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Wounds that Can't Be Seen: Implicit Trauma Associations Predict Posttraumatic Stress Disorder Symptoms

Kristen P. Lindgren¹, Debra Kaysen¹, Alexandra J. Werntz², Melissa L. Gasser¹, and Bethany A. Teachman²

Kristen P. Lindgren: KPL9716@uw.edu; Debra Kaysen: dkaysen@uw.edu; Alexandra J. Werntz: ajw3x@virginia.edu; Melissa L. Gasser: mlgasser@uw.edu; Bethany A. Teachman: bat5x@virginia.edu

¹University of Washington, Department of Psychiatry & Behavioral Sciences, 1100 NE 45th St, Suite 300, Seattle, WA 98105, USA

²University of Virginia, Department of Psychology, PO BOX 400400, Charlottesville, VA 22904, USA

Abstract

Background and Objectives—Prominent theories suggest that explicit and implicit cognitive biases are critical in the development and maintenance of posttraumatic stress disorder (PTSD). However, studies evaluating implicit PTSD-related cognitive biases are rare, and findings are mixed. We developed two adaptations of the Implicit Association Test (IAT), the “traumatized self” IAT (evaluations of the self as traumatized vs. healthy) and the “dangerous memory” IAT (evaluations of remembering as dangerous vs. safe), and investigated their psychometric properties and relations to PTSD symptoms and trauma exposure.

Methods—Participants were visitors to the Project Implicit research website. (Study 1: $N = 347$, Study 2: $N = 501$). They completed the IATs (Study 1: both IATs; Study 2: Traumatized Self IAT only), a trauma exposure measure, a PTSD symptom inventory, and explicit cognitive bias measures (Study 2 only).

Results—Both IATs had good internal consistency, but only the traumatized self IAT was correlated with PTSD symptoms and identified participants meeting clinical cutoffs for PTSD symptoms. Study 2 focused on the traumatized self IAT and included explicit cognitive bias measures. The IAT correlated with PTSD symptoms and explicit cognitions, and predicted variance in PTSD symptoms above and beyond trauma exposure and explicit cognitions.

Limitations—Study designs were cross-sectional; samples were unselected; and PTSD symptoms were self-reported.

Conclusions—Despite these limitations, these studies provide preliminary validation of an implicit measure of PTSD-related cognitive bias – the traumatized self IAT – that is consistent with PTSD theories and may ultimately improve the identification and treatment of individuals with PTSD.

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Corresponding Author: Kristen P. Lindgren, Ph. D., Center for the Study of Health & Risk Behaviors (CSHRB) University of Washington, School of Medicine, Department of Psychiatry & Behavioral Sciences 1100 NE 45th Street, Suite 300, Seattle, WA 98105, USA. KPL9716@uw.edu. Phone: +1.206.685.8083.

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Keywords

trauma; posttraumatic stress disorder; implicit cognition; Implicit Association Test

1. Introduction

Posttraumatic stress disorder (PTSD) has high personal and societal costs (Kessler, 2000), and there is a need for additional tools to identify and predict which individuals are vulnerable to developing PTSD (Gates et al., 2012). Self-report measures are common and well-validated tools, but are hampered by the potential for over- and under-reporting of symptoms. Therefore, we focus on implicit cognitive measures as novel tools that could aid in the prediction, identification, and ultimately, treatment of PTSD.

The use of implicit cognitive measures – a class of measures that are indirect – has increased greatly in psychopathology research (see Roefs et al., 2011). They capture aspects of cognition that are relatively reflexive, fast, spontaneous, and that may be less subject to conscious control and/or awareness. Thus, they appear to measure a different type of cognitive process than the reflective, slower, and/or controlled processes typically measured through self-report assessments. Surprisingly, there has been little published research about implicit cognitive measures and PTSD (for exceptions, see Engelhard, Huijding, van den Hout, & de Jong, 2007, Roth, Steffens, Morina, & Stangler, 2012). This is notable given the prominence of the role of cognitions in models of PTSD (e.g., Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000; Foa, Steketee, & Rothbaum, 1989). These models posit that changes in cognitive biases – both implicit and explicit – are key mechanisms in the development and maintenance of PTSD. Therefore, we sought to develop and validate an implicit measure of PTSD-related cognitions.

1.1 Implicit Cognitions and Anxiety

Interest in measuring implicit cognitive biases related to anxiety stems in part from cognitive theories of anxiety pointing to the uncontrollable nature of selectively processing potential threat cues by anxious individuals (e.g., Beck & Clark, 1997; Ehlers, Chen, Payne, & Shan, 2006; Michael, Ehlers, & Halligan, 2005). Developing measures that can access and reflect this less controlled processing thus allows for novel theoretical tests, and from a clinical assessment perspective, using implicit measures can help overcome self-report biases due to lack of conscious insight, introspection ability, or impression management (i.e., seeking to present oneself in a particular manner).

