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Assessing Post-Traumatic Tonic Immobility Responses: The Scale for Tonic Immobility Occurring Post-Trauma

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Abstract

Background: Peri-traumatic tonic immobility has been associated with the development and course of post-traumatic stress disorder. Despite serving as an adaptive late-stage defense response, tonic immobility that continues in response to post-traumatic reminders may lead to reduced functioning and a diminished sense of well-being. At present, no validated self-report measures assess post-traumatic tonic immobility responses specifically.

Methods: The primary objective of the present study was to evaluate the Scale for Tonic immobility Occurring Post-trauma (STOP), the first self-report measure developed to assess for the presence and severity of tonic immobility responses that persist following trauma exposure as part of post-traumatic symptomatology. Trauma-exposed clinical and non-clinical participants ($N = 462$) with a history of tonic immobility completed a demographic questionnaire, the STOP, and measures of post-traumatic symptoms, dissociation, anxiety, and depression.

Results: STOP assessed four latent constructs, which were interpreted following the human defense cascade model. Together, these factors capture the sensorimotor and perceptual alterations, and dissociative experiences, associated with post-traumatic tonic immobility as a trauma-related altered state. Residual symptoms and the experience of negative affect following this response (including guilt and shame) are also represented. STOP scores demonstrated excellent reliability, as well as good construct and convergent validity, with other measures of dissociation and post-traumatic stress disorder. Results from the present study suggest tonic immobility is most consistent with other dissociative post-traumatic symptomatology.

Conclusions: STOP demonstrates excellent preliminary psychometric properties and may be useful for researchers and clinicians wishing to assess chronic forms of tonic immobility across trauma-exposed, clinical and community samples.

Keywords

Post-traumatic stress disorder, tonic immobility, freezing, defense cascade model, scale development, Scale for Tonic immobility Occurring Post-trauma, assessment

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Introduction

Humans, like other animals, exhibit a series of active and passive defense responses, which are prompted when exposed to threat.[1–4] The defense cascade model[5] provides a key evolutionary framework for understanding how an individual defends against varying levels of attack. Defense responses are dynamic and elicited according to subjective appraisal of threat in relation to the level of personal power required to overcome that threat.[5] Passive defense responses are thought to serve as a last line of protection when threat is greatest and

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escape least possible.[4] Tonic immobility (TI) is an important passive defense response characterized by alterations in experience including physical immobility (motionlessness), tense body posture (increased muscle tone), loss of agency, analgesia, depersonalization, and derealisation.[6] TI, sometimes referred to as freezing, differs from the momentary orienting response thought to precede defensive responding.[4] In sharp contrast with active avoidance behavior, immobility responses are understood as a set of evolutionarily derived, defensive reflexes activated in response to overwhelming, unavoidable, threat.

Despite serving as an adaptive *acute* defense response, peri-traumatic TI is related to increased psychological impairment over the long term. It has been associated with the development and severity of post-traumatic stress disorder (PTSD) in survivors of physical[7] as well as of sexual and non-sexual psychological trauma.[8–10] In a sample of men and women with PTSD, for example, peri-traumatic TI was a better predictor of PTSD development and prognosis than peri-traumatic panic.[11] Moreover, peri-traumatic TI responses have been associated with poor treatment response to front-line pharmacological interventions for PTSD.[11,12]

Despite knowledge of the impact peri-traumatic TI may have on the development and course of PTSD, little is known about *post-traumatic* TI. Recent work suggests that post-traumatic symptomatology is influenced by peri-traumatic responses.[13–15] Evidence suggests a substantial proportion of individuals who immobilize peri-traumatically experience TI in response to post-traumatic reminders.[16] Several authors suggest that exposure to traumatic reminders may re-instantiate the original cascade of defensive stages, resulting in post-traumatic symptomology.[5,16,17] Consistent with this notion, prior TI experiences have been recently linked to increased TI proneness in both healthy controls and individuals with PTSD during stressful stimuli presentation.[18] TI proneness has also been related to prior adverse experience and insecure childhood attachment in samples of healthy female and adolescent participants.[19,20] Here, TI may serve as a defensive response that persists following initial (or repeated) trauma exposure.

TI responses that continue to be expressed over the long term may prove detrimental to one's health and social functioning. This physiologically taxing event serves vitally to disconnect an individual from normal waking experience, imposing a potent form of interpersonal avoidance. Over the long term, this non-responsive state may undermine the healing potential of interpersonal connection.[21] Accordingly, authors have called for research investigating the relation between chronic TI responses and psychopathology.[18,22] Unfortunately, to date, no self-report measures assess specifically for *post-traumatic* TI, hindering research on this topic. In the present study, we evaluate the factor structure and psychometric properties of the first self-report Scale for Tonic immobility Occurring Post-trauma (STOP).

Tonic Immobility

Biological indicators consistent with TI states in mammals have now been reported in humans and are proposed to be homologous.[9] For example, following exposure to a non-escapable biological stressor (20-s inhalation of 20% CO_2/balance O_2), participant-reported feelings of immobility more than doubled.[23] Moreover, whereas trauma-exposed community members demonstrated heart rate deceleration and decreased body sway when shown threat-based pictures depicting no means of escape, amplitude of heart rate and sway increased when a clear escape route was depicted.[24] In addition to significant reductions in body sway,[19,24–30] TI responses have been associated with increased muscle stiffness.[25] Changes in heart rate during TI responses have also been reported, although results remain equivocal. Specifically, whereas one body of evidence suggests TI is characterized by tachycardia or heart rate acceleration,[30] another suggests that it is associated with bradycardia or heart rate deceleration.[31] It is possible these conflicting data reflect the simultaneous activation of two opposing parts of the autonomic nervous system, sympathetic and parasympathetic, as observed in animal models of TI.[1,22,31]

