Diagnoses of PTSD were based on structured diagnostic interviews using the Clinician Administered PTSD Scale (CAPS; Blake et al., 1990) and additional Axis I disorders were diagnosed using the Structured Interview for DSM-IV Axis I Disorders (SCID-I; First, Gibbon, Spitzer, & Williams, 1996). Exclusion criteria included active psychosis or current manic episode, active suicidality, parasuicidality, current substance dependence, or a non-trauma-related sleep disorder diagnosis. To be eligible, at least 3 months must have elapsed since the most recent traumatic event and since the end of any domestic violence relationship, and at least 1 month must have elapsed since any psychotropic medication change.

The resulting sample was comprised of 52 women between the ages of 18 and 56 (*M* = 39.1, *SD* = 11.3). Demographic characteristics of the sample are presented in Table 1. There were approximately equal numbers of African American (*n* = 19) and White participants (*n* = 20), a substantial minority of Multiracial participants (*n* = 12), and two Hispanic participants. The average educational attainment among participants was 13.6 years. The majority of the sample reported annual household incomes of below $10,000, with 39% reporting income under $5,000. The majority of participants were either single (50%), divorced (19%), or separated (14%).

Table 1
Demographic Information

	M	*SD*
Age	39.1	11.3
Race[a]		
African American	19	37%
White	20	39%
Multiracial	12	23%
Ethnicity[a]		
Hispanic	2	4%
Non-Hispanic	47	90%
Years of education	13.6	2.6
Marital status[a]		
Single	26	50%
Married	5	9.6%
Separated	7	13.5%
Divorced	10	19.2%
Cohabiting	2	3.8%
Widowed	1	1.9%
Household income[a]		
Less than $5,000	20	38.5%
$5,000-$10,000	13	25%
$10,000-$20,000	11	21.2%
$20,000-$30,000	2	3.8%
$30,000-$50,000	3	5.8%
Greater than $50,000	2	3.8%

[a]Number and percentage of group total are presented. 1 participant was missing data on race, ethnicity, marital status, and income, and 3 participants did not report ethnicity.

Trauma-related characteristics. Participants were diagnosed with PTSD on the basis of the lifetime event they identified as their most distressing traumatic event (index event). Table 2 presents information regarding additional lifetime traumatic events reported by participants. The most common index event among the sample involved childhood sexual abuse (n = 23), followed by adult sexual assault (n = 14), adult physical assault (n = 12) and child physical abuse (n = 3). The length of time since the index event ranged from 3 months to 55 years (M = 16.6 years, Mdn = 12.4 years, SD = 15.3 years).

The sample as a whole reported a high level of lifetime exposure to multiple interpersonal traumas in addition to the index event. For instance, 48% of participants experienced sexual assault or abuse both in childhood and adulthood, 31% experienced physical assault or abuse in both childhood and adulthood, and 21% experienced both physical and sexual assault or abuse in both childhood and adulthood.

Table 2
Trauma-Related Information

	N	% of sample
Index event		
CSA	23	44.2%
ASA	14	26.9%
CPA	3	5.8%
APA	12	23.1%
Lifetime trauma exposure		
Sexual assault or abuse		
Childhood only	18	34.6%
Adulthood only	9	17.3%
Both	25	48.1%
Physical assault or abuse		
Childhood only	4	7.7%
Adulthood only	21	40.4%
Both	16	30.8%
Both sexual and physical assault/abuse		
Childhood only	4	7.7%
Adulthood only	7	13.5%
Both	11	21.1%

Note. CSA = child sexual abuse; ASA = adult sexual assault; CPA = child physical abuse; APA = adult physical assault

Procedures

IRB approval was obtained for the current study from the University of Missouri-St. Louis Human Subjects Committee. All participants in the current study first completed a two-phase assessment battery as part of the pre-treatment assessment for the treatment outcome study. Participants completed diagnostic interviews and self-report measures on Day 1, including the 4 questionnaires used in this study. Individuals eligible for the treatment outcome study returned one week later (Day 2) to participate in physiological assessments as part of study procedures for the treatment outcome study. Those eligible to participate in the current study were informed about optional participation in an additional study (image viewing session) upon arrival for Day 2, and completed a separate informed consent (see Appendix A).

Following informed consent for this study and prior to participating in the image viewing session, participants completed physiological assessment procedures as part of the treatment outcome study. These procedures, which consisted of an acoustic startle test and an idiographic trauma-related scripted imagery paradigm, were separate components of the Day 2 assessment and were not designed to serve as a priming condition in the current study. Image viewing procedures commenced after an interval of 10 minutes following the presentation of the last imagery script, which consisted of a neutral imagery scenario, followed by an additional 2-minute resting baseline.

Participants were seated in a comfortable armchair in a dimly illuminated, sound attenuated room. Prior to the image viewing procedure, participants were familiarized with physiological monitoring equipment, and monitoring electrodes were attached to monitor heart rate (HR), electrodermal activity (SCR), and electromyogram (EMG) following standardized procedures (see Appendix B). Measurement began with a 2-minute resting baseline during which participants were instructed to relax but not to close their eyes. Standardized instructions for the image viewing procedure were then given along with a demonstration of how to complete affective rating scales (see Appendix C).

Images and instructions for rating affective responses were presented on a 17-inch computer monitor and controlled via computer software. Participants were instructed that a variety of pictures would be presented and that they should attend to the pictures during the entire time that they are displayed on screen. This was followed by presentation of three practice images and completion of practice affective ratings.

International Affective Picture System (IAPS) image viewing session. The IAPS (Lang, Bradley, & Cuthbert, 1997) is a set of color photographs that have been used extensively in emotion research with both clinical and nonclinical samples. A total of 24 images (8 pleasant, 8 neutral, and 8 unpleasant) were chosen on the basis of IAPS normative ratings of valence and arousal from women. Images were chosen with the constraint that mean normative valence ratings for pleasant and unpleasant images were equidistant from neutral, and that mean arousal ratings did not differ for pleasant and unpleasant images. Images containing content likely to be associated with participants' assault histories were excluded (e.g., sexual content, images of interpersonal violence, or images of assaulted or cowering women or girls). Pleasant images included a range of interpersonal and impersonal scenes (e.g., smiling mother with baby, children playing on a water slide, kittens) and unpleasant images were selected to include a range of negative interpersonal and impersonal scenes (e.g., snake, starving child, vomit, grieving woman). Neutral images consisted of ordinary household objects. The order of image presentation was fixed, with pleasant, unpleasant, and neutral images presented in a randomly assigned order with the constraint that the last image was not an unpleasant one. A complete list of the IAPS images used for this study can be found in Appendix D.

Participants viewed a series of 24 IAPS images presented on the computer screen. Each image was preceded by a 5-second pre-stimulus baseline, then an 8-second period in which the image was displayed. Immediately following each image presentation, participants were shown a visual rating scale on the computer and provided affective ratings via keyboard responses. At the end of the image viewing procedure, participants were compensated $20 for their participation.

Measures

Self-Assessment Manikin (SAM). Participants made affective ratings following each image using a computerized version of this nonverbal measure, which uses a series of pictures to illustrate graduated ratings of arousal and valence (see Appendix C). Participants were instructed to rate how they felt when they viewed each image on a scale of 1 to 9 in terms of valence (happy-unhappy) and arousal (calm-excited). The SAM's valence and arousal ratings have been found to correlate highly with factor scores derived from the Semantic differential Scale of Mehrabian and Russell and have been widely used in studies of emotion (Bradley & Lang, 1994).

Posttraumatic Stress Diagnostic Scale (PDS). The PDS (Foa, Cashman, Jaycox, & Perry, 1997) is a brief screening and diagnostic instrument designed to assess the presence and severity of PTSD based on the DSM-IV criteria. Participants completed 17 items corresponding to the DSM-IV symptomatic criteria for PTSD over the preceding month. The PDS has shown excellent internal consistency in both treatment-seeking and non-treatment seeking samples at high risk for trauma ($\alpha = .92$ for the symptom items) and strong agreement between PTSD diagnoses obtained with repeated administration at

2-3 weeks (*k* = .74). It has shown good convergent validity with more comprehensive structured interviews including the Structured Clinical Interview for DSM-IV PTSD Module (Sheeran & Zimmerman, 2002) and the Clinician Administered PTSD Scale (Griffin, Uhlmansiek, Resick, & Mechanic, 2004).

In the current study, the sum of scores from the three PDS items addressing emotional numbing (EN) symptoms was used to define levels of low and high EN, and the sum of these items was used as a continuous measure in secondary analyses. These items assess diminished interest or pleasure in activities (item 30, “Having much less interest or participating much less often in important activities”), detachment from others (item 31, “Feeling distant or cut off from people around you”) and restricted range of affect (item 32, “Feeling emotionally numb (for example, being unable to cry or unable to have loving feelings)”). Internal consistency for the sum of EN items was $\alpha = .63$, which was lower than desirable but was deemed adequate for exploratory purposes. Internal consistency was good for both the PDS total score ($\alpha = .84$), which was used for descriptive purposes, and the total PDS score with emotional numbing items excluded ($\alpha = .84$), which was used as a covariate in supplemental analyses.

To define subgroups for analysis of low and high severity of emotional numbing (EN) symptoms, scores from the three PDS emotional numbing items were used. Possible responses to symptom items include scores of 0 (not at all or only one time), 1 (once a week or less/once in a while), 2 (2 to 4 times a week/half the time) or 3 (5 or more times a week/almost always). Total scores for the sum of these three items can thus range from 0 to 9. Since no previous method has been established for determining a cutoff score to identify low versus high severity of EN symptoms, a decision was made to define low EN severity as a score of 0 or 1 on all three EN items and high EN severity as a total score of 4 or above on the sum of these items. This method was chosen to yield a Low EN group that does not report any EN symptoms to occur more often than “once in a while” and a High EN group that reports at least one EN symptom to occur at least “half the time.”

Beck Depression Inventory-II (BDI-II). The BDI-II (Beck, Steer, & Garb, 1996) contains 21 items assessing depressive symptoms corresponding to the DSM-IV criteria for major depressive disorder. Items are related on a 4-point severity scale. Total scores are obtained by summing the items. The BDI-II displays excellent internal consistency (α =.92 with outpatients and .93 in a nonclinical sample) and test-retest reliability (*r* [one week] = .93. It has shown high correlations with the Hamilton Psychiatric Rating Scale for Depression – Revised (*r* = .71) and the SCL-90-R Depression subscale (*r* = .89; Steer, Ball, Ranieri, & Beck, 1997). Evidence for discriminant validity includes a relatively lower correlation (*r* = .47) with the Hamilton Anxiety Rating Scale – Revised and findings of significantly higher scores on the BDI-II for outpatients with mood disorders compared to those with anxiety, adjustment, or other disorders (Beck et al., 1996). Internal consistency was found to be excellent in the current sample, α = .92

Dissociative Experiences Scale-II (DES-II). The DES-II (Carlson & Putnam, 1993) is a 28-item self-report scale that quantifies a range of experiences commonly reported by individuals who dissociate, including absorption, derealization, amnesia, and depersonalization. For each item, participants circle a number ranging from 0 to 100 (by 10s) to represent the percentage of time they have that experience. The DES-II differs from the original DES only in the substitution of a numerical item response format in favor of a 100 mm visual analog scale for purposes of easier scoring. The DES-II has been found to produce scores very similar to the original DES among general population adults, late adolescents, and subjects diagnosed with multiple personality disorder. Estimates of internal consistency for the DES have generally been good (split-half *r*s ranging from .83 to .93; *a* = .95) and test-retest reliability has been adequate over intervals of 4 to 8 weeks (r =.79 [4-6 weeks], r [4 weeks] = .96). Evidence of convergent and discriminant validity for the DES includes findings of elevated scores among adults with dissociative disorders, moderate to strong correlations (r = .52 to .82) with another measure of dissociation, the Perceptual Alteration Scale, and modest to moderate correlations with measures of constructs related to dissociation, including the Tellegen Absorption Scale (r = .39) and the Ambiguity Intolerance Scale (r = .24). In the current sample, internal consistency was excellent (α = .96).

Emotional Reactivity and Numbing Scale (ERNS). The ERNS (Orsillo et al., 2007) is a 62-item questionnaire consisting of statements describing a range of possible reactions to emotion-eliciting events or situations. Each statement is rated on a 5-point scale from 1 “Not at all typical of me” to 5 “Entirely typical of me,” and coded to generate 5 subscales measuring reactivity along dimensions of positive emotions, anger, fear, sadness, and general emotional reactivity. For the present study, the ERNS-P subscale (26 items) and ERNS general subscale (8 items) were explored for use as supplementary measures of emotional numbing. Initial psychometric evaluation has shown good to excellent internal consistency for these subscales with Cronbach’s α of .81

for the general subscale and .91 for the positive subscale. Test-retest reliability over an average of 7.9 days was r = .72 for the general subscale and r = .82 for the positive subscale. Evidence of convergent validity has been found with a single-item measure of emotional numbing from the Distressing Experiences Questionnaire (r = -.56 with the general subscale and r = -.53 with the positive subscale). Individuals with PTSD versus without PTSD have also been shown to score lower on general and positive subscales of the ERNS (Orsillo et al., 2007). In the current sample, the ERNS-P subscale showed acceptable reliability for exploratory purposes (α = .63) and was included in the study. However, the ERNS general subscale showed poor reliability (α = .43) and was therefore not included.