The Implicit Association Test (IAT; Greenwald, McGhee, & Schwartz, 1998) is widely used in the social cognition field to assess memory associations that are more difficult to consciously control. The IAT has been increasingly applied in the anxiety disorders field (see reviews in Roefs et al., 2011; Teachman, Joormann, Steinman, & Gotlib, 2012). Disorder-specific implicit associations, as measured by the IAT or related tasks, appear to differentiate among persons with versus without specific fears or phobias (Teachman, Gregg, & Woody, 2001), persons with social anxiety (de Jong, 2002), anxiety sensitivity (Teachman, 2005), and panic disorder (Teachman, Smith-Janik, & Saporito, 2007). Moreover, these implicit associations predict avoidance behavior above and beyond self-report symptom measures (e.g., Teachman, 2007) and change over the course of successful treatment (e.g., Teachman & Woody, 2003). The extent of change in implicit associations appears to predict subsequent symptom reduction during treatment (Teachman, Marker, & Smith-Janik, 2008). Thus, these measures show promise for illuminating important aspects of a disorder. However, there has been little work examining implicit associations in the domain of PTSD.

1.2 Cognition and Theories of PTSD

Many theories of the etiology and maintenance of PTSD symptoms point to the importance of cognitions. A hallmark of PTSD is exposure to a traumatic event; however, the vast majority of trauma-exposed individuals do not develop PTSD (e.g., Kessler, Sonnega, Bromet, Hughes, & Nelson, 1995). Consequently, many theories propose that cognitive changes resulting from trauma exposure or pre-existing maladaptive cognitive styles play a critical role in the development of PTSD (see Dalgleish, 2004; Elwood, Hahn, Olatunji, & Williams 2009). These theories include schema models (e.g., Janoff-Bulman, 1985), associative network models (e.g., Foa et al., 1989), and integrative models (e.g., Ehlers & Clark, 2000).

Several PTSD theories suggest that memories of the traumatic event and interpretations of one's PTSD symptoms or the consequences of the traumatic event become associated with automatically activated negative appraisals (Brewin et al., 1996; Ehlers & Clark, 2000; Foa et al., 1989). Although different theories emphasize and/or posit different types of negative appraisals, there is often a focus on the memory of the traumatic event (e.g., Halligan, Michael, Clark, & Ehlers, 2003), such that the memory of the traumatic event is viewed as dangerous or threatening (Foa & Rothbaum, 1998). Thus, it may be that individuals with PTSD are more likely to have implicit associations connecting memory to danger than individuals without PTSD.

Trauma exposure may also disrupt beliefs about self: several theories implicate rigid or extreme beliefs about the self as inadequate, incompetent, or damaged in the development of PTSD (see Brewin et al., 1996; Dunmore, Clark, & Ehlers, 2001; Foa & Rothbaum, 1998). Trauma exposure is thought to change previously positive views of the self or reinforce negative views (Brewin et al., 1996; Foa & Rothbaum, 1998; Resick & Schnicke, 1993). Along these lines, negative appraisals of the self are associated with PTSD and prospectively predict PTSD following trauma exposure (Bryant & Guthrie, 2007; Dunmore et al., 2001; Foa et al., 1999; Owens, Chard, & Cox, 2008). Negative self-appraisals have traditionally been measured using explicit measures, but theories note that negative associations about the self can be automatically activated (Brewin et al., 1996; Ehlers & Clark, 2000; Resick & Schnicke, 1993). Consequently, individuals with PTSD may be more likely to have implicit associations with the self as traumatized or damaged than individuals without PTSD.

1.3 Implicit Associations & PTSD

Despite the increasing emphasis on implicit cognitive measures in anxiety research and the prominence of cognition in theories of PTSD, few published studies have examined implicit PTSD-related associations, and findings have been mixed. For example, Engelhard and colleagues (2007) adapted the IAT to measure associations with the self and vulnerability (vs. invulnerability) among a sample of Dutch soldiers deployed to Iraq. Pre-deployment IAT scores did not significantly predict clinician- or self-evaluated PTSD symptoms at either five- or 15-months post-deployment. However, post-deployment IAT scores were significantly correlated with clinician-rated, but not self-rated, PTSD symptoms at the concurrent (five month) assessment. In this prospective study of trauma-exposed combat veterans, implicit vulnerability associations were not a consistent or strong predictor of PTSD symptoms. Roth and colleagues (2012) also studied trauma-exposed participants, examining implicit self-esteem using an IAT. Findings were mixed. Participants with current PTSD had lower implicit self-esteem than participants who never met criteria. However, IAT scores did not differ significantly between current and past PTSD participants, or between past PTSD participants and participants who never met criteria. A final study, which included participants from the Netherlands Study of Depression and Anxiety, used the

IAT to measure implicit self-depression and self-anxiety associations (van Harmelen et al., 2010). Although not a study of PTSD specifically, the study focused on a trauma that is often a risk factor for PTSD: childhood abuse. Implicit negative self IAT scores were positively related to a history of childhood abuse and partially mediated the relationship between childhood emotional maltreatment and symptoms of anxiety and depression. PTSD symptoms were either not evaluated or not reported in this study; thus, their relation to IAT scores is unknown.