Dissociation is defined as a disturbance in the normal integration of consciousness, memory, identity, emotion, perception, body representation, motor control, and behavior.[32] Critically, dissociation is thought to increase alongside parasympathetic activity as an organism progresses through the cascade, from active to passive responses.[5,33,34] Here, dissociation serves a highly adaptive purpose in TI: an individual may endure unremitting threat, and injury, by becoming unresponsive to the environment.[4,35]

Measures of Post-Traumatic TI

Current measures assessing peri-traumatic TI[6,36] do not assess responses that continue to occur post-traumatically outside the context of an acute traumatic incident. A few measures assay aspects of post-traumatic TI; however, a comprehensive self-report measure is presently lacking. Whereas the Somatoform Dissociation Questionnaire (SDQ-20) evaluates the severity of somatoform manifestations of structural dissociation,[37] the STOP focuses on the post-traumatic TI response itself, as an expression of the human defense cascade. Although the SDQ-20 assesses some symptoms broadly consistent with TI (e.g., item 19: *I am paralyzed for a while*; item 20: *I grow stiff for a while*), other items pertain to symptoms that extend beyond what is expected to occur during

post-traumatic TI (e.g., item 2: *I dislike tastes that I usually like*; item 10: *I feel pain in my genitals*; item 17: *I cannot sleep for nights on end, but remain very active during daytime*). Furthermore, the SDQ-20 fails to adequately assess relevant aspects of depersonalization thought to occur during TI responses (i.e., out of body experience).

The Shutdown Dissociation Scale (Shut-D)[33] represents the first theoretically derived measure to focus on post-traumatic "shut down" symptomatology within a dissociative framework. The Shut-D assesses dissociative symptoms thought to occur alongside parasympathetic dominance ("shut down") during late-stage defense responding.[33] Unfortunately, the Shut-D is administered as a structured clinical interview, limiting its feasibility across settings. Conversely, the STOP represents the first self-report measure to capture TI specifically as part of this parasympathetic cascade.

Critically, neither the SDQ-20 nor the Shut-D considers the potential residual symptoms or affect associated with post-traumatic TI. Given patient report and emergent literature, it is essential that tools assessing post-traumatic TI include items that measure non-fear primary responses to trauma, including guilt and shame.[38,39]

The Present Study

In the present study, we evaluate the factor structure and psychometric properties of STOP, designed as the first self-report measure of post-traumatic TI. STOP assesses for the presence and severity of altered sensorimotor and perceptual experiences associated with TI occurring more than one month after acute trauma in response to traumatic reminders. Unlike the SDQ-20 and Shut-D, STOP items additionally assess the physical *and* emotional consequences of chronic TI, further facilitating clinical recognition and future research. Specifically, STOP was developed to inform treatment planning, guide the development of targeted interventions, and result in a better understanding of this altered state.

We predicted that STOP scores would be strongly and positively associated with other measures of post-traumatic symptom severity and dissociation. As persistent TI responses have been linked with state[20] and trait[23] anxiety as well as severe depression,[9] we also expected STOP scores to be positively associated with measures of anxiety and depression.

Methods

Participants

North American participants ($N_{pooled} = 713$) were recruited using two validated web-based, crowd-sourcing platforms (CrowdFlower; Amazon's Mechanical Turk) across two independent rounds of data collection ($N_{Crowdflower} = 340$; $N_{MTurk} = 373$).[40,41] Participants voluntarily responded to an online advertisement (see Supplemental Information; SI), self-identifying based on the following eligibility criteria: (i) no history of head injury (no loss of consciousness due to physical trauma, lack of oxygen, or electric shock), (ii) at least one episode of TI in response to a past traumatic event occurring more than one month prior, and (iii) at least one episode of TI in the past month, in response to reminder(s) related to the original traumatic event (i.e., post-traumatic TI).

Participants who completed less than one third of the survey battery were excluded from analyses. Data were manually inspected, and a total of 251 participants were excluded based on one or more of the following reasons: incomplete data ($n = 170$), incoherent response ($n = 72$), suspected random responding (e.g., entered 1's for all responses even when not applicable; $n = 4$), duplicate entry ($n = 3$), or self-reported head injury ($n = 2$). Excluded participants did not differ significantly from those retained on any demographic measure.

Remaining participants ($N_{pooled} = 462$) completed demographic information (Table 1). Participants (54.8% female) were generally of middle age ($M = 34.33$, $SD = 10.29$), ranging from 18 to 65 years old. Ninety participants reported no post-traumatic TI responses over the past month and were therefore excluded from these analyses pertaining to post-traumatic TI responses. Thus, 372 participant responses were retained for subsequent analyses ($N_{Crowdflower} = 181$; $N_{MTurk} = 191$).

Measures

Scale for Tonic Immobility Occurring Post-Trauma. STOP represents a novel, self-report measure informed by first-person accounts regarding the phenomenology of TI. STOP items were developed based on themes identified across first-person reports ($N = 6$), descriptions in the literature, and clinical expertise. STOP includes constructs described in peri-traumatic TI scales, such as fear, dissociation, and physical immobility.[6,36] Additionally, this measure was designed to capture the complex sensory-perceptual, cognitive, behavioral, and affective experiences preceding, during, and following a post-traumatic TI response. Initially, 41 items were categorized across 15 domains: *Fear/Panic*, *Analgesia*, *Alterations in Breathing*, *Alterations in Voice*, *Alterations in Vision*, *Alterations in Hearing*, *Physical Immobility*, *Loss of Agency*, *Emotional Detachment*, *Feelings of Safety*, *Altered Perception of Time*, *Altered Sense of Self*, *Altered Cognition*, *Sleep*, and *Collapsed Immobility*. Respondents were asked to rate their past-month TI experiences on a five-point Likert-type scale (0 = *Never*; 4 = *Extremely*). STOP items refer to "freezing" rather than "tonic immobility"

Table 1. Demographic and psychological characteristics.