Data Reduction Procedures

For measures of HR, SCR, and EMG, average change scores in response to pleasant and unpleasant images were calculated by averaging difference scores in response to image viewing for the 8 images comprising each category of image valence. For HR and EMG, these difference scores consisted of the difference between the mean (in beats per minute for HR and volts for EMG) for the final 6 seconds[3] of each 8-second image presentation minus the mean for the 5-second prestimulus baseline immediately prior to image presentation. For SC, the maximum skin conductance value in volts during the final 6 seconds of image presentation was subtracted from the mean SC value during the 5-second prestimulus baseline, to reflect skin conductance response (SCR) to each image.

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[3] The final 6 seconds of image presentation was selected to avoid contamination of physiological data due an orienting response during the first 2 seconds image presentation, consistent with prior studies (Amdur et al., 2000; Litz et al., 2000).

Data Analysis Plan

Categorical Approach to Hypotheses 1 through 5. Due to the multiple dependent variables being tested in the current study, a MANOVA approach was originally proposed to evaluate the effect of EN severity on subjective ratings of arousal and valence and psychophysiological measures of emotional response to pleasant and unpleasant images. This approach entailed dichotomizing EN severity into groups of low and high EN. As noted, a cutoff score of <=1 on each of the PDS emotional numbing items was originally proposed to define the low EN group and a score of >=4 on the sum of these items was originally proposed to define the high EN group. Two separate repeated measures MANOVAs were planned to examine families of dependent variables, with familywise alpha set at .025 to adjust for two separate omnibus tests. One 2 (EN group) x 2 (image category) MANOVA was planned to compare EN groups on mean arousal and valence ratings for the within-subjects factor of image type (pleasant and unpleasant). A separate 2 x 2 MANOVA was planned to compare the groups on physiological measures (HR, SCR, and EMG) by image categories. Follow-up univariate ANOVAs and tests of pairwise effects with Bonferroni correction for multiple comparisons were planned for analyses showing significant multivariate effects.

Results

Missing Data Analyses

Several of the dependent variables contained a large amount of missing data (i.e., missing values for > 5% of cases). Five participants were missing data on all HR SCR, and EMG response variables due to recording error. In addition, several cases had missing values due to excessive artifact in the data[4]. In all, HR change for pleasant images was missing for 9 cases (17% of sample); HR change for unpleasant images was missing for 10 cases (19% of sample); SCR for both pleasant and unpleasant images was missing for 5 cases (10% of sample); and EMG change for unpleasant images was missing for 9 cases (17% of sample). As a result, sample sizes were reduced for each of these analyses, with sample sizes ranging from $N = 42$ for HR change in response to unpleasant images to $N = 47$ for SCR in response to pleasant and unpleasant images.

On the self-report measures, two participants (4% of the sample) were missing data for all of the arousal and valence variables due to recording error, which reduced the sample sizes to 50 for these analyses. In addition, one participant failed to complete the DES, and two participants failed to complete the ERNS, which reduced the sample sizes to 51 and 50, respectively, for these measures. One participant was missing one item on the PDS, and the missing value for this item was replaced with the sample item mean.

Due to the large amount of missing data, logistic regression analyses were performed to test whether data were missing at random for all variables that contained approximately 5% or more missing data. For each variable, two sets of predictors were separately regressed on a dummy variable coded for missing versus non-missing data for the variable. The first set of predictors contained demographic variables of age, race, ethnicity, years of education, marital status, and income, and the second contained all of the symptom measures included in the study (sum of EN items from the PDS, PDS total, BDI, DES, and ERNS-P subscale). None of the Hosmer and Lemeshow χ^2 values for

[4] Mean values for image categories containing less than 80% of valid data for a physiological measure were

either model were statistically significant (all *p*'s >.05), indicating that neither demographic nor symptom variables significantly predicted missing versus non-missing data on any of the measures.

Distribution of EN Severity and EN High and Low Groups

The measure of EN severity was operationalized as the sum of PDS emotional numbing items 30, 31, and 32. The distribution of this variable was negatively skewed, reflecting the fact that the majority of the sample endorsed a high level of EN symptoms. Although the possible range of responses on this variable ranged from 0 to 9, the majority of scores fell in the upper range of severity (M = 6.4, SD = 2.1).

Using the predetermined cutoff of <=1 on each item to define the low EN group and sum of the items >=4 to define the high EN group resulted in an extremely uneven split of the sample, with only 5 participants in the low EN group and 45 participants in the high EN group. Two participants had scores that fell in between the cutoff scores for determining low and high EN groups. Further analysis revealed that each of these participants endorsed one EN symptom to occur more often than 'once a week or less/once in a while,' thus scoring above the originally proposed cutoff for the low EN group. Overall, these individuals' responses to the EN items were more similar to those of the Low EN group than the high EN group (i.e., no more than one symptom was reported to occur more often than once a week). Given this observation, together with the interest in retaining maximum power, a decision was made to include these two participants in the low EN group to maximize this sample size. The resulting samples are distinguished

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treated as missing

by a cutoff of <=3 on the sum of PDS emotional numbing items for the low EN group and >=4 for the high EN group.

Sample Characteristics

Descriptive statistics for each of the self-report measures assessing PTSD symptoms, depression, dissociation, and emotional reactivity are presented in Table 3. High and low EN groups differed substantially on the sum of PDS emotional numbing items, as expected (a difference of 3.5 standard deviations). The sample as a whole endorsed a moderate to severe level of PTSD symptoms on the PDS (*M* = 34.4, *SD* = 8.3) and a severe level of depressive symptoms on the BDI-II (*M* = 31.3, *SD* = 11.1). Notably, these scores were much lower in the low versus high EN group (PDS total score differed by 1.7 standard deviations; BDI-II score differed by 1.2 standard deviations). In contrast, dissociative experiences and emotional reactivity as measured by the ERNS-P and general subscales were quite similar between the groups.

Table 3

Self-Report Measures of PTSD, Depression, Dissociation, and Emotional Numbing

	High EN Group (*n* = 45)		Low EN Group (*n* = 7)		Total Sample (*N* = 52)	
	M	*SD*	*M*	*SD*	*M*	*SD*
PDS total	36.0	7.4	23.7	5.6	34.4	8.3
PDS intrusion subscale	9.4	3.2	6.9	4.1	9.1	3.4
PDS arousal subscale	11.2	2.2	8.1	2.2	10.8	2.4
PDS avoidance subscale	15.4	3.5	8.7	2.9	14.5	4.1
PDS emotional numbing items	7.0	1.4	2.3	0.8	6.4	2.1
BDI-II	33.0	10.3	21.0	10.9	31.3	11.1
DES-II[a]	24.9	18.0	23.6	20.1	24.7	18.1
ERNS-P subscale[b]	83.7	10.8	87.8	12.4	84.2	11.0

Note. PDS = Posttraumatic Stress Diagnostic Scale, total scores range from 0-51; PDS intrusion and arousal subscale scores range from 0-15; PDS avoidance subscale scores

range from 0-21; PDS emotional numbing items scores range from 0-9; BDI-II = Beck Depression Inventory-II, scores range from 0-63; DES-II = Dissociative Experiences Scale-II, scores range from 0-100; ERNS = Emotional Reactivity and Numbing Scale; ERNS-P subscale scores range from 26-130, with higher scores indicating greater emotional reactivity/less emotional numbing
[a]*N* = 51
[b]*N* = 50

Primary Analyses

Methodological considerations. Due to the extremely uneven split between low and high EN groups, several factors were considered to evaluate the appropriateness of employing the planned MANOVAs with these groups. First, the issue of reduced power for detecting differences between groups was considered. Although the very small sample size for individuals with low EN weakens power for these analyses, it was decided that this concern does not preclude conducting between-groups analyses. Despite low power, effect sizes for these comparisons can provide information about the likely effect in a larger sample. The reduced reliability of means based on the small sample size in the Low EN group was also considered to represent a methodological limitation. However, neither of these concerns were deemed to invalidate the use of MANOVA or ANOVA procedures.

Threats to the validity of parametric tests that result from small and unequal sample sizes were considered more pivotal in evaluating the planned analyses. With small sample sizes, *F*-based statistics are no longer robust to violations of univariate and multivariate normality assumptions, and the assumptions of homogeneity of variance and variance-covariance matrices are more likely to be violated, threats that are magnified with more unequal sample sizes (Boneau, 1960; Tabachnick & Fidell, 2001). Therefore, conservative criteria were employed to screen variables for the appropriateness of parametric tests, and planned analyses were modified on the basis of screening results.

Hypotheses 1 and 2: Arousal and valence. Hypothesis 1 predicted that individuals in the high EN group would give lower valence ratings in response to both pleasant and unpleasant images compared to individuals in the low EN group. Hypothesis 2 predicted that participants in the high EN group would give lower arousal ratings in response to pleasant images and higher arousal ratings in response to unpleasant images, compared to the low EN group. Descriptive statistics for raw arousal and valence ratings for pleasant and unpleasant images are presented in Table 4 along with normative ratings of the same IAPS images from published norms for female undergraduates (Lang et al., 1997).

Table 4

Self-Reported Valence and Arousal in Response to Pleasant and Unpleasant Images for High and Low EN Groups, Total Sample, and IAPS Norms

	Pleasant Images							
	High EN Group (n = 44)		Low EN Group (n = 6)		Total Sample (N = 50)		IAPS Norms	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Valence	7.3	1.1	7.5	1.2	7.3	1.1	7.8	1.7
Arousal	5.3	1.9	4.7	3.0	5.2	2.1	5.7	2.3
	Unpleasant Images							
	High EN Group (n = 44)		Low EN Group (n = 6)		Total Sample (N = 50)		IAPS Norms	
Valence	2.2	1.0	2.2	1.1	2.2	1.0	2.2	1.4
Arousal	4.7	2.4	3.1	1.7	4.5	2.4	6.2	2.1

Note. EN = Emotional numbing (sum of responses to items 30-32 from the Posttraumatic Stress Diagnostic Scale); Valence = Self-Assessment Manikin ratings of unhappy-happy feelings rated from 1 to 9, with higher ratings indicating greater happiness; Arousal = Self-Assessment Manikin ratings of calm-excited feelings rated from 1 to 9, with higher ratings indicating greater arousal; IAPS Norms = Normative ratings of selected images from the International Affective Pictures System (IAPS) for female undergraduates (Lang et al., 1997).

Prior to analysis, distributions of arousal and valence ratings were screened within each EN group for their fit with the assumptions of multivariate analysis. Examination of histograms and skewness and kurtosis statistics revealed a variety of deviations from normality among the variables[5] (see Table 5). Specifically, valence ratings for pleasant images were negatively skewed in both groups, valence ratings for unpleasant images were positively skewed in the high EN group, and arousal ratings for unpleasant images were negatively skewed in the high EN group. Although deviations from normality were not extreme for most variables, the combination of unequal sample sizes and the small size of the low EN group suggested stringent criteria be applied in screening for normality. Transformations were applied to the non-normal variables and succeeded in normalizing two variables (a reflection + square root transformation of valence ratings for pleasant images and a square root transformation of valence ratings for unpleasant images). One variable (arousal ratings for unpleasant images) was rejected for use in parametric tests because successive transformations failed to achieve normality of this variable in the high EN group.

[5] Normality was evaluated using the criterion of Shapiro-Wilk statistic <.05, following the recommendation of Riffenburgh (2006), as this statistic is more accurate than Kolmogorov-Smirnov in sample sizes of 5-50.

Table 5

Skewness and Kurtosis of Untransformed Dependent Variables

	High EN Group					
	Pleasant Images			Unpleasant Images		
	z of skewness	*z* of kurtosis	*P*	*z* of skewness	*z* of kurtosis	*p*
Valence	-1.92	0.45	.045	2.57	1.06	.006
Arousal	-1.47	-0.62	.058	0.63	-1.80	.011
HR	0.07	1.96	.446	0.64	3.05	.065
SCR	6.98	8.86	.000	5.27	4.14	.000
EMG[a]	--	--	--	1.57	-0.57	.078
	Low EN Group					
	Pleasant Images			Unpleasant Images		
	z of skewness	*z* of kurtosis	*P*	*z* of skewness	*z* of kurtosis	*p*
Valence	-2.55	2.83	.008	0.90	-0.02	.664
Arousal	-0.51	-1.21	.165	1.44	0.86	.480
HR	-0.82	0.66	.697	-2.07	1.81	.028
SCR	2.44	2.48	.001	2.44	2.48	.000
EMG[a]	--	--	--	1.02	-0.58	.192

Note: EN = emotional numbing (sum of responses to items 30-32 from the Posttraumatic Stress Diagnostic Scale); Valence = Self-Assessment Manikin ratings of unhappy-happy feelings rated from 1 to 9, with higher ratings indicating greater happiness; Arousal = Self-Assessment Manikin ratings of calm-excited feelings rated from 1 to 9, with higher ratings indicating greater arousal; HR = average heart rate change in beats per minute in response to image presentation; SCR = average skin conductance response in volts in response to image presentation; EMG = average corrugator electromyogram response in volts in response to image presentation; z of skewness = skewness/standard error of skewness, z of kurtosis = kurtosis/standard error of kurtosis, *p* = significance of Shapiro-Wilk test of normality. Shapiro-Wilk *p* values < .05 represent statistically significant departures from normality.

