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The Responses to Script-Driven Imagery Scale (RSDI): Assessment of State Posttraumatic Symptoms for Psychobiological and Treatment Research

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Abstract Studies of PTSD employing symptom provocation have seldom included self-report measures of the symptoms provoked. Doing so could benefit psychobiological research by improving diagnostic discrimination and capturing the heterogeneity of responses to script-driven imagery, and treatment research by complementing existing outcome measures. This paper describes the initial development and psychometric properties of the Responses to Script-Driven Imagery Scale (RSDI), a brief self-report measure of state PTSD and dissociative symptoms evoked by script-driven imagery, a widely used symptom provocation method in PTSD research. Across three samples and three variants of the script-driven imagery paradigm, confirmatory factor analysis fit a hypothesized and sample-invariant three-factor structure for the RSDI, composed of reexperiencing, avoidance, and dissociative symptoms. Subscales exhibited acceptable to high internal consistency reliabilities, and construct validity evidence was strong and consistent with predictions. The RSDI shows promise as a tool for psychobiological and treatment outcome research on PTSD.

Keywords PTSD · Assessment · Symptom provocation · Script-driven imagery · Re-experiencing · Avoidance · Dissociation

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Symptom provocation studies of PTSD, particularly those employing exposure to trauma-related cues, have seldom used self-report measures to assess the symptoms provoked. This paper begins with a description of the script-driven imagery method, a widely used symptom provocation method in psychophysiological (Orr and Roth 2000) and functional brain imaging research on PTSD (Lanius et al. 2006). Next, existing measures that can be used to assess self-reported state PTSD and dissociative symptoms evoked by this method are reviewed. This is followed by explanation of why such assessments have not typically been conducted, a rationale for doing so, and a report on the development of the Responses to Script-Driven Imagery Scale (RSDI).

Lang and colleagues (Lang et al. 1983) developed the script-driven imagery method, which Pitman and colleagues adapted for PTSD psychophysiology research (Pitman et al. 1987). In brief, research participants first describe their target traumatic experience in detail on a script preparation form. A research assistant then composes a written script of

the traumatic experience, which portrays the experiences in the second person and present tense. The script, typically 30 s in length when read aloud, is then narrated onto an audiotape or computer audio file for later playback, when the participant is instructed to remember the experience as vividly as possible, in all of its details, both while it plays ("script listening") and for an additional 30 s afterward ("script imaging"). (For additional methodology details, see Orr et al. 1993; Pitman et al. 1987.)

As reviewed by Orr and Roth (2000), the script-driven imagery method has been used by psychophysiologists to establish biological correlates of the DSM-IV PTSD diagnostic criterion B.5., "physiological reactivity on exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event" (American Psychiatric Association 1994), and more generally for purposes of diagnostic discrimination (e.g., Keane et al. 1998). It has also been used to elucidate the neural correlates of responses to trauma-related stimuli in PTSD (recently reviewed by Lanius et al. 2006). The method has been used less commonly to assess post-treatment reductions in physiological reactivity; the well-established finding that physiological reactivity to trauma-related stimuli in the laboratory habituates over time has limited this line of research (Orr and Roth 2000).

The only measure previously used to assess state PTSD symptom responses to symptom provocation is Southwick and colleagues' PTSD Symptom Scale (Southwick et al. 1993), which has been used in several symptom provocation studies, including two employing script-driven imagery (Bremner et al. 1999; Schmahl et al. 2002). However, psychometric information has not been published. In terms of face validity, avoidance symptoms are not included, and half of the items included in the total score (i.e., the only score reported) measure not DSM-IV PTSD symptoms but dissociative symptoms and emotions.

In contrast, Bremner and colleagues (Bremner et al. 1998) have published a full report on the development and psychometrics of the Clinician-Administered Dissociative States Scale (CADSS), an interview measure that has been used in PTSD brain imaging studies employing script-driven imagery (Bremner et al. 1999; Lanius et al. 2002, 2005). However, use of the CADSS to assess script-driven imagery responses that have just occurred requires an adaptation of the instrument. That is, 8 of the 27 CADSS items are interviewer scored, based on how the interviewee responded to the prior 19 items, and those 19 items must be adapted by changing the original instructions (i.e., "at this time, in this room"). Recently Kruger and Mace (2002) developed the State Scale of Dissociation (SSD), a comprehensive self-report measure of state dissociative symptoms consisting of 56 items and seven subscales. Extensive evidence of validity and reliability is provided, but this instrument too would require adaptation to the symptom provocation methodology. Finally, both the CADSS and SSD are relatively lengthy and may not be practical in many research and clinical contexts, especially when state PTSD symptoms are also being assessed.

That self-reported state symptoms are typically not assessed in PTSD symptom provocation studies may stem from two major orientations that have characterized this research from the outset. With respect to theory, studies have been used primarily to gather evidence for unitary models of PTSD pathophysiology and biological reactivity to trauma-related cues, thus neglecting heterogeneity of responses to provocation. Similarly, in terms of practical applications, researchers have largely focused on diagnostic discrimination and establishing PTSD case status (Keane et al. 1998; Orr and Roth 2000).

However, recent studies suggest that both psychological and physiological responses to trauma-related cues in PTSD are characterized by individual and subgroup differences, and that different responses may have distinct functional significances. Griffin and colleagues (Griffin et al. 1997) found that rape survivors with PTSD who had experienced high peritraumatic dissociation subsequently exhibited less physiological reactivity while talking about the event than those with low peritraumatic dissociation (but see Nixon et al. 2005). Lanius et al. (2002) compared PTSD participants with dissociative responses to script-driven imagery to trauma-exposed non-PTSD controls, using functional Magnetic Resonance Imaging (fMRI), heart rate monitoring, and a modified version of the CADSS. These researchers found that PTSD participants with dissociative responses had different patterns of brain activation than controls, and several of the dissociators exhibited no heart rate increases. Importantly, the fMRI findings for differential functional activation in PTSD participants who dissociated versus controls were in different brain structures from those revealed in another study, using the same methods, of PTSD participants reporting typical PTSD reexperiencing responses (Lanius et al. 2001).

These findings suggest that psychobiological PTSD symptom provocation research may benefit from self-report assessment of state PTSD reexperiencing and dissociative symptoms. Furthermore, measurement of self-reported avoidance symptoms might help to improve the diagnostic sensitivity of psychobiological assessment of PTSD. Indeed, one explanation for the high false negative rates of diagnostic classification in the PTSD psychophysiology literature is that a subgroup may avoid engaging with the trauma-related stimuli (Orr and Kaloupek 1997). Measurement of state PTSD numbing symptoms could also prove useful. However, because the DSM-IV delineates numbing in chronic and global terms, it is difficult to measure acute numbing responses without going beyond, and potentially altering, those diagnostic criteria.

Assessment of PTSD treatment outcome could also benefit from a method for provoking and measuring self-reported state PTSD and dissociative symptoms. While physiological responses to script-driven imagery habituate (Orr and Roth 2000), this may not be true for subjectively experienced distress and psychological symptoms. In addition, even gold-standard structured interviews are not designed to assess specific responses to trauma-related stimuli, and reports of such responses days or weeks in the past are plagued by the biases and distortions associated with reconstructive recall (Blair and Burton 1987; Friedman 1993; Sudman et al. 1996). Because of these limitations, the symptom profiles these scales yield may not correspond to symptoms provoked by real-life encounters with strong trauma reminders. Thus a method that reliably and validly *evokes and immediately assesses* self-reported state symptoms could complement existing measures and provide another test of treatment success.

In summary, although PTSD biology researchers may originally have aimed to "redeem PTSD from the subjectivity of self-report" (Pitman 1997, p.3), the field may now require better self-report data to continue its advance. Such data might improve diagnostic discrimination and help delineate the heterogeneity of responses to trauma reminders in PTSD. In the realm of treatment outcome research, a self-report measure for assessing state PTSD and dissociative symptoms immediately after they are provoked by strong trauma reminders would complement existing methods and could improve the external validity of outcome assessment.

This introduction has surveyed existing state measures of PTSD and dissociative symptoms and provided a rationale for measuring those evoked by symptom provocation methods, including script-driven imagery. Following is a report on the development of the RSDI, which was designed to be a brief and relatively face-valid scale, based closely on widely accepted DSM-IV symptom criteria for PTSD and standard measures of peritraumatic and state dissociation. The findings derive from three separate studies, each employing a variant of the script-driven imagery methodology, and provide evidence of the scale's factor structure, internal reliability, and construct validity. For two of the studies, physiological evidence of construct validity is presented. Additional construct validity evidence, consisting of functional brain activation correlates of RSDI subscale scores, is presented in a separate report (Hopper et al. 2007).

Materials and Methods

Item Generation and Selection

Fourteen items forming an original pilot version of the RSDI were derived from DSM-IV symptoms of PTSD and two measures of state dissociation, the CADSS (Bremner et al. 1998; see above) and the Peritraumatic Dissociative Experiences Scale (PDEQ; Marmar et al. 1997). Items selected for inclusion were deemed, by consensus of the authors, (1) likely to be elicited by script-driven imagery and (2) amenable to assessment with easily comprehended interview or self-report items. Eight of the original items were meant to assess DSM-IV reexperiencing and avoidant symptoms, and the other six tapped dissociative symptoms, for 14 items in total.