These studies are the only published studies of which we are aware that address – even indirectly – whether implicit associations measured by the IAT predict PTSD symptoms and/or trauma exposure. Findings are inconsistent, and the studies vary in their samples, design, and specific associations measured. Accordingly, we tested two adaptations of the IAT that were derived from prominent models of PTSD, investigating their predictive validity with self-reported PTSD scores.

1.4 Overview of Studies

Given the promise of implicit cognitive measures, the need for additional tools for identifying and predicting PTSD, and the theoretical importance of cognitive biases in the development and maintenance of PTSD symptoms, we sought to validate a novel implicit measure of PTSD-related cognitive bias. We focused on the IAT because it is widely-used and has reliable psychometric properties. Two trauma-related IATs were developed – a traumatized self IAT and a dangerous memory IAT. We expected that they would have good internal consistency and be positively correlated with self-reported PTSD symptoms.

2. Study 1

2.1 Method

2.1.1 Participants—Participants included 347¹ visitors (69% female; mean age=31.4, $SD=13.0$; 73% United States citizens) to the Project Implicit research website (<https://implicit.harvard.edu/implicit/>) between April 26, 2012 and May 10, 2012. Visitors volunteered to complete a research study at Project Implicit, and were then randomly assigned to this study (it was one of several studies available at the time) if they were 18 and older and fluent in English.

Participant ethnicity was reported as: 73% Not Hispanic or Latino, 12% Hispanic or Latino, and 15% reported other or unknown, or did not report ethnicity. Individuals reported race as 72% Caucasian or white, 9% as more than one race, 7% as African American or Black, 5% as other or unknown, 5% as Asian, < 1% as Native Hawaiian or other Pacific Islander, and < 1% as American Indian or Alaska Native. Education was reported as 11% having no college, 43% having some college or an associate's degree, 25% as having a bachelor's degree or some graduate school, and 20% as having an advanced degree. Although not representative of a specific population, Project Implicit samples are more diverse than a typical collegiate sample, and several studies support Project Implicit's approach to web-based data collection (see Nosek et al., 2007b; 2009).

¹Four hundred and four individuals were randomly assigned to this study; 347 consented to participate and saw the questionnaires; 313 continued to the first randomly assigned IAT instruction page; and 254 individuals continued to the second IAT instruction page. Two hundred and twenty-four (65% of consenters) individuals completed all of the study tasks and 223 continued through the first debriefing page. These completion ratings are typical of online data collection. Completers and non-completers were compared with respect to gender, age, education level, race, and ethnicity; no significant differences were observed.

2.1.2 Measures and materials

Trauma Exposure: Trauma exposure was evaluated with the 17-item Life Events Checklist (LEC; Blake et al., 1995). It consists of 16 examples (e.g., natural disaster, physical assault) of PTSD-related or distressing personal experiences. One item is used to indicate any unlisted but similarly distressing incident. Total trauma exposure was the sum of the number of items that participants indicated experiencing in their lifetime. The measure has good convergence with other measures of trauma exposure/history (see Gray, Litz, Hsu, & Lombardo, 2004).

PTSD Symptoms: PTSD symptoms were measured with the 17-item PTSD Checklist–Specific (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996; Weathers, Litz, Herman, Huska, & Keane, 1993). Items evaluate DSM-IV PTSD symptoms over the last month on a 5-point scale (1=*Not at all* to 5=*Extremely*). Participants were asked to evaluate their symptoms in relation to their worst traumatic event as identified on the trauma exposure measure. The final item was not administered due to a programming error. Alpha (in current sample) = .93.

Implicit Association Tests: The Implicit Association Test (IAT; Greenwald et al., 1998) measures the relative strength of association between constructs. The traumatized self IAT assessed how strongly the participant associated the self (vs. others) with traumatized versus healthy. During the task, participants are shown exemplar words from one of four categories one at a time in the center of the screen, and are asked to sort them into categories using two keys. There are two critical conditions during the task; in one, participants sort words fitting either the categories trauma or me using one key and words fitting either the categories healthy or not me using the other key. In the other condition, trauma and not me words are sorted using one key while healthy and me words are sorted using the other key. The difference in reaction time to classify the words between the two conditions is taken as a measure of the strength of associations. Individuals who implicitly associate the self with traumatized are expected to have faster response times in the trauma+me (and healthy +not me) condition than in the trauma+not me (and healthy +me) condition. The IAT scoring algorithm creates a *D* score; the difference between mean latencies of the critical blocks divided by the pooled standard deviation of the blocks (see Greenwald, Nosek, & Banaji, 2003). The format of the IAT followed the current standard: seven blocks with 20 or 40 trials depending on the block (for details, see Lane, Banaji, Nosek, & Greenwald, 2007).

