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Remember How This Feels: Inconsistency in Recalled Impact of a Mass Violence Incident Is Related to Poorer Mental Health Outcomes

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Past research has demonstrated that recalling greater exposure to a potentially traumatic event over time is related to poorer mental health outcomes. However, this literature has disproportionately focused on populations with multiple potentially traumatic exposures (e.g., military experience), and recall is typically assessed using objective counts of exposures. In the present study, we surveyed Boston area residents after the Boston Marathon bombings: once within 3 months of the bombings and once 6 months later. At both time points participants reported how affected they were by the bombings the week they occurred, and we examined how changes in recall over time were related to several mental health outcomes. Relative to individuals with consistent recall, individuals whose recall of the emotional impact of the bombings either decreased or increased over time reported significantly greater anxiety and marginally greater depression symptoms 9 months after the initial exposure. Posttraumatic stress symptoms (PTSS) were highest among individuals who exhibited decreases in their recall of the emotional impact of the bombings over time. These findings suggest that, among members of the general public, inconsistency in the recalled impact of a potentially traumatic exposure may be an important predictor of negative mental health outcomes, regardless of the direction of change.

Keywords: anxiety symptoms, depression symptoms, posttraumatic stress symptoms, recall bias, traumatic event

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Retrospectively recalled reports of potentially traumatic events have proven useful in predicting various physical and mental health outcomes (Bernet & Stein, 1999; McFarlane, 1988; Schwarz, Kowalski, & McNally, 1993) despite consensus that such accounts are subject to various recall biases (for reviews see Brewin, Andrews, & Gotlib, 1993; van Giezen, Arensman, Spinhoven, & Wolters, 2005). That is, although asking someone to recall a past traumatic event may not yield a precise account of what happened, patterns of change in event reports over time may be indicative of how traumatic memories are processed and integrated into a person's life. Past research has repeatedly demonstrated that certain patterns of recall are associated with poorer mental health outcomes. For example, numerous studies have demonstrated that increases in recalled exposure to a traumatic event over time are related to increases in posttraumatic stress disorder (PTSD) and/or posttraumatic stress symptoms (PTSS) (Garvey Wilson, Hoge, McGurk, Thomas, & Castro, 2010; King et al., 2000; Koenen, Stellman, Dohrenwend, Sommer, & Stellman, 2007; Roemer, Litz, Orsillo, Ehlich, & Friedman, 1998; Southwick, Morgan, Nicolaou, & Charney, 1997).

However, the existing literature has several important limitations. First, the existing research has focused almost exclusively on PTSS, and less is currently known about how patterns of recall change may relate to other mental health outcomes (for findings on anxiety and depression symptoms see Schwarz et al., 1993, and for findings on depression symptoms see Mollica, Caridad, & Massagli, 2007). Second, research has disproportionately sampled military personnel with combat experience (Garvey Wilson et al., 2010; King et al., 2000; Koenen et al., 2007; Southwick et al., 1997; Wessely et al., 2003) or peacekeeping personnel deployed to war zones (Bramsen, Dirkzwager, van Esch, & van der Ploeg, 2001; Roemer et al., 1998). Results from these studies may be sample or event specific and may not generalize to patterns found within the general population. For example, individuals who have chosen to go into combat or war zones likely have greater expectations of exposure to a potentially traumatic event than would civilians, and individuals in military samples are more likely to be exposed to multiple or recurring traumatic events, rather than a single traumatic event (Gradus, 2014). Indeed, research suggests that recall of war- and repeated assault-related events tends to increase over time whereas recall of unexpected "flashbulb" emotional events (e.g., natural disasters and assassination attempts) tends to be more stable or even diminish over time (van Giezen et al., 2005). These findings suggest that the nature of the event and the extent of its impact on the person affected may have an important influence on the consistency with which the event is recalled over time.

The existing literature has also largely relied on limited assessments of exposure. Many studies track changes in recall by counting reported instances of potentially traumatic events that a subject adds to or subtracts from their report over time (Bramsen et al., 2001; Garvey Wilson et al., 2010; Giosan, Malta, Jayasinghe, Spielman, & Difede, 2009; King et al., 2000; Koenen et al., 2007; Mollica et al., 2007; Roemer et al., 1998; Southwick et al., 1997; Wessely et al., 2003). Although this count may make sense for populations experiencing multiple potential traumatic exposures (i.e., military personnel, refugees, disaster restoration workers), it may not translate readily to assessments of individuals exposed to a single traumatic event, such as an incident of mass violence. Moreover, an objective count of exposures does not capture the emotional impact of an event. Among World Trade Center disaster workers after 9/11, the most inconsistently reported objective or subjective exposure across an 11-month period was being disturbed by the smell at the World Trade Center site (Giosan et al., 2009). This is an important point given the evidence that subjective reports are powerful predictors of mental and physical health outcomes (Cohen & Wills, 1985).

