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Reduced Reactivity to and Suppression of Thoughts Mediate the Effects of Mindfulness Training on Recovery Outcomes Following Exposure to Potentially Traumatic Stress

Yaara Nitzan-Assayag[1] · Kim Yuval[1] · Galia Tanay[1] · Idan M. Aderka[1] ·
Anka A. Vujanovic[2] · Brett Litz[3] · Amit Bernstein[1]

Abstract We tested whether reduced thought suppression and reactivity to thought content (i.e., cognitive defusion) mediate the effects of a four-session mindfulness training intervention on clinical outcomes important to recovery in a general community-sample of adults ($N = 38$) recently exposed to potentially traumatic event (PTE). Thought suppression mediated the effects of mindfulness training on all studied distal risk factors and symptom outcomes—anxiety sensitivity, rumination, and negative affect, as well as posttraumatic stress and depression symptoms. Cognitive defusion mediated the effects of mindfulness training on anxiety sensitivity, negative affect, and posttraumatic stress symptoms, but not rumination or depression symptoms. Thus, we found that reduced reactivity to and reduced suppression of thoughts mediated the effects of mindfulness training on recovery outcomes following exposure to PTE. Findings are discussed with respect to their theoretical and clinical implications for the potential role and mediating mechanisms of mindfulness in recovery following trauma.

Keywords Cognitive fusion · Decentering · Mediation ·
Mindfulness · Posttraumatic stress · Prevention · PTSD ·
Thought suppression · Trauma

✉ Amit Bernstein
abernstein@psy.haifa.ac.il

[1] Department of Psychology, University of Haifa, Mount Carmel, 31905 Haifa, Israel

[2] University of Houston, Houston, TX, USA

[3] VA Boston Healthcare System and Boston University, Boston, MA, USA

Introduction

A growing body of research has focused on understanding and therapeutically targeting actionable causal risk and protective factors found to be associated with the development or maintenance of psychopathology symptoms (e.g., posttraumatic stress, depression) following potentially traumatizing events (PTE; Bomyea et al. 2012; Elwood et al. 2009; Feldner et al. 2007a, b; Williams et al. 2014). This area of research is important to advancing prevention and early intervention for trauma-related psychopathology (Kalill et al. 2014; Shalev et al. 2011; Vujanovic et al. 2013; Zvolensky et al. 2006).

The construct of *mindfulness* is a promising, actionable, or trainable target that may promote resilience and recovery from exposure to PTE (Vujanovic et al. 2013). Mindfulness is conceptualized as a quality of consciousness characterized by clarity of attention, flexibility of attention, and non-discriminatory awareness (also referred to as nonjudgmental awareness) of the present moment (Hölzel et al. 2011; Kabat-Zinn 1990; Kiyota 1991; Shulman 2010; Tanay and Bernstein 2013; Vago and Silbersweig 2012). This phenomenon may be cultivated through a range of practices widely disseminated in contemporary clinical psychology and allied disciplines.

In the context of exposure to PTE, mindfulness practice is hypothesized to entail meta-awareness, non-discriminatory attention, and experiential contact with a range of internal experiences, including aversive memories and other painful thoughts and emotions. Because a common response to PTE entails behavioral and cognitive avoidance of unwanted internal states linked to the event (e.g., memories, anxious arousal; Dunmore et al. 2001; Foa et al. 1995; Wenzlaff and Wegner 2000), mindfulness has been conceptualized as a strategy for redressing this experiential avoidance and the poor recovery outcomes likely to follow such responding to PTE.

Accordingly, mindfulness has been increasingly examined as a potential therapeutic target in the context of posttraumatic stress (Bernstein et al. 2011; Follette et al. 2006; Ogden et al. 2006; Vujanovic et al. 2013; Walser and Westrup 2007).

Cross-sectional studies of individuals exposed to PTE have documented that higher levels of dispositional mindfulness are related to lower levels of posttraumatic stress symptoms, psychiatric multi-morbidity, anxious arousal, and depressive symptoms (e.g., Bernstein et al. 2011; Kalill et al. 2014; Schoorl et al. 2015; Thompson et al. 2011; Thompson and Waltz 2010; Vujanovic et al. 2009). Mindfulness has also been associated with the frequency and severity of posttraumatic stress disorder (PTSD) symptoms, depressive symptoms, physical symptoms, and alcohol problems in patients with PTSD (Boden et al. 2012; Chopko and Schwartz 2013; Frewen et al. 2011; Vujanovic et al. 2009).

Initial prospective longitudinal studies among individual exposed to PTE have similarly pointed to salutary functions of mindfulness. Call et al. (2015) found that trait mindfulness levels at 3 months post-deployment predicted general distress, anxiety, and hyperarousal but not other PTSD symptoms at 12 months post-deployment in two samples of Army National Guard soldiers. Directly informing the present study, Nitzan-Assayag et al. (2015) found that in a community-based sample of adults studied in the 6 months following exposure to PTE, reactivity to thought content (i.e., cognitive fusion) mediated the effect of trait mindfulness on distress posttrauma including negative affect, depression, and posttraumatic stress symptoms, and thought suppression mediated the effect of mindfulness on distal risk factors linked to negative self-referential processes including rumination and anxiety sensitivity. These are also some of the first data directly examining candidate-mediating mechanisms through which mindfulness may act upon key clinical outcomes over the course of recovery following PTE.

Furthermore, preliminary research has examined the potential therapeutic role of mindfulness training for reduction of posttraumatic stress and promotion of recovery posttrauma. First, in an uncontrolled pilot intervention, Kimbrough et al. (2010) evaluated the efficacy of an 8-week mindfulness-based stress reduction (MBSR) program in a sample of adult survivors of childhood sexual abuse. Mindfulness training was related to reduced depression and PTSD symptoms (avoidance and numbing) at 24 weeks postintervention (Kimbrough et al. 2010). Second, in an uncontrolled intervention study, Owens et al. (2012) found that elevations in self-reported dispositional mindful awareness were related to reductions in PTSD and depression symptoms among a veteran sample over the course of an extended multi-intervention residential PTSD treatment program. Boden et al. (2012) replicated these findings among a similar sample of veterans in residential PTSD treatment, also documenting that self-reported levels of non-judgmental acceptance were inversely associated with posttreatment

depression severity levels. Kearney et al. (2012) evaluated the efficacy of an 8-week MBSR intervention delivered in addition to other psychiatric and psychological care, targeting PTSD among war veterans. The authors found significant improvements in PTSD symptoms, depression, behavioral activation, acceptance, and mindfulness following the MBSR intervention (Kearney et al. 2012). More recently, in a large rigorous randomized clinical trial, Polusny et al. (2015) found that relative to an active control condition focused on current life problems, eight 2.5-h group sessions and a day-long retreat of mindfulness-based stress reduction led to significantly reduced levels of PTSD symptoms, although no differences in rates of PTSD among veterans with PTSD. Also among veterans, but in a primary care setting, Possemato et al. (2016) found that relative to a treatment as usual in primary care, primary care with a brief four-session mindfulness intervention demonstrated reduced symptom levels of PTSD and depression and that these changes may be related to various mindfulness skills (e.g., describing, non-judging, and acting with awareness skills).

