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**A prospective study of the mediating role of tonic immobility and peritraumatic dissociation
on the four DSM-5 symptom clusters of posttraumatic stress disorder**

Sarah Bøgelund Docked^{1,2}, sdokkedahl@health.sdu.dk, telephone +45 65 50 49 75

ORCID: <https://orcid.org/0000-0003-3090-4660>

Yael Lahav, Ph.D.^{1*}, yaellah1@tauex.tau.ac.il, telephone +972.3.6405438

ORCID: <https://orcid.org/0000-0003-1242-9042>

¹ Department of Occupational Therapy, School of Health Professions, Faculty of Medicine, Tel Aviv University, Israel

² National Center of Psychotraumatology, Department of Psychology, University of Southern Denmark, Odense M, Denmark

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Abstract

Objective: Tonic immobility (TI) and peritraumatic dissociation (PD) are common peritraumatic reactions associated with psychopathology following trauma. The present study aimed to test whether TI and PD mediated the relationship between perceived threat during an episode of rocket shelling and subsequent posttraumatic stress symptoms. **Methods:** In a prospective study among N = 226 Israeli civilians, data was collected both during rocket shelling, between May 14th, 2021, until ceasefire on May 21st, 2021 (T₁) and one to two months after ceasefire (T₂). Measures included the *Tonic Immobility Scale*, *Peritraumatic Dissociative Experiences Questionnaire*, and the *PCL-5*. Four mediation models were applied for each posttraumatic stress symptom cluster. **Results:** Findings showed that a substantial proportion of participants had developed PTSD symptoms at the time of follow-up (18.8%). Both TI and PD fully mediated the relationship between perceived threat and symptoms of intrusion, avoidance, and negative alterations in mood and cognition, but only PD mediated the relationship with alterations in arousal and reactivity. **Conclusion:** The present findings suggest that TI and PD may serve as mechanisms underlying the link between individuals' appraisals of threat during the peritraumatic phase and subsequent PTSD symptomatology. Future research should seek to replicate the present findings before we can draw any conclusions. In particular, the association between PD and arousal and reactivity symptoms should be further explored, given that it might be multifaceted in nature.

Introduction

War can expose large populations of civilians to trauma, which can result in posttraumatic stress disorder (PTSD)¹⁻⁴. PTSD is a severe psychiatric disorder associated with functional impairment and decreased quality of life^{5,6}. Although traumatic events can elicit peritraumatic and acute trauma-related symptoms, the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) require persistence of symptoms for more than one month, as many victims exhibit spontaneous remission within the first few weeks⁷. Key diagnostic criteria are distributed across four symptom clusters: intrusion, avoidance, negative alterations in mood and cognition, and alterations in arousal and reactivity⁷.

Given that not all trauma victims develop PTSD, it is important to uncover risk factors that contribute to trauma psychopathology. Several risk factors have already been identified, including age at the time of trauma^{8,9}; gender¹⁰; history of mental health problems¹¹; and previous exposure to traumatic events, such as childhood abuse¹¹⁻¹³. Moreover, perceived threat^{14,15} has also been associated with PTSD, suggesting that the subjective appraisal of threat during trauma exposure explains subsequent PTSD.

Peritraumatic reactions, which denote emotional, behavioral, cognitive, and psychological responses that occur during or immediately after a traumatic event¹⁶, represent another important group of factors associated with PTSD development¹⁷. Tonic immobility (TI) and peritraumatic dissociation (PD) are both common peritraumatic reactions associated with psychopathology following trauma¹⁸.

PD is a central defense mechanism against overwhelming danger, and represents a psychological escape from elevated distress resulting from trauma exposure¹⁹. This defensive reaction may involve both compartmentalization, i.e., psychobiological functioning is disconnected and consciousness divided^{19,20}, and detachment, i.e., derealization, depersonalization, and emotional

numbing^{19,21}. PD has been linked to a variety of traumatic events^{19,22,23}, including war- and terror-related trauma in veterans²⁴ as well as child and adult civilians^{4,25,26}.