The five reexperiencing items covered DSM-IV PTSD criteria B1, B3, B4 and B5 (B2 concerns dreams). Three items separately addressed the avoidance of sensations, thoughts, and feelings associated with criterion C1 (C2, avoiding people, places and conversations, is not relevant to a script-driven imagery paradigm).

From the outset there were concerns that three of the DSM-IV numbing symptoms are not particularly relevant to acute responses to script-driven imagery: C4, "diminished interest or participation in activities," C5, "feelings of detachment or estrangement from others," and C7, "sense of a foreshortened future." Similarly, DSM-IV hyperarousal symptoms were either irrelevant (i.e., D1, difficulty falling or staying asleep, and D5, exaggerated startle) or inappropriate to the experimental procedure (i.e., D2, irritability or outbursts of anger, D3, difficulty concentrating, and D4, hypervigilance). Indeed, the only DSM-III-R hyperarousal symptom clearly linked to trauma reminders, B5, "physiological reactivity on exposure to internal or external cues," was moved to the *reexperiencing* criterion in DSM-IV, and is addressed by an RSDI Reexperiencing subscale item.

In unpublished work conducted before the studies reported here, these concerns were born out. Items assessing DSM-IV numbing and hyperarousal symptoms were found to be inappropriate. That work was conducted with ten adult participants in a pilot study of a psychological treatment for PTSD secondary to child and adult sexual and physical assault or motor vehicle accidents. Immediately after script-driven imagery those participants were administered items based on the DSM-IV PTSD symptom criteria and measures of state dissociative symptoms, then thoroughly debriefed about several issues: (a) their understanding of the items, (b) the meaning of their ratings for each item, and (c) whether the experiences referenced by items had been evoked by the script-driven imagery as opposed to having been already present beforehand, including as more enduring traits. For example, the fourth DSM-IV numbing symptom, C4, "restricted range of affect" (assessed with items including, "Did you feel numb?") was either (a) already present before the script-driven imagery procedure or (b) not reliably elicited in most participants. The quantitative (i.e., rating severities per item) and qualitative data from these debriefings were then discussed by the co-authors

who were practicing clinicians at the time (JWH, MS, RAL, BAvdK), with regard to how consistent those data were with observations made over years of clinical practice. On these bases, the 14 items of the pilot RSDI were chosen.

The original six dissociation items were adapted from items of the CADSS and PDEQ addressing depersonalization and derealization. Item generation for the dissociative subscale of the RSDI was informed by a view of dissociation as a multidimensional construct, and empirical work published after data collection confirms this view (Briere 2002; Briere et al. 2005). The same pilot work cited above identified one dimension of dissociation that appeared relevant to symptom provocation paradigms, depersonalization/derealization, which is assessed by RSDI items. Of the other empirically derived dimensions of dissociation (Briere 2002; Briere et al. 2005) *identity dissociation* and *memory disturbance* are not relevant to script-driven imagery responses, and *emotional constriction* overlaps with the construct of emotional numbing that, as described above, was unreliably elicited and difficult to distinguish as an acute symptomatic response versus a more enduring condition. Finally, *disengagement* (i.e., cognitive or attentional disengagement) was not conceptualized as separate from depersonalization or derealization during development of the RSDI.

Importantly, the RSDI was not designed to measure all possible clinically relevant subjective responses to script-driven imagery. For example, stress-induced analgesia and somatoform dissociation are forms of numbing and dissociation, respectively, that are not addressed by DSM-IV and that the RSDI was not designed to assess. This would have required attempting to assess responses without general acceptance in the literature, as well as much larger sample sizes, and probably several successive samples, to establish the psychometrics of a more comprehensive scale. Instead, as noted above, the RSDI was designed to measure widely accepted DSM-IV PTSD symptoms and typically assessed dissociative symptoms that are reliably elicited by script-driven imagery. Development of additional RSDI subscales or more comprehensive alternative measures are tasks for future research.

Finally, before the psychometric analyses reported below were conducted, discussions with those who had administered the RSDI revealed that three of the original 14 items were unsuitable for inclusion in the analyses. Some participants had found one reexperiencing item difficult to understand: "Did you remember images, sounds, or smells from the event that distressed you?" (i.e., they were confused about whether "that distressed you" referred to the sensations as remembered in the experimental context or to the original event itself). Two dissociation items were found by German participants in study 2 to be confusing or to have a different meaning than intended, despite being accurately translated to German and back-translated to English; this appeared to stem from different cultural constructions of the experience of being a self in relation to particular experiences. These two items were: "Did it feel like you were unreal?" and "Did you have moments of losing track of what was going on-'blanking out' or 'spacing out' or in some way feel that you were not part of the experience?" Accordingly, 11 items were retained for the scale subjected to the analyses reported below. The 11-item RSDI is available in the Appendix.

Overview of Samples and Procedures

Four samples were employed for all reported analyses: three clinical samples with PTSD and other posttraumatic disorders, and one control group. Table 1 presents demographics, primary traumas, diagnoses, and psychometrics for each clinical sample. Sample 1 consisted of 58 adults from a large city in the Northeastern United States. All were participants in an outpatient treatment study, and assessed with script-driven imagery immediately before and after receiving treatment; data from pre-treatment assessment are reported here, including physiological data. Sample 2 consisted of 61 adults seeking treatment for trauma-related psychological problems at an outpatient clinic in a medium-sized German city. All were participants in a study of relationships between trauma-related symptoms and autonomic regulation during exposure to trauma-related stimuli; again, physiological data were collected and are reported here. Sample 3 consisted of 27 participants in fMRI investigations of PTSD treatment outcome and subtypes of symptomatic responses to script-driven imagery, conducted in a small city in Ontario, Canada.

As noted in Table 1, all three clinical samples were mostly women with a mean age of approximately 36 years. Besides the language in which the RSDI was administered, major differences between the samples were (a) type of primary trauma (childhood interpersonal trauma versus motor vehicle accident in adulthood), (b) prevalence of current dissociative disorders (high in sample 2), (c) prevalence of major depression and severity of current depressive symptoms (low/mild in sample 1, moderate in sample 2, and high/severe in sample 3), and (d) prevalence of past alcohol and substance dependence (moderate in sample 1, not assessed in sample 2, low in Sample 3).

Sample 4 consisted of 17 control participants, recruited for the same fMRI studies as sample 3 participants. All had experienced motor vehicle accidents meeting the traumatic stressor criterion for PTSD in DSM-IV, but had never developed PTSD; all had CAPS scores under 15 and did not meet criteria for any other psychiatric diagnoses. Consistent with their diagnostic status, these participants were more highly educated and more likely to be employed than the 27 PTSD participants in sample 3 or

Table 1 Demographics, trauma exposures, diagnoses, and psychometrics

Variable	Sample 1 (n=58)	Sample 2 (n=61)	Sample 3 (n=27)
Country	United States	Germany	Canada
Age	35.8 (13.7)	35.0 (11.2)	35.9 (10.5)
Sex: Women/Men (%)	81/19	77/23	74/26
Race[a] (%)			
Caucasian	62	100	96
African American	17	0	0
Hispanic	7	0	0
Asian	2	0	0
Native American	0	0	4
Other/mixed race	10	0	0
Education level (%)			
Less than high school	0	23	0
High school (or equiv.)	14	44	22
Some college	40	20	44
College degree	46	13	33
Relationship status[a] (%)			
Single	63	26	46
Married/living with partner	16	54	42
Divorced/separated	14	10	12
Widowed	7	10	0
Employment status (%)			
Full time	40	35	54
Part time	29	23	12
Unemployed student	10	11	8
Full-time parent/retired	6	8	0
Unemployed/looking for work	14	23	27
Primary Trauma (%)			
Child Sexual/Physical Assault	57	70	7
Motor Vehicle Accident	17	0	89
Adult Sexual Assault	7	56	0
Adult Physical Assault	10	70	4
Other	9	0	0
Diagnoses (%)			
PTSD	100	69	100
Dissociative Disorder	–	40	–
Major Depression[b]	15	–	60
Generalized Anxiety Disorder[b]	22	–	7
Panic Disorder	12	–	11
Social Phobia	9	–	0
Somatoform Disorder[b]	11	–	0
Past Alcohol Dependence[b]	31	–	7
Past Substance Dependence[b]	22	–	0
Other Likely (ICD-10) Disorder	–	20	–
CAPS	68.60 (13.20)	–	69.00 (20.70)
PDS	–	1.74 (0.67)	–
BDI-II[b]	16.10 (19.70)	–	30.90 (12.55)
CES-D	–	24.70 (10.78)	–
BAI	14.80 (8.66)	–	21.40 (12.66)
DES	14.90 (6.80)	13.50 (10.56)	9 .30 (7.12)
PDEQ	28.00 (6.80)	–	29.50 (7.31)
IES	–	44.70 (14.83)	–

Dashes indicate that the diagnosis was not assessed or the scale was not administered for that sample
CAPS = Clinician Administered PTSD Scale; PDS = PTSD Diagnostic Scale; BDI-II = Beck Depression Inventory II; CES-D = Center for Epidemiological Studies Depression Scale; BAI = Beck Anxiety Inventory; DES = Dissociative Experiences Scale; PDEQ = Peritraumatic Dissociative Experiences Questionnaire; IES = Impact of Events Scale
[a] Significant difference (χ^2 test) between samples 1 and both 2 and 3, $p<0.05$
[b] Significant difference (χ^2 and t tests) between samples 1 and 3, $p<0.05$

the other samples, but did not differ on mean age or gender distribution.