[a]EMG change for pleasant images was not included as a study variable.

Different transformations were required to achieve normality for different variables due to the opposite direction of skewness in the data. As a result, the use of a repeated measures analysis using image category as a within-subjects independent variable was no longer possible, as this analysis would have entailed comparing variables that were subjected to different transformations. Therefore, the planned 2 (EN group) x 2 (image category) MANOVA comparing arousal and valence ratings between groups was rejected. Instead of treating image category as a repeated-measures independent variable in a two-way MANOVA, the use of a one-way between-subjects MANOVA was chosen as an alternative, with repeated measures used as multiple dependent variables. This design eliminates the main effect of image category and its interaction with EN group from the analysis, and simply tests the difference between EN groups on the dependent variables.

A one-way between subjects MANOVA was performed on three dependent variables: untransformed arousal ratings for pleasant images, reflected and square-root-transformed valence ratings for pleasant images, and square-root transformed valence ratings for unpleasant images. EN group (low versus high) was the independent variable. SPSS MANOVA was used for the analysis with Type III sums of squares to adjust for unequal sample sizes. Total *N* of 52 was reduced to 50 due to missing data from two participants, one in each group. There were no univariate or multivariate within-cell outliers at $p < .001$, and results of evaluation of assumptions of homogeneity of variance-covariance matrices, linearity, and multicollinearity were satisfactory. There was no significant multivariate effect of EN group on the combination of arousal and valence variables, $F(3, 46) = 0.23$, $p = .88$, partial $\eta^2 = .02$. The results of univariate comparisons were non-significant as well. Examination of effect sizes for these comparisons indicated that transformed valence ratings for pleasant images showed a very small effect in the predicted direction (*d* = -.12) (the high EN group had a very slight tendency to rate pleasant images as less pleasant than those in the low EN group). There was also a very small trend in the opposite of the predicted direction for arousal ratings in response to pleasant images (*d* = .13), (the high EN group tended to rate pleasant images as very slightly more arousing than those in the low EN group). The effect size for transformed valence ratings for unpleasant images was extremely small (*d* = .02).

Next, the hypothesis that individuals in the high EN group would give higher arousal ratings than those in the low EN group in response to unpleasant images was examined. Due to non-normality of arousal ratings for unpleasant images, this effect was examined using a Mann-Whitney *U* test. Arousal ratings for unpleasant images among individuals in the high EN group (*M* = 4.68, *Mdn* = 3.94, *SD* = 0.37, *n* = 44), were not significantly different from those in the low EN group (*M* = 3.08, *Mdn* = 2.62, *SD* = 0.70, *n* = 6), *z* = -1.6, *p* = .11. The difference between mean ranks of groups corresponded to an effect size *r* = -.23 (a small effect). Mean differences were in the predicted direction, with participants in the high EN group endorsing slightly greater arousal for unpleasant images than those in the low EN group.

Hypotheses 3, 4, and 5: HR, SCR and corrugator EMG. Hypotheses 3, 4, and 5 collectively predicted that individuals in the high EN group would show a pattern of response consistent with dampened physiological reactivity (HR change and SCR) in response to pleasant images, but show heightened physiological and expressive-motor responses (HR change, SCR, and corrugator EMG change) to unpleasant images, compared to the low EN group. Descriptive statistics for each of the physiological and expressive-motor response variables is presented in Table 6.

Table 6

Physiological and Expressive Motor Responses to Pleasant and Unpleasant Images for High and Low EN Groups and Total Sample

	High EN Group					
	Pleasant Images			Unpleasant Images		
	M	*SD*	*n*	*M*	*SD*	*n*
HR	-0.8	1.7	38	-1.6	2.3	37
SCR	.040	.061	38	.112	.025	41
EMG[a]	--	--	--	.029	.032	38
	Low EN Group					
	Pleasant Images			Unpleasant Images		
	M	*SD*	*n*	*M*	*SD*	*n*
HR	.16	2.2	5	-1.8	3.1	5
SCR	.038	.078	6	.136	.295	6
EMG[a]	--	--	--	.031	.033	5
	Total Sample					
	Pleasant Images			Unpleasant Images		
	M	*SD*	*n*	*M*	*SD*	*n*
HR	-0.7	1.8	43	-1.6	2.3	42
SCR	.04	.06	44	.12	.21	47
EMG[a]	--	--	--	.03	.03	43

Note. EN = Emotional numbing (sum of responses to items 30-32 from the Posttraumatic Stress Diagnostic Scale); HR = average heart rate change in beats per minute in response to image presentation; SCR = average skin conductance response in volts in response to image presentation; EMG = average corrugator electromyogram response in volts in response to image presentation
[a]EMG change for pleasant images was not included as a study variable.

Prior to analysis, screening was conducted on each of the variables within each group to determine the appropriateness of multivariate analyses. Initial screening indicated that high correlations between SCR for pleasant and unpleasant images (r = .99) and between SCR and EMG change for unpleasant images (r = .98) caused singularity among the variables. As a result, the planned use of MANOVA to examine differences on this set of dependent variables was rejected.

Further screening was conducted to determine if subsets of these variables could be examined using MANOVA or other between-groups parametric tests. Similar to the results of normality screening with arousal and valence ratings, a variety of deviations from normality (Shapiro-Wilk statistics $<.05$) were found within the physiological variables (see Table 5). SCR data for both pleasant and unpleasant images were extremely positively skewed in the High EN group, and successive transformations did not succeed in normalizing these variables. Normality screening was repeated after three univariate outliers on SCR for pleasant images in the high EN group were removed, but the variable remained significantly non-normal. HR change for unpleasant images was skewed in opposite directions in high and low EN groups, and was therefore not able to be normalized with the same transformation. Therefore, these variables were rejected for parametric tests. HR change for pleasant images and EMG change for unpleasant images were the only measures that approximated normality in both high and low EN groups. As a result, these variables were the only candidates for parametric analysis among the physiological measures.

A one-way between subjects MANOVA was performed comparing high and low EN groups on HR change in response to pleasant images and EMG change in response to unpleasant images. SPSS MANOVA was used for the analysis with Type III sums of squares to adjust for unequal sample sizes. Sample sizes for this comparison were reduced to n = 38 in the high EN group and n = 5 in the low EN group due to missing data. There were no univariate or multivariate within-cell outliers at $p < .001$, and results of evaluation of assumptions of homogeneity of variance-covariance matrices, linearity, and multicollinearity were satisfactory. There was no significant multivariate effect of EN group on the combination of HR and EMG variables, $F(2, 37) = 1.14$, $p = .33$, *ns*, partial $\eta^2 = .06$. The results of univariate comparisons were non-significant as well. EMG change in response to unpleasant images showed a trivial effect size ($d = -.04$). HR in response to pleasant images showed a small effect size, $d = -.33$.) The direction of differences in HR suggested there was a tendency for those in the high EN group to show a decrease in HR while those in the low EN group showed an increase in HR in response to pleasant images.

A Mann-Whitney *U* test indicated the amount of SCR change in volts in response to pleasant images was not significantly different between participants in the high EN group ($M = 0.04$, $Mdn = 0.02$, $SD = 0.06$, $n = 38$) and those in the low EN group ($M = 0.04$, $Mdn = 0.0$, $SD = 0.08$, $n = 6$), $z = -0.68$, $p = .50$. effect size $r = -.10$.

To evaluate the hypotheses that unpleasant images would evoke greater HR and SCR increase than those in the low EN group, two Mann-Whitney *U* tests were conducted. Neither comparison showed a significant difference between groups. In response to unpleasant images, HR change was not significantly different between participants in the high EN group ($M = -1.6$, $Mdn = -1.3$, $SD = 2.3$, $n = 37$) and those in the low EN group ($M = -1.8$, $Mdn = -0.4$, $SD = 3.1$, $n = 5$), $z = -0.68$, $p = .50$. effect size $r = -.10$. The amount of SCR change was likewise not significantly different between participants in the high EN group ($M = -0.11$, $Mdn = 0.03$, $SD = 0.21$, $n = 41$) and those in the low EN group (*M* = 0.14, *Mdn* = 0.02, *SD* = 0.29, *n* = 6), $z = -0.57$, $p = .57$, effect size $r = -.08$.

In summary, comparisons of low and high EN groups across measures of HR, SC, and EMG responses to pleasant and unpleasant images all failed to show significant differences. The effect sizes for these comparisons were uniformly very small, with the largest effect size (for the difference between HR change in response to pleasant images), in the small range. The direction of the latter effect suggested a tendency for those in the high EN group to show a slight decrease in HR while those in the low EN group showed a slight increase.

Hypothesis 6: Correlation between arousal and valence. Hypothesis 6 predicted that arousal and valence ratings would be negatively correlated in the high EN group (i.e., that subjectively unpleasant images would be rated as more arousing than pleasant ones), but uncorrelated in the low EN group. Contrary to this hypothesis, the correlation between mean arousal and valence ratings in the high EN group was small and not statistically significant, $r = .20$, $p = .35$. Rather, the relationship was curvilinear, with both pleasant and unpleasant images evoking higher arousal ratings than neutral images (see Figure 1). For comparison purposes, Figure 2 shows the relationship between arousal and valence ratings in the normative sample for female undergraduates using the same images from the IAPS (Lang et al., 1997). Unexpectedly, the low EN group showed a strong positive correlation between arousal and valence ratings, $r = .73$, $p < .001$, indicating that participants in the low EN group gave higher arousal ratings to images that were more pleasant (Figure 3).

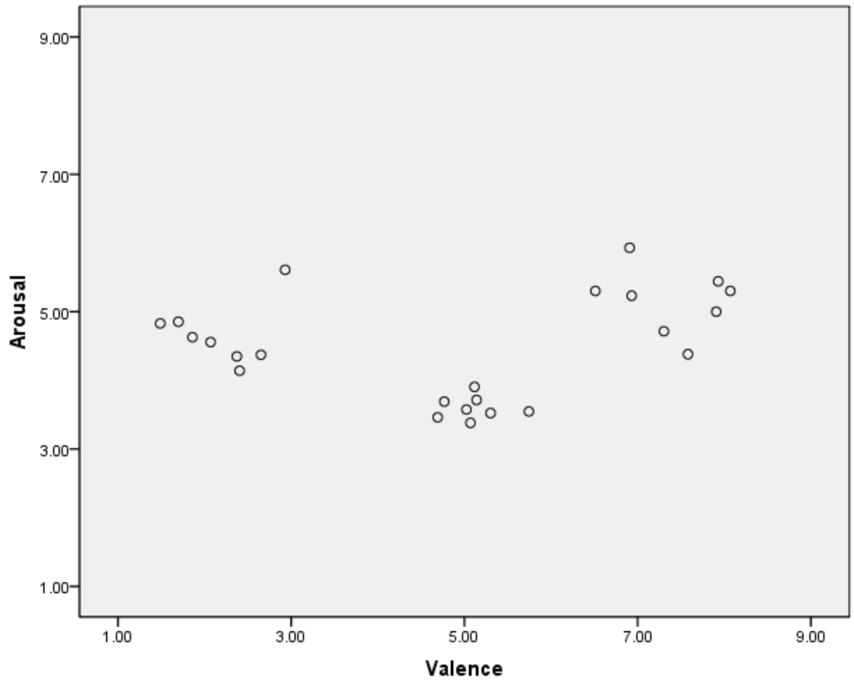

Figure 1. Relationship between self-reported arousal and valence ratings of images in high EN group.