The other peritraumatic reaction, TI, is characterized by strong motoric inhibition and paralysis of movement, thought, vocalization, and emotion²⁷. This reaction evolved to protect humans and other animals when facing an impending threat to life where escape is perceived to be impossible²⁸. Although TI has been described as maladaptive²⁹, it serves to protect victims from pain via analgesia, and to increase chances of survival, as the predator is more likely to lose interest in, or get distracted by a victim who appears paralyzed or dead²⁹. Whereas TI in humans has primarily been studied in relation to sexual assault^{28,30}, it has also been linked with war³⁰⁻³², accidents³³, and disasters³⁴.

Although TI and PD are often associated and co-occur under threat¹⁸, they may arise independently and have different protective purposes¹⁸. When victims are experiencing PD, manifested in disconnection from their surroundings or themselves, they may not necessarily be in a state of tonic immobility. Similarly, when victims are experiencing TI, they remain conscious to scan their surroundings for ways to escape^{28,35}.

As previously noted, PD and TI have defensive qualities; nevertheless, they appear to put individuals at risk for PTSD. This might be explained by the effect of PD on dysfunctional trauma memories²⁵ and self-related cognitions³⁶, as well as the elevated guilt that has been found in relation to TI²⁸. Research has indeed indicated that both predict subsequent PTSD^{18,28,37} and posttraumatic distress manifested in depression, anxiety, and chronic dissociation^{11,34,37-39}. Furthermore, the trauma literature implies that both may serve as mechanisms at the basis of the relationship between perceived threat and PTSD^{18,29}. According to this view, elevated sense of threat during trauma exposure may generate defensive reactions of PD and TI that, in turn, impede re-processing the trauma, and therefore may lead to PTSD.

To date, no studies have examined the mediating role of TI and PD in the relationship between perceived threat and PTSD, and only a few studies have explored the contribution of both TI and PD in explaining PTSD. Results of these studies indicated contradictory patterns: while some indicated that TI is associated with PTSD after controlling for PD^{33,40,41}, others found PD to be the only significant predictor of PTSD, after controlling for TI^{42,43}. Yet, given that these studies used retrospective and cross-sectional data their ability to infer the role of TI and PD in predicting subsequent PTSD is limited.

Furthermore, to date the contribution of both peritraumatic reactions in explaining different PTSD symptom clusters has received limited attention. One study has demonstrated that, whereas TI mediated the relationship of fear, with reexperiencing and avoidance/numbing, it did not mediate the relationship between fear and hyperarousal symptoms⁴⁴. Another study⁴⁵ indicated that victims with high PD score significantly higher on all PTSD symptom clusters. These findings suggest that the implications of TI and PD may not be the same for all PTSD clusters. As suggested by Bovin and colleagues⁴⁴, the co-occurrence of TI and PD might interfere with our understanding of the link between these two peritraumatic reactions and PTSD symptomatology. Therefore, an investigation assessing the mediating role of TI and PD, while exploring each of the PTSD symptom clusters, is needed.

The present prospective study aimed to fill these gaps. This study was conducted among Israeli civilians affected by rocket shelling during the Operation Guardian of the Walls - the operation lasted for 11 days in May 2021 and involved 4360 rockets and mortar shells being fired at Israel. The data is unique in that it was collected both during the operation (T₁) and one to two months after ceasefire (T₂), and thus measured both peritraumatic reactions and subsequent PTSD symptomatology.

The current study aimed to test whether TI and PD mediated the relationship between perceived threat and PTSD symptom clusters. Given that both TI and PD are known to occur under severe threat¹⁸, and both have been identified as important risk factors for PTSD symptomatology^{18,28,37}, two main hypotheses were set: 1) TI and PD at T₁ would predict PTSD symptoms at T₂; 2) TI and PD at T₁ would mediate the relationship between perceived threat at T₁ and PTSD symptom clusters at T₂, after adjusting for well-documented risk factors for PTSD (e.g., age, gender, mental health history, and history of childhood abuse). As the study is exploratory in nature, no specific hypothesis was formed for each PTSD symptom cluster.