Although several studies have examined how the recalled emotional impact of a potentially traumatic event changes over time (for a review see van Giezen et al., 2005), only two studies have examined how changes in the recalled emotional impact relate to mental health outcomes, and both were in community samples. In one study following a 1988 school shooting outside of Chicago (Schwarz et al., 1993), researchers assessed changes in recalled sensory experiences (e.g., did you see the perpetrator?) and emotional experiences (e.g., how scared did you feel?). Findings demonstrated that in-

creased recall of sensory experiences over time was related to greater PTSS, and decreased recall of emotional experiences was related to decreased depression and anxiety. However, the other report that examined how changes in recalled emotional impact related to mental health in a community sample is not consistent with the findings from Schwarz et al. (1993). Across two studies, Zoellner, Saks, and Foa (2001) sampled 90 sexual assault victims and found decreases over time in memory for the general emotional and dissociative intensity of the assault in participants with acute PTSS. These results clearly diverge from the relationship between exposure recall and mental health outcomes typically observed in the literature on PTSD in military personnel (i.e., that increased recalled exposure over time is associated with poorer mental health outcomes, including greater PTSS). Thus, it remains unclear whether relationships between recall consistency and mental health generalize across different types of traumatic events (i.e., combat-related vs. mass violence-related), types of recall (i.e., objective exposure counts vs. recalled emotional impact), and types of samples (i.e., military personnel vs. general population).

The current investigation seeks to extend the existing literature on recalled exposure and mental health by examining a community sample exposed to a potentially traumatic event (i.e., an incident of mass violence) and measuring changes in the degree to which participants recalled feeling emotionally affected by the incident. Specifically, in members of the Boston area community, we examined whether several mental health outcomes were related to the direction or extent of change over time in recall of emotional reactions to the Boston Marathon bombings of April 15, 2013. Using a longitudinal design, we assessed the recalled emotional impact of the bombings at two time points: once within 3 months of the bombings (Time 1 [T1]) and once approximately 9 months after the bombings (Time 2 [T2]). Although the existing literature has focused mostly on the relationship between PTSD and recall consistency, we sought to expand on these findings by more generally examining relationships between recall consistency and mental health outcomes. Thus, we measured anxiety symptoms, depressive symptoms, physical symptom severity, current distress, and PTSS as mental health outcomes at T2.

Given the inconsistency of findings in the existing literature concerning how changes in recalled emotional impact relate to mental health outcomes, it remains unclear whether increases or decreases in the recalled impact of the bombings over time are more likely to be related to poorer mental health outcomes. Although the bulk of previous studies with military personnel found that increases in objective counts of exposures over time were related to greater likelihood of PTSD or greater PTSS severity, Zoellner et al. (2001) instead found decreases in the recalled impact of a traumatic event over time among individuals with acute PTSD, suggesting that increases and decreases in recalled impact of the bombings over time may relate to poorer mental health outcomes in our sample. Moreover, findings are similarly mixed in the small literature on recall consistency with mental health outcomes other than PTSD. For example, Schwarz et al. (1993) found that decreased recall of emotional experiences was related to decreased depression and anxiety symptoms among witnesses of a school shooting whereas Mollica et al. (2007) found that individuals with more depressive symptoms at baseline reported fewer events over time in a sample of Bosnian refugees reporting over a 3-year period and that there was a nonsignificant trend toward increased reporting in those who went on to develop either PTSS alone or PTSS and depressive symptoms. Therefore, in the current research we are interested in whether any inconsistency in recalled impact may be indicative of poorer mental health outcomes, regardless of the direction of change.

The current study also expands on previous work by examining the relationships among recall consistency, mental health, and social support. Access to and use of a strong social support network is a well-established determinant of successful coping after exposure to a traumatic event (Cohen & Wills, 1985; Coyne & Downey, 1991; Kaniasty, 2012; Uchino, 2006). For example, the stress-buffering hypothesis posits that when stressful events occur, people who perceive high levels of social support generally have better health than those who perceive lower levels of social support (Cohen & Wills, 1985). However, relationships among social support, event recall, and mental health

outcomes after a potentially traumatic terrorist event are unclear. After disasters and terrorist incidents, there is often a complex trajectory of changes in social support with an initial increase in support for victims, followed by a decline that leaves some survivors feeling forgotten and unsupported (Aldrich, 2012; Kaniasty, 2012). The initial postevent increase in support appears to be especially likely to occur when the potentially traumatic event is widely experienced by those in a community instead of by only one or a few individuals (Punamäki, Komproe, Qouta, El-Masri, & De Jong, 2005). The later-occurring decline in social support after an event has been observed after disasters (i.e., the social deterioration model; Kaniasty, 2012) and in the larger psychological trauma literature after more individualized event exposures (i.e., the erosion model; Clapp & Gayle Beck, 2009). Thus, we wanted to examine, for the first time, whether social support was also related to consistency in the recalled impact of a potentially traumatic event over time, although we leave explorations of potential mechanisms underlying observed relationships for future work. For example, it is possible that consistent or decreasing recall over time may be related to having a stronger social support network with which one can discuss exposure to a potentially traumatic event and work through emotional reactions and distress. Moreover, because reports of emotional responses are critical to mental health diagnosis and treatment, and social support may buffer the impact of these emotional experiences, this research stands to uncover relationships with important clinical implications.