Categories and word stimuli for the traumatized self IAT were me (self, me, my, mine), not me (not me, other, they, them), traumatized (traumatized, damaged, broken, distressed), and healthy (healthy, adjusted, capable, whole). This IAT was intended as a measure of implicit negative self-appraisal. Stimuli were derived from other self-appraisal or self-concept IATs (e.g., Devos, 2006; Greenwald & Farnham, 2000; Lindgren, et al., 2012), clinical examples from two-study co-authors (Kaysen & Lindgren), and self-report measures of PTSD-related cognitions. Categories and stimuli for the dangerous memory IAT were remember (remember, memories, recall, reminders), forget (forget, avoid, ignore, suppress), dangerous (dangerous, threatening, hurtful, scary), and safe (safe, fine, harmless, manageable). This IAT was intended as a measure of implicit fear about remembering, given the centrality of intrusive trauma memories in PTSD. Stimuli were for this IAT were adapted from other anxiety-related IATs (e.g., Teachman et al., 2001), clinical examples from study co-authors, and PTSD intrusive symptoms assessments. Final stimuli were selected and adjusted in accordance with recommended practices by Nosek et al. (2007a).

IAT data were screened for participants who responded too rapidly, made too many errors, and/or had missing data, following recommendations from Greenwald et al. (2003) and

Nosek et al. (2007a). For the traumatic self IAT, 20 out of 243 IAT scores were flagged. For the dangerous memory IAT, 35 out of 243 scores were flagged. Analyses were run with and without those participants. Because the results were unchanged, all participants were retained in analyses.

2.1.3 Procedure—Following informed consent, participants completed the trauma exposure questionnaire. If participants endorsed one or more traumatic events, they were administered the PTSD symptom questionnaire, followed by the trauma-self IAT and the danger-remember IAT in random order. If participants did not endorse a traumatic event, they only completed the IATs. At the study's conclusion, all participants were debriefed and given the option to receive information about their IAT results (standard at the Project Implicit website).

2.2 Results and Discussion

Please see Table 1 for descriptive statistics and Pearson correlations among primary variables.

2.2.1 Psychometric properties of the IATs—Average traumatized self IAT scores indicated that participants were more likely to associate “healthy” with “me” (and “traumatized” with “not me”) than “traumatized” with “me” (and “healthy” with “not me”). Average dangerous memory IAT scores indicated that participants were more likely to associate “safe” with “remember” (and “dangerous” with “forget”) than “dangerous” with “remember” (and “safe” with “forget”). Internal consistencies for each IAT were calculated by correlating two separate IAT scores (for each IAT) consisting of alternating couplets of trials. Internal consistencies were .69 for the traumatized self IAT and .77 for the dangerous memory IAT ($p < .001$), indicating good reliability. The correlation between the IATs was modest.

2.2.2 Relations between the IATs, trauma exposure, and PTSD symptoms—

Traumatized self IAT scores were positively and significantly correlated with PTSD symptoms, but were not significantly correlated with trauma exposure, indicating that reactions to trauma are key versus trauma exposure, per se, as would be expected by PTSD theories. Dangerous memory IAT scores were not significantly correlated with PTSD symptoms or trauma exposure.

Whether IAT scores differed as a function of PTSD symptoms was also examined using independent samples t-tests. We compared those who did and did not meet the PTSD clinical cutoff (e.g., a score of 44 or more, following Blanchard et al., 1996). Participants who met the PTSD clinical cutoff had higher traumatized self IAT scores ($M = -0.36$, $SD = .42$, $n = 33$) than those below the cutoff ($M = -0.63$, $SD = .35$, $n = 176$), $t(207) = 2.46$, $p < .001$, Cohen's $d = .56$. There were no significant differences in dangerous memory IAT scores as a function of meeting the PTSD clinical cutoff, $t(207) = .50$, $p = .62$, Cohen's $d = .07$.

Finally, a two-step hierarchical linear regression model was used to test whether IAT scores predicted PTSD symptoms after controlling for gender and trauma exposure. Both factors are consistent, strong predictors of PTSD: women have higher rates of PTSD than men, and higher rates of prior trauma exposure are linked to greater likelihood of PTSD (see Kessler et al., 1995; Olff, Langeland, Draijer, & Gersons, 2007). Analyses were limited to the traumatized self IAT because only it was related to PTSD symptoms. Gender and trauma exposure were entered in the first step; IAT score was entered in the second step. The full model predicted 13% of the variance in PTSD symptoms, and R^2 change for entering IAT scores was significant, $F_{\text{change}}(1, 204) = 8.64$, $p = .004$. Trauma exposure and IAT scores

predicted unique variance in PTSD symptoms: greater number of traumatic experiences predicted higher PTSD symptoms, $B=1.41$, $SE=0.32$, $p<.001$, Cohen's $d=.61$, and higher traumatized self IAT scores predicted higher PTSD symptoms, $B=6.69$, $SE=2.28$, $p=.004$, Cohen's $d=.41$. Gender was not significant, $B=-.20$, $SE=1.90$, $p=.92$, Cohen's $d=.01$.

2.2.3 Summary and discussion—Results provided preliminary support for the validity of the traumatized self IAT but not for the dangerous memory IAT. Both IATs had good internal consistency, but only the traumatized self IAT was related to PTSD symptoms. The traumatized self IAT was also related to PTSD symptoms even after controlling for trauma exposure and gender. That IAT also distinguished between participants above or below clinical cutoffs for PTSD.