Methods

Participants and procedure

A convenience sample of Israeli adults was drawn from an online survey distributed on social media platforms. Data was collected at two timepoints; 1) *During the peritraumatic phase* (T₁), from the fifth day of Operation Guardian of the Walls, May 14th, 2021, until ceasefire on May 21st, 2021; 2) *During the posttraumatic phase* (T₂), one to two months after ceasefire between June 30th and July 31st, 2021. The survey was administrated using Qualtrics software (QualtricsLabs, inc., Provo, UT, US), and the completion time ranged from 15 to 30 minutes. All procedures and instruments were approved by the [masked for review] institutional review board (IRB). Participants were informed about the research goals, nature of the questions, and approval of the study by the relevant IRB. A consent form was signed by all respondents.

A total of 739 individuals who participated at T₁ had been exposed to rocket shelling during the operation, and thereby qualified for inclusion in the study. Of them, 226 participated at T₂ (30.6%), which constitutes the current sample. Respondents were Jewish. The mean age was $M = 37.7$ ($SD = 10.4$), and 151 (66.8%) were secular. The majority of the sample were female (81%)

and had an undergraduate or graduate degree (64.2%). In terms of income levels, 101 (44.7%) reported a below-average income, 60 (26.5%) an average income, and 65 (28.8%) an above-average income. More than half of the sample (53.5%) reported a history of childhood abuse, and 23.3% reported a history of mental health problems.

Dropout analyses

No significant differences were found at T1 between participants who took part in the study at T1 and T2 and those who dropped out between waves in terms of gender ($\chi^2(1) = 2.15, p = .14$, Cramer's $V = .05$), religiosity ($\chi^2(1) = 0.65, p = .42$, Cramer's $V = .30$), relationship status ($\chi^2(1) = 2.55, p = .11$, Cramer's $V = .06$), mental health history ($\chi^2(1) = 2.30, p = .13$, Cramer's $V = .06$), childhood abuse ($\chi^2(1) = 1.70, p = .19$, Cramer's $V = .06$), age ($t(731) = 1.13, p = .19$, perceived threat $t(731) = 1.10, p = .27$, TI $t(657) = 1.10, p = .57$, and PD $t(674) = 0.87, p = .39$).

Measures

Background variables. Participants completed a brief demographic questionnaire assessing age, gender, income, education, religiosity, and history of mental health problems.

Perceived threat. Respondents were asked to rate at T₁ the degree to which they felt threatened by the rocket shelling from 0 (not at all) to 100 (very much).

Tonic Immobility Scale (TIS). Consistent with previous research^{32,41,46-48} TI was assessed at T₁ via three items of the TIS (i.e., *froze or felt paralyzed*, *felt unable to move even though not restrained*, and *unable to call out or scream*). Participants rated the items on a 7-point Likert scale ranging from “0 = not at all” to “6 = completely”^{35,49}. In this study, internal consistency was good ($\alpha = .79$).

Peritraumatic Dissociative Experiences Questionnaire (PDEQ). PD was assessed at T₁ via seven out of eight items of the PDEQ^{50,51}. Given that less than 1% of the sample had suffered a physical injury an item which refers to physical injury was omitted. In the present study, internal consistency was good ($\alpha = .85$).

Posttraumatic stress disorder (PCL-5). The PCL-5 was used to assess for PTSD symptoms at T₂⁵². The 20-item self-report measure asks participants to indicate the extent to which they experienced each PTSD symptom on a 5-point Likert scale ranging from “0 = *not at all*” to “4 = *extremely*.” Items correspond to PTSD criteria in the DSM-5⁷. The original version was adapted so that index event was the rocket shelling during Operation Guardian of the Walls. Research has suggested that a cut-off score of 33 is a useful threshold for indicating clinical symptomatology⁵³. The PCL-5 has good psychometric properties⁵³. Internal consistency was good in the current study for intrusion, avoidance, negative alterations in mood and cognition, and alterations in arousal and reactivity ($\alpha = .90, .88, .91$, and $.86$ respectively).