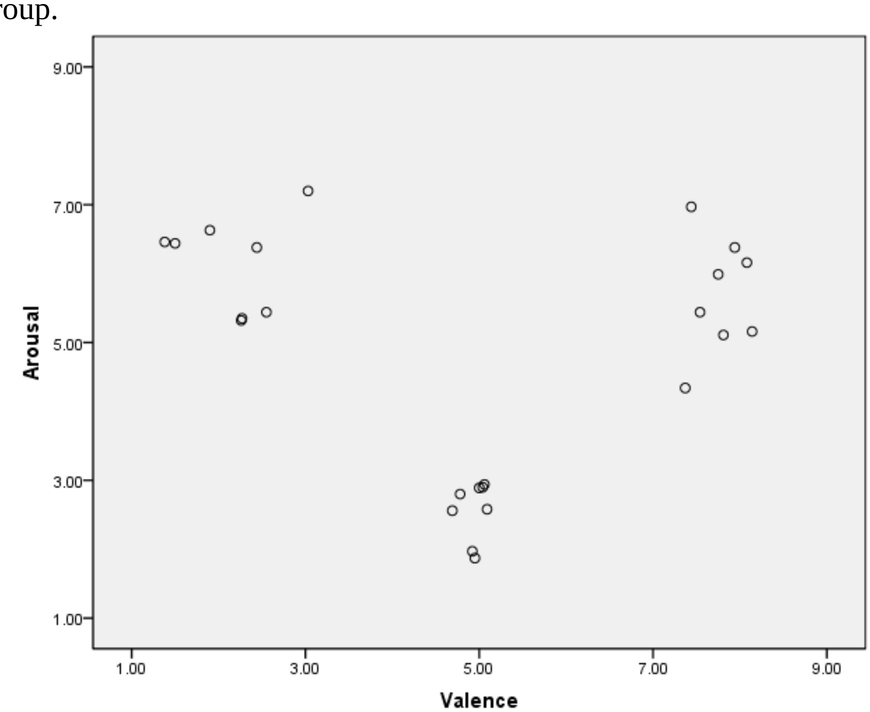

Figure 2. Relationship between self-reported arousal and valence ratings of images in

Lang et al. (1997) normative sample of female undergraduates

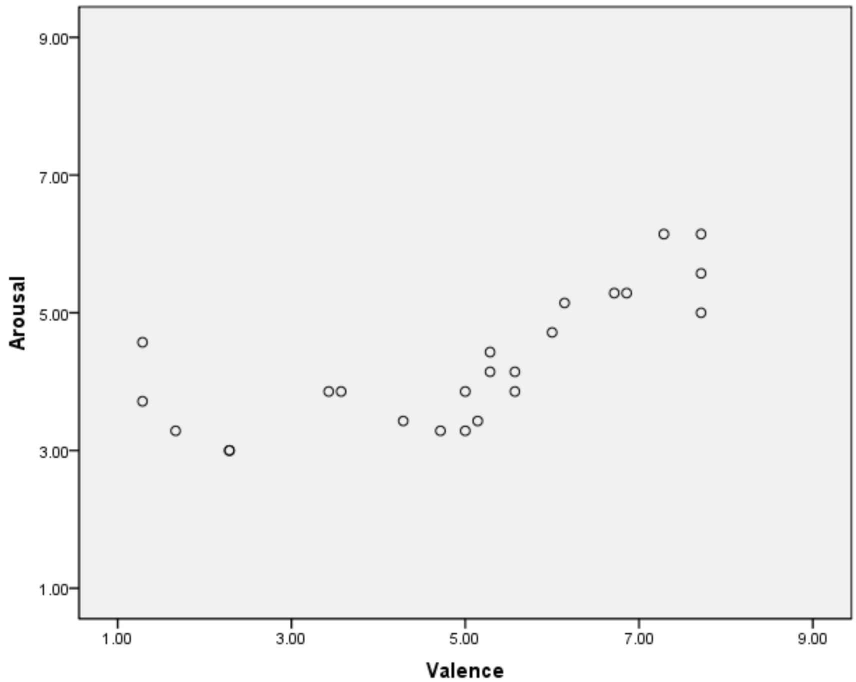

Figure 3. Relationship between self-reported arousal and valence ratings of images in low EN group.

Hypothesis 7: Relationship between depression, dissociation and EN. An additional hypothesis of the study predicted that depression (BDI-II) scores would be more closely associated with emotional numbing severity than would a measure of dissociation (DES-2). A t-test of the difference between two non-independent correlations addressed the hypothesis that the correlation between depression and EN severity would be greater than that for dissociation and EN severity. This hypothesis was supported: the correlation between BDI total score and EN severity, $r = .48$ was significantly greater than that between DES total score and EN severity, $r = .14$, $t(48) = 2.12$, $p < .05$.

Secondary Analyses

Although the primary hypotheses of the study were conceptualized in terms of differences between groups with high and low EN severity, the distribution of EN severity in the present sample created a highly uneven split between groups defined by the chosen cutoff, with a very low sample size for the low EN group. Therefore, several alternative data analytic approaches were considered to further evaluate the relationship between emotional numbing and subjective, physiological, and expressive motor responses. Alternative methods of dichotomizing the sample based on EN severity to produce a more balanced design were considered, including the use of a median split, the use of a cutoff of 1 SD above and below the mean, and the use of an alternative definition of low and high EN groups based on responses to the single “restricted range of affect” item on the PDS.

The lack of a conceptual rationale for hypothesizing differences between “low” and “high” groups on the basis of a median split led to rejecting the use of a median split. Other ways of dichotomizing the sample, such as examining low and high groups at the tails of the distribution, were also rejected, as dichotomization entails a greater loss in power when it occurs farther away from the mean of the sample (Cohen, 1983; MacCallum, Zhang, Preacher, & Rucker, 2002). The use of an alternative cutoff based on responses to a single-item measure of emotional numbing has drawbacks as well, most notably the reduced reliability of measurement inherent in a single-item measure, which further weakens power. Given the reduction in power inherent in dichotomizing a continuous independent variable, a further reduction in power was deemed unsuitable.

Instead, the alternative of examining correlations between the continuous measure of EN severity and the dependent variables was chosen as a secondary approach to data analysis.

Correlational analyses were conducted to examine the extent of any relationships between measures of affective response to photographs and the continuous independent variable of EN severity, as defined by the sum of PDS emotional numbing items. The expected pattern of relationships between EN severity and indicators of emotional response were tested by examining Pearson's product-moment correlations between this continuous measure of EN severity and each of the variables measuring emotional responsiveness to photographs. Descriptive statistics for each of the dependent variables for the combined sample are presented in Tables 3 and 5.

Continuous approach to Hypotheses 1-5. Distributions of ungrouped variables were first examined for the entire sample for the presence of univariate and multivariate outliers, non-normality, and non-linearity. A less conservative criterion for evaluating normality was applied in screening the ungrouped data, given the larger sample size and the robustness of Pearson's product-moment correlational analyses to all but extreme violations of normality (Fowler, 1987). Ungrouped variables were considered to require transformation only if skewness or kurtosis was extreme, as indicated by a z-score greater than 3.29. Inspection of bivariate scatterplots and Mahalonobis distances was used to examine distributions for the presence of multivariate outliers and possible curvilinear relationships between EN severity and the dependent variables.

For the continuous measure of EN severity, there were no univariate outliers, and skewness and kurtosis were not extreme. For arousal and valence ratings, there were no univariate or multivariate outliers in the sample, and no variables showed extreme non-normality. Among the physiological variables, there were several univariate outliers greater than 3.29 standard deviations above the mean. There were 2 outliers on SCR in response to pleasant images, and 1 outlier on EMG in response to negative images. These outliers were removed prior to further analysis. There were also three multivariate outliers, two of which were on SCR in response to pleasant images and one of which was on SCR in response to unpleasant images. These cases were removed from their respective analyses. Normality screening revealed that SCR data for the combined sample were extremely positively skewed and leptokurtic for both pleasant and unpleasant images. Normality was improved with a log10 transformation; however, SCR variables remained extremely positively skewed and leptokurtic even with this transformation (pleasant images, z of skewness = 6.87, z of kurtosis = 9.37; unpleasant images, z of skewness = 4.49, z of kurtosis = 8.09). Further transformations (e.g., inverse transformation) did not improve normality for these variables. The log10 transformed SCR variables were therefore used in the final analysis, as they represented the closest approximation of normal distributions possible for these variables. None of the dependent variables showed evidence of curvilinear relationships with EN severity.

Results of correlational analysis. Correlations between EN severity and each measure of affective response to photographs are presented in Table 7. Contrary to study hypotheses, none of the correlations were statistically significant at $p < .05$.

Table 7

Correlations between EN Severity and Affective Responses to Photographs

	Pleasant Images		Unpleasant Images	
	r	*n*	*r*	*N*
Valence	-.05	50	-.24	50
Arousal	.25	50	.05	50
HR	-.25	43	-.07	42
SCR[a]	.16	43	.12	46
EMG[b]	--	--	-.10	43

Note. EN = emotional numbing (sum of responses to items 30-32 from the Posttraumatic Stress Diagnostic Scale); Valence = Self-Assessment Manikin ratings of unhappy-happy feelings rated from 1 to 9, with higher ratings indicating greater happiness; Arousal = Self-Assessment Manikin ratings of calm-excited feelings rated from 1 to 9, with higher ratings indicating greater arousal; HR = average heart rate change in beats per minute in response to image presentation; SCR = average skin conductance response in volts in response to image presentation; EMG = average corrugator electromyogram response in volts in response to image presentation. All correlations were non-significant, $p > .05$.
[a]SCR variables were logarithmically transformed prior to analysis.
[b]EMG change in response to pleasant images was not included as a study variable.

Hypothesis 1. It was hypothesized that EN severity would be negatively correlated with valence ratings in response to both pleasant and unpleasant images, indicating lower subjective happiness/ greater unhappiness in response to emotional stimuli among those with higher EN. Contrary to this hypothesis, there was no significant correlation between EN severity and valence ratings in response to pleasant images, $r = -.05$, $p = .74$, reflecting an extremely small magnitude of effect. There was a small correlation in the predicted direction between EN severity and valence in response to unpleasant images, $r = -.24$, suggesting that individuals with higher EN tended to rate unpleasant images as slightly more unpleasant than those with lower EN severity. However, this relationship was not statistically significant ($p = .10$).

Hypothesis 2. It was hypothesized that EN severity would be negatively correlated with arousal ratings in response to pleasant images, but would be positively correlated with arousal ratings in response to unpleasant images. This hypothesis was not supported. Arousal ratings showed no statistically significant relationship to EN severity in response to either pleasant images or unpleasant images. In response to pleasant images, there was a small but statistically non-significant positive association between EN severity and arousal, $r = .25$, $p = .08$, suggesting a trend in the opposite direction from the predicted relationship. That is, there may have been a tendency for respondents with higher EN to endorse slightly greater arousal in response to pleasant images. In response to unpleasant images, the correlation between EN severity and arousal was very small and non-significant, $r = .05$, $p = .73$.

Hypothesis 3. It was hypothesized that EN severity would be negatively correlated with HR change in response to pleasant images, but positively correlated with HR change in response to unpleasant images. The correlation between EN severity and HR change in response to pleasant images, $r = -.25$ represented a small effect in the predicted direction, but was not statistically significant ($p = .11$). In response to unpleasant images, the correlation between EN severity and HR change was non-significant and of very small magnitude, $r = -.07$, $p = .68$. Thus, overall, correlational results did not support the hypothesis. However, there was a trend toward individuals with higher EN showing less heart rate reactivity to pleasant images than those with lower EN.

Hypothesis 4. It was hypothesized that EN severity would be negatively correlated with SCR in response to pleasant images, but positively correlated with SCR in response to unpleasant images. This was not supported. For responses to pleasant and unpleasant images, the correlations of log-transformed SCR responses with EN severity were non-significant and of small magnitude: in response to pleasant images, $r = .16$, $p = .32$; in response to unpleasant images, $r = .12$, $p = .44$.

Hypothesis 5. It was hypothesized that EN severity would be positively correlated with increase in corrugator EMG activity in response to unpleasant images, consistent with augmented reactivity to negative emotional stimuli for individuals with greater EN. This hypothesis was not supported. The correlation between EN severity and corrugator EMG change in response to negative images was small and not statistically significant, $r = -.10$, $p = .54$.

Supplementary Analyses

ERNS-P Subscale and Affective Responses to Photographs. The availability of the ERNS as a supplemental index of EN severity allowed exploration of whether a similar or different pattern would be observed when a measure of EN with a greater range of possible responses was used. The ERNS-P subscale (ERNS-P) consists of 26 items that specifically address emotional reactivity to positive emotional stimuli. Raw scores are coded so that higher scores reflect lower emotional numbing (see Table 3 for descriptive statistics using raw scores). For ease in interpreting correlations, this measure was reverse-scored prior to correlational analysis, so that positive correlations represent correlations of study variables with emotional numbing. Two participants were missing the ERNS, resulting in 50 participants who completed this measure.

Prior to analysis, ERNS-P scores were examined for univariate and multivariate outliers, non-normality, and non-linearity, and found to be satisfactory. There were no univariate outliers. Two multivariate outliers were found among the measures of responses to pleasant images. One case was a multivariate outlier on valence ratings for pleasant images, and one case was an outlier on SCR response to pleasant images. These cases were removed from their respective analyses. As noted above, the distributions of SCR scores were positively skewed, and therefore a log10 transformation was applied to improve normality of these variables. None of the dependent variables showed evidence of a curvilinear relationship with the ERNS positive subscale.

Overall, it was anticipated that higher scores on the reverse-scored ERNS-P subscale would be associated with lower emotional reactivity to pleasant images and higher emotional reactivity to unpleasant images. Pearson's product-moment correlations were computed between the (reverse-scored) ERNS-P subscale and each of the self-report and physiological indicators of emotional responsiveness to pleasant and unpleasant images. These results are presented in Table 8. In addition, intercorrelations between this subscale and measures of PTSD, depression, and dissociation were computed for comparison purposes (Table 9).

Similar to the results found when examining EN severity as measured by the PDS items, there were no statistically significant correlations between this subscale and any of the measures of affective response to photographs. The size of the correlations was also uniformly small for each of the indicators. There were several effects in the range of r = .20; however, the direction of these relationships were mixed in terms of correspondence with the hypothesized patterns of emotional reactivity. Although there was a slight tendency for individuals who endorsed higher emotional numbing on this subscale to show lower HR reactivity in response to pleasant images (r = -.20), the exact opposite tendency was found for SCR (r = .20).