Characteristic	% ($N = 462$)
Gender	
Female	54.8 (253)
Male	44.8 (207)
Choose not to say	0.4 (2)
Ethnicity	
Caucasian	63.9 (295)
African American / Canadian	8.4 (39)
Latin American / Canadian	7.1 (33)
Asian American / Canadian	7.1 (33)
Native American / Canadian	3.9 (18)
Mixed race	3.9 (18)
Other	4.1 (19)
Choose not to say	1.5 (7)
Marital status	
Single	43.9 (203)
Common-law or married	48.0 (222)
Divorced	6.5 (30)
Other	1.1 (5)
Choose not to say	0.4 (2)
Education	
< High school	0.9 (4)
High school	12.8 (59)
Some post-secondary	25.8 (119)
University degree	31.2 (144)
College diploma	16.2 (75)
Graduate or professional school	12.6 (58)
Other	0.6 (3)
Employment	
Part-time or full-time	69.7 (322)
Self-employed	12.6 (58)
Unemployed	8.2 (38)
Not able to work	1.9 (9)
Student	5.8 (27)
Other	1.7 (8)
Psychiatric diagnosis	
Yes, currently	16.2 (75)
Yes, in the past but not currently	10.6 (49)
Never	69.7 (322)
Choose not to say	3.5 (16)

to increase accessibility to the intended lay audience (see SI for scale).

Other Self-Report Measures

PTSD Checklist for DSM-5 (PCL-5). The 20-item PCL-5[42] was administered to all participants to measure past-month PTSD symptoms. Scores range from 0 to 80, with higher scores indicating greater PTSD severity (probable PTSD ≥ 38). The PCL-5 has demonstrated strong psychometric properties including high internal consistency ($\alpha \geq .94$) and good convergent and discriminant validity.[42] Ten additional items were appended[41] to assess for dissociative experiences related to trauma-related altered states of consciousness (TRASC).[43]

Patient Health Questionnaire. The four-item *Patient Health Questionnaire* (PHQ-4)[44] was administered to all participants to measure symptoms of anxiety and depression. Scores on this abbreviated inventory range from 0 to 12. The PHQ-4 has demonstrated good construct validity and reliability ($\alpha = .85$).[44]

Peri-Traumatic Dissociative Experiences Questionnaire. A seven-item abbreviated version of the *Peri-Traumatic Dissociative Experiences Questionnaire* (PDEQ)[45,46] was administered in the first round of data collection only ($N_{\text{Crowdflower}} = 181$). The PDEQ measures dissociation at the time of a traumatic event and has well-established psychometric properties.[46,47] Scores range from 7 to 35, with higher scores indicating greater peri-traumatic dissociation.

Dissociative Symptoms Scale. The 20-item *Dissociative Symptoms Scale* (DSS)[48] was also administered in the first round of data collection only ($N_{\text{Crowdflower}} = 181$). The DSS measures moderately severe levels of depersonalization, derealization, gaps in awareness or memory, and dissociative re-experiencing in clinical and non-clinical populations ($\alpha \geq .87$).[48]

Procedure

This study was approved by the Western University Ethics Board for Health Sciences Research (#108288). To preserve participant anonymity and confidentiality, data collection occurred on a secure, encrypted website (Qualtics) independent of crowd-sourcing access sites.

Participants who self-identified as eligible for the study were presented with a letter of information and provided written consent prior to completing survey material. Consenting participants completed demographic information, followed by the STOP and additional measures of PTSD, dissociation, anxiety, and depression. The location of items and response scales were varied to ensure participants were attending to item content and response quality. Participants included in the final sample responded to validity items accurately (e.g., "What year is it?"). Participants were provided with a code to tender $1 compensation comparative to rates offered by similar studies.

Statistical Analysis

We used a stepwise approach to determine the ideal item-count and factor structure of the 41-item STOP. First,

exploratory factor analysis (EFA) was conducted with a principal axis extraction and Promax (oblique) rotation. Second, exploratory structural equation models were conducted with a maximum likelihood estimator and a target rotation with cross-loadings specified to approximately zero. Using these two methods, items with strong cross-loadings (i.e., > .40) were removed. Finally, we tested the suitability of a simple structure to STOP with confirmatory factor analysis (CFA) with maximum likelihood estimation and robust standard errors. EFA procedures were conducted using SPSS software, and exploratory structural equation model and CFA procedures were performed in MPlus version 7.4.[49]

Factor structure was explored initially using EFA and ESCM in Sample 2 ($n_{\text{MTurk}} = 191$) and testing the resultant model for fit (CFA) in Sample 1 ($_{\text{Crowdflower}} = 181$). The opposite procedure was also conducted (i.e., EFA on Sample 1, CFA Sample 2). Results of these cross-validation analyses yielded consistent factor structures in Samples 1 and 2. Since a near-identical factor structure emerged when considering the total (pooled) sample, the results reported here will focus on the total sample.[1]

Results

Exploratory Analysis

Factor loadings and intercorrelations of EFA conducted on the 41-item STOP were examined. Six latent variables emerged with an eigenvalue greater than one, rendering a solution accounting for 65.3% of the variance. Each eigenvalue was compared to the 95th percentile of a sampling distribution of 100 randomly generated eigenvalue correlation matrices. Three factors emerged before the randomly generated eigenvalues exceeded those from our data. A fourth factor (eigenvalue > 1) was retained for theoretical reasons, together accounting for 59.7% of the variance. Pattern and structural matrices were used to interpret the factor structure, with items supporting the following factor labels (% variance explained): (1) Sensorimotor and Perceptual Alterations (45.5%), (2) Somatic Detachment and Amnesia (6.2%), (3) Residual Symptoms (4.8%), and (4) Negative Affect (3.1%; Figure 1).