Although these preliminary intervention studies show notable potential for mindfulness in the context of trauma recovery, a number of questions remain. First, mindfulness training may be uniquely well-suited as a form of *selective prevention*. Selective prevention targets all individuals exposed to a given PTE, for example, members of a community exposed to a serious disaster (Feldner et al. 2007b; Shalev et al. 2012). Ordinarily, selective prevention is not indicated because it is costly and intrusive for those who do not seek or require help chiefly because their exposure was distal or minimal, they are not experiencing preclinical levels of distress or impairment, or they have sufficient indigenous resources to heal and recover homeostasis. However, low-cost, low-demand selective prevention approaches to promote coping and management in the face of PTE, such as mindfulness training, are not intrusive, will putatively help those most in need, and may otherwise be useful in everyday life as a wellness promotion strategy for all those exposed to PTE including those at relatively lower levels of risk for poor recovery.

Second, research has yet to focus on the mediating mechanisms through which mindfulness may promote recovery following PTE exposure (Bernstein et al. 2011; Boden et al. 2012; Follette et al. 2006; Vujanovic et al. 2013; Walser and Westrup 2007). If a given mediator of mindfulness training is responsible for the most impact in a given context or for certain individuals, these component processes may be emphasized in those contexts or with those individuals most likely to benefit from the intervention (Baker et al. 2008; Shoham and Insel 2011). This knowledge is furthermore important to understand what processes account for theorized salutary effects of present moment attention on recovery following PTE exposure (Hölzel et al. 2011; Vago and Silbersweig 2012).

Specifically, although research has yet to test candidate mediating mechanisms underlying therapeutic effects of mindfulness on key clinical outcomes in the months following exposure to PTEs, theory and extant mindfulness mechanisms research point to a number of promising candidate processes. We focus on two—reduced thought suppression (see Desbordes et al. 2014 for a review of equanimity-related processes) and cognitive fusion (see Bernstein et al. 2015 for a review of meta-cognitive processes underlying cognitive fusion and related processes such as decentering).

First, mindfulness is theorized to reduce efforts to control internal states, including negatively valenced thoughts—as reflected by thought suppression (Bowen et al. 2007; Vujanovic et al. 2013; Walser and Westrup 2007). Through this theorized proximal process, mindfulness may provide a novel means of cognitive and emotional exposure and facilitate an alternative set of behaviors to avoidant strategies such as suppression of intrusive thoughts, avoidance of situations that may elicit negative experiences, or other means of avoidance detrimental to recovery posttrauma. Furthermore, reduced thought suppression may increase willingness to approach and not avoid/control fearful and distressing responses to trauma and trauma-related memories and thereby facilitate emotional processing. Thus, reduced thought suppression is not only an important theorized proximal process of mindfulness but one that may be particularly important to understanding putative relations between mindfulness and trauma recovery (Nitzan-Assayag et al. 2015).

Second, mindfulness is theorized to reduce reactivity to thought content, i.e., the reduced effects of thought content on other mental processes (e.g., attention, emotion, cognitive elaboration, motivation, motor planning), as reflected by cognitive (de)fusion (Bernstein et al. 2015; Hölzel et al. 2011; Josefsson et al. 2014; Vago and Silbersweig 2012). Engendered through mindfulness training, cognitive defusion may facilitate experience of thoughts and memories related to traumatic experiences without triggering well-habituated dysregulated emotional responding and relate other maladaptive responses to trauma cues, as well as facilitate adaptive responding by permitting greater behavioral control in the face of trauma cues. Thus, reduced cognitive fusion (i.e., reduced reactivity to thought content) is not only an important theorized proximal process of mindfulness but one that may be particularly important to understanding putative relations between mindfulness and trauma recovery (Nitzan-Assayag et al. 2015).

These putative proximal mediating processes may be key to understanding the effects of mindfulness training on various distal clinical outcomes of trauma recovery (e.g., Hölzel et al. 2011; Tanay et al. 2012). First, posttraumatic stress and depression symptoms represent the most common poor mental health outcomes following PTE (Breslau et al. 2000). In addition, extant research and theory suggests that mindfulness

training and its theorized mediating processes likely impact a number of malleable risk factors—including, rumination, anxiety sensitivity, and negative affect—implicated in the development and maintenance of posttraumatic stress and depressive symptoms following PTE (e.g., Nitzan-Assayag et al. 2015). Inclusion of these distal risk outcomes is particularly important in study of recovery among unselected community samples wherein levels of psychopathology are expected to be low (e.g., Bonanno 2005).

Thus, the primary objective of this study was to examine the hypothesized mediating processes of a mindfulness intervention on key clinical outcomes among adults exposed in the last 6 months to a PTE. We measured state and dispositional mindfulness, hypothesized proximal and distal processes, and psychopathology symptoms over the course of a 4-week Mahasi mindfulness meditation intervention, and then at 1 and 6 weeks postintervention. We predicted that reduced thought suppression and cognitive fusion would mediate the effect of the mindfulness intervention on rumination, anxiety sensitivity, negative affect, posttraumatic stress, and depressive symptoms.

Method

Participants

Thirty-eight participants (M_{age} = 30.6, SD_{age} = 10.0; 60.5% women), recently exposed to potentially traumatic events, were recruited from the community in the greater Haifa area in Northern Israel. Broadly representative of the population in this region, 83.8% of participants identified as Jewish, 10.8% Muslim, 2.7% Christian, and 2.7% Druze. Recent exposure to potentially traumatic events was evaluated via phone interview using the list of potential lifetime traumatic events from the *Posttraumatic Diagnostic Scale* (PDS; Foa et al. 1997) and the *List of Threatening Experiences* questionnaire (LTE-Q; Brugha et al. 1985).