Control variables. Given that age^{8,9}, gender^{9,10}, childhood abuse^{11,12}, and mental health history¹¹ have been found to be related to PTSD, they were included as control variables in the mediation analyses. Participants were asked whether they had been diagnosed with a mental disorder prior to Operation Guardian of the Walls. History of childhood abuse was assessed via 15 items of the short form of the Childhood Trauma Questionnaire (CTQ-SF)⁵⁴, which refer to emotional, physical or sexual abuse.

Data analysis

We used SPSS 28 and PROCESS computational macro⁵⁵ to analyze the data. First, Pearson correlation tests (for continuous variables), independent sample t-tests, and chi-square tests with Yate's continuity correction (for dummy variables) were conducted to assess the

association between TI, PD, and PTSD symptoms. Next, we used a bootstrapping method with 5.000 bootstrap resamples in PROCESS (model 4⁵⁶). Bootstrapping is a nonparametric method that generates an estimate of the indirect effect, including a 95% confidence interval (CI). When zero is not in the 95% CI, one can conclude that the indirect effect is significantly different from zero at $P < .05$ (2-tailed). Thus, the effect of the independent variable (perceived threat) on the dependent variable (PTSD symptoms) is mediated by the proposed mediating variable (TI, PD)⁵⁶.

Results

At T₁, on average participants reported perceived threat, $M = 56.33$, $SD = 28.41$ [range: 0-100], PD, $M = 9.96$, $SD = 4.33$ [range: 5-35], and only low levels of TI, $M = .99$, $SD = 2.45$ [range: 0-18]. At T₂, 18.8% ($N = 39$) scored above the cut-off score for clinically significant PTSD symptoms. Of the total sample, 45.7% ($N = 95$) reported at least one intrusion symptom, 29.8% ($N = 62$) reported at least one avoidance symptom, 47.6% ($N = 99$) reported at least one symptom of negative alterations in mood and cognition, and 69.1% ($N = 143$) reported at least one arousal and reactivity symptom.

Intercorrelations for study variables are evident from Table 1. TI and PD had significant positive correlations of medium effect sizes with all PTSD symptom clusters. The higher the TI and PD level at T₁, the higher the PTSD symptoms level at T₂. Perceived threats also correlated positively with TI and PD, as well as with all PTSD symptom clusters, with small to medium effect sizes. Hence, the higher the perceived threat levels, the higher the TI, PD, and the PTSD symptoms level.

Table 2 and Figure 1 present the results of the mediation. Results showed that TI and PD mediated the relationship between perceived threat and intrusion, avoidance, and negative

alterations in mood and cognition, and that the direct effect of perceived threat became non-significant. Hence, TI and PD fully mediated these relationships.

On the other hand, results indicated that only PD mediated the relationship between perceived threat and alteration in arousal and reactivity, and that the direct effect of perceived threat became non-significant. Thereby, PD fully mediated the relationship between perceived threat and alterations in arousal and reactivity. Both the direct and indirect effect of TI on arousal and reactivity was non-significant.

Discussion

This study explored the relationship between perceived threat, TI, PD, and PTSD symptoms among civilians following exposure to war. Results showed that a substantial proportion of participants had scored above the cut-off score for clinically significant PTSD symptoms at follow-up, and many more exhibited subclinical symptoms of PTSD. Interestingly, TI and PD fully mediated the relationship between perceived threat and symptoms of intrusion, avoidance, and negative alterations in mood and cognition; but only PD mediated the relationship with alteration in arousal and reactivity.

Findings indicate that both TI and PD were at the basis of the link between perceived threat and intrusion, avoidance, and negative alterations in mood and cognition. Therefore, it appears that individuals who evaluated their exposure to rocket shelling as particularly threatening tended to experience TI and PD during the peritraumatic phase. Despite their potential defensive qualities, these reactions may negatively affect adjustment over time. A peritraumatic reaction of TI may enhance learning of avoidance^{28,44} and thus may increase the risk for avoidance PTSD symptoms. At the same time, as victims interpret their immobility as an inability to protect themselves²⁸, the reaction of TI may arouse feelings of guilt, which are part of the negative alterations in mood and

cognition PTSD cluster. Furthermore, blaming oneself for one's reaction during trauma exposure may result in rumination, which could fuel intrusion symptoms⁴⁴.