Due to inconsistent factor loadings, three items were removed from the final scale versions (b2, b22, and b40) and excluded from CFA analyses. Factors were strongly and positively correlated in the factor correlation matrix (r's between .4 and .7). Therefore, in CFA analyses, a hierarchical structure was tested.

Confirmatory Factor Analysis

Using a hierarchical four-factor structure, CFA metrics suggested an acceptable model fit. Model fit was assessed by evaluating the global fit indices, including the Root Mean Square Error of Approximation, Standardized Root Mean Residual, Tucker-Lewis Index, and Comparative Fit Index.[50,51] Minimal modifications were made to improve overall fit by allowing one pair of items to correlate residuals (Table 2). Each of the four factors loaded strongly on its higher order parent factor, supporting the rationale for a global score calculation, in addition to subscale scores (see SI for scoring procedure).

Reliability and Validity

Internal Consistency of STOP Subscales. STOP subscales demonstrated excellent internal consistency (Table 3); Cronbach's alpha coefficients could not be improved through item deletion.

Construct and Convergent Validity. Controlling for age and gender, STOP demonstrated good construct validity, and good convergent validity with other measures of traumatic stress and dissociative symptomatology (Table 3).

Discriminant Validity. Subscale and global STOP scores demonstrated strong positive associations with other measures of dissociation and PTSD symptomatology (Table 3). In descending order, the strongest association was found between global STOP scores and TRASC scores. The association was slightly reduced when current PTSD symptoms were also considered (PCL + TRASC items), and reduced further when considering PTSD symptoms alone (PCL-20 items only). A positive correlation between global STOP scores and current dissociative symptoms (DSS) was observed, in addition to a weaker but positive association with PDEQ. Finally, a weak positive correlation was found between global STOP scores, anxiety and depression (PHQ-4).

Of note, 51.7% ($n = 166$) of respondents completing the PCL-5 ($n = 321$) met criteria for probable PTSD (PCL-5 $\geq$ 38). Of the respondents meeting probable PTSD criteria, 63.8% ($n = 106$) indicated additional symptoms consistent with the PTSD dissociative subtype. The latter was quantified by endorsement of at least moderate distress ($\geq$3) over the past week on one or more of the following items: (i) derealization, (ii) out-of-body experience, or (iii) disturbed body ownership. Given these findings, we suggest that TI may be a dissociative phenomenon relevant to community and psychiatric samples.

Discussion

Peri-traumatic TI has long-term implications for functioning and well-being. Accordingly, it is critical that TI responses expressed as part of post-traumatic sequelae be identified to facilitate treatment. In contrast to the assessment literature examining peri-traumatic TI, little formal research has been conducted to inform the assessment of

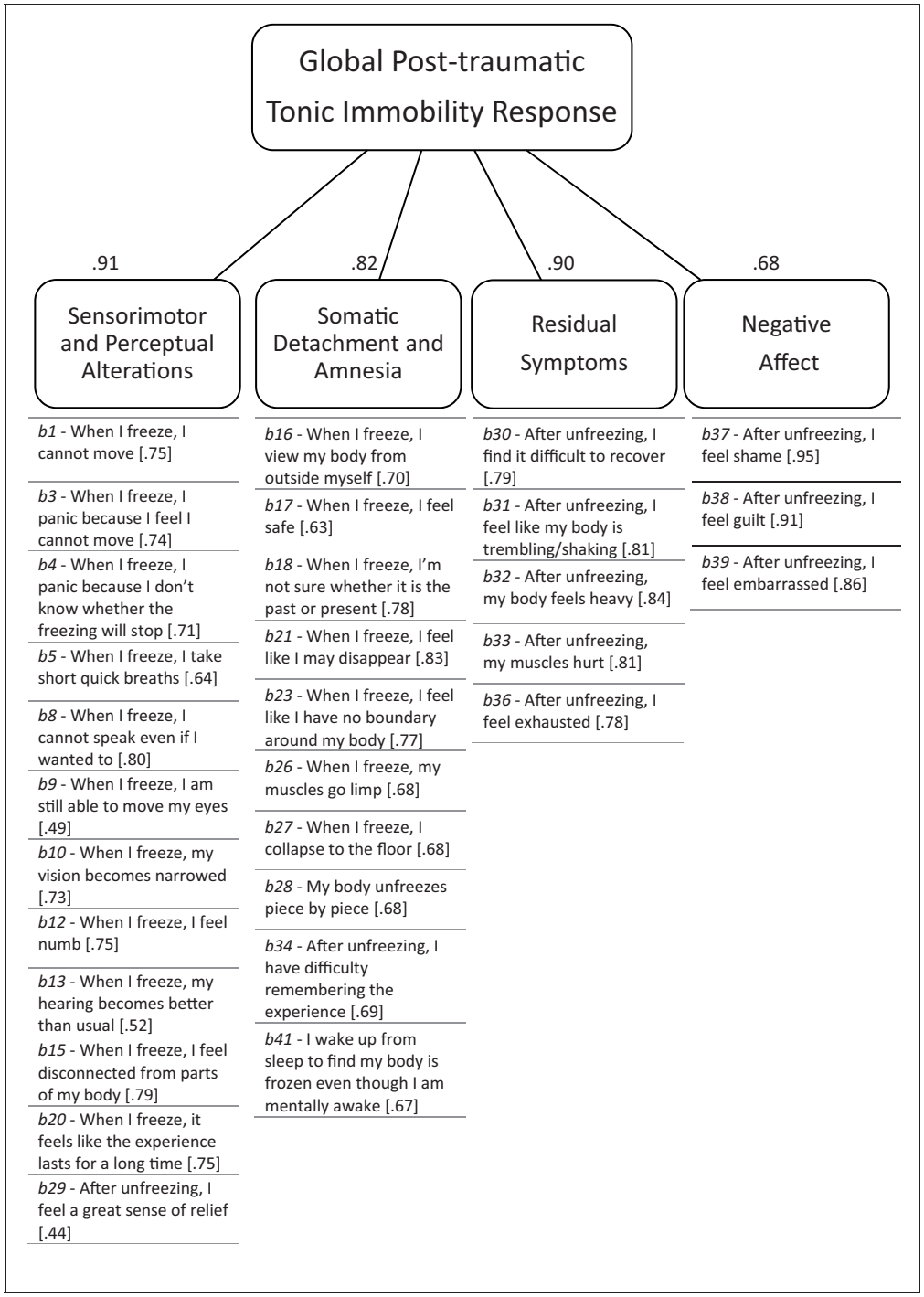

Figure 1. Hierarchical factor structure and standardized factor loadings of the four-factor CFA model 2.