In terms of *lifetime* history, the $M(SD)$ number of PTEs reported by participants was 2.2(1.5) per the PDS; 10.5% (n = 4) reported one, 38.5% (n = 15) reported two, 13.2% (n = 5) reported three, 13.2% (n = 5) reported four, and the remaining 7.9% (n = 3) reported exposure to five or more types of traumatic events. Per study inclusion criteria, 100% of the participants reported past 6-month exposure to a PTE on either the PDS or LTE-Q. Specifically, 84% (n = 32) reported past 6-month exposure to a PTE per the PDS (e.g., assault), and 55.8% (n = 29) of participants also reported past 6-month exposure to a PTE per the LTE-Q. Depression symptom levels (M = 44.4; SD = 13.1) and posttraumatic stress symptom levels (M = 7.3; SD = 3.6) were typical of a non-clinical, general community sample (*Inventory of Depression and Anxiety Symptoms*; Watson et al. 2007).

Potential participants were excluded based on evidence of (a) current use of psychiatric medication, (b) current participation in regular yoga practice (weekly) or a weekly yoga class/workshop, (c) past/current participation in a mindfulness meditation practice or mindfulness meditation class/workshop, (d) current major chronic illness (e.g., epilepsy, cancer), (e) lack of Hebrew language fluency, and (e) the inability to give informed, written consent.

Procedure

Baseline Assessment All potential participants were screened by phone according to the inclusion/exclusion criteria detailed above. Participants meeting the criteria were randomly assigned to either an experimental (mindfulness skills training) or control (no intervention) group. Participants in both groups were asked to complete an online consent form, after which they completed an online battery of self-report measures, as described above.

Mindfulness Skills Training Program Following the baseline assessment, participants randomly assigned to the experimental condition received four weekly, 60-min Mahasi mindfulness skills training sessions. Mindfulness training sessions were held 7 days apart, over 21 days. In these sessions, participants were taught fundamentals of mindfulness practice (i.e., directing attention to present moment physical sensations, to thoughts and emotions as they come and go) based on established techniques from the mindfulness literature (Gilpin 2008; Kabat-Zinn 1990; Tanay and Bernstein 2013).

The first mindfulness skills training session included a short introduction to mindfulness and the purpose of mindfulness training (i.e., to enhance participants' ability to pay attention to their moment-to-moment subjective experience). Participants were *not* instructed that the purpose of the study is to ultimately reduce mood and anxiety vulnerability or to understand these outcomes with respect to mindfulness—so as to reduce experimental demand characteristics, social desirability effects, and placebo expectancy effects—and instead focused on mindfulness as an outcome in and of itself (Tanay et al. 2012). Participants then engaged in a 20-min guided practice of a core mindfulness technique (i.e., mindful attention using the breath as an attentional anchor). Specifically, participants were guided to sit with closed eyes and to direct their attention to the physical sensations of their breath. Participants were further guided to use these sensations as an attentional anchor in order to orient and maintain their attention to the present moment. Participants were asked to pay attention to any other sensation(s), thought, or emotion as it occurs or appears and to use an additional mindfulness technique, mental labeling of these events (i.e., "aching sensation," "planning," "worrying," "hearing"). Participants were instructed to label their immediate experience in present

tense. Labels referred to internal experiences whether physical (pain, heat cold, movement, etc.) or mental (anger, fear, worry, planning, boredom, etc.). Participants were encouraged to take a curious approach toward their experiences and the process of developing mindfulness gradually over the course of mindfulness practice will be emphasized. At the end of the 20-min guided practice period, participants were provided time to ask questions about the practice of mindfulness for 15 min. Then, participants had an additional 10-min period to practice mindfulness as described above.

In addition, participants in the mindfulness group were requested to practice the mindfulness techniques at home (15 min, three times in the first week; 20 min, four times in the second week; and 25-min, four times in the third week) using a compact disk with audio-guided instructions for mindfulness practice (reinforcing the in-session training and practice). Training also entailed encouraging participants to monitor how mindful they are in their daily activities and to integrate mindful attention and awareness, as a way of being, into their daily lives—not only during mindfulness meditation exercises. Finally, participants were encouraged to continue to practice mindfulness following completion of the intervention. The compact disk was given to each participant at the end of session 1. Sessions 2 to 4 mirrored the structure of session 1 and included a discussion of participants' mindfulness skills practice at home since the previous session. Participants were asked to report the frequency and duration of their practice of mindfulness skills exercises between sessions, at home.

Weekly Assessments At the beginning of each mindfulness skills session, participants completed a battery of measures, including measures of mindfulness and the putative mediating factors (proximal and distal factors). In addition, participants completed measures at the end of each session, as this is an index of state mindfulness following the mindfulness exercise.

Postintervention Assessment Participants completed measures of mindfulness, putative (proximal) mediating factors, and (distal) risk factors and symptoms, following the final mindfulness skills training session (session 4).

Follow-up Assessment Follow-ups were 1 week and then 6 weeks postintervention.

Measures

Translation and Back-Translation Process Questionnaires were translated and back-translated from English to Hebrew by laboratory staff fluent in both languages using structured guidelines (Brislin 1970).

Posttraumatic Diagnostic Scale (PDS; Foa et al. 1997) The PDS is a self-report instrument measuring trauma exposure and posttraumatic stress symptoms, based on *DSM-IV* criteria (American Psychiatric Association 2000). The PDS includes information regarding lifetime exposure to 12 possible traumatic event types (e.g., serious fire, accident, or explosion; sexual assault; military combat or war zone).

In the current study, the PDS was used to evaluate (a) history of lifetime trauma (via self report) and (b) eligibility to participate in the study—past 6-month exposure (via phone-based structured interview). The PDS has been validated in a wide range of studies and has demonstrated sound internal consistency, satisfactory test-retest reliability, and multiple forms of validity (Foa et al. 1997).

The List of Threatening Experiences Questionnaire (LTE-Q: Brugha et al. 1985) The LTE-Q is a brief list of 12 major categories of potentially traumatic, major life stressors, and related serious life-threatening events. In the current study, the LTE-Q was used to evaluate eligibility to participate in the study—past 6-month exposure (via phone-based structured interview).