Table 8
Correlations between Reverse-Scored[a] ERNS-P Subscale and Affective Responses to Photographs

	ERNS-P Subscale[a]			
	Pleasant Images		Unpleasant Images	
	r	*N*	*r*	*N*
Valence	.03	47	.05	48
Arousal	.11	48	-.16	48
HR	-.20	41	.03	40
SCR[b]	.20	42	.05	45
EMG	--	--	-.04	41

Note. ERNS = Emotional Reactivity and Numbing Scale; Valence = Self-Assessment Manikin ratings of unhappy-happy feelings rated from 1 to 9, with higher ratings indicating greater happiness; Arousal = Self-Assessment Manikin ratings of calm-excited feelings rated from 1 to 9, with higher ratings indicating greater arousal; HR = average heart rate change in beats per minute in response to image presentation; SCR = average skin conductance response in volts in response to image presentation; EMG = average corrugator electromyogram response in volts in response to image presentation. All correlations were non-significant, $p > .05$.

As seen in Table 9, the ERNS-P subscale did not show statistically significant correlations with any of the symptom measures examined in this study. The strongest relationship with this measure was a small to moderate positive relationship (r = .27) with the DES-II. Interestingly, the ERNS-P did not show a positive correlation with depressive symptoms, and showed only a small relationship with the primary measure of EN symptoms used in this study, (sum of EN items on the PDS) and a weak relationship with total PDS score.

Table 9

Intercorrelations among Self-Report Measures of Emotional Numbing, PTSD Symptom Severity, Depression, and Dissociation

	ERNS-P[a]	PDS Total	PDS-EN	BDI-II
ERNS-P[a]	--			
PDS Total	.15	--		
PDS-EN	.19	.64**	--	
BDI-II	-.02	.68**	.48**	--
DES-II	.27	.23	.24	.24

Note. ERNS-P = Emotional Reactivity and Numbing Scale, positive subscale; PDS Total = Posttraumatic Stress Diagnostic Scale total score, including emotional numbing items; PDS-EN = Sum of PDS emotional numbing items; BDI-II = Beck Depression Inventory-II; DES-II = Dissociative Experiences Scale-II.
[a]ERNS-P subscale scores were reversed prior to correlation, so that positive correlations indicate positive relationships with emotional numbing
** Correlations were statistically significant at $p < .01$.

Post-hoc analysis of covariance controlling for BDI and PDS. Due to the substantial differences observed between low and high EN groups on both BDI and PDS total scores, use of these measures as covariates in between-groups comparisons was explored in post-hoc analyses of dependent variables that were appropriate for parametric analyses. Total PDS score with the removal of EN items (partial PDS total score) was computed for use in covariate analyses. Prior to analysis, relationships between dependent variables and covariates were screened for linearity, homogeneity of regression, absence of multicollinearity, and multivariate outliers. Heterogeneity of variance on arousal ratings for pleasant images prevented the use of the partial PDS total score as a covariate for this measure. Instead, partial PDS and BDI scores were used as covariates in a MANCOVA examining transformed valence ratings for pleasant and unpleasant images, while BDI scores alone were used as a covariate in an ANCOVA examining arousal ratings for pleasant images.

Controlling for differences in depression and other PTSD symptoms, there remained no significant difference between EN groups on valence ratings, multivariate $F(2, 45) = 0.66$, $p = .52$, partial $\eta^2 = .03$. Univariate effects remained small and non-significant as well, for EN group on valence of pleasant images, partial $\eta^2 = .01$, and for EN group on valence of unpleasant images, partial $\eta^2 = .02$. An ANCOVA controlling for the effects of BDI scores on arousal to pleasant images showed no difference between low and high EN groups, $F(1, 47) = 0.14$, $p = .71$, partial $\eta^2 =.00$.

A further MANCOVA examined the effects of EN group on HR change for pleasant images and EMG change for unpleasant images, controlling for the effects of BDI and partial PDS total score. There was no significant multivariate effect when controlling for these measures, $F(2, 37) = 1.16$, $p = 0.32$, partial $\eta^2 =.04$. Univariate effects remained small and non-significant as well (for the effect on EMG change for unpleasant images partial $\eta^2 =.01$; for the effect on HR change for pleasant images, partial $\eta^2 = .04$).

Post-hoc partial correlations controlling for BDI and partial PDS total score: Finally, a series of partial correlations was computed to examine the relationships between EN severity and affective responses to photographs controlling for depression severity and severity of other PTSD symptoms. As shown in Table 10, partial correlations between EN severity and each of the dependent variables remained non-significant after controlling for these variables.

Table 10
Zero-order Correlations between EN Severity and Affective Responses to Photographs and Partial Correlations Controlling for BDI-II and partial PDS Total Scores

	Pleasant Images			Unpleasant Images		
	zero-order r	*partial r*	*n*	*zero-order r*	*partial r*	*n*
Valence	-.05	-.10	50	-.24	-.11	50
Arousal	.25	.15	50	.05	-.12	50
HR	-.25	-.31	43	-.07	-.03	42
SCR[a]	.16	-.08	43	.12	-.21	46
EMG[b]	--	--	--	-.10	-.11	43

Note. EN = emotional numbing (sum of responses to items 30-32 from the Posttraumatic Stress Diagnostic Scale); Valence = Self-Assessment Manikin ratings of unhappy-happy feelings rated from 1 to 9, with higher ratings indicating greater happiness; Arousal = Self-Assessment Manikin ratings of calm-excited feelings rated from 1 to 9, with higher ratings indicating greater arousal; HR = average heart rate change in beats per minute in response to image presentation; SCR = average skin conductance response in volts in response to image presentation; EMG = average corrugator electromyogram response in volts in response to image presentation. All correlations were non-significant, $p > .05$.
[a]Partial PDS Total score consisted of the total score for all PDS symptoms with emotional numbing items removed.
[b]SCR variables were logarithmically transformed prior to analysis.
[c]EMG change in response to pleasant images was not included as a study variable.

Overall, controlling for the influence of BDI and partial PDS total scores did not have a substantial impact on the relationship between EN severity and the dependent measures. All of the partial correlations remained statistically non-significant ($p > .05$) controlling for the severity of depression and PTSD symptoms other than emotional numbing. Several correlations that had previously shown small relationships in the predicted direction were slightly strengthened after removing the influence of these variables. For example, there appeared to be a slightly stronger negative correlation between EN severity and HR in response to pleasant images controlling for covariates (partial correlation = -.31, versus zero-order correlation of - .25), and the relationship between EN severity and SCR in response to pleasant images became negative (partial correlation = -.08). However, there were also slight shifts in the opposite direction of study predictions for several correlations (e.g., the negative correlation between EN and valence for unpleasant images was weakened, and the correlation between EN and SCR for unpleasant images became negative). Overall, however, EN severity continued to show only small or very small correlations with each of the indices of affective response to photographs when controlling for severity of depression and other PTSD symptoms.

Discussion

Summary of Results

Overall, there were no significant differences on subjective, physiological, or expressive motor responses to affective stimuli between study participants classified as "low" and "high" on emotional numbing in the current study. Several non-statistically significant relationships in the data were observed, corresponding to effect sizes in the small range. The following summary integrates the results from categorical and continuous analyses with a focus on the effect sizes obtained for each hypothesis.

Hypothesis 1: Valence ratings. There was a very slight trend suggesting a relationship between EN and reduced valence ratings for pleasant images, consistent with the hypothesized direction of effect. Individuals with higher EN showed a very slight tendency to rate pleasant images as creating less happy feelings. Using Cohen's (1977) heuristic for the interpretation of effect sizes, categorical results on this measure were well below the minimum guideline for interpreting an effect size to be in the small range (d = .20), and correlational analysis echoed the small size of this effect. This small relationship remained when controlling for PTSD and depression severity, suggesting that the slight correlation was not accounted for by differences on overall symptomatology. However, the practical difference between groups was only a fraction of a percentage point on a 0 to 9 scale. Therefore, the magnitude of this relationship suggested that differences in valence for pleasant images showed a negligible association with EN severity as measured by the sum of EN items on the PDS. Likewise, the ERNS-P as a supplemental measure of EN severity did not show more than a trivial relationship with this measure.

Valence ratings for unpleasant images did not differ in categorical comparisons of low and high EN groups, as reflected in the equivalent means and standard deviations of the two groups. The use of correlational analysis suggested there may have been a slight effect that was observable when data from the entire sample was considered. Although this effect was in the predicted direction, with higher EN individuals rating unpleasant images as less pleasant, this effect was reduced to a negligible size when controlling for depression and other PTSD symptoms. There was no increase in relationship between EN and valence ratings for unpleasant images with the use of the ERNS-P.

Hypothesis 2: Arousal ratings. Self-reported arousal in reaction to pleasant images showed a slight trend in the opposite direction from study predictions, i.e., higher EN related to slightly higher arousal ratings for pleasant images, in both categorical and continuous analyses. However, this trend was reduced when controlling for other PTSD and depression symptoms. The size of this effect when controlling for these symptoms was very small, suggesting that any unique relationship between increased arousal for pleasant images among those with higher EN in this sample was negligible in magnitude.

Arousal ratings for unpleasant images showed a slight trend for those with higher EN to endorse greater arousal for unpleasant images, consistent with the direction of predicted differences. The effect sizes in both categorical and continuous analyses were in the small range, however, and were negligible when controlling for depression and other PTSD symptoms. Likewise, the ERNS-P showed a trivial relationship with this measure.

Hypothesis 3: HR. Overall, HR tended to decrease in response to image presentation regardless of stimulus valence. However, individuals with low EN showed a slight increase in HR in response to pleasant images, while those with high EN showed a slight decrease. Thus, there was a small trend suggesting lowered HR reactivity in response to pleasant images among those with higher EN in both categorical and continuous analyses, with continuous analyses showing the same trend when EN was measured with the PDS items and with the ERNS-P. Controlling for depression and PTSD severity did not change this relationship. However, the size of the relationship was small, and in practical terms, the magnitude of these changes in HR was extremely small (less than a 1 beat-per-minute mean difference in between-groups comparisons).

HR reactivity to unpleasant images showed even less correspondence with EN severity in both categorical and continuous analyses. The direction of the relationship was actually in the opposite direction from prediction, with higher EN participants showing slightly lower HR in reaction to unpleasant images. The size and strength of this relationship was not substantially affected by method of analysis, the use of the PDS or the ERNS-P to measure EN, or by the inclusion of depression and other PTSD symptoms as covariates.

Hypothesis 4: SCR. SCR for pleasant images showed very little relationship to EN severity, with categorical comparisons showing essentially equivalent responses between groups, and correlational analysis showing only a weak relationship. The raw correlations between SCR for pleasant images with EN, measured by both PDS items and ERNS-P, were in the opposite of the direction predicted, with higher EN associated with greater SCR reactivity to pleasant images. However, the magnitude of each of these effects was trivial, with the highest effect size being that for emotional numbing on the ERNS-P and increased SCR for pleasant images (r =.20). The direction of this relationship changed when controlling for depression and other PTSD symptoms, but the resulting relationship was in the trivial range.

SCR in response to unpleasant images similarly showed weak relationships with EN severity. Categorical and continuous analyses showed very small trends in opposite directions on this variable, with categorical results suggesting slightly lower SCR for the high EN group, and correlational results suggesting slightly higher SCR for those with higher EN. The ERNS-P echoed the finding of a slightly higher SCR response for those with higher EN. When controlling for depression and other PTSD symptoms, the positive correlation between SCR for unpleasant images and EN as measured by the PDS became even lower than initial results indicated. Thus the overall pattern and strengths of effects, while mostly consistent with the predicted direction, suggested that this variable showed trivial differences in relation to EN severity.

Hypothesis 5: EMG. Facial muscle responses reflecting activation of negative affect in response to unpleasant images were essentially equivalent between high and low EN groups. If anything, there was an extremely small effect in the opposite of the direction predicted, with higher EN individuals showing very slightly lower EMG reactivity to unpleasant images. Effect sizes in both categorical and correlational results suggested that the magnitude of any relationship between EN and EMG was negligible. The lack of relationship was consistent whether this variable was examined in relation to the PDS or the ERNS-P. Controlling for other PTSD symptoms and depression showed no change in this relationship.

Hypothesis 6: Relationship between arousal and valence ratings. The hypothesis that arousal and valence would be negatively correlated in the high EN group was not supported. Rather, individuals in this group tended to respond with increased arousal to both pleasant and unpleasant images in comparison to neutral images, consistent with a curvilinear pattern that mirrored normative ratings. In contrast, the low EN group showed a strong positive linear relationship between arousal and valence ratings, indicating they rated images as more arousing the more subjectively pleasant they were.

Hypothesis 7: Relationships between EN severity, dissociation, and depression. The hypothesis that received the most support was that of a stronger correlation between depression and EN severity than between dissociation and EN severity. Both BDI-II and

DES-II scores were positively associated with EN severity. However, the association between EN severity and depression was significantly higher.

In summary, hypotheses predicting reduced emotional responsiveness to pleasant images and augmented responsiveness to unpleasant images received little support from the data. Overall, the results of both categorical and continuous analyses showed very weak to weak relationships between EN severity and responses to pleasant and unpleasant images, whether measured via self-reported arousal and valence or physiological and expressive-motor response channels. The prediction that individuals with high EN would show lower arousal ratings associated with higher subjective ratings of stimulus valence was also not supported, as these individuals showed a pattern that was similar to normative responses. The final hypothesis predicting a greater relationship between EN and depression than that between EN and dissociation was supported, and provided the only statistically significant effect in support of overall study predictions.