post-traumatic TI. We tested the first self-report measure of post-traumatic TI in two trauma-exposed samples. Overall, STOP demonstrated excellent psychometric properties, providing an important step towards validation. Internal consistency was shown to be excellent for all subscales. Good construct and convergent validity was demonstrated with other measures of post-traumatic stress and dissociation. Interestingly, global STOP scores were most strongly associated with other trauma-related dissociative symptoms. Less significant associations were found with non-dissociative PTSD symptom severity and peri-traumatic dissociative symptoms. This pattern of results is appropriate given that we would expect post-traumatic TI to be more closely associated with present-day dissociative symptomatology than past peri-traumatic dissociative responses.

Table 2. Tested models and associated fit indices of the STOP with CFA ($n = 372$).

Model	$\chi^2(df)$	BIC	RMSEA [CI]	CFI	TLI	SRMR
STOP						
1. Base four-factor	1299.55 (430), $p < .0001$	36075.85	.074 [.069, .078]	.89	.88	.06
2. Base four-factor – allow Correlated residual items: *b3* with *b4*; Eliminate item: *b40*	1101.99 (400), $p < .0001$	34788.56	.069 [.064, .074]	.91	.90	.06

Note: BIC: Bayesian Information Criterion; RMSEA: root mean square error of approximation; CI: 95% confidence interval; CFI: comparative fit index; TLI: Tucker-Lewis index; SRMR: standard root mean square residual. The traditional "gold standard" RMSEA threshold of 0.05 or less (Hu & Bentler, 1999) has been identified as often too stringent, affecting the generalizability of the model (Marsh, Hau, & Wen, 2004). Therefore, acceptable model fit was evaluated by adopting the following standards: RMSEA < .08, SRMR < .08, TLI > .85, and CFI > .85.

Table 3. Descriptive statistics for STOP subscales and correlations with symptom measures.

	M	*SD*	α	r_{PCL}	r_{TRASC}	r_{PCL+}	r_{DSS}	r_{PDEQ}	r_{PHQ-4}
Global Post-traumatic Tonic Immobility Response	52.74	28.30	.96	.50**	.56**	.53**	.42**	.39**	.14*
Sensorimotor and Perceptual Alterations	2.11	1.01	.92	.38**	.43**	.41**	.32**	.36**	.10
Somatic Detachment and Amnesia	1.29	1.09	.93	.47**	.60**	.53**	.46**	.32**	.04
Residual Symptoms	2.08	1.22	.90	.44**	.42**	.45**	.36**	.44**	.27**
Negative Affect	1.68	1.43	.93	.44**	.45**	.45**	.31**	.32**	.23**
Cronbach's α	–	–	–	.97	.97	.98	.97	.85	.90

Note: r_{PCL}: PTSD Checklist – 20 item version; r_{TRASC}: 10 items designed to measure trauma-related altered states of consciousness (TRASC); r_{PCL+}: PTSD Checklist – 20 item version + 10 TRASC items.
*$p < .01$. **$p < .0001$.

Notably, subscale items clustered together to describe the phenomenological experience and aftermath of post-traumatic TI responses. Items belonging to *Sensorimotor and Perceptual Alterations* and *Somatic Detachment and Amnesia* describe alterations in consciousness consistent with the transition to, and experience of, post-traumatic TI. STOP improves upon existing measures by also quantifying the consequential effects (*Residual Symptoms*) and emotional impact (*Negative Affect*) relevant to TI responses.

The Onset and Maintenance of TI

The *Sensorimotor and Perceptual Alterations* and the *Somatic Detachment and Amnesia* subscales contain items that describe alterations in experience that accompany the onset and maintenance of TI. This transition may include disturbances in somatic experience (e.g., b1: "I cannot move"), emotional experience (e.g., b12: "I feel numb"), and perception of time (e.g., b20: "it feels like the experience lasts for a long time").[43] Items describe loss of speech as this function is secondary to respiration (i.e., b5: "I take short quick breaths"; b8: "I cannot speak even if I wanted to"), along with seemingly adaptive alterations in vision (i.e., b10: "my vision becomes narrowed"; b9: "I am still able to move my eyes").[52] The final stages in the defense cascade, beyond TI, are thought to result in eventual loss of consciousness.[5,33] Two items pertaining to a flag and faint response (b26: "my muscles go limp"; b27: "I collapse to the floor") were retained as part of the *Somatic Detachment and Amnesia* subscale, providing an indicator of response severity.

STOP items reflect an updated conceptualization of the human TI response as an evolutionarily adaptive defense response. TI and dissociation are conceptualized traditionally as separate constructs that co-occur frequently in response to acute stress.[6] Some authors caution against a unified conceptualization of these constructs (i.e., attributing dissociative symptoms to the cognitive experience of TI).[53] Schauer and Elbert (2010) hypothesize that sympathetic and parasympathetic nervous system activity underpin the hyperarousal and "shut-down" symptomatology observed, respectively, in PTSD and its dissociative subtype. In our own work, we posit that TI is *characterized* by parasympathetic dominance and by associated dissociative symptoms. As a late-stage defensive response, these dissociative symptoms function to disengage and protect the individual from injury.[5,54] Accordingly, a number of items within this subscale represent depersonalization symptoms (e.g., b16: "I view my body from outside myself"). Dissociating the body from conscious awareness is inherent

to TI and can function as an adaptive strategy under imminent threat (e.g., reduced pain). This state, however, also serves to disturb integration of the traumatic experience with one's sense of self.[55] For example, TI was endorsed as evoking feelings of safety (b17: "I feel safe") and amnesia (b34: "I have difficulty remembering the experience"), possibly reflecting the protective function of TI.