Mindful Attention Awareness Scale (MAAS; Brown and Ryan 2003) The MAAS is a 15-item questionnaire in which respondents indicate, on a six-point Likert-type scale (1 = *almost always* to 6 = *almost never*), their degree of awareness and attention to present events and experiences (Brown and Ryan 2003). The MAAS shows good internal consistency across a wide range of samples. Test-retest reliability data over a 1-month time period indicates that habitual mindful attention and awareness, as indexed by the MAAS, is stable (Brown and Ryan 2003).

The State Mindful Scale (SMS; Tanay and Bernstein 2013) The SMS is a 21-item questionnaire in which respondents indicate on a five-point Likert-type scale (1 = *not at all* to 5 = *very well*) their perceived level of awareness and attention to their present experience during a specific period of time (i.e., past 15 min) and context (e.g., following mindfulness meditation or other activity). Initial cross-sectional as well as controlled experimental and prospective research has demonstrated the convergent, discriminant and incremental convergent validity of SMS as well as context-specific prospective stability, construct validity, incremental sensitivity to change, and incremental predictive validity (Tanay and Bernstein 2013; Tanay et al. 2012).

Cognitive Fusion Questionnaire (CFQ; Gillanders et al. 2014) The CFQ is a recently developed seven-item self-report scale, in which participants rate on a seven-point Likert-type scale (1 = *never true* to 7 = *always true*) their tendency to react strongly to thoughts. The CFQ demonstrates sound reliability and multiple forms of validity (e.g., Gillanders et al. 2014).

The White Bear Suppression Inventory (*WBSI*; Wegner and Zanakos 1994) is a 15-item self-report measure designed to assess the tendency to suppress unwanted negative thoughts. Participants are asked to indicate on a five-point Likert-type scale the extent to which they agree with each statement (1 = *strongly disagree* to 5 = *strongly agree*). The WBSI was conceptualized as reflecting cognitive experiential avoidance (Hayes et al. 2004). The WBSI has demonstrated multiple forms of reliability and validity (e.g., Wegner and Zanakos 1994).

Anxiety Sensitivity Index-3 (ASI-3; Taylor et al. 2007) The ASI-3 is an 18-item scale that has demonstrated the strongest psychometric properties of all measures of anxiety sensitivity to date (Taylor et al. 2007). The ASI-3 is composed of three subscales: physical concerns, cognitive concerns, and social concerns, and one total scale score comprised of these subscales. ASI-3 items are rated on a five-point Likert-type scale (0 = *very little* to 4 = *very much*). The ASI-3 and its subscales have demonstrated strong and improved reliability and factorial validity relative to previous measures of the construct, as well as convergent, discriminate, and criterion-related (known-group) validity (Taylor et al. 2007).

Positive Affect Negative Affect Scale (PANAS; Watson et al. 1988) The PANAS is a 20-item self-report measure on which respondents indicate, on a five-point Likert-type scale (1 = *very slightly or not at all* to 5 = *extremely*), the extent to which they generally feel different feelings and emotions (e.g., hostile). In the proposed research, we evaluate only the PANAS-Negative Affectivity subscale, which has demonstrated multiple forms of reliability and validity (Watson 2000).

Response Style Questionnaire-Ruminative Response Subscale (RSQ-RRS; Nolen-Hoeksema and Morrow 1991) The RSQ-RRS is a 22-item scale, in which participants indicate on a four-point Likert-type scale (from 1 = *never* to 4 = *always*) their tendency to ruminate in response to sad mood and depression that focus on self, symptoms, and the possible consequences of those symptoms. The RSQ-RRS has demonstrated good internal consistency (Knowles et al. 2005), test-retest reliability (Parker and Larson 1994), and multiple forms of validity (Knowles et al. 2005; Nolen-Hoeksema and Morrow 1991).

The Inventory of Depression and Anxiety Symptoms (IDAS; Watson et al. 2007) The IDAS is a factor-analytically derived, multidimensional inventory that uses a five-point Likert scale (1 = *not at all* to 5 = *Extremely*) to assess current symptoms. The IDAS contains 12 symptom scales; we focused a priori on general depression and traumatic intrusions. In the proposed study, we will focus on symptoms of psychopathology related to traumatic stress, including traumatic intrusions and general depression subscales. The IDAS has demonstrated

strong internal consistency, test-retest reliability, and good convergent and discriminant validity with respect to formal diagnostic and self-report symptom measures (Watson et al. 2007).

We modified the instructions of the CFQ, WBSI, ASI-3, PANAS, RSQ-RRS, and IDAS at all follow-up assessments to specifically measure experiences (e.g., symptoms) present since the previous assessment time point.

Data Analyses

We tested multilevel models (MLMs) of mediation (Kenny et al. 2003) wherein time (i.e., the effect of repeated mindfulness training sessions over the course of the intervention) was the predictor, proximal processes of mindfulness (thought suppression, cognitive fusion) the mediators, and distal risk processes (negative affect, rumination, anxiety sensitivity) as well as posttraumatic stress and depression symptom severity the outcomes (see Table 1 and Fig. 1). Models were lagged such that proximal processes at time t predicted distal processes and symptom outcomes at time $t + 1$. Time was modeled using the measurement number (i.e., T1, T2, T3) consistent with the expected linear effects. Finally, mediating and outcome variables were standardized to facilitate interpretation of the path coefficients across models of mediation. In addition, in the event that a null effect of time was observed, we tested mediation without the lag; in these instances, we tested the effect of time and of the putative mediating variables at time t on symptom outcomes at time t. The lagged model has a number of notable benefits with respect to testing the mediating effect of proximal processes on distal symptom outcomes including its rigor for testing prospective associations (Singer and Willett 2003). However, the lag reduces the statistical power of the MLM to detect an effect of time and thus a non-lagged analysis is important to rule out a null effect of time in underpowered tests (e.g., analyses of sample sizes) (Singer and Willett 2003). In addition, we used the program RMediation to calculate confidence intervals for the indirect effect using the distribution of product of coefficients method (PRODCLIN; Tofighi and MacKinnon 2011). This method has more accurate Type-I error rates and more statistical power than other more commonly used tests for mediation (MacKinnon et al. 2007). See Table 1 and Fig. 1 for visual summary of all mediation effects, reported below in detail.