Similarly, PD may contribute to PTSD symptomatology^{11,57}. It has been argued that when PD occurs, the prefrontal cortex inhibits emotional processing in limbic structures like the amygdala, resulting in fragmented trauma memories^{25,58}. Difficulties with recalling a coherent chronological memory, in turn, may result in intrusion and negative alteration in mood and cognition, as the traumatic memories are replaced by impulsive sensations. Therefore, it is theorized that PTSD development is partly explained by the inability to process an event at a verbal and symbolic level following PD^{25,59,60}. It is important to note, however, that researchers have questioned the trauma fragmentation theory, as evidence to support this theory has been severely limited⁶¹. Rather than actual fragmented memories, empirical evidence suggested that the *perception* of fragmented trauma memories following PD during trauma, may be associated with PTSD development⁶¹. Thus, empirical investigations that rely on prospective and experimental studies and that include control groups, more rigorous designs, and precise definitions of dissociation and trauma fragmentation are needed to fully understand the link between PD and PTSD⁶¹.

Nevertheless, our results indicated that only PD mediated the relationship between perceived threat during the peritraumatic phase and arousal and reactivity symptoms at follow-up. These results support the notion according to which TI and PD are two distinct phenomena¹⁸, and suggest that PD might be underlying arousal symptoms among individuals who view traumatic events as particularly threatening. Several explanations might be offered for the present findings.

According to the first, it might be that, although both TI and PD underlie arousal and reactivity symptoms^{29,62}, the effects of PD are particularly strong, and therefore overshadow those of TI. Alternatively, it might be that, contrary to PD, TI does not underlie the linkage between perceived threat and arousal symptoms. This idea is consistent with the findings of Bovin and colleagues⁴⁴

which indicated that TI did not mediate the relationship between fear and arousal symptoms among sexual assault survivors. Bovin and colleagues⁴⁴ suggested that this finding reflects a reduced autonomic responding linked to TI, which has been documented in animal studies^{44,63,64}. However, as the psychophysiological correlates of TI vary by species, more research is warranted.⁴⁴

Another potential explanation offered by Bovin et al.⁴⁴ is that PTSD arousal symptoms might be dampened by the same process that promote PD^{45,65}. However, the current findings challenge this notion, as PD was found to mediate the relationship between perceived threat and elevated, rather than dampened, arousal.

According to theoretical models⁶⁶ and empirical studies^{45,65,67} PD is associated with decreased autonomic response, e.g., bradycardia. The DSM-5 has even included a dissociative-PTSD subtype⁷, characterized by chronic dissociation, which differs from the regular PTSD diagnosis, which is sometimes referred to as the reexperiencing/hyperaroused subtype⁶⁸. Nevertheless, studies have also demonstrated that PD is associated with later hyperarousal. For instance, Griffin and colleagues⁴⁵ found that trauma victims who experienced high PD reported elevated hyperarousal compared to a low-PD group. Yet, whereas the high-PD group exhibited similar physiological responses at baseline and when discussing a neutral topic, they exhibited significantly lower heart rates when talking about the traumatic event and in the time hereafter than did the low-PD group.

This discrepancy between self-reported arousal vs. physiological responses might reflect the implications of PD on emotional or behavioral arousal, manifested in irritable, aggressive, and reckless behaviors, as compared to its effects on physiological arousal, manifested in autonomic responses. It is plausible that PD reduces the ability to process the traumatic event and therefore fuels emotional and behavioral symptoms of arousal over time, but simultaneously dampens autonomic response in the face of trauma reminders. Hence, the current findings, which relied on

the self-reported measure (PCL-5⁵³), and did not incorporate autonomic responses assessment, might reflect the implications of PD for emotional and behavioral manifestations of arousal only.