Residual Symptoms of TI

The *Residual Symptoms* subscale refers largely to the aftermath of TI (e.g., b33: "After unfreezing my muscles hurt"). Here, items reflect the heightened impact post-traumatic TI has on the brain and body, following transitions between TI responses and normal-waking states of consciousness (e.g., b30: "After unfreezing, I find it difficult to recover").

The aftermath of post-traumatic TI was further captured on the *Negative Affect* subscale, which indexes social-moral feelings of guilt, shame, and/or embarrassment that may emerge following an episode (e.g., b37: "After unfreezing, I feel shame"). TI involves a loss of agency and a failure to act, both of which may represent socially violating behavior capable of eliciting negative social-moral emotion.[56] Guilt is elicited by negative evaluation of specific action(s), motivating approach behavior intended to repair the wrongdoing; shame serves to condemn the self thereby motivating self-evaluation and withdrawal.[57] Both shame and dissociation have been identified as forms of interpersonal avoidance,[58] serving ultimately to increase social distance (e.g., alienation). We propose that shame, like TI, serves as a functional and protective response to threat. Any social avoidance that may result is better viewed as a secondary effect of a response intended to prevent further social harm, ridicule, and/or condemnation. Moreover, embarrassment is related directly to the response of an actual or perceived audience who witnesses the humiliating behavior.[59] An individual who immobilizes in front of others, for example, may worry about their social image thereby motivating efforts to preserve reputation, rather than the reparative and avoidant efforts seen in guilt and shame, respectively.[57]

Limitations

Although provocative, the present study has a number of limitations including a reliance on retrospective, self-report data. As participants were invited to self-select based on at least one previous TI experience, selection bias may contribute to the present findings, limiting generalizability to other samples. Further limiting these findings, qualitative information about the measure was not collected in this sample. Crowd-sourcing platforms are increasingly used in studies of PTSD; however, it is not well understood how data quality compares to in-vivo methods and results should be interpreted with caution. Although the STOP is designed to measure post-traumatic TI responses, we are unable to definitively link this experience to trauma without future examination. In the present study, the STOP was validated in two independent, trauma-exposed (post-trauma) samples. Research utilizing multi-method and multi-informant approaches is required to determine convergent and discriminant validity and to strengthen evidence for the structural model developed in this study.

Future Directions

The present findings suggest a need to consider TI items in measures of post-traumatic symptomatology and dissociation used in clinical and research settings. It will be important to understand the role of shame and guilt in relation to TI moving forward. Relations between sex, gender, and TI, in addition to clinical and cultural differences in the prevalence and expression of TI responses, should be examined.[60] Evidence suggests that aversive stimuli can produce TI rather than active defensive action, as the former is more adaptive than the latter.[25] Future research should therefore examine the relation between intrusive symptoms and post-traumatic TI responses in individuals with and without a prior history of peri-traumatic TI. Future work is also needed to explore the intersection between TI and the dissociative subtype of PTSD, and other dissociative phenomena. Finally, dissociative symptoms consistent with post-traumatic TI responses (e.g., depersonalization, analgesia, and amnesia) present transdiagnostically across psychiatric disorders including personality disorders, schizophrenia, and eating and mood disorders.[61–63] Symptoms relevant to TI may present clinically as conversion disorder[60,64,65] or somatoform disorder.[66,67] Future research is needed to investigate the intersection between post-traumatic TI and these disorders.

Conclusion

STOP represents the first self-report measure of post-traumatic TI to demonstrate high-quality psychometric properties and utility in both clinical and community samples. Existing measures of TI reflect models that include fear, physical immobility, and dissociation. In addition to capturing these models, STOP is the first measure capable of capturing residual effects associated with post-traumatic TI. We expect that clinicians and researchers will find this preliminary scale useful for detecting and evaluating post-traumatic TI in trauma-exposed groups.

Declaration of Conflicting Interests

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Supplemental Material

Supplemental material for this article is available online.