Results

Prospective Intervention Retention and Attrition

Over a total of 7 time points, 6 out of 38 (15.8%) participants dropped out and did not complete subsequent assessment sessions of the experimental condition.

Proximal Processes Mediating Effect of Mindfulness Intervention on Recovery Outcomes

Negative Affect We first tested the degree to which cognitive fusion mediated the effect of time on negative affect. Negative affect levels decreased significantly over time ($\beta = -0.12$, $SE = 0.04$, $t = 3.01$, $p < .01$). Levels of cognitive fusion decreased significantly over time ($\beta = -0.09$, $SE = 0.04$, $t = 2.4$, $p < .05$). We then regressed negative affect on both time and cognitive fusion simultaneously. The effect of cognitive fusion was significant, indicating that lower levels of cognitive fusion at time T1 to T5 predicted lower levels of negative affect at T2 to T6 ($\beta = 0.23$, $SE = 0.07$, $t = 3.08$, $p < .01$). The effect of time remained significant ($\beta = -0.14$, $SE = .04$, $t = 2.59$, $p < .01$), indicating that cognitive fusion partially mediated the effect of the mindfulness intervention on negative affect. To cross-validate evidence of mediation, we also used the PRODCLIN method and found an indirect effect $= -0.021$ ($SE = 0.021$) and 95% CI $= -0.047$ to -0.002. This mediated effect was significant as the CI does not include zero.

We then tested the degree to which thought suppression mediated the effect of time on negative affect. Again, levels of negative affect decreased over time (see above). Levels of thought suppression decreased significantly over time ($\beta = -0.13$, $SE = 0.04$, $t = 3.61$, $p < .01$). We then regressed negative affect on both time and thought suppression simultaneously. The effect of thought suppression was significant, indicating that lower levels of thought suppression at time T1 to T5 predicted lower levels of negative affect at T2 to T6, ($\beta = 0.18$, $SE = 0.09$, $t = 2.02$, $p < .05$). The effect of time remained significant ($\beta = -0.14$, $SE = 0.04$, $t = 3.38$, $p < .01$), indicating that thought suppression partially mediated the effect of the mindfulness intervention on negative affect. Again, using PRODCLIN, we found an indirect effect $= -0.023$ ($SE = 0.009$) and 95% CI $= -0.043$ to -0.008. This mediated effect was significant as the CI does not include zero.

Rumination We then tested the degree to which cognitive fusion mediated the effect of time on rumination. Rumination levels did not change significantly over time ($\beta = 0.041$, $SE = 0.045$, $t = 0.909$, $p = .367$). Cognitive fusion levels decreased significantly over time ($\beta = -0.091$, $SE = 0.026$, $t = -3.45$, $p = .001$). Finally, we regressed rumination on both time and cognitive fusion simultaneously. The effect of cognitive fusion was significant, indicating that lower levels of cognitive fusion at time T1 to T6 predicted lower levels of rumination at T2 to T7, respectively ($\beta = 0.345$, $SE = 0.118$, $t = 2.954$, $p < .05$). The effect of time remained non-significant ($\beta = 0.054$, $SE = 0.056$, $t = 0.96$, $p = .34$). Because the pattern of results was different from that of classic mediation wherein the direct effect is smaller than the total effect, we conducted an additional

Table 1 Summary of mediation analyses

	Thought Suppression PRODCLIN Indirect effect (SE) [95%CI]	Cognitive Fusion	Fixed change in mediators and outcomes from preintervention to postintervention
Thought suppression (WBSI)	NA	NA	$\beta = -0.13$, $SE = 0.04$, $t = 3.61$, $p < .01$
Cognitive fusion (CFQ)			$\beta = -0.09$, $SE = 0.04$, $t = 2.4$, $p < .05$
Negative affect (PANAS)	0.023 (0.009) [−0.043, −0.008][b]	−0.021(0.021) [−0.047, −0.002][b]	$\beta = -0.12$, $SE = 0.04$, $t = 3.01$, $p < .01$
Anxiety sensitivity (ASI-3)	−0.064 (0.023) [−.114, −.024][b]	−0.040 (0.017) [−0.077, −0.011][b]	$\beta = -0.058$, $SE = 0.055$, $t = -1.041$, $p = .30$
Rumination (EQ)	−0.035 (0.02) [−0.079, −0.003][b]	−0.029 (0.018) [−0.07, 0]	$\beta = 0.041$, $SE = 0.045$, $t = 0.909$, $p = .367$
Posttraumatic stress symptoms (IDAS)	−0.063 (0.016) [−0.096, −0.035][a]	−0.032 (0.013) [−0.06 to −0.009][a]	$\beta = -0.03$, $SE = 0.05$, $t = -0.48$, $p = .63$
Depression symptoms (IDAS)	−0.05 (0.013) [−0.079, −0.026][a]	−0.01 (0.014) [−0.041, 0.016]	$\beta = 0.04$, $SE = 0.05$, $t = 0.82$, $p = .41$

All reverse mediation models were null

NA not applicable

[a] Evidence of significant non-lagged mediation

[b] Evidence of significant lagged mediation

analysis to examine whether the mediated (i.e., indirect) effect was significant. For the cognitive fusion mediational model, we found an indirect effect = −0.029 (*SE* = 0.018) and 95% CI = −0.07 to 0. Because the CI includes zero, the mediated effect was not significant. Direct effects are typically smaller than total effects. However, when the predictor affects the outcome through multiple processes/mediators that may operate in opposite directions, a smaller total effect may be observed. Thus, when a mediator is included (e.g., one accounting for much of the negative processes), the direct effect is left with only the positive effects making it

larger than the total effect. This atypical pattern of mediation was observed between time and rumination.