We sought to replicate and extend Study 1 by including two measures of explicit negative cognitions: the negative self subscale of the Posttraumatic Cognitions Inventory (Foa et al., 1999), and semantic differential items that evaluate how healthy versus traumatized participants view themselves and view others. This extension allowed us to investigate whether the traumatized self IAT correlated with its explicit counterparts and whether it accounted for unique variance in PTSD symptoms after controlling for explicit cognitions. We expected that the traumatized self IAT would be positively correlated with the explicit measures and that it would account for unique variance in PTSD symptoms after controlling for explicit negative self cognitions. Study 2 also addressed a limitation of Study 1, the inadvertent omission of the final item on the PTSD symptom inventory.

3. Study 2

3.1 Method

3.1.1 Participants—Participants were 501² visitors (61% female; mean age=32.8, $SD=12.0$; 60% United States citizens) to the Project Implicit research website from July 30, 2012 to August 9, 2012. Individuals under 18 and those that participated in Study 1 were ineligible. Seventy-four percent of participants were Not Hispanic or Latino, 7% were Hispanic or Latino, 19% reported other or unknown ethnicity, or did not report ethnicity. Individuals reported race as 68% Caucasian or white, 11% as Asian, 8% as more than one race, 7% as black or African American, 4% as other or unknown, <1% as American Indian or Alaska Native, Native Hawaiian, or other Pacific Islander. Eight percent had no college education, 31% had some college or an associate's degree, 36% had a bachelor's degree or some graduate school, and 25% had an advanced degree.

3.1.2 Measures and materials

Trauma Exposure: Trauma exposure was measured using the Life Events Checklist (Blake et al., 1995).

PTSD Symptoms: The PTSD Checklist-Specific (Blanchard et al., 1996; Weathers et al., 1993) measured PTSD symptoms. Alpha = .93.

Explicit Trauma Cognitions: The Negative Cognitions about Self subscale from the Posttraumatic Cognitions Inventory (Foa et al., 1999) was used because it is a reliable and widely-used measure of explicit cognitive bias. It has 21 post-trauma thoughts about the self

²Of the 608 individuals randomly assigned to the current study, 501 consented to participate; 486 continued to the questionnaires; 395 individuals continued to the IAT instructions or the semantic differential items; and 342 individuals completed both tasks. Two hundred and eighty-five (57% of consenters) completed the study and saw the first debriefing page. Completers and non-completers were compared with respect to gender, age, education level, race, and ethnicity; no significant differences were observed.

(e.g., “My life has been destroyed by the trauma,”), each rated on a 7-point scale (1= *Totally disagree* to 7= *Totally agree*). $\alpha=.95$.

IAT: Only the traumatized self IAT was administered. IAT data were again screened for problematic scores. Thirty-nine participants were flagged. Analyses were run with and without those participants. Because the results were unchanged, all participants were retained.

Trauma Self Differential: To enable a more direct implicit/explicit comparison, semantic differential items were developed to assess the same relative evaluations as the IAT. Participants reported “to what extent do you think of *yourself* as traumatized or healthy?” and “to what extent do you think of others as traumatized or healthy?” on a 9-point Likert scale (from *extremely traumatized* to *extremely healthy*). A difference score that matched the IAT’s structure was created (“trauma self differential”), with higher scores indicating stronger self-as-traumatized explicit evaluations.

3.1.3 Procedure—Project Implicit visitors were randomly assigned to the study. Following informed consent, participants completed the trauma exposure questionnaire. Those endorsing at least one traumatic experience completed the PTSD symptom inventory and the explicit trauma cognitions questions before completing the trauma-self IAT and semantic differential items in random order. Participants who did not endorse a traumatic experience only completed the IAT. All participants were debriefed and given the opportunity to view feedback describing their IAT results.

3.2 Results and Discussion

Please see Table 2 for descriptive statistics and correlations among primary variables.

3.2.1 Psychometric properties of the IAT—Average IAT scores again indicated participants have stronger associations with “healthy” and “me” than with “traumatized” and “me.” Internal consistency was calculated using split-half reliability (see Section 2.2.1), $r=.65$, $p<.001$.

3.2.2 Relations between the IAT and other study variables—As expected, the traumatized self IAT was positively and significantly correlated with the trauma self semantic differential and the negative self cognitions subscale. Consistent with Study 1, IAT scores were positively and significantly correlated with PTSD symptoms but not with trauma exposure. Next, the three subscales of the PTSD checklist (re-experiencing, avoidance, and hyperarousal symptom subscales) were examined; the IAT was positively and significantly correlated with each subscale.

3.2.3 The IAT and PTSD clinical cutoff—We tested for differences in IAT scores as a function of PTSD symptoms using a series of independent samples t-tests. Participants who met the PTSD clinical cutoff of 44 or more had higher IAT scores ($M=-.46$, $SD=.39$, $n=50$) than participants scoring below the cutoff ($M=-.75$, $SD=.31$, $n=240$), $t(288)=5.66$, $p<.001$, Cohen’s $d=.67$. Next, we examined whether participants meeting PTSD criteria for intrusive, avoidance, or hyperarousal symptoms (scoring a three or more on at least one, three, or two subscale items, respectively; see Orsillo, 2001; Weathers et al., 1993) differed in their IAT scores compared to those who did not meet criteria. For each symptom subscale, results indicated that participants had higher IAT scores if they met criteria compared to those who did not meet criteria: intrusion, $t(288)=5.89$, $p<.001$, Cohen’s $d=.69$; avoidance, $t(288)=4.64$, $p<.001$, Cohen’s $d=.55$, and hyperarousal, $t(288)=4.70$, $p<.001$, Cohen’s $d=.55$.