Note

1. Supporting data are available upon request from the corresponding author.

References

1. Vila J, Guerra P, Munoz M, et al. Cardiac defense: from attention to action. *Int J Psychophysiol* 2007; 66: 169–182.
2. Fanselow MS. Neural organization of the defensive behavior system responsible for fear. *Psychon Bull Rev* 1994; 1: 429–438.
3. Blanchard RJ, Blanchard DC. Attack and defense in rodents as ethoexperimental models for the study of emotion. *Prog Neuropsychopharmacol Biol Psychiatry* 1989; 13: S3–S14.
4. Kozlowska K, Walker P, McLean L, et al. Fear and the defense cascade. *Harv Rev Psychiatry* 2015; 23: 263–287.
5. Schauer M, Elbert T. Dissociation following traumatic stress. *J Psychol* 2010; 218: 109–127.
6. Abrams MP, Nicholas Carleton R, Taylor S, et al. Human tonic immobility: measurement and correlates. *Depress Anxiety* 2009; 26: 550–556.
7. Maia DB, Nóbrega A, Marques-Portella C, et al. Peritraumatic tonic immobility is associated with PTSD symptom severity in Brazilian police officers: a prospective study. *Rev Bras Psiquiatr* 2015; 37: 49–54.
8. Mooren N, van Minnen A. Feeling psychologically restrained: the effect of social exclusion on tonic immobility. *Eur J Psychotraumatol* 2014; 5: 22928.
9. Möller A, Söndergaard HP, Helström L. Tonic immobility during sexual assault—a common reaction predicting posttraumatic stress disorder and severe depression. *Acta Obstet Gynecol Scand* 2017; 96: 932–938.
10. Rocha-Rego V, Fiszman A, Portugal LC, et al. Is tonic immobility the core sign among conventional peritraumatic signs and symptoms listed for PTSD? *J Affect Disord* 2009; 115: 269–273.
11. Lima AA, Fiszman A, Marques-Portella C, et al. The impact of tonic immobility reaction on the prognosis of posttraumatic stress disorder Litz. *J Psychiatr Res* 2010; 44: 224–228.
12. Fiszman A, Mendlowicz MV, Marques-Portella C, et al. Peritraumatic tonic immobility predicts a poor response to pharmacological treatment in victims of urban violence with PTSD. *J Affect Disord* 2008; 107: 193–197.
13. Aho N, Proczkowska Björklund M, Svedin CG. Peritraumatic reactions in relation to trauma exposure and symptoms of posttraumatic stress in high school students. *Eur J Psychotraumatol* 2017; 8: 1380998.
14. Gandubert C, Scali J, Ancelin ML, et al. Biological and psychological predictors of posttraumatic stress disorder onset and chronicity. A one-year prospective study. *Neurobiol Stress* 2016; 3: 61–67.
15. Sugar J, Ford JD. Peritraumatic reactions and posttraumatic stress disorder in psychiatrically impaired youth. *J Trauma Stress* 2012; 25: 41–49.
16. de Kleine RA, Hagenaars MA, van Minnen A. Tonic immobility during re-experiencing the traumatic event in posttraumatic stress disorder. *Psychiatry Res* 2018; 270: 1105–1109.
17. Keane T, Zimering R, Caddell J. A behavioral formulation of post-traumatic stress disorder in vietnam veterans. *Behav Ther* 1985; 8: 9–12.
18. Fragkaki I, Stins J, Roelofs K, et al. Tonic immobility differentiates stress responses in PTSD. *Brain Behav* 2016; 6: e00546.
19. Hagenaars MA, Stins JF, Roelofs K. Aversive life events enhance human freezing responses. *J Exp Psychol Gen* 2012; 141: 98–105.
20. Niermann HCM, Ly V, Smeekens S, et al. Infant attachment predicts bodily freezing in adolescence: evidence from a prospective longitudinal study. *Front Behav Neurosci* 2015; 9: 1–10.
21. Bryant RA. Social attachments and traumatic stress. *Eur J Psychotraumatol* 2016; 7: 1–8.
22. Roelofs K. Freeze for action: neurobiological mechanisms in animal and human freezing. *Philos Trans R Soc Lond B Biol Sci* 2017; 372: pii. 20160206.
23. Schmidt, Norman B, Richey JA, et al. Exploring human freeze responses to a threat stressor. *J Behav Ther Exp Psychiatry* 2008; 39: 292–304.
24. Bastos AF, Vieira AS, Oliveira JM, et al. Stop or move: defensive strategies in humans. *Behav Brain Res* 2016; 302: 252–262.
25. Azevedo TM, Volchan E, Imbiriba LA, et al. A freezing-like posture to pictures of mutilation. *Psychophysiology* 2005; 42: 255–260.
26. Stins JF, Beek PJ. Effects of affective picture viewing on postural control in healthy male subjects. *Cranio – J Craniomandib Pract* 2007; 31: 202–210.
27. Gladwin TE, Hashemi MM, van Ast V, et al. Ready and waiting: freezing as active action preparation under threat. *Neurosci Lett* 2016; 619: 182–188.
28. Fragkaki I, Roelofs K, Stins J, et al. Reduced freezing in posttraumatic stress disorder patients while watching affective pictures. *Front Psychiatry* 2017; 8: 39.
29. Roelofs K, Hagenaars MA, Stins J. Facing freeze: social threat induces bodily freeze in humans. *Psychol Sci* 2010; 21: 1575–1581.
30. Volchan E, Rocha-Rego V, Bastos AF, et al. Immobility reactions under threat: a contribution to human defensive cascade and PTSD. *Neurosci Biobehav Rev* 2017; 76: 29–38.