We next tested the degree to which thought suppression mediated the effect of time on rumination. Again, rumination did not change over time (see above). Levels of thought suppression decreased significantly over time ($\beta = -0.131$, $SE = 0.027$, $t = 4.781$, $p < .001$). Finally, we regressed rumination on both time and thought suppression simultaneously. The effect of thought suppression was significant, indicating that lower levels of thought suppression from T1 to T6 predicted lower levels of rumination from T2 to T7 ($\beta = 0.350$,

Fig. 1 Multilevel modeling of processes mediating effects of mindfulness training on recovery outcomes following exposure to potentially traumatic event(s)
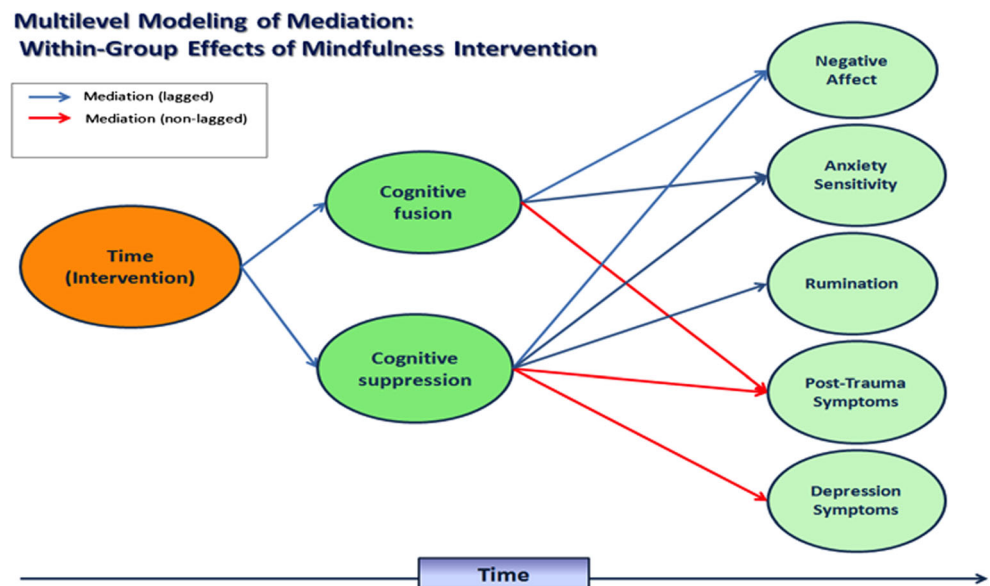
$SE = 0.122$, $t = 2.860$, $p < .01$). The effect of time remained non-significant ($\beta = 0.088$, $SE = 0.055$, $t = 1.595$, $p > .05$). Again, due to the lack of the direct effect of time on rumination outcomes, we tested mediation by means of PRODCLIN. We found an indirect effect $= -0.035$ ($SE = 0.02$) and 95%CI $= -0.079$ to -0.003. Because the CI did not include zero, reduced levels of thought suppression mediated the effect of the intervention on rumination over time.

Anxiety Sensitivity We then tested the degree to which cognitive fusion mediated the effect of time on anxiety sensitivity. We first regressed anxiety sensitivity on time. Anxiety sensitivity levels did not change significantly over time ($\beta = -0.058$, $SE = 0.055$, $t = -1.041$, $p = .30$). Cognitive fusion levels decreased significantly (see above or ($\beta = -0.091$, $SE = 0.030$, $t = -3.45$, $p = .001$)). Finally, we regressed anxiety sensitivity on both time and cognitive fusion simultaneously. The effect of cognitive fusion was significant, indicating that lower levels of cognitive fusion from T1 to T6 predicted lower levels of anxiety sensitivity from T2 to T7 ($\beta = 0.436$, $SE = 0.112$, $t = 3.88$, $p < .001$). The effect of time remained non-significant ($\beta = 0.010$, $SE = 0.065$, $t = 0.159$, $p = .87$), indicating that time did not have an additional effect on anxiety sensitivity above and beyond the effect of cognitive fusion. Due to the lack of the direct effect of time on the outcome, we tested mediation by means of the PRODCLIN method. We found an indirect effect $= -0.040$ ($SE = .017$) and 95% CI $= -0.077$ to -0.011. Because the CI did not include zero, reduced levels of cognitive fusion mediated the effect of the intervention on anxiety sensitivity over time.

We then tested the degree to which thought suppression mediated the effect of time on anxiety sensitivity. Anxiety sensitivity levels did not change over time (see above). Again, levels of thought suppression decreased over time (see above). Finally, we regressed anxiety sensitivity on both time and thought suppression simultaneously. The effect of thought suppression was significant, indicating that lower levels of thought suppression from T1 to T6 predicted lower levels of anxiety sensitivity from T2 to T7 ($\beta = 0.49$, $SE = 0.14$, $t = 3.47$, $p = .001$). The effect of time remained non-significant ($\beta = 0.04$, $SE = 0.07$, $t = 0.58$, $p = .57$), indicating that time did not have an additional effect on anxiety sensitivity above and beyond the effect of cognitive fusion. Due to the lack of the direct effect of time on the outcome, we tested mediation by means of the PRODCLIN method. We found an indirect effect $= -0.064$ ($SE = .023$) and 95% CI $= -0.114$ to -0.024. Again, because the CI did not include zero, reduced levels of thought suppression mediated the effect of the intervention on anxiety sensitivity over time.

Posttraumatic Stress Symptom Severity We then tested the degree to which cognitive fusion mediated the effect of time on posttraumatic stress symptoms. Levels of posttraumatic

stress symptoms did not change significantly over time ($\beta = -0.03$, $SE = 0.05$, $t = -0.48$, $p = .63$). Cognitive fusion levels decreased over time ($\beta = -0.091$, $SE = 0.026$, $t = -3.45$, $p = .001$). Finally, we regressed posttraumatic stress symptoms on both time and cognitive fusion simultaneously. Both the effects of cognitive fusion and time were not significant ($\beta = 0.133$, $SE = 0.127$, $t = 1.04$, $p = .31$; $\beta = 0.002$, $SE = 0.058$, $t = 0.04$, $p = .97$). Due to the null effects in the lagged mediational model, we tested mediation in a non-lagged model. Change in posttraumatic stress symptoms neared significance ($\beta = -0.04$, $SE = 0.02$, $t = -1.83$, $p = .07$). Cognitive fusion levels decreased over time ($\beta = -0.09$, $SE = 0.02$, $t = -3.77$, $p < .001$). Finally, we again regressed posttraumatic stress symptoms on both time and cognitive fusion simultaneously. The effect of cognitive fusion was significant, indicating that lower levels of cognitive fusion concurrently predicted lower levels of posttraumatic stress symptoms ($\beta = 0.35$, $SE = 0.12$, $t = 2.85$, $p > .05$). The effect of time became non-significant ($\beta = 0.02$, $SE = 0.02$, $t = 0.76$, $p = .45$), indicating that reductions in cognitive fusion mediated the effect of the intervention on posttraumatic stress symptoms in the non-lagged model. To cross-validate evidence of mediation, we also used the PRODCLIN method and found a significant indirect effect $= -0.032$ ($SE = .013$) and 95% CI $= -0.06$ to -0.009. Because the CI did not include zero, reduced levels of cognitive fusion mediated the effect of the intervention on posttraumatic stress symptoms over time in the non-lagged model.