Interpretation

In order to determine the nature of any conclusions that may be drawn from the present results, an evaluation of methodological factors that impacted the study as a whole is necessary. The following discussion highlights several important factors that affect the interpretation of the null findings obtained in this study, as well as other general methodological factors that apply to the study as a whole. Factors that affect general conclusions of the study are first examined, before turning to an examination of specific study hypotheses in the context of research in the field of emotional numbing.

Low power. An important issue in interpreting the results of the current study is the extent to which Type II errors may have been responsible for the lack of significant effects. The majority of mean differences between low and high EN groups were in the small range (*d* = .20). Post-hoc power analyses were conducted to estimate the level of power obtained for effects at this magnitude, given the sample size of the study. An alpha level of .01 was selected to estimate the maximum power at an experimentwise Type I of .05 (applying a modified Bonferonni correction with 5 planned significance tests). With two groups and a per-group sample size of 25, the power to detect effect sizes in the range of *d* = .20 is approximately .03 (Cohen, 1977).

Given this extremely low level of statistical power for detecting small effects, the preponderance of null findings in this study is not surprising. Many of the tests of mean differences also involved further reductions in sample size due to missing data, thus further reducing power. Thus, for many of the effects in the study, the likelihood of committing a Type II error exceeded 97%. The likelihood that comparisons suffered from Type II errors is not only a function of sample size, however, but also of the size of the effects being tested. Had medium effect sizes (*d* = .50), been present in the data, the likelihood of detecting these effects in analysis of variance was also extremely low (power = .19 for per-group sample size of 25) and was reduced to approximately .15 in analyses with the smallest per-group sample sizes of 21. Thus, while a loss of data contributed to low power, the overall likelihood of committing a Type II error for medium effects had there been no loss of data was a high 81%.

The question of whether the relationships within the data contained effects that were missed in categorical analyses with low power is able to be partly addressed through examination of correlational results. Since the power of significance tests for the relationship between two continuous variables is much greater than that for a continuous variable with a dichotomous one, power was expected to be higher for the examination of correlational data. Indeed, for a two-tailed test with alpha of .01, the power to detect a medium effect (r = .50) with a sample size of 50 is approximately .93. The power to detect an effect of r = .20, the size of many correlations obtained in the study, however, is much lower (.18); a sample size of 286 participants would have been required for a correlation of this size to reach significance at a power level of .80. Thus, the low level of correlations among the variables selected for the study was a significant reason for the lack of statistically significant findings. However, the small magnitude of the effects themselves speaks to the more central issue of whether the relationships within the data were meaningful.

Characteristics of the sample. Aside from the issue of low power, the small number of participants who endorsed low EN symptom levels also creates a number of challenges to the meaningfulness of study results. With small sample sizes such as these, observed effects have a greater chance of stemming from idiosyncratic characteristics of the particular sample. Given the small sample size for the low EN group in this study, caution is warranted in drawing inferences about patterns of emotional response in the population. Separate from concerns about low power, the small size of this sample suggests that any trends within the data (or lack thereof) may represent spurious patterns associated with sampling error.

A number of methodological features of the current study may have contributed to weakening the strength of the relationships between EN and the emotional response patterns investigated. One important factor that likely reduced the ability to detect relationships between the measured constructs was a restriction of range on the primary construct of interest, emotional numbing. Several characteristics of the sample suggest that the range of emotional numbing symptom severity may have been restricted. In light of the relationship between EN as a predictor of PTSD diagnostic status (Foa et al., 1995a), chronicity of PTSD (Breslau et al., 1992; Marshall et al., 2006), and other negative psychiatric and psychosocial outcomes (Galovski & Lyons, 2004), it is not surprising that the current sample of distressed women with chronic PTSD reported a high level of emotional numbing symptoms. Since all participants were not only diagnosed with PTSD but were also seeking treatment, there is likely to have been a floor effect on emotional numbing.

Overall, the strength of the relationships between EN and most indices of affective response to the photographic stimuli in this study was quite low. One interpretation of this finding is that the participants simply did not differ enough from each other on the underlying construct to provide an adequate test of the hypothesized patterns of emotional response. Due to the high symptomaticity of the sample and the associated concerns of restricted range, the conditions of this study likely served as an overly stringent test of the study hypotheses. Thus, while low statistical power certainly contributed to the current lack of findings, the lack of correlation between EN and predicted response patterns was likely more directly related to the study sample. In order to provide a more sensitive test of the nature of emotional response patterns in EN, it would be necessary to examine the same responses from a sample with a greater range on EN symptom severity.

Measurement issues The use of emotional numbing items from the PDS to serve as the primary independent variable entailed limitation of the variability possible along the primary independent variable. The maximum score possible on the sum of these items is 9. Therefore, additional attenuation of relationships within the data was likely impacted by the use of this measure. Further, the internal consistency of this measure was marginal, which suggests that the range of possible correlations with other variables was attenuated. Currently, the field lacks a well-validated questionnaire measure of DSM emotional numbing symptoms. Unfortunately, the use of responses from the Clinician-Administered PTSD Scale was not possible in the current study, as these items provide a greater range of possible scores and superior reliability of measurement.

The use of the ERNS as a supplementary measure of emotional numbing symptoms was designed to augment the primary measure of EN symptoms in this study. However, , despite the greater range of items on this measure, inter-item consistency was no greater than for the sum of PDS emotional numbing items. Thus, lower than expected reliability of the measure may have contributed to attenuated correlations with study variables. Interestingly, participants in the high and low EN conditions in this study did not show differences in their overall responses to this subscale, and the correlations between this measure and measures of PTSD and depression symptoms were quite low. The weak relationship between the ERNS-P subscale and overall PTSD symptoms, in particular, is in contrast to results from the initial validation study using this measure (Orsillo et al., 2007). It may be that, in addition to attenuated correlations associated with low reliability of the measure in this sample, the sensitivity of this measure for detecting individual differences in emotional numbing severity was restricted by virtue of the restricted range of EN symptoms in the sample.

Limited sensitivity of methods. Several methodological variations in the current study are also worth considering with regard to the consequences for detection of individual differences related to emotional numbing. Although previous research has identified differences among individuals with and without PTSD on patterns of self-reported affect in the absence of a trauma prime (e.g., Amdur et al., 2000; Orsillo et al., 2004; Spahic-Mihajlovic et al., 2005) the use of a trauma prime may increase the likelihood that participants process information in ways consistent with emotional numbing. That is, the activation of threatening information is one of the hypothesized mechanisms for emotional numbing in both the conceptual model of EN as a selective deficit for positive emotions and as a defensive “shutting down” of emotions. In the current study, efforts were specifically made to reduce the activation of fear networks associated with the trauma, in order to investigate emotional responses under non-trauma primed conditions. This included ordering the sequence of image viewing sessions to coincide with a sufficient baseline resting period following a trauma-related scripted imagery procedure for physiological measures to stabilize. In addition, photographic stimuli were limited to contents that were unrelated to interpersonal assault. It may be that the combination of less distressing stimuli and non-trauma primed condition may not have provided enough activation of threat cues to provoke the kinds of emotional reactions that would maximize response patterns associated with EN. The fact that subjective emotional responses were quite similar to those found in normative ratings for the same images suggests that this may have been the case.

In summary, a variety of methodological constraints in the present study contributed to limiting the conclusions that may be drawn from the findings as a whole. A significant drawback to the study design was the lack sufficient numbers of participants with low levels of emotional numbing, as this factor appears to have restricted the range of correlations possible within the sample and hampered interpretation of the null findings obtained. Taken together, the combination of low power, restricted range and reliability of measurement, and restricted variability within the sample provide competing explanations for the lack of stronger relationships between EN and the predicted emotional response patterns. These methodological issues prevent clear conclusions about lack of effects in the population.

Implications

Due to the methodological limitations noted, the current findings do not provide conclusive evidence to either support or refute the model of EN as a selective deficit for positive emotions. Previous studies comparing trauma-exposed groups with and without PTSD have found PTSD positive individuals to show reduced reactivity to positive emotional stimuli and increased reactivity to negative stimuli across a range of emotional response channels (Amdur et al., 2000, Litz et al., 2000, Orsillo et al., 2004; Spahic-

Mihajlovic et al., 2005). However, each of the prior studies examining multiple channels of emotional response tended to show isolated effects, reflecting desynchrony between self-report, physiological, and expressive-motor indices of emotion. Given that the construct hypothesized to be responsible for these effects was the severity of EN symptoms between participants, it was hypothesized that a direct comparison of individuals with different levels of EN would provide a more sensitive and relevant test of the selective processing deficit model. Instead, the current study appeared to suffer from a restricted range of EN severity across participants, which reduced potential relationships between EN severity and emotional response measures. Therefore, the present results cannot speak to whether a sample with greater range on EN severity would have shown the patterns predicted.

With these cautions in mind, the following discussion addresses the potential implications of the current study's findings in the context of research that has examined similar constructs. An effort is made to identify common elements that suggest areas where further research and methodological advances would assist in answering the questions this study aimed to investigate.

Hypotheses 1 and 2. The prediction that arousal and valence ratings would show evidence of decreased responsiveness to positive stimuli and augmented responsiveness to negative stimuli was not supported in the current study. Other researchers have suggested that self-report ratings along these dimensions of emotions may differ little in relationship to emotional numbing. For instance, Litz et al. (2000) noted that the PTSD positive combat veterans in their study showed evidence of reduced facial reactivity to pleasant stimuli, but this response was not reflected in their self-report ratings of emotion. Amdur et al. (2000), in another study with combat veterans, found evidence of differences between veterans with and without PTSD only on self-report ratings of specific positive and negative emotions, and then only in response to photographs that were classified as highly evocative. Although there has been one study that found reduced arousal ratings among PTSD positive versus negative individuals in response to standardized evocative images (for neutral images), the majority of studies in this area have found no differences among self-report ratings of arousal and valence.

Despite these largely null findings in the larger literature with regard to arousal and valence ratings, in designing the current study, it was suggested that these response variables deserved further investigation before concluding that EN has no relationship to self-reported emotional responses to affective pictures. EN symptoms, while likely to be higher in PTSD than non-PTSD individuals, were expected to show a stronger relationship with hypothesized emotional response patterns than PTSD status considered alone. Unfortunately, the restricted range of variation on EN in the current study did not permit firm conclusions about self-report of emotional reactivity in relationship to these symptoms. The direction of the small trends in the current study were generally consistent with the hypothesized pattern of reduced self-reported reactivity to positive stimuli and increased self-reported reactivity to negative stimuli, but the small size of effects suggests that any differences were trivial. The small magnitude of these effects may have simply reflected an overall lack of any strong association between EN symptoms and these dimensions of emotional response. In order to provide a more sensitive test of these relationships, however, further research involving samples with a greater range of EN symptoms would be required.

Other study procedures may have limited the ability to detect individual differences in arousal as well. Although efforts were made to select pleasant images that specifically evoked high arousal, the selection was limited to subjects that did not involve sexual contents. In contrast, the majority of images from the IAPS that are associated with both high valence and high arousal are erotic images, and previous studies examining positive and negative emotional reactivity in male veterans have employed these as stimuli. Thus, the selection of pleasant images in the current study did not approach the highest range of arousal scores possible on the IAPS. Other researchers (e.g., Orsillo et al., 2004) have also noted a need for more work to identify standardized stimuli capable of evoking emotions high on both pleasure and arousal. Although this suggestion applies to research designs involving both genders, there are further considerations that suggest development of appropriate evocative stimuli may be especially important for studying the reactions of female assault victims. The selection of images from the IAPS tapping high arousal and high pleasantness is confounded with sexual content, which creates obstacles to the selection of highly arousing pleasant stimuli with victims of sexual assault. Future studies to test the limits of emotional responsivity to positive images in this population would therefore likely benefit from identifying a further range of evocative stimuli that taps positive arousal.

Hypotheses 3-5. Research examining the nature of emotional numbing symptoms as expressed in self-report, physiological, and expressive-motor response channels is in its early stages, and has yet to identify a singular pattern of emotional responding that exemplifies a state of “emotional numbness.” Further complicating the issue of assessment, findings of desynchrony between self-report, autonomic, and facial motor response systems call into question the accuracy of any single channel of information for determining the presence of numbing. Thus, examining multiple channels of emotional expression represents an important component of research to elucidate patterns of over- or under-reactivity associated with EN.

Few studies have examined the physiological and expressive motor components of emotional response when examining affective responses to standardized emotional stimuli in PTSD. Those that have (Amdur et al.,2000; Litz et al., 2000) have not found evidence of differences in HR, SCR, or frontalis EMG, a marker of negative emotional response, when comparing PTSD and non-PTSD samples. Thus, the same considerations that apply to the interpretation of the current study’s null findings with regard to arousal and valence ratings apply to these response variables as well. The lack of strong relationships with these response variables in the current study may either reflect a true lack of relationship between EN severity and differences in emotional reactivity along these dimensions, or it may be that the lack of stronger findings was a function of the restricted range of EN severity and other methodological constraints.