As described in detail below, each sample underwent different variations of the script-driven imagery paradigm. Sample 1 participants experienced a standard protocol (Pitman et al. 1987), with two trauma scripts and two neutral scripts, each with 30 s script listening and 60 s script imaging periods, in the following sequence: neutral, trauma, neutral, trauma. Sample 2 participants, in addition to two neutral script exposures, were administered only one trauma script, which was 2 min in duration and not followed by a subsequent script imaging period. Sample 3 participants, consistent with the fMRI block design paradigm, were exposed to three successive trauma scripts, each with the standard 30 s script listening period followed by a 30 s script imaging period.

With respect to RSDI administration, across all three clinical samples and the control sample, ratings covered responses across both the script listening and script imaging periods. This approach was employed because debriefings during the pilot research revealed individual differences in maximal symptomatic responses to the script, with most participants experiencing the greatest response during script listening but some during script imaging (e.g., "once the script ended I really got upset"). Instructions to participants were as follows:

> You will be asked to describe whether and to what extent you have had particular experiences, during the tape [of the script] and the imagining period between the tape and the rest period. You will be asked to give ratings on a scale from 'Not at all' to 'A great deal.'

The response format was a seven-point Likert scale, from 0 for "Not at all" to 6 for "A great deal," with only those anchors at the extremes. For the interview version, participants were then handed a piece of paper with the rating scale and anchors, which they held in front of them throughout the interview. For the self-report version, response options were placed below each item. The interview version was used for the initial study to ensure that participants understood and responded to each individual item. Mean subscale scores were used, rather than sum scores, to facilitate comparison of symptom intensities on subscales with different numbers of items.

Hypotheses

A three-factor structure for the RSDI was hypothesized. RSDI items 1–4 were predicted to load on a 'Reexperiencing' factor, items 5–7 on an 'Avoidance' factor, and items 8–11 on a 'Dissociation' factor (see Appendix for items). This structure was predicted to obtain for the aggregate sample of 146 participants drawn from all three clinical samples, and to exhibit invariance with respect to each individual clinical sample. It was also hypothesized that each RSDI subscale would exhibit adequate to high internal consistency reliability.

Although it was assumed that the three factors would not be orthogonal, directions and magnitudes of factor covariances were not predicted. This lack of prediction was based on the following considerations, supported by clinical experience and the pilot work cited above: avoidance or dissociation could occur at the *outset* of the script-driven imagery procedure and thereby decrease engagement with trauma-related stimuli, which in turn could result in *negative* associations of RSDI Avoidance and Dissociation with RSDI Reexperiencing, or *after* engagement with trauma-related stimuli had already occurred, which could result in *positive* associations of Avoidance and Dissociation with Reexperiencing.

For an instrument like the RSDI that measures self-reported *state* symptoms evoked under specific circumstances, it would be illogical to expect a completely uniform pattern of relationships with related constructs across different samples and methodologies. Instead, the pattern of findings for the three samples should exhibit both commonalities and divergences, with the latter amenable to prediction based on salient methodological parameters, the approach used here.

In terms of convergent construct validity, there were two main types of evidence: *relatively direct evidence*, based on relationships between RSDI subscale scores and measures of other responses to the same instance of script-driven imagery assessed with the RSDI; and *indirect evidence*, based on relationships between RSDI subscale scores and scores on measures of recent, trait, and peritraumatic PTSD and dissociative symptoms. With regard to the more direct evidence, two forms of data were collected, as described in detail below: ratings of script-driven *memory characteristics*, including intensity of visual images, bodily sensations, emotions, and extent to which the participant felt "overwhelmed" by the script-driven remembrance; and *heart rate (HR) data*, for assessing psychophysiological reactivity.

In the samples from which data on memory characteristics were collected (1 and 3), it was predicted that RSDI *Reexperiencing* scores would exhibit large positive correlations with intensities of visual images, bodily sensations, emotions, and the experience of feeling overwhelmed by the memory. Predictions about relationships between RSDI Avoidance and RSDI Dissociation and memory characteristics were less straightforward. To the extent that such avoidance and dissociation were "successful," negative correlations would be expected. However, because avoidance and dissociation could occur *after* intense engagement with characteristics of the traumatic memory, only small negative correlations were predicted.

In the samples from which HR data were collected (1 and 2), medium-sized positive correlations were predicted between RSDI *Reexperiencing* scores and HR reactivity indices. Because avoidance could occur from the outset or after engagement with trauma-related stimuli had occurred and physiological reactivity had manifested, small correlations were tentatively predicted for correlations between RSDI Avoidance and HR reactivity. Based on prior conflicting findings with respect to dissociation and physiological reactivity (e.g., Griffin et al. 1997; Nixon et al. 2005), as well as the possibility that dissociation could occur immediately or later in the process, no general prediction was made with regard to correlations between RSDI Dissociation and HR reactivity across both samples. However, though sample 2 did not differ from the other two clinical samples on the measure of trait dissociation (see below), it was thought that qualitative differences associated with suffering from a dissociative disorder could manifest as different relationships between RSDI Dissociation scores and HR reactivity in response to the trauma script. Due to insufficient theoretical and empirical bases, however, no specific prediction was made about the nature of such a potential difference between samples 1 and 2.

The less direct evidence of convergent validity was based on measures of recent, trait, and peritraumatic PTSD and dissociative symptoms. For recent and trait symptoms, small positive correlations were predicted between corresponding scores, for example, RSDI Reexperiencing and reexperiencing symptoms assessed by structured interview. That is, based on clinical experience, it was *not* believed that self-reported severity of a specific symptom type over an entire month would necessarily correspond with its severity in response to a specific strong reminder in the laboratory (or daily life). With regard to peritraumatic dissociative responses to the original trauma, typically years before, no correlations were expected with RSDI Dissociation scores. Relationships between RSDI subscale scores and measures of recent, trait, and peritraumatic symptoms are nevertheless important to assess and report, if only to document that these posttraumatic symptoms lack simple stability over time.

Finally, evidence relevant to *discriminant* construct validity consisted of comparisons of RSDI subscale scores in sample 3 PTSD participants and sample 4 control participants—all participants in the same fMRI studies and primarily survivors of motor vehicle accidents in adulthood. It was predicted that controls' RSDI Reexperiencing, Avoidance, and Dissociation scores would be uniformly low and significantly lower than those of sample 3.

In summary, the RSDI factor structure and subscale internal consistency reliabilities were hypothesized to be invariant across the three clinical samples. Similarly, with respect to *within-sample* evidence of convergent validity across these three samples, consistent relationships between RSDI *Reexperiencing* scores and both memory characteristic and HR reactivity were expected across all three clinical samples. Given the potential complexity of avoidance and dissociative responses (i.e., different onset times and effects within and across trauma scripts), it was predicted more tentatively that there would be small correlations of RSDI Avoidance and Dissociation with memory characteristics, and a small correlation of RSDI Avoidance with HR reactivity. It was also tentatively predicted that, as a function of the high prevalence of dissociative disorders in sample 2, RSDI *Dissociation* scores and HR reactivity might exhibit significant associations, but the direction was not predicted due to insufficient bases for doing so. Based on clinical experience, only small correlations were predicted between RSDI subscale scores and recent and trait measures of the same constructs, and no relationships were expected between RSDI dissociation and peritraumatic dissociation years earlier. Finally, for *between-group* evidence of discriminant validity, based on comparisons of samples 3 and 4, it was predicted that controls would exhibit significantly lower RSDI Reexperiencing, Avoidance, and Dissociation scores than the PTSD sample.

Sample 1

Participants

Fifty-eight adults with PTSD participating in a treatment outcome study provided the data included in this report, all of which were collected before treatment. Participants were recruited via fliers and advertisements posted in the community and clinician referrals. Demographics, trauma exposures, diagnoses, and psychometrics are summarized in Table 1.

Exclusion criteria for this sample included alcohol or substance dependence within 1 year or abuse within the past 6 months, current or prior psychosis or bipolar disorder, a score of 30 or higher on the Dissociative Experiences Scale (DES-II; Bernstein and Putnam 1986; Carlson and Putnam 1993), any medical condition not stabilized for 6 months prior to entering the study, and taking medications that altered cardiac sympathetic or parasympathetic activity. The DES cut-off was chosen because one treatment condition was exposure-based, and dissociation can interfere with the emotional engagement thought to be essential to treatment success (Jaycox et al. 1998). Written informed consent was obtained from all participants, and the study was approved by the Institutional Review Board of the Boston University School of Medicine.

PTSD diagnosis was established with the PTSD module of the Structured Interview for DSM-IV Mental Disorders (SCID; First et al. 1997) and the Clinician Administered PTSD Scale (CAPS; Blake et al. 1995). The CAPS is a

widely used structured interview for assessing PTSD diagnosis and severity, with excellent reliability, yielding consistent scores across items, raters, and testing occasions, as well as strong evidence of validity, including excellent convergent and discriminant validity, diagnostic utility, and sensitivity to clinical change (Weathers et al. 2001). Determination of diagnostic status with the SCID was based on the scoring rules of that interview. Diagnosis with the CAPS was based on the F1/I2 scoring rule, which considers a PTSD symptom present if the frequency of the corresponding CAPS item is rated as 1 or higher and the intensity 2 or higher, plus the S4 scoring rule, which requires that the sum of the frequency and intensity for the item is 4 or higher (Weathers et al. 1999). Individuals with total CAPS scores under 50 were also excluded, which is slightly more conservative than the 45 total scoring rule, to ensure participants had PTSD of moderate severity. SCID-based PTSD diagnosis constituted an initial threshold that all participants had to meet, after which the CAPS was administered and its more stringent CAPS diagnostic criteria and symptom severity cut-off were applied. Interrater reliability among the five study interviewers was established at study onset, based on ten SCID and CAPS per interviewer, and re-assessed at regular intervals to avoid rater drift. Interrater reliability for CAPS diagnosis, based on Cohen's kappa, was good (kappa=0.82; percent agreement=0.92), and was excellent for CAPS symptom severity (intraclass correlation coefficient=0.96).