We next tested the degree to which thought suppression mediated the effect of time on posttraumatic stress symptoms. The effects of thought suppression and time were not significant in the lagged model ($\beta = 0.03$, $SE = 0.12$, $t = 0.28$, $p = .78$; $\beta = 0.03$, $SE = 0.05$, $t = 0.55$, $p = .58$). Again, we tested a non-lagged model. As reported in the above non-lagged model, change in posttraumatic stress symptoms approached significance. Thought suppression levels decreased significantly ($\beta = -0.14$, $SE = 0.02$, $t = -6.14$, $p < .001$). Finally, we regressed posttraumatic stress symptoms on both time and thought suppression simultaneously. The effect of thought suppression was significant, indicating that lower levels of thought suppression concurrently predicted lower levels of posttraumatic stress ($\beta = 0.45$, $SE = 0.09$, $t = 5.2$, $p < .001$). The effect of time became non-significant ($\beta = 0.01$, $SE = 0.02$, $t = 0.30$, $p = .76$), indicating that reductions in thought suppression mediated the effect of the intervention on posttraumatic stress symptoms in the non-lagged model. Again, to cross-validate evidence of mediation, we also used the PRODCLIN method and found a significant indirect effect $= -0.063$ ($SE = .016$) and 95% CI $= -0.096$ to -0.035. Because the CI did not include zero, reduced levels of thought suppression mediated the effect of the intervention on posttraumatic stress symptoms over time in the non-lagged model. Reverse mediation analyses were non-significant—

posttraumatic stress symptom levels did *not* mediate the effect of the intervention (time) on either thought suppression or cognitive fusion; rather, only levels of the proximal processes mediated the effect of the intervention (time) on posttraumatic stress symptom levels. Similarly, PRODCLIN analyses conducted on the non-lagged *reverse* mediation models indicated no evidence of mediation (CIs included zero).

Depression Symptom Severity We tested the degree to which cognitive fusion mediated the effect of time on depression symptoms. Depression symptom levels did not change significantly over time ($\beta = 0.04$, $SE = 0.05$, $t = 0.82$, $p = .41$). Cognitive fusion symptoms decreased significantly ($\beta = -0.091$, $SE = 0.026$, $t = -3.45$, $p = .001$). Finally, we regressed depression symptoms on time and cognitive fusion simultaneously. The effect of cognitive fusion was not significant ($\beta = 0.112$, $SE = 0.146$, $t = 0.76$, $p = .46$) and the effect of time became significant ($\beta = 0.114$, $SE = 0.050$, $t = 2.27$, $p < .05$), indicating that time significantly predicts depression symptoms *when* cognitive fusion is taken into account. Because this pattern of results was different from that of classic mediation in which the direct effect is smaller than the total effect, we conducted an additional analysis to examine whether the mediated (i.e., indirect) effect was significant. We again used the program RMediation (PRODCLIN; Tofighi and MacKinnon 2011). For the cognitive fusion mediational model, we found an indirect effect = -0.01 ($SE = 0.014$) and 95%CI = -0.041 to 0.016. As the confidence interval included zero, the mediated effect was not significant.

Finally, we tested the degree to which thought suppression mediated the effect of time on depression symptoms. Depression symptoms did not change over time (see above). Again, thought suppression levels decreased over time (see above). We regressed depression symptoms on time and thought suppression simultaneously. Both the effects of thought suppression and time were not significant ($\beta = 0.07$, $SE = 0.16$, $t = -0.62$, $p = .54$; $\beta = 0.078$, $SE = 0.057$, $t = 1.37$, $p = .18$). Due to the null effect in the lagged model, we tested the non-lagged model. Change over time in depression symptoms levels remained non-significant ($\beta = -0.02$, $SE = 0.02$, $t = -0.92$, $p = .36$). Thought suppression levels decreased significantly ($\beta = -0.14$, $SE = 0.02$, $t = -6.14$, $p < .001$). We regressed depression symptoms on both time and thought suppression simultaneously. The effect of thought suppression was significant, indicating that lower levels of thought suppression predicted lower levels of depression symptoms ($\beta = 0.36$, $SE = 0.08$, $t = 4.3$, $p < .001$). The effect of time stayed non-significant ($\beta = 0.02$, $SE = 0.02$, $t = 0.69$, $p = .49$), indicating that reductions in thought suppression mediated the effect of the intervention on depression symptoms in the non-lagged model. Again, to cross-validate evidence of mediation, we used the PRODCLIN method and found a significant indirect effect = -0.05 ($SE = 0.013$) and 95% CI = -0.079 to

-0.026. Because the CI did not include zero, reduced levels of thought suppression mediated the effect of the intervention on depression symptoms over time in the non-lagged model. Reverse mediation analyses were non-significant—depression symptom levels did *not* mediate the effect of the intervention (time) on thought suppression; rather, only levels of thought suppression mediated the effect of the intervention (time) on depression symptom levels. Similarly, PRODCLIN analyses conducted on the non-lagged *reverse* mediation model indicated no evidence of mediation (CI included zero).

Discussion

We tested whether reduced thought suppression and cognitive fusion (i.e., reactivity to thought content) mediate the effect of mindfulness training on clinical outcomes important to recovery in a general community-sample of adults recently exposed to PTE. First, both theorized proximal processes mediated the effect of mindfulness training on anxiety sensitivity and partially mediated the effect of mindfulness on negative affect. These data suggest that mindfulness may mitigate fear of anxious arousal in the aftermath of exposure to PTE (Tanay et al. 2012) and are consistent with earlier findings linking mindfulness to reduced negative affect (e.g., Jha et al. 2010) as well as reduced sensitivity to anxiety (e.g., Schoorl et al. 2015).