31. Hagenaars MA, Oitzl M, Roelofs K. Updating freeze: aligning animal and human research. *Neurosci Biobehav Rev* 2014; 47: 165–176.
32. APA. *DSM 5*. Arlington, VA: American Psychiatric Publishing, 2013.
33. Schalinski I, Schauer M, Elbert T. The shutdown dissociation scale (Shut-D). *Eur J Psychotraumatol* 2015; 6: 25652.
34. Fenster RJ, Lebois LAM, Ressler KJ, et al. Brain circuit dysfunction in post-traumatic stress disorder: from mouse to man. *Nat Rev Neurosci* 2018; 19: 535–551.
35. Ogden P, Minton K, Pain C. *Trauma and the Body: A Sensorimotor Approach to Psychotherapy*. New York, NY: W.W. Norton; 2006.
36. Fusé T, Forsyth JP, Marx B, et al. Factor structure of the Tonic Immobility Scale in female sexual assault survivors: an exploratory and confirmatory factor analysis. *J Anxiety Disord* 2007; 21: 265–283.
37. Nijenhuis ER, Spinhoven P, Van Dyck R, et al. The development and psychometric characteristics of the Somatoform Dissociation Questionnaire (SDQ-20). *J Nerv Ment Dis* 1996; 184: 688–694.
38. Badour CL, Resnick HS, Kilpatrick DG. Associations between specific negative emotions and DSM-5 PTSD among a national sample of interpersonal trauma survivors. *J Interpers Violence* 2015; 32: 1620–1641.
39. Freed S, D'Andrea W. Autonomic arousal and emotion in victims of interpersonal violence: shame proneness but not anxiety predicts vagal tone. *J Trauma Dissociation*. 2015; 16: 367–383.
40. Chandler J, Shapiro D. Conducting clinical research using crowdsourced convenience samples. *Annu Rev Clin Psychol* 2016; 12: 53–81.
41. Frewen PA, Brown MF, Steuwe C, et al. Latent profile analysis and principal axis factoring of the DSM-5 dissociative subtype. *Eur J Psychotraumatol* 2015; 6: 26406.
42. Blevins CA, Weathers FW, Davis MT, et al. The Posttraumatic Stress Disorder Checklist for DSM-5 (PCL-5): development and initial psychometric evaluation. *J Trauma Stress* 2015; 28: 489–498.
43. Frewen PA, Lanius RA. Trauma-related altered states of consciousness: exploring the 4-D model. *J Trauma Dissociation* 2014; 15: 436–456.
44. Kroenke K, Spitzer RL, Williams JBW, et al. An ultra-brief screening scale for anxiety and depression: the PHQ-4. *Psychosomatics* 2009; 50: 613–621.
45. Engelhard IM, Van den Hout MA, Kindt M, et al. Peritraumatic dissociation and posttraumatic stress after pregnancy loss: a prospective study. *Behav Res Ther* 2003; 41: 67–78.
46. Marmar CR, Weiss DS, Metzler TJ. Preitraumatic dissociation experiences questionnaire. In: Wilson JP, Keane TM, (eds). *Assessing Psychological Trauma and PTSD*. New York, NY: Guilford Press; 1997, pp.412–428.
47. Birmes P, Brunet A, Benoit M, et al. Validation of the peritraumatic dissociative experiences questionnaire self-report version in two samples of French-speaking individuals exposed to trauma. *Eur Psychiatry* 2005; 20: 145–151.
48. Carlson EB, Waelde LC, Palmieri PA, et al. Development and validation of the Dissociative Symptoms Scale. *Assessment* 2018; 25: 84–98.
49. Muthén, L.K. and Muthén, B.O. *Mplus User's Guide*. Seventh Edition. Los Angeles, CA: Muthén & Muthén, 1998–2012.
50. Hu L, Bentler PM. Cutoff criteria for fit indexes in covariance structure analysis: conventional criteria versus new alternatives. *Struct Equ Model A Multidiscip J* 1999; 6: 1–55.
51. Marsh HW, Hau K-T, Wen Z. In search of golden rules: comment on hypothesis-testing approaches to setting cutoff values for fit indexes and dangers in overgeneralizing Hu and Bentler's (1999) findings. *Struct Equ Model A Multidiscip J* 2004; 11: 320–341.
52. Lojowska M, Gladwin TE, Hermans EJ, et al. Freezing promotes perception of coarse visual features. *J Exp Psychol: Gen* 2015; 144: 1080–1088.
53. Lanius UF, Paulsen S, Corrigan FM. *Neurobiology and Treatment of Traumatic Dissociation: Toward an Embodied Self*. New York, NY: Springer Publishing Company; 2014.
54. Dalenberg CJ, Brand BL, Gleaves DH, et al. Evaluation of the evidence for the trauma and fantasy models of dissociation. *Psychol Bull* 2012; 138: 550–588.
55. Spiegel D, Lewis-Fernández R, Lanius R, et al. Dissociative disorders in DSM-5. *Annu Rev Clin Psychol* 2013; 9: 299–326.
56. Tangney J, Stuewig J, Mashek D. Moral emotions and moral behaviour. *Annu Rev Psychol* 2007; 58: 345–372.
57. Tangney JP, Miller RS, Flicker L, et al. Are shame, guilt, and embarrassment distinct emotions? *J Pers Soc Psychol* 1996; 70: 1256–1269.
58. Dorahy MJ. The impact of dissociation, shame, and guilt on interpersonal relationships in chronically traumatized individuals: a pilot study. *J Trauma Stress* 2010; 23: 653–656.
59. Bastin C, Harrison BJ, Davey CG, et al. Feelings of shame, embarrassment and guilt and their neural correlates: a systematic review. *Neurosci Biobehav Rev* 2016; 71: 455–471.
60. Sallin K, Lagercrantz H, Evers K, et al. Resignation syndrome: catatonia? Culture-bound? *Front Behav Neurosci* 2016; 10: 1–18.
61. Lyssenko L, Schmahl C, Bockhacker L, et al. Dissociation in psychiatric disorders: a meta-analysis of studies using the dissociative experiences scale. *Am J Psychiatry* 2018; 175: 37–46.
62. Sar V, Alioğlu F, Akyuz G. Depersonalization and derealization in self-report and clinical interview: the spectrum of borderline personality disorder, dissociative disorders, and healthy controls. *J Trauma Dissociation* 2017; 18: 490–506.
63. Şar V. The many faces of dissociation: opportunities for innovative research in psychiatry. *Clin Psychopharmacol Neurosci* 2014; 12: 171–179.
64. Del Río-Casanova L, González-Vázquez AI, Justo A, et al. The role of emotion dysregulation in conversion disorder. *Actas Esp Psiquiatr* 2018; 46: 92–103.
65. Sar V, Akyüz G, Dogan O, et al. The prevalence of conversion symptoms in women from a general turkish population. *Psychosomatics* 2009; 50: 50–58.
66. Kienle J, Rockstroh B, Bohus M, et al. Somatoform dissociation and posttraumatic stress syndrome – two sides of the same medal? A comparison of symptom profiles, trauma history and altered affect regulation between patients with functional neurological symptoms and patients with PTSD. *BMC Psychiatry* 2017; 17: 1–11.
67. Sar V. Epidemiology of dissociative disorders: an overview. *Epidemiol Res Int* 2011; 2011: 1–8.