3.2.4 The IAT as a unique predictor of PTSD symptoms—Finally, a three-step hierarchical linear regression model was used to test whether IAT scores predicted PTSD symptoms after controlling for gender, trauma exposure, and explicit cognitions, and whether there was significant explicit x implicit interaction. All control variables were entered in the first step. The IAT score was entered in the second step. The IAT x explicit interaction was entered in the third step. We used only the negative self cognitions scale as our measure of explicit trauma self cognitions because it is a well-established and validated measure, providing a rigorous test of the IAT's incremental validity. See Table 3. The addition of the IAT score in step two was significant, $F_{\text{change}}(1, 284)=12.52, p<.001$, indicating that the IAT predicts incremental variance in PTSD symptoms. The addition of the IAT x explicit cognitions interaction in step 3 was also significant, $F_{\text{change}}(1, 283)=5.16, p=.024$, such that the IAT was a stronger predictor of PTSD symptoms among participants at higher versus lower levels of explicit cognitions (see Figure 1).

3.2.5 Summary and discussion—Study 2 results replicated key findings from Study 1, including the good inter-item consistency, and predictive and incremental validity of the traumatized self IAT. Findings also indicated that traumatized self IAT scores were correlated with PTSD symptom subscales and with explicit trauma cognitions. Finally, regression analyses supported the incremental predictive validity of the IAT when controlling for trauma exposure, gender, and explicit cognitions.

4. General Discussion

The purpose of the current studies was to validate a novel implicit measure of PTSD-related cognitive bias; in particular, to develop and evaluate two trauma-related IATs (the traumatized self IAT and the dangerous memory IAT). In Study 1, we investigated both IATs and expected that they would have good internal consistency and be positively correlated with self-reported PTSD symptoms. Our hypotheses were supported with respect to the traumatized self IAT, which was both internally consistent and positively associated with PTSD symptoms. Moreover, analyses indicated that the traumatized self IAT differentiated between participants meeting (vs. not meeting) clinical cutoffs for PTSD symptoms. In contrast, the dangerous memory IAT findings were only partially consistent with hypotheses. It had reasonable internal consistency, but was not significantly correlated with PTSD symptoms. Additionally, the dangerous memory IAT did not differentiate between participants above versus below clinical cutoffs for PTSD symptoms. Collectively, Study 1 findings were supportive of the validity of the traumatized self IAT but not the dangerous memory IAT.

Given the encouraging findings for the traumatized self IAT in Study 1, a follow up study was undertaken. In addition to seeking to replicate Study 1's findings, Study 2 assessed how the IAT correlated with two explicit measures of negative self cognitions (counterparts to the traumatized self IAT) and investigated whether the IAT accounted for incremental variance in PTSD symptoms after controlling for those explicit measures. We predicted that the IAT would be positively correlated with the explicit measures and would account for incremental variance in PTSD symptoms after controlling for explicit negative self cognitions. The results of Study 2 were consistent with hypotheses. Ultimately, findings from both studies provide promising but preliminary support for the validity of the traumatized self IAT as an implicit measure of PTSD-related cognitive bias.

Beyond testing the validity of these novel IATs, this study adds to our understanding of implicit and explicit trauma associations in unique ways. First, by including measures of trauma exposure, it was possible to investigate whether or not trauma exposure was related to IAT scores. Findings from both studies indicated that trauma exposure was not

significantly related to the traumatized self IAT (or to the dangerous memory IAT in Study 1), consistent with findings that trauma exposure *per se* is not sufficient to lead to PTSD. Second, the current findings are also consistent with (and extend) prior literature in that the magnitude of the correlations between the traumatized self IAT and the explicit measures of PTSD-related cognitive bias were consistent with implicit-explicit correlations reported in IAT meta-analyses (see Greenwald, Poehlman, Uhlmann, & Banaji, 2009). Third, evaluating both the traumatized IAT and explicit measures allowed for identification of a moderation effect, with IAT scores being stronger predictors of PTSD symptoms when participants had higher levels of explicit negative cognitions. The effect was small and the analysis was exploratory, and as such, should be replicated in future studies.