In the current study, the use of corrugator instead of zygomatic EMG precluded further examination of parameters of positive emotional responding. This information would have provided a useful further test of the extent to which individuals processed the images in the “pleasant” category. Litz et al. (2000) suggested that examining facial muscle responses of combat veterans with PTSD allowed subtle evidence of reduced processing of positive emotions, while the veterans themselves reported no detectable differences in their subjective levels of emotional arousal or positive feelings. The use of corrugator EMG represented an effort to examine a marker that has been suggested to provide a sensitive indicator of fear, anger, and sadness (Dimberg, 1990). However, in order to provide the most sensitive test of emotional response characteristics associated with EN, studies involving individuals with greater range of EN severity would ideally be designed to include measures of facial muscle reactivity to both positive and negative stimuli.

To the author's knowledge, this study was the first to examine psychophysiological and expressive motor correlates of emotional numbing in women with PTSD. As such, these data contribute to the slim descriptive literature concerning the psychophysiology of PTSD among women. Although caution is warranted in generalizing beyond women who share characteristics of the study sample, the current data provides a reference point for future research exploring characteristics of emotional response among female victims of interpersonal assault. Interestingly, the pattern of HR, SCR, and EMG change in this study suggested that autonomic and facial muscle reactivity to these stimuli was not particularly high in this sample overall. In fact, HR tended to decrease slightly regardless of stimulus valence, but remained remarkably consistent in response to stimuli that varied in emotional content and self-reported subjective arousal.[6] Although the lack of a

[6] This pattern was found for neutral images as well. Although reactions to neutral images were not a focus of hypotheses in the present study, responses to neutral images were examined in exploratory analyses and found not to differ as a function of EN.

sufficiently large comparison group of low EN women prevents clear interpretation of this pattern, the low level of reactivity observed in the overall study stimulates questions as to whether, perhaps, the high level of EN in the sample was related to a tendency for physiological and expressive motor responses to be somewhat blunted. This observation contrasts with the general findings that PTSD does not show evidence of generalized numbing of negative emotions, and would require further replication with a larger sample and more diverse range of EN symptoms to warrant conclusions.

Hypothesis 6. Contrary to expectation, individuals in the high EN group did not show a negative linear relationship between arousal and valence ratings. Rather, arousal showed a curvilinear pattern similar to that found in previous research with normative samples (Lang et al., 1997; Spahic-Mihajlovic et al., 2005). This pattern stands in contrast to findings of a medium to strong negative association between these variables in combat veterans and Bosnian refugees with PTSD (Amdur et al., 2000; Spahic-Mihajlovic et al., 2005). The fact that the high EN group in this study did not show reduced arousal in association with pleasant images was unexpected, based on the theory that individuals with high EN show deficits in the ability process positive emotional stimuli at a deep level (Litz et al., 2000; 2002). The conceptualization of EN as a selective deficit for positive emotions provides a basis for expecting that individuals with high levels of EN would fail to show the normative pattern of high arousal in relation to both positive and negative emotional stimuli. Amdur et al. (2000) also suggested that EN may be associated with a tendency to find arousing stimuli of all kinds to be aversive, thereby suggesting a further reason to expect a negative correlation between arousal and valence. Thus, given the high level of EN symptoms endorsed by participants, it is curious that such a relationship did not emerge. There were several differences between the samples in the current study and those of studies that have found this relationship, including gender and trauma type. It is possible that characteristics of the current sample may relate to differences in the pattern of emotional arousal experienced in response to similar stimuli used in previous studies. It is also worth considering whether use of different IAPS images may have influenced the arousal-valence relationship.

Hypothesis 7. The two competing conceptualizations of EN that prompted this study suggest different predictions about the relationship of EN symptoms to dissociative experiences. The model of EN as a form of non-effortful avoidance suggests that shutting off emotions is an automatic, defensive response to negative emotion, which shares the same function as other dissociative phenomena. In contrast, the model of EN as a selective deficit for positive emotions suggests that EN does not entail the shutting down of negative emotions; rather, the experience of EN is characterized by low positive emotions and high negative emotions, a clinical picture which bears greater similarity to depression than dissociative experiences. Thus, a minimal test of these propositions is to compare the extent to which EN symptoms overlap with dissociative experiences versus symptoms of depression.

The finding that EN symptoms were more highly correlated with depression than dissociation is consistent with the model of EN as a selective deficit for positive emotions, and provides further support to the idea that equating EN with dissociation is unwarranted. It should be noted that the DES-II does not specifically assesses the extent to which negative emotional stimuli prompt a shutting down of emotions, but rather assesses a range of normal and abnormal dissociative experiences (Carlson & Putnam, 1993). The level of dissociative experiences endorsed by study participants was in the high range, and was similar to that reported in other PTSD samples (e.g., Amdur et al., 2000; Marshall et al., 2007). Unfortunately, the field lacks established measures for assessing dissociation in response to aversive emotional stimuli directly. However, to the extent that dissociative experiences tapped by the DES-II correspond with a tendency engage in dissociative coping, correlation of this measure with EN symptoms provides an estimate of the overlap in these constructs.

Limitations

In addition to the methodological limitations outlined above, it is important to note several general limitations that should be kept in mind in evaluating the study as a whole and in considering directions for future research. As with any non-experimental design, it is not possible to infer causality from associations observed in the data. Differences in EN were not randomly assigned, and many other sources of variation between participants could have caused the obtained trends. The confounding of depression and PTSD levels with EN symptoms further complicates the interpretation of between-group comparisons. Although statistical methods were used to control for differing levels of depression and PTSD where this was possible, statistical adjustment for these confounds may not fully address the confounding of EN with other, unmeasured variables. For example, in addition to creating distress, EN symptoms may serve as a proxy indicator of general distress or other higher-order factors that create overlap between EN severity, depressive symptoms, and overall PTSD severity.

Finally, several other characteristics related to the generazability of findings to PTSD should be noted. The sample was limited to adult female victims of sexual assault who met current criteria for PTSD on the basis of an interpersonal assault. However, although a large proportion of the sample identified sexual assault or abuse as their index event, the participant's index event was not limited to sexual assault. Therefore observations may be less generalizable to women with current sexual-assault-related PTSD than would be the case for a sample with only sexual assault index events. The sample did not include men or victims of traumas other than interpersonal assault. Generalizability is also limited to individuals seeking treatment for assault-related PTSD, and may not extend to others with PTSD who do not seek treatment.

Directions for Future Research

Although research investigating emotional responses to standardized evocative stimuli in PTSD has not shown a consistent pattern of hyporeactivity to positive stimuli or hyperreactivity to negative stimuli across different indices of emotional response, these studies have been consistent in showing no evidence that PTSD was associated with numbing of negative emotions (Amdur et al., 2000; Litz et al., 2000; Orsillo et al., 2004; Spahic-Mihajlovic et al., 2005). While this evidence does not conclusively prove the absence of an effect, it appears consistent with findings from factor analytic research which have accumulated rapidly in support of the distinctiveness of EN and avoidance. In a review of these findings, Elklit, Aramour, & Shevlin (2010) concluded that the overwhelming majority of factor analytic findings have failed to support models that include EN and avoidance symptoms on the same factor.

The recognition that EN symptoms are empirically distinct from active efforts to avoid thoughts, feelings, or situations reminiscent of the trauma is reflected in the reorganization of PTSD symptom clusters currently under consideration by the DSM Task Force (APA, 2010). Among the changes proposed by the Task Force, the language being considered to describe restricted range of affect is “Persistent inability to experience positive emotions (e.g., unable to have loving feelings, psychic numbing),” a symptom that is explicitly separated from the Avoidance cluster (APA, 2010). Of note, there is no proposed mention of “numbing of general responsiveness” present in DSM-IV. Thus, the proposed language implicitly rejects the view of restricted range of affect as encompassing the numbing of negative emotions.

Based on these proposed changes, it would seem that the emerging consensus in the field is that emotional numbing in PTSD does not extend to negative emotions. Such a conclusion is consistent with the view of EN as a selective deficit for positive emotions and the lack of evidence that PTSD-positive diagnostic status is associated with generalized numbing of emotions. However, as previous research has only examined the prediction of emotional response patterns on the basis of PTSD diagnostic status, and not severity of EN symptoms, the specific association between EN symptoms and processing of positive and negative emotions remains unknown. The effort to link patterns of emotional over- and underreactivity directly to the extent of self-reported EN symptoms in the present study was premised on the need to clarify the kinds of emotions that appear to be “numbed” among individuals who endorse high levels of emotional numbing. Unfortunately, the present study suffered from a number of methodological limitations which prevent clear conclusions about this relationship.

Despite the apparent acceptance of the view of EN as applicable to positive emotions only, it appears that studies to date have not refuted the possibility that symptoms of emotional numbing endorsed by PTSD sufferers may include non-effortful avoidance of negative emotions. Evidence that EN symptoms fail to cluster together with active avoidance does not negate the possibility that these symptoms reflect a form of avoidance, albeit non-effortful. The conceptualization of emotional numbing described by Foa and colleagues suggests that it is a response that occurs when active efforts at avoidance fail at reducing intense negative affect (Foa et al., 1995a). Thus, an argument could be made that factor analytic findings of distinctiveness between avoidance and EN reflect the distinction between effortful and non-effortful avoidance. However, further investigation of the relationship between symptom reports of EN and indices of reduced negative emotions in response to negative stimuli appears to be needed before this issue is to be firmly settled.

The view of EN as a defensive emotional response does not have a counterpart among the symptoms of PTSD under consideration in DSM V. The implications of removing generalized numbing from the DSM include revising the clinical picture of PTSD to account for a construct that consists of numbing of positive emotions, but that does not include the type of experience to which Horowitz referred when describing the “numbness” clinicians had observed with combat veterans, concentration camp survivors, and victims of disaster, rape, and nuclear holocaust (1986). As Horowitz described this phenomenon, “Numbness is not simply an absence of emotions; it is a sense of being ‘benumbed.’ The individual may actually feel surrounded by a layer of insulation” (1986, p. 33).

The removal of numbing of general responsiveness from the diagnosis of PTSD leaves phenomenological experiences such as this uncounted among the core symptoms of the disorder. The possibility that such experiences are not a common enough feature of PTSD to constitute symptoms required for diagnosis, as well as the possibility that different subtypes of PTSD sufferers may experience differing patterns of emotional numbing (Amdur et al., 2000) are empirical questions that suggest further study. To date, most research that has investigated the parameters of emotional response deficits in PTSD has not specifically addressed whether indices of emotional reactivity were related to participants’ self-reported EN symptoms. Therefore, the phenomena to which *patients* are referring when they endorse symptoms such as “difficulty accessing the full range of emotions” on diagnostic measures remains unclear.

Interestingly, a proliferation of factor analytic studies of PTSD symptoms in the past several years (e.g., Simms, Watson, and Doebbeling, 2002; Bashnageal, O’Conner, Colder, & Hawk, 2005; Elklit et al., 2010; Krause, Kaltman, Goodman, & Dutton, 2007; Palmieri, Weathers, Difede, & King, 2007) appears to suggest that EN symptoms and hyperarousal symptoms of irritability/anger, difficulty sleeping, and difficulty concentrating form a distinct factor which has been labeled *dysphoria*. There remains some debate as to whether EN symptoms comprise a distinct factor separate from these hyperarousal symptoms, but the accumulation of findings across a wide range of trauma populations tends to indicate that the best-fitting model is one in which EN symptoms are subsumed by a dysphoria factor (Elklit et al., 2010).

The conceptualization of EN symptoms as a component of generalized dysphoria has important implications for the diagnosis of PTSD as a whole. The convergence of factor analytic findings supporting a dysphoria factor in PTSD has fueled debate as to whether or not these symptoms represent a unique component of PTSD that should be required for diagnosis. The argument has been put forward that the degree of overlap between symptoms associated with the dysphoria factor and depression and general anxiety causes inflated estimates of comorbidity, and that greater specificity in diagnosing PTSD would benefit from removal of these symptoms from diagnostic criteria (McHugh & Treisman, 2007; Spitzer, First, & Wakefield, 2007).

Efforts to clarify the contribution of EN symptoms to the total symptom picture of PTSD must take into account the high degree of overlap between EN symptoms and those of other (often comorbid) mood and anxiety disorder diagnoses. The utility of diagnostic criteria for mapping the construct of PTSD depends in part on the degree to which the symptoms represent unique, distinguishable features from other disorders. However, to a great extent, the utility of symptom criteria depends on the extent to which they describe the specific phenomenological experience of individuals who share a common disorder. The existence of competing definitions of emotional numbing has led to confusion and lack of precision in formulating our understanding of these PTSD symptoms. Although a body of research has begun to emerge in support of the model of EN as a selective deficit for positive emotions, the empirical basis of this model would benefit from further data on the relationship between EN symptoms and patterns of emotional response.

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Appendix A

Informed Consent Form

Department of Psychology

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Telephone: 314-516-5391
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Informed Consent for Participation in Research Activities

Response to Pictures Study

Participant ______________________________ HSC Approval Number ____________________

Principal Investigator ___Tristan Robinson, M.A.___ PI's Phone Number_(314) 516-6738_

Why am I being asked to participate?