Second, thought suppression, but not cognitive fusion, mediated the effect of the intervention on rumination. This finding is consistent with a growing body of evidence linking mindfulness to reduced negative self-referential processes (e.g., rumination, worry; Manicavasagar et al. 2012; Mennin and Fresco 2013). Moreover, these effects are consistent with recent longitudinal data documenting the mediating function of thought suppression in the prospective association between dispositional mindfulness and negative self-referential processes (i.e., rumination, worry) in the 6 months following exposure to PTE (Nitzan-Assayag et al. 2015). Together, these effects are notable in light of the role of these risk factors in the development and maintenance of prevalent stress- and trauma-related disorders (e.g., Elwood et al. 2009; Hadash et al. 2016; Whitfield-Gabrieli and Ford 2012).

Third, whereas both proximal processes concurrently mediated the effect of the intervention on posttraumatic stress symptom severity, only thought suppression concurrently mediated the effect of the intervention on depression symptom severity. Importantly, when reverse mediation was tested in these non-lagged models, symptom levels did not similarly mediate the effect of mindfulness training on the putative proximal processes. Thus, as theorized, it is more likely that over the course of mindfulness training, change in the proximal processes contributed to change in symptoms, and not vice-versa. These findings are also consistent with recent longitudinal data documenting the mediating function of

cognitive fusion in the prospective association between dispositional mindfulness and distress and symptom outcomes (i.e., negative affect, depression, and posttraumatic stress symptoms) (Nitzan-Assayag et al. 2015), as well as growing evidence of the role of equanimity developed through mindfulness on stress-related mental health outcomes (e.g., Desbordes et al. 2014). Future research may help clarify the directionality of these mediation effects by means of integrating intensive experience sampling measurement methods designed to capture change processes over the course of mindfulness training in the months following PTE.

The present findings have a number of conceptual and clinical implications. First, the findings contribute to research suggesting that reduced reactivity to thought content as reflected by cognitive fusion (Gillanders et al. 2014), as well as an attitude of acceptance as reflected by reduced thought suppression (Wegner and Zanakos 1994), may mediate the salutary effects of mindfulness on various clinical outcomes (see Bernstein et al. 2015 for a review; see Desbordes et al. 2014 for a review). The present study extends these findings to the salutary properties of mindfulness training among adults recently exposed to PTE. Moreover, the observed effects are noteworthy in light of the nature and specificity of the intervention. Indeed, mindfulness was the exclusive training target of the delivered intervention; other specialty care-based cognitive-behavioral intervention strategies (MBCT; King et al. 2013) or alternative medicine techniques such as yoga (Kimbrough et al. 2010) were not incorporated, as in various mindfulness-based interventions.

Second, the present findings may inform prevention and treatment efforts targeting mindfulness to promote resilience and recovery from traumatic stress (Feldner et al. 2007b; Vujanovic et al. 2013). Indeed, the findings provide preliminary support for the feasibility and acceptability of mindfulness training in a sample of adults exposed recently to potentially traumatic events (King et al. 2013). Furthermore, identifying mediating processes that may be important to positive therapeutic outcomes of mindfulness training following PTE may guide clinical assessment and clinical decision-making. Such assessment may be important to predict responding to mindfulness training and later trauma recovery outcomes and therein to help identify individuals that may need additional intervention beyond mindfulness training to promote recovery.

Finally, the intervention delivered in the present study is grounded in the Mahasi tradition (Mahasi 1978). Mindfulness training sessions followed a manualized protocol developed in our lab, based on Mahasi Sayadaws' technique of mindfulness sitting meditation (Sayadaw U Pandita 2002). The Mahasi tradition practice is slightly different than the mindfulness meditation practiced in mindfulness-based stress reduction and related interventions. First, it makes use of mental labeling, and second, it is focused mainly on two specific types of meditation: focused attention meditation on the breath and open monitoring meditation (of sensations, emotions, or thoughts as they occur, using the breath as an attentional anchor).

This study is limited in a number of respects. First, the sample size was small and the design uncontrolled. A large randomized controlled study is needed to further investigate the effects, and mediating as well as moderating mechanisms of mindfulness, on the severity and incidence of PTSD and related disorders over time. Second, the study relied exclusively on self-report measurement. Future work should consider laboratory-based or behavioral measures of mindfulness or perhaps neural markers (Grossman 2011). Although, it should be noted that at the end of the day, community-based field studies of selective intervention strategies in the aftermath of PTE will always have to minimize subject burden. Furthermore, measurement of posttraumatic stress symptom severity was limited and relatively global. Future research may examine more rigorous and specified diagnostic PTS and PTS symptom cluster outcomes. Third, with the exception of the in-session measurement of state mindfulness, assessments over time entailed retrospective reporting (i.e., "past week"). To better map the proximal and distal mechanisms of mindfulness broadly and specifically in the context of early recovery from trauma, future study would benefit greatly by the application of experience sampling measurement methods (Geschwind et al. 2011; Weinstein et al. 2009). Fourth, the intervention was brief (four sessions, home practice). There may have not been a sufficient dose of the training, and the degree of practice outside of the training session may have been low because of the short duration of the training. Future research should examine the impact of the number of training sessions. Ultimately, to be valid, selective prevention strategies have to be as short as possible but also impactful early on to promote success experience and confidence that the effort will pay off. Fifth, although the majority of participants were exposed to PTEs in the past 3 months, some were exposed between 3 and 6 months posttrauma. Based on research on the course of post-PTE adaptation (e.g., Bonanno 2005; McFarlane and Yehuda 1996), some participants may have started to recover prior to the mindfulness training. In this context, it may be worthwhile to examine mindfulness training in an indicated prevention framework, which would only target individuals who have preclinical or subsyndromal levels of PTSD and impairment in the days and weeks following exposure to PTE. It is nevertheless important to note that in light of the documented iatrogenic effects of interventions such as critical incident debriefing for PTSD outcomes, selective and indicated mindfulness-based prevention studies must be carried out with a great degree of rigor, monitoring, and oversight (Rose et al. 2002).

We found that reduced reactivity to and reduced suppression of thoughts mediated the effects of mindfulness training on key facets of recovery following exposure to PTE. The present study

may help advance understanding of mechanisms through which mindfulness may contribute to recovery following PTE, and thereby, more broadly, insight into psychological factors that may be important to trauma resilience and recovery. These findings moreover point to the potential importance of future, randomized-control study of mindfulness as a stand-alone or complementary prevention/intervention approach to promote resilience to and recovery following PTE.

Compliance with Ethical Standards

Ethical Approval   All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards.

Informed Consent   Informed consent was obtained from all individual participants included in the study.

Conflict of Interest   The authors declare that they have no conflicts of interest.

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