4.1 Theoretical Implications

The consistent findings for the traumatized self IAT have several theoretical implications. First and foremost, the traumatized self IAT findings extend research showing that explicit self-appraisals are linked to PTSD (e.g., Dunmore et al., 2001; Foa et al., 1999; Owens et al., 2008). Critically, the current findings suggest that negative self-appraisals are accessible (and measurable) at an implicit level, consistent with cognitive models pointing to the importance of automatically activated negative associations about the self (e.g., Brewin et al., 1996; Ehlers & Clark, 2000; Resick & Schnicke, 1993). Moreover, findings that the traumatized self IAT predicted PTSD symptoms above and beyond explicit cognitions argue for the value of assessing both implicit and explicit self-cognitions in PTSD and trauma research. This recommendation is further bolstered by the fact that the magnitude of the positive correlations between the IAT and explicit counterparts was small to moderate, suggesting that the measures are capturing overlapping but distinct, and uniquely informative constructs. [Please note that throughout these studies, we refer to the traumatized self IAT and the traumatized self semantic differential as measuring traumatized self associations/appraisals. However, both measures are relative in nature, thus these associations can validly be simultaneously interpreted as a preferential association with others and healthy. We emphasize the traumatized self associations for simplicity and because information about the self has a tendency to be processed preferentially (see Baumeister, 1998).]

Second, findings from the studies also suggest several promising areas for future research. For example, determining which aspects of PTSD are better predicted by implicit versus explicit cognitions will be an important next step. This study cannot answer this question, but the double dissociation hypothesis (see Asendorpf et al., 2002; Roefs et al., 2011) offers hints. This hypothesis suggests that implicit measures will be more predictive when outcomes are difficult to consciously control, or when individuals have limited resources to exert cognitive control, while explicit measures will be more predictive when responses are more readily controllable. Thus, intrusive symptoms (by definition, unbidden) may be particularly associated with implicit associations. Future work should also investigate more interactions between implicit and explicit PTSD cognitive measures. Here, the IAT was a stronger predictor of PTSD symptoms among participants with high levels of explicit cognitions, perhaps pointing to a double cognitive vulnerability, but this effect was small and replication will be important. Future studies that delineate which implicit association measures most consistently predict different types of PTSD-relevant symptoms (e.g., intrusive vs. avoidance vs. hyperarousal) and stages (e.g., pre-trauma vulnerability marker vs. post-trauma risk factor vs. post-treatment response indicator, etc.) will be helpful. This will be important clinically and will help clarify inconsistent findings in studies that previously tried to assess implicit PTSD-relevant associations (Engelhard et al., 2007; Roth et al., 2012).

Finally, the lack of support for the dangerous memory IAT also has potentially important implications. Such a lack of support runs counter to PTSD theories emphasizing negative appraisals of the memory of the traumatic event (e.g., Halligan et al., 2003). It may be that negative appraisals predict PTSD symptoms when expressed explicitly (e.g., Dunmore et al., 2001; Ehlers et al., 1998), but not at an implicit level. However, it is also possible that methodological factors might explain the null results. The dangerous memory IAT may not have assessed associations tied to memories *about the trauma* as dangerous, but instead measured associations about memories as a more global/general construct. Also, the relative nature of the IAT may have made it challenging to assess evaluations of memories as dangerous. Specifically, the category remember was contrasted with forget in this study, and it may be that persons with PTSD symptoms think that both remembering and forgetting are dangerous. Thus, before concluding that negative appraisals of traumatic memories are not instantiated implicitly, it may be helpful to use a different implicit measure that does not require an explicitly-labeled contrast category (e.g., the Brief IAT; Sriram & Greenwald, 2009) and/or to more clearly invoke associations tied to traumatic memories.

4.2 Clinical Implications

Although study findings are preliminary - they are cross-sectional and based on self-reported symptoms - they have important clinical implications, especially as the diagnosis of PTSD moves toward including the effects of trauma on cognitions. First, there is a need to better identify those at risk for developing PTSD, either prior to trauma exposure or shortly thereafter. Earlier and improved identification would allow clinicians to better target prevention and early intervention efforts toward those most at risk. The promising findings for the traumatized self IAT suggest that it could represent a possible risk factor. Future research should evaluate the traumatized self IAT in at-risk populations, such as first responders or active duty military, as well as evaluate the traumatized self IAT prospectively for those who have been trauma-exposed. Such research would provide important information about the development of implicit traumatized self associations in relation to trauma exposure and PTSD. For example, do such associations precede and/or increase as a function of trauma exposure? Do they precede and/or increase as a function of PTSD symptoms?

Second, study results also highlight the import of addressing negative self-appraisals in treatment. Both cognitive and behavioral interventions for PTSD have been found to change explicit trauma-related cognitions (Bryant, Moulds, Guthrie, Dang, & Nixon, 2003; Foa & Rauch, 2004). The dearth of research on implicit measures of PTSD-related cognitions means that whether or how implicit cognitions respond to existing treatment is an open question. Future research should examine whether interventions change implicit traumatized self associations and whether a lack of (or minimal) change in those associations might be a marker for potential relapse or poorer treatment response. Assessment of those associations may not only provide useful, additional information about response to treatment, but may also provide helpful information regarding treatment matching, including who might be better served by predominantly cognitive versus behavioral interventions (Ehlers, Clark, Dunmore, Jaycox, Meadows, & Foa, 1998).