Although the current findings yielded interesting results, they should be understood in light of their strengths and limitations. Obvious strengths include the prospective nature of the study, which allowed us to assess the peritraumatic reactions with limited risk of recall bias, and to examine symptom development in the posttraumatic phase. Nevertheless, this study suffers from several limitations. First, the study relied on self-report measures, rather than on a thorough clinical assessment. Second, the sample was a convenience sample collected online and thus not representative of all victims of the rocket shelling. The prevalence of childhood abuse and mental health problems was high in present study and female participants were overrepresented in the sample. Given the fact that we assessed three subtypes of childhood abuse (physical, emotional, and sexual), the present rates of childhood abuse seem to be consistent with global rates reported by the World Health Organization⁶⁹ (WHO). Yet, given that history of mental health was assessed via asking participants to report prior mental health problems, current rates are presumably elevated compared to clinically diagnosed mental health disorders. Furthermore, previous research has shown that women are more likely to develop PTSD than are men⁹. Hence, although the present study controlled for gender, it would be relevant to replicate the present findings in a male sample. Third, the presence of TI was small in the present sample, which might be explained by trauma type^{30,31}. Fourth, perceived threat was not measured by a validated measure. Hence, replicating these findings while utilizing validated measure is needed. Finally, the drop-out rate was high, which is, unfortunately, common for this type of study.

Despite the limitations mentioned, the present findings imply that individuals who evaluate the traumatic event as a substantial threat may benefit from clinical interventions provided during the peritraumatic phase, and that interventions that aim to weaken TI and PD may reduce their risk for

later PTSD symptoms. However, future research should replicate the present findings before we can draw any conclusions. In particular, future studies that explore the association between PD and arousal symptoms are necessary, given that its nature might be multifaceted.

Clinical points

- Perceived threat and peritraumatic reactions like tonic immobility (TI) and peritraumatic dissociation (PD) are associated with PTSD. Yet, their contribution in explaining different PTSD symptom clusters is not well understood.
- PD and TI mediated the relationship between perceived threat and different PTSD clusters. Interventions aiming to weaken TI and PD may reduce a client's risk for later PTSD.

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Table 1.

Intercorrelations between all study variables

	1.	2.	3.	4.	5.	6.	7.	8.	9.	10.	11.	12.
1. Age	1											
2. Gender[†]	2.24*	1										
3. Childhood abuse	.03	-.55	1									
4. Mental health history[†]	-1.47	.01	3.96***	1								
5. Threat	.02	-3.12**	.02	-1.38	1							
6. TI	-.10	-.30	.18**	1.86	.28**	1						
7. PD	-.20**	-2.2*	.32**	2.25**	.31**	.63**	1					
8. Intrusion	-.06	-3.28**	.26**	1.48	.32**	.47**	.50**	1				
9. Avoidance	-.05	-2.25*	.18**	1.96	.27**	.42**	.39**	.71**	1			
10. Negative alterations	-.08	-.76	.20**	-.76	.19**	.48**	.42**	.64**	.64**	1		
11. Arousal	.01	-1.46	.16*	.42	.23**	.35**	.40**	.68**	.55**	.71**	1	
12. PTSD symptoms[†]	1.26	.81	-2.83**	4.42*	-2.98**	-3.78***	-3.97***	-12.07***	-12.32***	-12.28***	-11.65***	1
Mean/%	37.68	81%	56.33	23.3%	56.33	.99	9.96	1.21	.46	1.33	1.89	18.8
SD/category	10.41	Women	28.41	Yes	28.41	2.45	4.33	1.68	.76	1.94	1.74	Yes

Note. * $p < .05$; ** $p < .01$; *** $p < .001$. [†] Intercorrelations between dummy variables was calculated using either an independent samples *t*-test, or the Chi square test for independence with Yate's continuity correction.

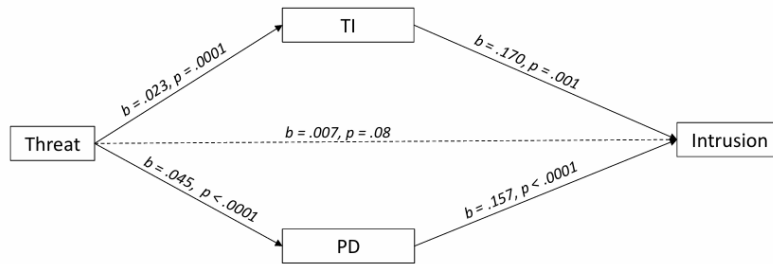
Table 2.