Procedure

Script-driven imagery procedures followed those originally described by Pitman et al. (1987), with 30 s script listening and 60 s imaging periods. Two scripts each of one traumatic and one neutral experience, differing slightly from each other to reduce habituation, were derived from participants' written descriptions of the event associated with their most severe reexperiencing symptoms, and an emotionally neutral event occurring within 2 years of the traumatic one. Assessment took place approximately 1 week after script construction in a dedicated, sound-attenuated room. Participants were seated in a comfortable chair and instructed to refrain from moving during data collection. The following sequence of events occurred after placement of physiological sensors and a 3-min adaptation period: 5 min eyes-closed and resting baseline; 30 s neutral script listening, 60 s neutral script imaging, and 60 s recovery; trauma script listening, imaging, recovery; additional 2 min of recovery; neutral script listening, imaging, recovery; trauma script listening, imaging, recovery.

Electrocardiogram (ECG) signals were obtained from two disposable Ag–AgCl electrodes placed on the lowest ribs. The ECG signal was amplified and digitized with a J&J Engineering I-330 C2 interface (Poulsbo, WA). ECG data were sampled at 500 Hz for detection of r-waves and acquisition of interbeat intervals (IBIs), then transferred to a PC. The USE data acquisition software (DOS version, J&J, Poulsbo, WA) digitized and stored raw IBI data. MXEDIT software (Delta-Biometrics, Bethesda, MD) was used to graphically display the IBI data, to edit outliers, and derive HR values for each period of interest. To calculate HR reactivity indices, the 30 s baseline periods immediately preceding each trauma script listening period were averaged and subtracted from (a) the mean of the 30 s script listening periods and (b) the mean of the first 30 s of the script imaging periods. (The first 30 s of the 60 s imaging period was selected for comparability to studies using the standard 30 s script imaging period, and because HR during the second half of the imaging period consistently decreased from HR during the first half.)

Immediately after the final recovery period, characteristics of memories experienced across script listening and imagery periods of each trauma script were assessed with a short form of the Traumatic Memory Inventory-Post-Script Version (TMI-PS; Hopper and van der Kolk 2001). In contrast to the original TMI-PS, no inquiry was made about specific memory contents. Participants were asked to report, on a scale from 0 ("not present") to 10 ("most intense possible"), intensities for each of the following memory components: visual images, bodily sensations, emotions, sounds, and smells. (Prior work with this scale, including that reported in Hopper and van der Kolk 2001, indicated that smells and sounds are not typically experienced as components of script-driven traumatic memories, thus those scores are not included in the analyses reported below.) Participants were also asked to indicate the extent to which they felt "overwhelmed by the memory," again on a 0–10 scale, from "not at all overwhelmed" to "completely overwhelmed." Issues relating to the validity and reliability of these relatively face-valid items are discussed in detail elsewhere (Hopper and van der Kolk 2001). This structured interview takes approximately five minutes to complete.

Immediately following the TMI-PS, the RSDI was administered. The RSDI took about twice as long as the TMI-PS, and this raised concerns about attempting to assess responses to both trauma scripts. That is, assessing responses to both trauma scripts with the RSDI, as opposed to just one, would have increased the post-scripts interview length by about 50% (approximately 5–10 min), which could have decreased the accuracy and validity of RSDI data. In addition, script-driven imagery can be quite distressing, and following it with a long interview about the experience can be difficult for participants to tolerate. Based on this reasoning, only one of the two trauma script responses was assessed. The procedure for selecting this "focus script," based on a different research question, was as follows: Participants first gave a forced-choice catego-

rization of responses to each script, as "reliving it and/or upset about it," or "numb and/or spaced out." If they characterized one response as "numb and/or spaced out," that script response was assessed; if they categorized both responses in the same way, they were asked which response was "most" that way and that one was assessed.

Measures

Participants were administered the Beck Anxiety Inventory (BAI; Beck and Steer 1993), the Beck Depression Inventory (BDI-II; Beck et al. 1996), the Dissociative Experiences Scale (DES-II; Carlson and Putnam 1993), and the Peritraumatic Dissociative Experiences Questionnaire (PDEQ; Marmar et al. 1997). For descriptive statistics, see Table 1.

Beck Anxiety Inventory (BAI). The BAI is a widely used 21-item self-report measure of anxiety symptoms (Beck and Steer 1993). Each item is rated on a scale ranging from 0 to 3. Beck and colleagues (Beck et al. 1988) reported high internal consistency (α=0.92), test–retest reliability (r=0.75), and good discrimination of anxiety disorders from nonanxiety disorders over 1 week. The psychometric properties of the BAI have been further supported in clinical and nonclinical samples (Clark et al. 1994; Hewitt and Norton 1993; Steer et al. 1993).

Beck Depression Inventory (BDI-II). The BDI-II is a widely used 21-item self-report inventory of depressive symptoms. Each item is rated on a scale ranging from 0 to 3. The BDI-II is a revision of earlier versions of the BDI (Beck and Steer 1987) that conforms to changes made in the DSM-IV. The internal consistency and factor structure of the BDI-II have received ample support in outpatient samples of adults and adolescents (coefficient alphas typically at or above 0.90; e.g., Beck et al. 1996), indicating that the BDI-II is reliable and well validated as an index of depressive symptom severity.

Dissociative Experiences Scale (DES-II). The 28-item DES-II (Carlson and Putnam 1993) is the most widely used measure of trait dissociation. The original version possesses excellent reliability and validity (Bernstein and Putnam 1986), and consists of 28 items, each one with a graphic scale of 0–100. The authors simplified its format in 1993, using a numerical scale from 0 to 100 in ten-point intervals (Carlson and Putnam 1993), and the psychometric properties of this version are comparable to those of the original (Ellason et al. 1994). The DES-II has been shown to have high internal consistency, with a Cronbach's alpha of 0.95 (Frischholz et al. 1990). Carlson and Putnam (1993) reported test–retest reliability ranging from 0.84 to 0.96 in different studies. The original DES and DES-II have demonstrated reliability and strong evidence of various types of validity (Carlson and Putnam 1993).

Peritraumatic Dissociative Experiences Questionnaire (PDEQ). The PDEQ (Marmar et al. 1997) is a validated ten-item questionnaire that measures dissociative experiences that are remembered as having occurred during a trauma. It uses a 5-point Likert-type scale, with responses ranging from "not at all true" to "extremely true." The PDEQ exhibited good internal consistency (α=.80) in a study of veteran men (Marmar et al. 1994) and detailed convergent validity and reliability findings have been reported (Marmar et al. 1997).

Sample 2

Participants

All participants were part of a study investigating relationships between trauma-related symptoms and autonomic regulation during exposure to a trauma reminder. Participants were recruited from consecutive patients seeking treatment for trauma-related psychological problems at an outpatient clinic in a teaching hospital of a medium-sized German city. From a total of 102 eligible patients, 14 declined script-driven imagery assessment because they believed it would be too distressing, 8 reported partial trauma-related amnesia, 5 were on beta-blocker medications, and 13 could not be included for scheduling or organizational reasons. Data for the present study were collected from 61 participants. Demographics, trauma exposures, diagnoses, and psychometrics are presented in Table 1.

Inclusion criteria included reporting at least one experience meeting the traumatic event criterion for PTSD in ICD-10 (World Health Organization 1992), age between 18 and 65, and sufficient German language knowledge to complete the questionnaires. Exclusion criteria were trauma exposure within the previous 3 months, alcohol or substance dependence within 1 year or abuse within the past 6 months, and acute psychotic symptoms. Written informed consent was obtained from all participants, and the study was approved by the Research Ethics Committee of Hannover Medical School. PTSD diagnosis was established with the SCID PTSD module and dissociative disorders diagnoses with the SCID-D interview (Steinberg 1994). In addition to the findings reported in Table 1, 19 participants (31%) had both PTSD and a dissociative disorder, and among those with ICD-10 dissociative disorders, 6 had Depersonalization/Derealization, 4 Loss of Sensory or Motor Function, 3 Dissociative Amnesia, 2 Dissociative Fugue, 1 Dissociative Identity Disorder, and 9 Dissociative Disorder Not Otherwise Specified. In the 12 patients without PTSD or a dissociative disorder, likelihood of other diagnoses was assessed with a checklist for diagnosis of ICD-10 mental disorders (CES; Hiller et al. 1995), which suggested the

following were present: five anxiety disorders, two depressive disorders, three adjustment disorders, and two somatoform disorders. All interviews were conducted by the third author (MS), a doctoral-level researcher and clinician with several years of experience administering these scales.

Translation of the RSDI to German

The English RSDI was translated into German by the third author (MS) and back-translated to English by a German psychologist fluent in English who does not conduct research on PTSD, dissociation or anxiety disorders, and who was blind to the purpose of the measure and the study design. The first author (JWH) evaluated the English back-translated versions of the 11 final items as identical in wording or meaning to the original English language items. Both the German translation and the back-translation are available from the authors.