4.3 Limitations and Conclusion

Several limitations should be noted. First, the data are cross-sectional in nature, which means that the temporal or causal link between implicit PTSD associations and symptoms cannot be established. It will be important to investigate the traumatized self IAT (and/or other implicit PTSD-related cognitions) using prospective designs. Other study limitations include the lack of measures to assess other cognitive biases also implicated in PTSD theories (e.g., misperceived estimates of threat or danger, catastrophic thinking) and the use

of unselected samples. Also, our trauma exposure measure assessed lifetime exposure, so we cannot evaluate when the exposure occurred. Use of high-risk and clinical samples followed prospectively, and obtaining information about when trauma exposure occurred, will be important next steps. Further, this study validated several aspects of the IAT, but other psychometric properties need to be evaluated (e.g., test-retest reliability, convergent validity with other related implicit measures). Despite these limitations, study findings provide preliminary validation of an implicit measure of PTSD-related cognitions, indicating that the traumatized self IAT has reasonable internal consistency, is positively associated with self-reported PTSD symptoms, differentiates between individuals as a function of PTSD clinical cutoff scores, and predicts significant incremental variance in PTSD symptoms even after controlling for trauma exposure and explicit measures of negative self cognitions. Ultimately, it is hoped that the traumatized self IAT could bolster PTSD diagnostic and treatment efforts.

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- We developed and tested two PTSD-related Implicit Association Tests (IATs).
- They were internally consistent and one (traumatized self) predicted PTSD symptoms.
- It also predicted symptoms after controlling for trauma exposure and explicit bias.
- Study findings provided initial validation of the traumatized self IAT.
- Findings are also consistent with theories of PTSD etiology and maintenance.

Figure 1.
Interaction of IAT scores and Explicit Cognitions. Low and High groups indicate ± 1 SD from the mean.

Table 1

Descriptives and Zero-order Correlations for Study 1 Variables

Measure	1	2	3	4	M	SD
1. Traumatized Self IAT	--	.26***	-.04	.20***	-.58	.37
2. Dangerous Memory IAT		--	-.11	.06	-.67	.38
3. Trauma Exposure			--	.33***	4.94	2.85
4. PTSD Symptoms				--	31.70	12.96

Note. IAT = Implicit Association Test. PTSD = Posttraumatic Stress Disorder. Higher IAT scores = relatively stronger associations with trauma and me (Traumatized Self IAT) or with remember and danger (Dangerous Memory IAT). Trauma Exposure = number of traumatic events endorsed on the trauma assessment portion of the Clinician-Administered PTSD (CAPS) scale. PTSD symptoms were assessed using the PTSD Checklist (PCL). The total score is missing the last item from the PCL due to an error in administration.

* $p < .05$.
** $p < .10$.
*** $p < .001$

Table 2

Descriptives and Zero-order Correlations for Study 2 Variables

Measure	1	2	3	4	5	6	7	8	M	SD
1. Traumatized Self IAT	--	.18**	.37***	.04	.37***	.31***	.30***	.33***	-.70	.34
2. Trauma Self Differential		--	.46***	.04	.38***	.25***	.36***	.32***	-.55	2.02
3. Explicit Trauma Cognitions			--	.12*	.65***	.50***	.62***	.52***	43.81	23.43
4 Trauma Exposure				--	.26***	.24***	.17***	.17***	4.83	2.77
5. PTSD Symptoms					--	.83***	.87***	.82***	31.34	12.88
6. Re-experiencing Subscale						--	.67***	.62***	.98	1.50
7. Avoidance Subscale							--	.63***	1.63	1.89
8. Hyperarousal Subscale								--	1.25	1.49

Note.

IAT = Implicit Association Test. PTSD = Posttraumatic Stress Disorder. Higher IAT scores = stronger associations with trauma and me. Trauma Self Differential = difference score of ratings of how traumatized one sees one's self versus others, higher scores indicate higher ratings of self as traumatized. Explicit cognitions = the negative self subscale of the Posttraumatic Cognitions Inventory. Trauma Exposure = number of traumatic events endorsed on the trauma assessment portion of the Clinician-Administered PTSD (CAPS) scale. PTSD symptoms were assessed using the PTSD Checklist (PCL).

* $p < .05$.

** $p < .01$.

*** $p < .001$.

Table 3

Three-step Hierarchical Regression Model Predicting PTSD Symptoms as a Function of IAT scores and Explicit Negative Self Cognitions

	<i>B</i>	<i>SE</i>	<i>t</i>	<i>p</i> -value	<i>Cohen's D</i>
Total PTSD Symptoms					
Step 1			$R^2 = .45$		
Gender	2.57	1.17	2.20	.03	.26
Trauma Exposure	1.21	0.23	5.19	< .001	.61
Explicit Cognitions	0.33	0.03	13.23	< .001	1.57
Step 2			$\Delta R^2 = .02$		
IAT Scores	6.06	1.71	3.54	< .001	.42
Step 3			$\Delta R^2 = .01$		
Explicit Cognitions x IAT Scores	0.15	0.07	2.27	.02	.27

Note. N = 289. Predictors other than gender were mean-centered. Gender was coded 0 = male, 1 = female. Trauma Exposure = number of traumatic events endorsed. Explicit cognitions = the negative self subscale of the Posttraumatic Cognitions Inventory (Foa et al., 1999). Higher IAT scores = stronger associations with me and traumatized.