Indirect effects of TI and PD on the four symptom clusters

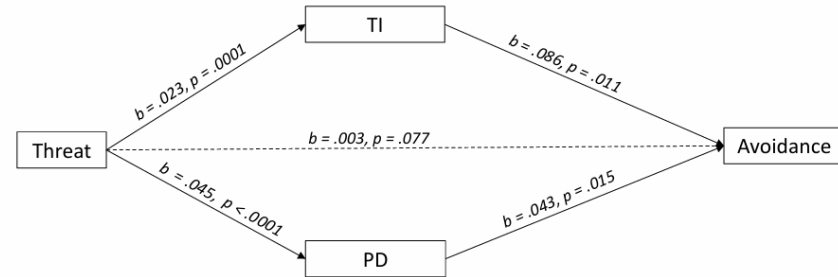
	Intrusion			Avoidance			Negative alterations			Arousal		
Indirect effect	β (SE)	95% CI		β (SE)	95% CI		β (SE)	95% CI		β (SE)	95% CI	
Threat → TI → PTSS	.004 (.002)	.001-.008		.002 (.001)	.001-.004		.006 (.003)	.002-.013		.002 (.002)	-.002 to .005	
Threat → PD → PTSS	.007 (.002)	.003-.012		.002 (.001)	.0003-.004		.006 (.003)	.001-.011		.008 (.002)	.004-.013	
Total indirect effect	.011 (.003)	.007-.016		.004 (.001)	.002-.006		.012 (.003)	.006-.018		.010 (.002)	.006-.015	
Total model	β (SE)	<i>p</i>	R^2	β (SE)	<i>p</i>	R^2	β (SE)	<i>p</i>	R^2	β (SE)	<i>p</i>	R^2
	.018 (.004)	<.0001	39%	.007 (.002)	.0002	26.6%	.014 (.005)	.005	29.5%	.015 (.004)	.001	25.3%

Note. Models controlled for age, gender, childhood abuse and previous mental health problems.

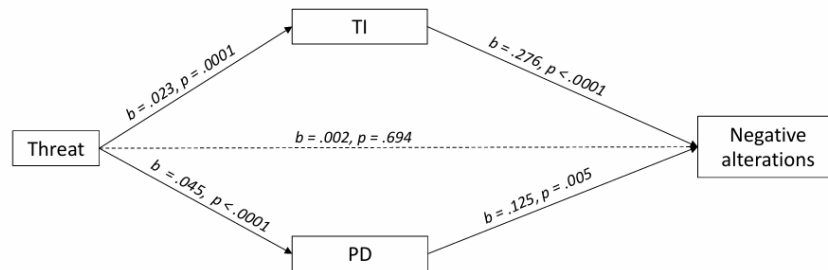
A. Intrusion



B. Avoidance



C. Negative alterations in mood and cognition



D. Alterations in arousal and reactivity

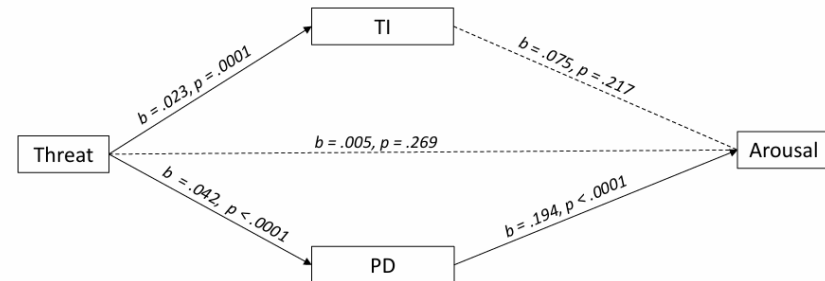


Figure 1.