Procedure

All trauma scripts were prepared by the German study's principal investigator (MS), and described participants' most disturbing traumatic events, sequentially unfolding the details in the present tense and first person. Scripts were then read to the patient to check for any inconsistencies with their memories, and recorded onto audiotape. The script driven imagery procedure differed from the standard approach (Pitman et al. 1987) by employing a script of 2 min rather than 30 s, and no imagery period after the script ended.

Script-driven imagery sessions were conducted in a second session, approximately 1 week after script construction, which took place in the patients' familiar therapy office to assure a sense of safety and familiarity with the surroundings. Participants were seated in a comfortable chair and asked to remain still during the recording procedure.

ECG signals were obtained via three commercial disposable Ag–AgCl electrodes placed on the chest and recorded by a miniaturized amplifier (Par-Port, Par-Elektronik, Berlin, Germany). The sampling rate for acquisition of IBIs was 1,000 Hz. Data were transferred to a PC and a time series of IBIs was generated, then visually displayed for editing of outliers. Except for singular premature heart beats in three cases, which were edited with a standard averaging procedure, all ECG data were free from artifacts and no further corrections were required. As for sample 1, and to ensure comparability of results, HR reactivity indices were calculated for changes from the baseline period immediately preceding the trauma script to the periods corresponding to 0–30 s and 30–60 s of the 2-min script listening period.

After ECG electrode placement and a 5-min adaptation period, a sequence of five scripts was played back via tape recorder, in a fixed order: (1) 2-min scripted relaxation exercise followed by a 1-min break; (2) 2-min neutral script of imagining washing dishes followed by 1-min break; (3) 2-min trauma script followed by a 5-minute break; (4) repeat of relaxation script/exercise and 1-min break; (5) repeat of neutral script. Levels of subjective units of distress (SUDs) on an 11-point (0–10) scale were assessed immediately after the trauma script. The RSDI was completed immediately after the final neutral script. In this study the RSDI was administered as a questionnaire, in the presence of the investigator to ensure comprehension of the directions and allow participants to ask for clarification about particular items.

Measures

Participants were administered German translations of the Posttraumatic Diagnostic Scale (PDS; Ehlers et al. unpublished manuscript), the Impact of Events Scale (IES; Hütter and Fischer 1997), and the Dissociative Experiences Scale (DES; Freyberger et al. 1999). For descriptive statistics, see Table 1.

Posttraumatic Diagnostic Scale (PDS). The PDS (Foa 1995) asks participants to rate the extent to which they experience each PTSD symptom specified in DSM-IV, ranging from 0 (never) to 3 (five times per week or more/nearly always), and yields scores for total symptom severity and intrusions, avoidance, and hyperarousal subscales. Several studies have supported the reliability and validity of the original English-language PDS. In the initial validation study, Cronbach's alpha was 0.91, test–retest reliability of the overall severity score was 0.74, and the PDS demonstrated concurrent and convergent validity with other measures of psychopathology (Foa et al. 1993). A subsequent investigation found a total-score Cronbach's alpha of 0.92, a test–retest reliability coefficient of 0.83, and additional construct validity evidence (Foa et al. 1997). There are no published data on the psychometric properties of the German translation of the PDS (Ehlers et al., unpublished manuscript). Internal reliability data from the current sample are as follows: PDS Total, α=0.88; PDS Avoidance, α=0.75; PDS Intrusions, α=0.84; PDS Hyperarousal, α=0.72.

Impact of Events Scale (IES). Though published data are available on the German translation of the IES-R (Weiss and Marmar 1997), that version was not available in German when data collection began, and there are no published data on psychometrics of the German translation of the original IES (Hütter and Fischer 1997). The current sample yielded the following internal consistency statistics: IES Total, α=0.85; IES Avoidance, α=0.77; IES Intrusions, α=0.85.

Dissociative Experiences Scale (DES). Psychometric properties of the English language version are described above (Sample 1, Measures). In a sample of 813, including a majority of psychiatric inpatients and outpatients, plus healthy controls, students, and medical patients, the German translation of the DES demonstrated good internal consistency reliability (α=0.91) and retest-reliability at 14-days (r=0.82) (Freyberger et al. 1999). In the current sample, internal consistency reliability was similar (α=0.88).

Sample 3

Participants

All were participants in fMRI investigations of PTSD treatment outcome and subtypes of symptomatic responses to script-driven imagery. Participants were recruited from local therapists and via fliers placed in the community and the medical center where the research was conducted. To date a total of 27 participants with PTSD have been assessed with the RSDI, and constitute this sample. Demographics, trauma exposures, diagnoses, and psychometrics are presented in Table 1.

Exclusion criteria included alcohol or substance dependence within 1 year or abuse within the past 6 months, current or prior psychosis or bipolar disorder, a score of 30 or higher on the Dissociative Experiences Scale (DES-II), and any medical condition not stabilized for 6 months prior to entering the study. Most (24) were participants in a medication treatment outcome study with the additional exclusion criterion of prior treatment with a serotonergic reuptake inhibitor. Written informed consent was obtained from all participants, and the studies were approved by the Health Sciences Research Ethics Board of the University of Western Ontario.

PTSD diagnosis was established with the CAPS (Blake et al. 1995), using the F1/I2 scoring rule plus the S4 scoring rule (see Sample 1, Participants, and Weathers et al. 1999). Seven participants underwent a 2-week medication washout period before the script-driven imagery and fMRI protocol, after which they were re-administered the CAPS to assess for PTSD diagnosis and severity. Interviews were conducted by the fourth author (RAL), or a registered nurse or masters-level research assistant (both of whom were trained by RAL and a co-developer of the CAPS).

Procedure

Script-driven imagery procedures followed those originally described by Pitman et al. (1987), with 30 s script listening and 30 s imaging periods, adapted to the fMRI environment as described in previous publications (e.g., Lanius et al. 2001). Scripts were constructed based on participants' written descriptions of emotionally traumatic, neutral, sad, and anxious experiences. In a block design, three consecutive scripts of the same type were presented, each separated by a 2-min rest period, while blood oxygen level dependent (BOLD) signals were detected by the MRI scanner (relationships between fMRI data and RSDI scores are reported in Hopper et al. 2007).

As with sample 1, immediately after the final recovery period, characteristics of memories experienced across script listening and imagery periods of each trauma script were assessed with the TMI-PS, which was immediately followed by the RSDI interview.

Measures

As with sample 1, each participant completed the Beck Anxiety Inventory (BAI), Beck Depression Inventory (BDI-II), Dissociative Experiences Scale (DES-II), and Peritraumatic Dissociative Experiences Questionnaire (PDEQ). For their psychometric properties, see above (Sample 1, Measures), and for descriptive statistics, see Table 1.

Results

Confirmatory Factor Analysis

Before conducting the factor analysis, normally distributed responses to each item were confirmed. As previously noted, a three-factor model was hypothesized a priori to account for variation in RSDI ratings. RSDI items 1–4 were hypothesized to load on a first factor, labeled 'Reexperiencing', items 5–7 were predicted to form a second factor, labeled 'Avoidance,' and items 8–11 were hypothesized to load on a third factor, labeled 'Dissociation.' Table 2 reports correlations coefficients among the 11 RSDI items across all three clinical samples. All predicted (within-subscale) correlations were significant (p<0.05, Bonferroni corrected), except between Dissociation items 9 and 11, which was low but significant with a one-tailed test (p<0.05, Bonferroni corrected). None of the other (across-subscale) correlations were significant, and all but three were trivial in magnitude.

A confirmatory factor analysis (CFA) employing maximum likelihood estimation was used to evaluate the tenability of the hypothesized three-factor solution, relative to the alternative saturated (i.e., single-factor) and independence (i.e., 11-factor) models, and conducted with Analysis of Moments Software (AMOS, version 7.0; SPSS, Chicago, IL). Factor loadings, variances, and covariances among the factors were tested for invariance pertaining to both the measurement and structural models across the three clinical

Table 2 Correlation coefficients for the final 11 items of the RSDI across all three samples

Item	1	2	3	4	5	6	7	8	9	10	11
1	1.00										
2	0.72**	1.00									
3	0.69**	0.89**	1.00								
4	0.60**	0.67**	0.65**	1.00							
5	−0.10	−0.02	0.01	−0.07	1.00						
6	−0.14	−0.03	0.00	−0.14	0.83**	1.00					
7	−0.08	−0.07	−0.02	−0.14	0.73**	0.76**	1.00				
8	−0.12	−0.12	−0.09	−0.02	0.06	0.01	0.05	1.00			
9	−0.17	−0.20	−0.20	−0.15	0.07	0.02	−0.01	0.53**	1.00		
10	−0.10	−0.06	−0.03	0.01	0.13	0.08	0.13	0.56**	0.55**	1.00	
11	−0.24	−0.13	−0.13	−0.04	0.02	−0.04	−0.04	0.34**	0.24*	0.43**	1.00

Reexperiencing, items 1–4; Avoidance, items 5–7; Dissociation, items 8–11
* $p<0.05$, one-tailed, Bonferroni corrected ($p<0.0009$). ** $p<0.05$, two-tailed, Bonferroni corrected ($p<0.0009$)

samples, following methods outlined by Byrne (2001). That is, model fit was evaluated against the χ^2 statistic, in addition to two standard indices of model fit: the *Comparative Fit Index* (CFI), a statistic derived from the comparison of the three-factor hypothesized model with an independence model ($n_{\text{factors}}=n_{\text{items}}$), with models with strong fit demonstrating values ≥ 0.95; and the *Root Mean Square Error of Approximation* (RMSEA), a measure of the degree to which the three-factor model, with optimally-chosen parameter values, would fit the population covariance matrix if known, taking into account the error of approximation inherent to estimates of the latter, with values ≤ 0.05 indicative of strong model fit.