You are invited to participate in a research study about emotional responses among people who have experienced a traumatic event, conducted by Tristan Robinson, M.A., at the Center for Trauma Recovery at the University of Missouri-St. Louis. You have been asked to participate in the research because you indicated that you had experienced a traumatic event at some time in your life, and may be eligible to participate. We ask that you read this form and ask any questions you may have before agreeing to be in the research. Your participation in this research is voluntary. Your decision whether to participate will not affect your current or future relations with the University or the Center for Trauma Recovery. If you decide to participate, you are free to withdraw at any time without affecting that relationship.

What is the purpose of this research?

The purpose of this research is to learn about the kinds of emotional reactions that different people who have experienced a traumatic event may have.

What procedures are involved?

If you agree to participate in this research, you can expect:

- To complete a series of questionnaires about different kinds of emotional experiences and mental health symptoms

- To view and rate your reactions to a series of photographs depicting a range of emotional images. These images include some images that may be pleasant, some neutral, and some that may be very unpleasant or even distressing.
- Physiological measurements will be taken during the viewing of the photographs. Sensors will be attached with a paste to your left wrist, right ankle, face, and two fingers on the left hand to record these measurements. These measures are non-invasive and include measures of heart rate, skin conductance, and specific facial muscle activity.
- It is expected that the total duration of these procedures will be less than 1 hour, with a maximum of 1 ½ hours.

Approximately 70 participants may be involved in this research at the University of Missouri-St. Louis.

What are the potential risks and discomforts?

There are certain risks and discomforts that may be associated with this research. They include the possibility of personal discomfort when answering questionnaires about emotional experiences and mental health symptoms. In addition, some of the images you view may contain material that is upsetting or offensive, and you may experience personal discomfort while viewing some images.

If you should experience intense stress at any time during the study and wish to discontinue participation, you may do so at any time without consequences of any kind.

Are there benefits to taking part in the research?

There are not any anticipated direct benefits to those who participate in this study. However, the study does have some benefits for society. The results of this study can be used to gain a better understanding of the nature of emotional responses among people who have experienced traumatic events, which can be used to help develop assessment and treatment strategies.

What other options are there?

If you do not wish to participate in this study, you may simply decline.

Will I be told about new information that may affect my decision to participate?

During the course of the study, you will be informed of any significant new findings (either good or bad), such as changes in the risks or benefits resulting from participation in the research, or new alternatives to participation, that might cause you to change your mind about continuing in the study. If new information is provided to you, your consent to continue to participate in this study will be re-obtained.

What about privacy and confidentiality?

Protected Health Information (PHI) is any health information through which you can be identified. PHI is protected by federal law under HIPAA (the Health Insurance Portability and Accountability Act).

- ➢ This study does not involve PHI.

1. The research team will look at your questionnaires and responses to the images in the study, and record information needed for the study in your research file. Your research file will be coded and the investigator will keep a master list separate from your file. This way, only the research team will be able to identify you.

2. Only information you provide (such as responses to a questionnaire) will be recorded for the study.

The only people who will know that you are a research subject are members of the research team. No information about you, or provided by you during the research, will be disclosed to others without your written permission, except:

- if necessary to protect your rights or welfare (for example, if you are injured and need emergency care or when the University of Missouri-St Louis Institutional Review Board monitors the research or consent process); or
- if required by law.

When the results of the research are published or discussed in conferences, no information will be included that would reveal your identity. If photographs, videos or audiotape recordings of you will be used for educational purposes, your identity will be protected or disguised. Any information that is obtained in connection with this study, and that can be identified with you, will remain confidential and will be disclosed only with your permission or as required by law.

Your research file will be identified by a code number and will be stored in a locked file in a research area at the Center for Trauma Recovery. Only the research team will have access to this file. A separate list that links code numbers with personally identifying information will be maintained by the researcher, and will be stored in a locked file in a separate research area at the Center for Trauma Recovery. The primary investigator will be the only person who has access to this list.

If any other uses of your information are contemplated, the primary investigator would contact you to describe the contemplated use and obtain your written permission to use your information.

The research team will use your information until data analysis is complete. At that point, the investigator will remove the identifiers from your information, making it impossible to link you to the study. Individual responses to survey questionnaires and responses to images in the study will be destroyed following analyses of the data.

Do you already have contact restrictions in place with UM-SL? [ ] Yes [ ] No
(Example: no calls at home, no messages left for you, etc.)

Please specify any contact restrictions you want to request for this study only.

____

What are the costs for participating in this research?

There are no costs associated with participating in this research.

Will I be paid for my participation in this research?

Yes. Participants will be paid $20 for their participation in this study immediately following completion of study procedures.

Can I withdraw or be removed from the study?

You can choose whether to be in this study. If you volunteer to be in this study, you may withdraw at any time without consequences of any kind. You also may refuse to answer any questions you do not want to answer and still remain in the study. The investigator may withdraw you from this research if circumstances arise which warrant doing so. If you decide to end your participation in the study, please complete the withdrawal letter found at http://www.umsl.edu/services/ora/IRB.html, or you may request that the Investigator send you a copy of the letter.

Who should I contact if I have questions?

The researcher conducting this study is Tristan Robinson, M.A., under the supervision of Steven E. Bruce, Ph.D. You may ask any questions you have now. If you have questions later, you may contact the researcher(s) at (314) 516-6738.

What are my rights as a research subject?

If you have any questions about your rights as a research subject, you may call the Chairperson of the Institutional Review Board at (314) 516-5897.

What if I am a UMSL student?

You may choose not to participate, or to stop your participation in this research, at any time. This decision will not affect your class standing or grades at UM-SL. The investigator also may end your participation in the research. If this happens, your class standing will not be affected. You will not be offered or receive any special consideration if you participate in this research.

What if I am a UMSL employee?

Your participation in this research is, in no way, part of your university duties, and your refusal to participate will not in any way affect your employment with the university or the benefits, privileges, or opportunities associated with your employment at UM-SL. You will not be offered or receive any special consideration if you participate in this research.

Remember: Your participation in this research is voluntary. Your decision whether to participate will not affect your current or future relations with the University or the Center for Trauma Recovery. If you decide to participate, you are free to withdraw at any time without affecting that relationship.

You will be given a copy of this form for your information and to keep for your records.

I have read the above statement and have been able to express my concerns, to which the investigator has responded satisfactorily. I believe I understand the purpose of the study, as well as the potential benefits and risks that are involved. I give my permission to participate in the research described above.

All signature dates must match.

______________________________________ __________________________

Participant's Signature Date Participant's Printed Name

____

Researcher's Signature Date

Appendix B

Procedures for Physiological Measurement

Physiological measures of heart rate (HR), electrodermal activity (SCR), and electromyogram (EMG) were generated using Coulburn system modular components. Prior to the attachment of electrodes, the participant was seated and familiarized with the equipment. A small area of the skin over sites for detecting the electrocardiogram and electromyogram signals was lightly abraded using electrode paste with a mild abrasive (NuPrep) to reduce skin resistance and permit cleaner detection of bioelectric signals. Heart rate was measured with disposable electrodes placed on the insides of the left wrist and right ankle. These leads were connected to a Coulbourn high gain bioamplifier (S75-01). Facial muscle tension was measured via two small (4mm) Beckman-type silver/silver chloride electrodes placed over the corrugator muscle site according to published specifications, and were amplified with a Coulbourn high gain bioamplifier (S75-01) and filtered to retain the 90 - 250-Hz frequency range. Skin conductance was measured from 9mm silver/silver chloride electrodes attached to the medial phalanges of the first and third finger on the left hand. The electrodes were attached to a Coulburn electrodermal response amplifier that applies a constant voltage (0.5V) and was used to measure skin conductance responses (SCR). The sites for skin conductance were not abraded and an isotonic paste was used. The attachment of electrodes in the manner described above is relatively non-invasive and was well tolerated by participants. Reusable electrodes were sanitized between uses by soaking them in Cidex disinfecting solution.

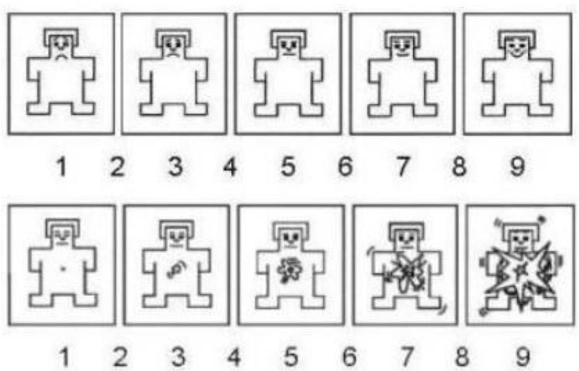
Appendix C

Instructions for Image Viewing Segment and Affective Ratings

In this study, we are interested in how people respond to pictures that represent a lot of different events that occur in life. For about the next 15 minutes, you will be looking at different pictures on the computer screen in front of you, and you will be rating each picture in terms of how it made you feel while viewing it. There are no right or wrong answers, so simply respond as honestly as you can.

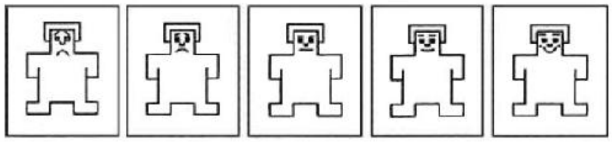
Press spacebar to continue →

After each picture, you will see two different rating scales. We call these scales "SAM." You will be using SAM to rate how you felt while viewing each picture.



SAM shows two different kinds of feelings: Happy vs. Unhappy and Excited vs. Calm. You will be rating both kinds of feelings for each picture that you observe.

Press spacebar to continue →



1 2 3 4 5 6 7 8 9

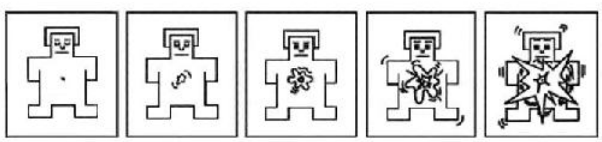
The first SAM scale is the Happy-Unhappy scale, which ranges from a smile to a frown. At one extreme of the Happy vs. Unhappy scale, the feeling is completely happy, pleased, satisfied, contented. If you felt completely happy while viewing the picture, you can indicate this by selecting the number 9 at the top of the keyboard.

At the other end of the scale, the feeling is completely unhappy, annoyed, unsatisfied, upset. You can indicate feeling completely unhappy by selecting the number 1.

If you felt completely neutral, neither happy nor sad, you can indicate this by selecting the number 5.

If, in your judgment, your feeling of happy vs. unhappy falls between two of the pictures, you can select a number that falls in between two of the pictures.

Press spacebar to continue →



1 2 3 4 5 6 7 8 9

The second type of feeling you will be rating is Excited vs. Calm. At one extreme of the scale, the feeling is completely aroused, stimulated, excited, wide-awake. If you felt completely aroused while viewing the picture, you can indicate this by selecting the number 9 at the top of the keyboard.

At the other end of the scale, the feeling is completely calm, relaxed, sleepy, unaroused. You can indicate you felt completely calm by selecting the number 1.

If you felt completely neutral, neither excited nor calm, you can indicate this by selecting the number 5.

Again, if your feeling of excited vs. calm falls between two of the pictures, you can select a number that falls in between two of the pictures.

Press spacebar to continue →

The procedure will be as follows: Before each of the pictures which you will rate, there will be a slide that shows a + in the middle of the screen. When you see this slide, simply rest and relax while you wait for the picture to appear, but do not close your eyes.

It is important that your eyes be directed towards the screen when the pictures to be rated are shown. You'll have only a few seconds to watch each picture. Please view the picture for the entire time it is on and make your ratings immediately after the picture is removed, using the number keys at the top of the keyboard. You will have 10 seconds to make each rating.

Press spacebar to continue →

Some of the pictures you'll be viewing may prompt emotional experiences; others may seem relatively neutral. Your rating of each picture should reflect your immediate personal experience, and no more. Please rate each one AS YOU ACTUALLY FELT WHILE YOU WATCHED THE PICTURE.

Press spacebar to continue →

Before we begin, you will be shown two examples of the kinds of pictures you will be viewing and rating. Just to help you get a feel for how the ratings are done, you will practice rating the following pictures. After these practice ratings, there will be a 2-minute rest period before the next pictures appear. During the rest period, simply relax and wait but do not close your eyes.

Do you have any questions before we begin?

Press spacebar to continue →

Appendix D

Selected Photographs from the International Affective Picture System (IAPS)

Type of Image	IAPS image number	Content	Order in Set
Pleasant	8490	people on roller coaster	1
	2310	mother and child	4
	2345	laughing children	6
	2550	smiling couple	9
	8190	skier	15
	1463	kittens	18
	8496	kids on waterslide	21
	5700	mountains	24
Neutral	7235	chair	5
	7006	bowl	11
	7175	lamp	13
	7705	cabinet	14
	7050	hairdryer	20
	6150	outlet	22
	7150	umbrella	23
	7010	basket	5
Unpleasant	9050	plane crash	3
	9320	vomit	7
	1120	snake	8
	9040	starving child	10
	9571	dead cat	12
	9042	tribal man with pole through lip	16
	2141	grieving woman	17
	3160	eye disease	19