The fit of the a priori specified three-factor model, when constrained invariant across the three-separate samples, in terms of factor loadings, variances and covariances among the factors, χ^2 (134)=181.46, $p<0.004$, was *not* associated with a statistically significant reduction in model fit relative to the same model with parameters estimated freely within each clinical sample, χ^2 (123)=168.56, $p<0.004$, even at a liberal statistical threshold, $\Delta\chi^2$ (11)=12.90, $p=0.30$. This indicates that the fit of the three-factor model approximated invariance across the three different samples in which it was tested. The fit indices for this model, constrained invariant in terms of its measurement and structural properties, were: CFI=0.949, and RMSEA=0.050, both representative of strong model fit.

The parameters that best fit the observed RSDI data when constrained equal across the three samples are presented in Fig. 1. Examination of this model indicates the following: (a) all items loaded significantly ($p<0.001$) on their respective factors, (b) there were no statistically significant error covariances observed at two-tailed thresholds, and (c) the modification indices did not reveal any parameters that, if freely estimated, would substantively or statistically improve model fit.

Finally, and particularly relevant to sample size adequacy (Meade and Lautenschlager 2004), communalities were generally high: Reexperiencing items, 0.55–0.90, $M=0.73$, SD=0.21; Avoidance items, 0.71–0.82, $M=0.75$, SD=0.07; and Dissociation items, 0.28–0.79, $M=0.49$, SD=0.20.

As explained previously, although it was assumed that the three factors would not be orthogonal, the direction and magnitude of factor covariances were not predicted. The negative covariance observed between Reexperiencing and Avoidance was statistically significant ($p=0.05$, two-tailed), as was the positive covariance between Avoidance and Dissociation ($p=0.01$, two-tailed). The negative covariance between Reexperiencing and Dissociation was not significant ($p=0.12$, two-tailed).

Descriptive Statistics and Internal Consistency Reliability

Table 3 reports descriptive statistics (means and standard deviations) and internal consistency reliabilities (coefficient alpha and intraclass correlation coefficients) for the three RSDI subscales of Reexperiencing, Avoidance, and Dissociation. Statistics are reported for the combined sample and the separate clinical samples. Internal consistencies were high for the Reexperiencing and Avoidance subscales, and adequate for Dissociation.

Convergent Validity with Psychometric Measures of Symptom Provocation Effects: TMI-PS and SUDs

Table 4 reports correlations observed between the RSDI scores and TMI-PS ratings of script-evoked memory characteristics, the first type of relatively direct evidence for assessing construct validity, for samples 1 and 3. As predicted, in both samples RSDI *Reexperiencing* scores were highly positively correlated with reported intensities of visual images, bodily sensations and emotions, and

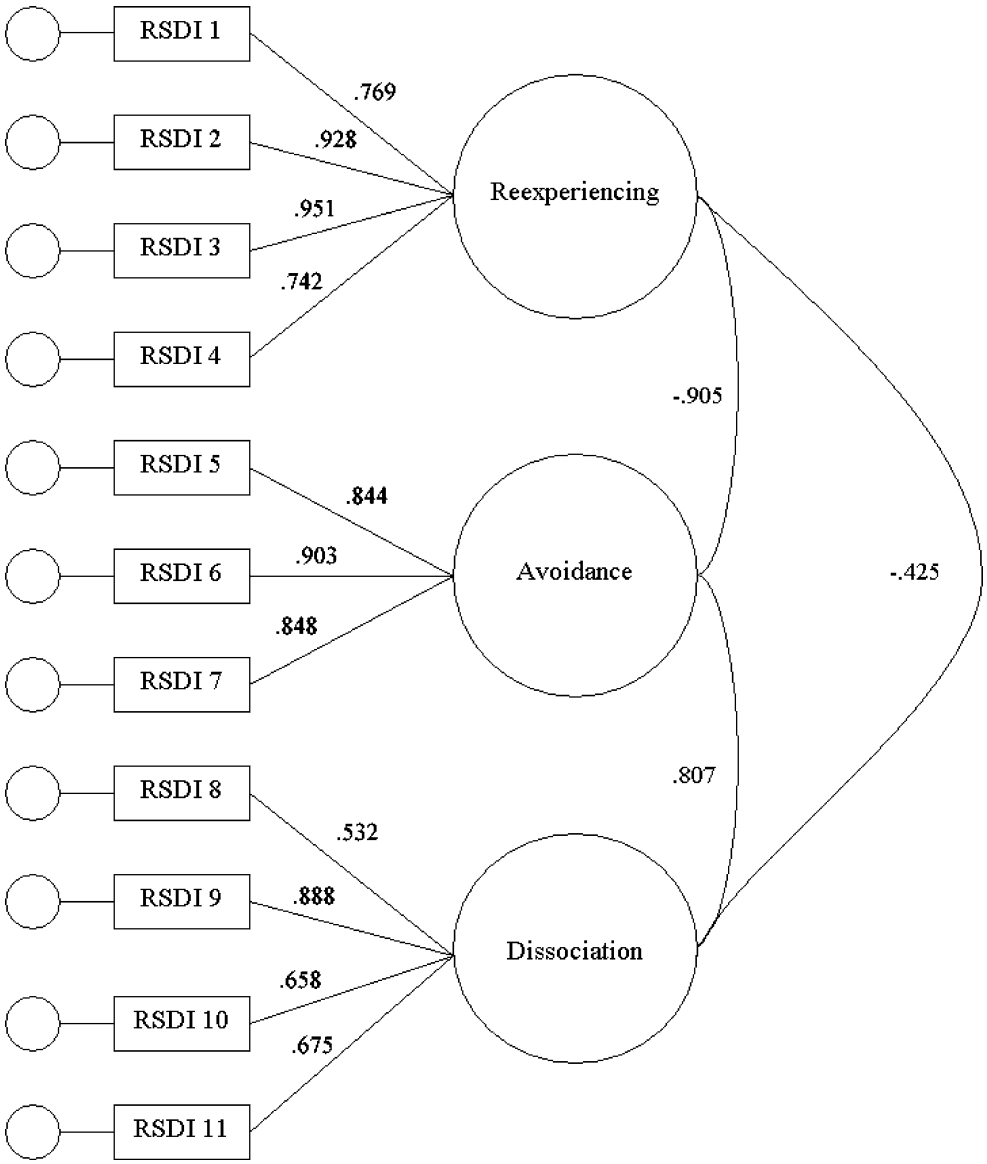

Fig. 1 Confirmatory factor model of the RSDI constrained invariant across three samples. Item regression weights are standardized. Variances estimates for the factors were Reexperiencing=2.209 (SE=0.561), Avoidance=3.417 (SE=0.710), and Dissociation= 0.846 (SE=0.373); all *ps*<0.025

extent of feeling overwhelmed by the script-evoked memory.

As explained previously, because avoidance and dissociation could occur at the onset of script-driven imagery and preclude engagement with the memory, but also *after* a participant had already experienced a vivid, intense and overwhelming remembrance, small correlations were tentatively predicted between RSDI Avoidance and Dissociation subscale scores and memory characteristics. Consistent with this prediction, in sample 1 RSDI Avoidance and Dissociation scores exhibited small to medium negative correlations with those variables. In contrast, in sample 3 there was medium-sized positive correlation between RSDI Avoidance and reported intensity of bodily sensations, but no other evidence for relationships between memory characteristics measured by the TMI-PS and either RSDI Avoidance or Dissociation.

With reference to sample 2, given the overlapping item content, not surprisingly RSDI Reexperiencing was found have a large positive correlation with the SUD rating for the trauma script ($r(59)=0.60$, $p<0.001$). In addition, the SUD rating exhibited a small and marginally significant negative correlation with RSDI Dissociation ($r(59)=-0.24$, $p=0.068$), and there was no evidence of a relationship with RSDI Avoidance ($r(59)=-0.16$, $p=0.23$).

Convergent Validity with a Physiometric Measure of Symptom Provocation: Heart-rate Reactivity

For samples 1 and 2, HR reactivity to the script-driven imagery constituted the other relatively direct form of evidence for assessing convergent validity. As with the memory characteristics data, the only firm prediction was that

Table 3 Means, standard deviations, coefficient alpha, and intraclass correlation coefficients of the RSDI subscales

	Overall				Sample 1				Sample 2				Sample 3			
RSDI subscale	*M*	SD	α	*r*	*M*	SD	α	*r*	*M*	SD	α	*r*	*M*	SD	α	*r*
Reexperiencing	14.28	6.79	0.90	0.70	14.21	6.40	0.89	0.66	14.08	6.54	0.92	0.74	14.90	8.24	0.92	0.73
95% CI, lower			0.87	0.63			0.83	0.55			0.88	0.65			0.85	0.58
95% CI, upper			0.93	0.87			0.93	0.76			0.95	0.82			0.96	0.85
Avoidance	8.91	6.03	0.91	0.78	7.55	5.62	0.88	0.72	11.20	5.47	0.90	0.75	6.64	6.57	0.95	0.85
95% CI, lower			0.88	0.72			0.82	0.60			0.85	0.65			0.90	0.75
95% CI, upper			0.93	0.83			0.93	0.81			0.94	0.83			0.97	0.93
Dissociation	7.36	6.27	0.76	0.44	7.09	5.68	0.71	0.38	7.11	6.38	0.78	0.48	8.48	7.29	0.79	0.48
95% CI, lower			0.69	0.36			0.57	0.25			0.68	0.35			0.61	0.28
95% CI, upper			0.82	0.53			0.82	0.53			0.86	0.61			0.89	0.67

RSDI *Reexperiencing* scores would be positively correlated with HR reactivity to script-driven trauma imagery. For each sample, HR reactivity to the trauma scripts was determined before correlational analyses were conducted.

For sample 1, the mean baseline HR was 71.5 bpm (SD= 11.27), and mean HR increases from baseline to the 30 s script listening period and the first 30 s of the script imaging period were 5.47 bpm (SD=6.40) and 3.37 bpm (SD=6.59), respectively. Paired *t*-tests revealed that both HR changes from baseline were significant, $t(57)=6.51$, $p<0.001$, and $t(57)=4.47$, $p<0.001$, respectively. As reported in Table 5, predicted medium-sized positive correlations between RSDI Reexperiencing scores and HR reactivity indices were found in sample 1 (and sample 3, addressed below). There were no statistically significant correlations between RSDI Avoidance or Dissociation scores and HR reactivity in sample 1, for which small negative correlations were only tentatively predicted because such symptomatic responses could precede or follow physiological arousal responses to the script. Further, to focus on the relationship between cardiac reactivity and subjectively experienced physiological reactivity, correlations were computed between the HR reactivity indices and the RSDI item, "Did you have physical reactions in your body (for example, sweaty, racing heart, trembling, short of breath)?" The correlations were small, in the expected directions, and almost identical to those for the Reexperiencing subscale: script listening, $r(56)=0.29$, $p<0.05$; script imaging, $r(56)=0.22$, $p=0.09$.

In sample 2, mean pre-script baseline HR was high, at 80.5 bpm (SD=11.59), likely due to anticipatory anxiety associated with the impending trauma script. Nonetheless, mean HR increases from baseline to the periods spanning 0–30 and 30–60 s of the trauma script (selected for comparability with sample 1) were 8.60 bpm (SD=8.40) and 10.64 bpm (SD=12.95), respectively. Paired *t*-tests revealed that both changes from baseline were significant, $t(60)=38.75$, $p<0.001$, and $t(60)=30.93$, $p<0.001$, respectively. As reported in Table 5, and as predicted, HR changes from baseline to the 0–30 s and 30–60 s periods were again both significantly positively correlated with RSDI Reexperiencing; in this sample the relationships were stronger, of medium and large magnitudes. As with sample 1, HR changes from baseline to 0–30 s and 30–60 s of script listening, respectively, were not significantly correlated with RSDI Avoidance. A small but significant negative correlation was observed between RSDI Dissociation and HR reactivity for the 30–60 s period of script listening in this sample (in contrast to the lack of correlations for the script listening and imaging periods in sample 1). This finding was consistent with the

Table 4 Correlations between RSDI-assessed state PTSD and dissociative symptoms and memory characteristics related to script-driven imagery

RSDI subscale		Intensity of memory characteristic (TMI-PS)			
		Visual images	Bodily sensations	Emotions	Feeling overwhelmed
Reexperiencing	Sample 1	0.71****	0.78****	0.78****	0.78****
	Sample 3	0.79****	0.67****	0.79****	0.81****
Avoidance	Sample 1	−0.38***	−0.27**	−0.29**	−0.20
	Sample 3	0.26	0.55***	0.23	0.31
Dissociation	Sample 1	−0.28**	−0.25*	−0.29**	−0.12
	Sample 3	−0.17	0.09	0.10	−0.12

RSDI = Responses to Script-Driven Imagery Scale; TMI-PS = Traumatic Memory Inventory–Post-Script Version, HR = heart rate
*$p=0.06$, **$p<0.05$, ***$p<0.01$, ****$p<0.001$, all two-tailed

Table 5 Correlations between RSDI-assessed state PTSD and dissociative symptoms and heart rate change from baseline during script-driven imagery

Sample	Reexperiencing		Avoidance		Dissociation	
	Script listening/ 0 to 30 s	Script imaging/ 30 to 60 s	Script listening/ 0 to 30 s	Script imaging/ 30 to 60 s	Script listening/ 0 to 30 s	Script imaging/ 30 to 60 s
Sample 1	0.28**	0.25*	0.06	−0.02	−0.04	0.01
Sample 2	0.48***	0.53***	−0.19	−0.10	−0.11	−0.28**

For sample 1, "script listening" corresponds to the standard 30-s script listening period, and "script imaging" to the first 30 s of the 60 s script listening period. For sample 2, results for the first 30-s of the 2-min script listening period and 30–60 s of script listening are reported, for comparability purposes. See "Materials and Methods" Section for details.
RSDI = Responses to Script-Driven Imagery Scale; HR = heart rate
*p=0.06, **p<0.05, ***p<0.001, all two-tailed

prediction that the high prevalence of dissociative disorders could result in a different relationship between state dissociation and HR reactivity in this sample than in sample 1. Finally, as with sample 1, correlations between each HR reactivity index and the specific RSDI item concerning subjectively perceived physiological reactivity were in the expected direction, medium in size, and slightly smaller than for the entire Reexperiencing subscale: 0–30 s, $r(59)=0.40$, $p=0.001$; 30–60 s, $r(59)=0.44$, $p<0.001$.

Convergent Validity with Psychometric Measures of Recent PTSD Symptoms, Trait and Peritraumatic Dissociation

As noted above, based on clinical experience, recent and trait measures of PTSD and dissociative symptoms were expected to exhibit small correlations with corresponding state symptoms assessed with the RSDI, and peritraumatic dissociative symptoms were not expected to correlate significantly with RSDI Dissociation scores.

For samples 1 and 3, both of which were assessed with the CAPS, correlations were computed between RSDI Reexperiencing and Avoidance scores and the CAPS subscales of Reexperiencing and Effortful Avoidance (the latter excludes numbing items; King et al. 1998). Consistent with predictions, in sample 1 a trend for a small positive correlation between CAPS and RSDI Reexperiencing scores was found ($r(56)=0.24$, $p=0.07$). In sample 3 this positive correlation was medium in size and statistically significant, $r(25)=0.40$, $p<0.05$. RSDI Avoidance scores were not found to be correlated with CAPS Effortful Avoidance scores in sample 1, $r(56)=0.01$, $p>0.90$, but a significant medium-sized correlation was found in sample 3, $r(25)=0.43$, $p<0.05$. In neither samples 1 nor 3 were RSDI Dissociation and DES scores significantly correlated (sample 1, $r(56)=-0.06$, sample 3, $r(25)=0.07$, $ps>0.60$). As predicted, PDEQ scores reflecting dissociation during the original trauma were not found to be significantly correlated with RSDI Dissociation scores (sample 1, $r(56)=0.02$, sample 3, $r(25)=0.29$, $p>0.19$).

In sample 2, the predicted relatively small but significant positive correlation between RSDI Reexperiencing and IES Intrusions was observed, $r(59)=0.30$, $p<0.05$, while the correlation with PDS Intrusions was not significant, $r(59)=0.11$, $p=0.42$. Regarding the relationship between RSDI Avoidance and IES and PDS Avoidance, unexpected *negative* associations were observed for both scales: $r(59)=-0.33$, $p<0.01$, and $r(59)=-0.31$, $p<0.05$, respectively. (For comparability with findings for samples 1 and 3, correlations were also calculated after removing the single numbing items from IES and PDS Avoidance subscales; the results were essentially unchanged, with r values within 0.02 and p values within 0.006 of those for the original Avoidance subscales.) Finally, in this sample, which had a greater proportion of participants with dissociative disorders than samples 1 or 3, RSDI Dissociation exhibited a medium but significant correlation with trait dissociation as assessed by the DES, $r(59)=0.30$, $p<0.05$.

Discriminative Validity: Differences Between PTSD and Trauma-exposed Control Participants

As predicted, upon undergoing the same script-driven imagery procedures, sample 4 control participants' RSDI item and subscale scores were uniformly low, with severe range restriction that precluded statistical analyses. For RSDI Reexperiencing, 11 of 17 control participants had scores of 1 or lower on the 0–6 scale, and none higher than 3.5; for RSDI Avoidance, 12 had scores of 0 and four scores of 1 or lower; for RSDI Dissociation, all 17 control participants had scores of 0. Thus statistical analyses were not only impossible but unnecessary, given the prima facie evidence of discriminative validity.

Discussion

These findings suggest that the RSDI has an excellent factor structure for measuring self-reported state reexper-

iencing, avoidance, and dissociative symptoms evoked by script-driven imagery. Importantly, the predicted three-factor solution was strongly supported by a CFA testing for invariance of the measurement and structural models across the three clinical samples, with the fully constrained model exhibiting good fit. Internal consistency reliabilities were high for the Reexperiencing and Avoidance subscales and adequate for Dissociation.

Though specific relationships between RSDI subscales were not predicted, Reexperiencing and Avoidance exhibited a negative association, and Avoidance and Dissociation a significant positive correlation. These findings are consistent with avoidance being, at least in part, a response to reexperiencing symptoms. The RSDI, however, is designed to assess subtypes and individual differences in constellations of symptomatic responses to script-driven imagery. Indeed, debriefings revealed various combinations of simultaneously or sequentially unfolding reexperiencing, avoidance, or dissociative symptoms. Thus fine-grained temporal analyses of symptomatic response trajectories, and empirically deriving response types, may be fruitful areas of future investigation.

Evidence for construct validity was on balance consistent with hypotheses. As predicted for relatively direct evidence of convergent validity, across three clinical samples RSDI Reexperiencing scores exhibited (a) large positive correlations with self-reported intensities of visual images, bodily sensations and emotions, and extent of feeling overwhelmed, and (b) medium positive correlations with HR reactivity. Item overlap may partly account for the large positive correlation between RSDI Reexperiencing and SUD rating in sample 2 and the convergence of RSDI Reexperiencing and TMI-PS memory ratings. However, the RSDI has the advantage of items that closely mirror the PTSD reexperiencing criteria delineated in DSM-IV.

The RSDI Avoidance subscale is unique, as avoidant responses to script-driven imagery have not been measured previously. The Dissociation subscale is not comprehensive, but has the advantage of brevity relative to existing state dissociation measures. Assessing the construct validity of these two RSDI subscales, however, is not straightforward. In fact, inconsistent findings were expected across samples, because (1) avoidance and dissociation may arise immediately or after substantial reexperiencing, (2) dissociative disorders (e.g., sample 2) may entail unique relationships between state dissociation and other variables, and (3) conflicting findings have been reported on relationships between dissociation and HR reactivity in different samples (Griffin et al. 1997; Nixon et al. 2005).

Thus small negative correlations of RSDI Avoidance and Dissociation scores with memory characteristics, and Avoidance with HR reactivity, were tentatively hypothesized. Consistent with these predictions, in sample 1 correlations of RSDI Avoidance and Dissociation scores with TMI-PS ratings were negative and small to medium in magnitude. For sample 3, in contrast, the only significant correlation between memory ratings and RSDI Avoidance or Dissociation scores was a *positive* correlation between RSDI Avoidance and intensity of bodily sensations. Perhaps experiencing three trauma scripts in immediate succession increases the likelihood of substantial engagement with the traumatic memory and compensatory avoidance. Finally, RSDI Avoidance scores were not associated with HR reactivity, suggesting that magnitude of avoidance symptoms may not be associated with magnitude of physiological reactivity, and thus avoidance may not account for false negatives in psychophysiological diagnostic discrimination paradigms (Orr and Kaloupek 1997).

For reasons stated above, no general prediction was made about RSDI Dissociation and HR reactivity, though it was thought that sample 2 might exhibit a significant (positive or negative) relationship. Consistent with this prediction, only in sample 2 was there significant though small negative correlation of RSDI Dissociation with HR reactivity.

For the less direct tests of convergent validity, that is, relationships between RSDI subscales and recent, trait, and peritraumatic symptoms, predictions of small positive associations were largely supported. Aside from one finding of no relationship, correlations between corresponding RSDI and CAPS scales in samples 1 and 3 were small and medium in magnitude. In sample 2, unexpectedly, RSDI Avoidance was *negatively* correlated with both IES and PDS Avoidance (these are the study's only truly surprising findings, and difficult to interpret, even speculatively.) Consistent with predictions, RSDI Dissociation and trait dissociation (DES) were unrelated in samples 1 and 2, though a medium-sized correlation was found in sample 2. Finally, as predicted RSDI Dissociation scores were not associated with dissociation at the time of the trauma, typically years before study participation.

To summarize, patterns of relationships largely consistent with convergent validity hypotheses were observed between the RSDI subscales and (a) script-driven memory characteristics assessed with the TMI-PS, (b) physiological reactivity, and (c) recent, trait and peritraumatic measures of PTSD and dissociation. These findings, along with the strong discriminant validity finding that control participants' RSDI scores were uniformly low, especially for Avoidance and Dissociation, provide preliminary support for construct validity.

Collectively, these findings also indicate that *within* PTSD samples it is more straightforward to assess the construct validity of the RSDI Reexperiencing subscale than the Avoidance and Dissociation subscales. In the

current research, procedural and sample differences further complicated assessment of the latter. However, that different participants within the same sample may experience avoidance and dissociation immediately, thereby reducing reexperiencing symptoms, *or* only after substantial reexperiencing has occurred, constitutes an *inherent* limitation of research on responses to script-driven imagery. As noted above, more fine-grained temporal analyses of symptomatic response trajectories, perhaps based on alternative RSDI item response options, might clarify these issues and allow stronger construct validity tests of the Avoidance and Dissociation subscales *within* PTSD samples.

In contrast, *between-group* designs appear best for assessing the construct validity of the Avoidance and Dissociation subscales. This is suggested by the finding that control participants exhibited minimal to no symptomatic responses, especially on those subscales. The between-group divergent validity findings also suggest that the RSDI holds promise for improving PTSD diagnostic discrimination. Finally, these findings also suggest that the RSDI can assess state dissociative responses, which may also constitute distinct subtypes of psychobiological responses to trauma-related stimuli in PTSD (Griffin et al. 1997; Lanius et al. 2002, 2005, 2006).

If it is found that successful PTSD treatment results in RSDI-measured responses to script-driven imagery like those exhibited by controls, the RSDI may prove useful as a treatment outcome measure—the other main purpose for which it was designed. Several methodological issues must be addressed, however, including generalizability from responses to scripts associated with one trauma memory to those associated with other trauma memories (Shalev et al. 1992) and to strong reminders of the same memories in daily life. Importantly, issues of clinical and functional significance in daily life—including of avoidant and dissociative responses—not just diagnostic discrimination in the laboratory, are particularly relevant for treatment research.

The present research has several limitations that should be addressed in future studies. Across the three studies from which the samples were drawn, different versions of the script-driven imagery paradigm were employed, and both interview and questionnaire versions of the RSDI were administered, in English and German. It can be argued that this heterogeneity strengthens confidence in the consistent evidence for the factor structure, model invariance, and internal consistency reliability across the three samples. However, this argument is weaker without evidence from a larger and more homogeneous sample. Also, it is possible that some differing methodological parameters could have biased the findings. In addition, though the clinical samples included a diversity of trauma types, most participants were Caucasian women who had experienced child abuse trauma. Thus generalizability to samples with greater proportions of men and other trauma types needs to be established. Future work might also expand the RSDI to include other responses to script-driven imagery, including forms of emotional numbing and dissociation not captured by standard DSM-IV symptoms.

Another limitation concerns sample sizes, both of the individual samples and the overall sample. The sample sizes are small relative to traditional rules of thumb for confirmatory factor analysis. However, the ratio of participants to variables was approximately 13:1 for the overall sample and over 5:1 for the two non-fMRI samples, and communalities were generally high. As has been demonstrated for exploratory factor analysis (MacCallum et al. 1999), it has recently been shown for CFA as well (Meade and Lautenschlager 2004) that under such circumstances, sample size is relatively unimportant as an influence on the ability to obtain factor solutions that are excellent approximations of the model in the population. Further, the RSDI items are highly face valid, and adapted from well-established measures of PTSD symptoms and dissociation with excellent psychometric properties across a variety of samples. Finally, with the exception of a single multi-site project (Keane et al. 1998), the sample sizes are large for psychophysiological and functional brain imaging studies employing script-driven imagery. Nonetheless, additional research with larger and more homogenous samples will be important to assess more convincingly the validity and reliability of the RSDI.

In conclusion, the RSDI was developed as a brief and relatively face-valid measure to advance psychobiological and treatment outcome research on PTSD and other posttraumatic disorders. Findings presented here suggest that the RSDI possesses an excellent factor structure and sufficient internal consistency to measure self-reported state reexperiencing, avoidance, and depersonalization/derealization dissociative symptoms evoked by script-driven imagery. Evidence for construct validity was on balance strong and consistent with predictions, but more complex, as expected for a measure of state symptoms provoked in particular samples by specific experimental procedures. Together the findings suggest that the RSDI holds promise for refining empirical investigations on distinct psychobiological responses to strong trauma reminders and how they respond to different treatment interventions.

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Appendix

Responses to Script-Driven Imagery Scale

Notes on Administration

This scale can be administered as an interview or a questionnaire, and can be used immediately after the entire script-driven imagery protocol (e.g., before removing electrodes, etc.), or immediately after the post-imaging rest period for each script. For the interview version, print the Likert scale on a separate page and give it to the subject at that point in the directions.

Directions for Participant

"You will be asked to describe the extent to which you have had particular experiences, during the script and the imagining periods between the script and the rest period."

"You will be asked to give ratings on this scale:

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

"If you have difficulty remembering and/or estimating the extent of your experience for a particular item, just make the best estimation you can of your experience based on your memory now."

1. Did you feel as though the event was reoccurring, like you were reliving it?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

2. Were you distressed?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

3. Were you emotionally upset?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

4. Did you have physical reactions in your body (for example, sweaty, racing heart, trembling, short of breath)?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

5. Did you avoid experiencing images, sounds, or smells connected to the event?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

6. Did you avoid thoughts about the event?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

7. Did you avoid feelings about the event?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

8. Did what you were experiencing seem unreal to you, like you were in a dream or watching a movie or play?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

9. Did you feel like you were a spectator watching what was happening to you, like an observer or outsider?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

10. Did you feel disconnected from your body?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

11. Did you feel like you were in a fog?

Not at all A great deal

0 ---------- 1 ---------- 2 ---------- 3 ---------- 4 ---------- 5 ---------- 6

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