Method

Sample

Participants were recruited through advertisements on Craigslist.com and fliers posted around Northeastern University for a study on threat perception after the Boston Marathon bombings, although it was made clear in the advertisements that no direct exposure to the bombings was required to be eligible to participate. Potential participants completed the eight-item Patient Health Questionnaire (PHQ-8; Kroenke et al., 2009) and those without significant depressive symptomology ($<$10 on the PHQ-8) were eligible to participate. Eighty-two participants (42% male) were paid $10 per hour for their participation at T1. Data for T1 were collected as part of an in-lab experiment in which participants first completed several other tasks unrelated to the current investigation (reported in Wormwood, Lynn, Feldmann Barrett, & Quigley, 2016).

Approximately 6 months after the conclusion of T1 (~9 months after the Boston Marathon bombings), participants were recontacted via email and asked if they would be willing to participate in a follow-up online survey for a chance to win one of three Amazon.com gift cards (for $50, $30, or $20). Forty-four participants (38% male) from T1 responded (53.6% response rate) and completed the follow-up survey at T2. Participants ranged in age from 18 to 54 years with an average age of 26.68 years (SD = 10.13). Twenty-eight participants were European American, 6 were Black or African American, 5 were Asian, 1 was American Indian or Alaskan Native, and 4 were multiracial. Analyses revealed that participants who responded at T2 did not differ significantly from those who did not respond at T2 on any of the variables of interest collected at T1 (see Table S1 in the online supplemental materials). Participants were varied in their employment status, with 55% full-time students, 40% working full time, and 5% unemployed or disabled.

T1 Measures

Recalled emotional impact. To measure the recalled emotional impact of the marathon bombings, participants were asked to complete a recall survey in which they answered 19 open-ended questions about their feelings and experiences during the week of the Boston Marathon bombings and the subsequent public manhunt and citywide lockdown on April 18–19, 2013. After these questions, participants were asked to reflect on their answers and their experiences before responding to a final question on a 7-point Likert scale. Participants were asked "How affected did you feel by the Boston Marathon bombings the week they occurred?"; the scale ranged from 1 (*not at all*) to 7 (*extremely*). Answers to this final question served as the measure of recalled emotional impact.

Current distress: Impact of Event Scale. The Impact of Events Scale (IES) is a 15-item

self-report measure that assesses current subjective distress caused by potentially traumatic events (Horowitz, Wilner, & Alvarez, 1979). At T1, participants were asked to indicate how frequently a series of statements were true of them regarding the Boston Marathon bombings since its occurrence on April 15, 2013 on a 4-point Likert scale from *not at all* to *often*. Sample items include "I thought about the Boston Marathon bombings when I didn't mean to" and "I had waves of strong feeling about the Boston Marathon bombings." A total current distress score was calculated by summing responses for all 15 items. To match the time frame covered by this measure at T1, participants at T2 rated the same statements in terms of how true they were "over the past 3 months" as opposed to "since its occurrence on April 15, 2013."

Perceived social support. Participants also completed the eight-item modified Medical Outcomes Study Social Support Survey (mMOS-SS; Moser, Stuck, Silliman, Ganz, & Clough-Gorr, 2012) of the Medical Outcomes Study Social Support Survey (MOS-SS; Sherbourne & Stewart, 1991). The mMOS-SS has two subscales—emotional and instrumental social support—composed of items that maintain the structure of the original MOS-SS. Participants indicated how often each of several kinds of emotional or instrumental support were available to them on 5-point Likert scales from *none of the time* to *most of the time*. Example items include "someone to share your most private worries and fears with" and "someone to give you information to help you understand a situation." Items were averaged to create a single social support score and then transformed such that values ranged from 0 to 100 (Cronbach's α at T1 = .95; at T2 = .98) using the following formula: 100 $\times$ (observed score – minimum possible score)/(maximum possible score – minimum possible score; Moser et al., 2012).

State anxiety. Participants completed the 21-item Beck Anxiety Inventory (BAI; Beck & Steer, 1990). The BAI consists of 21 symptoms (e.g., heart pounding/racing, nervous, indigestion) that are rated on a 4-point severity scale referring to the experience of symptoms over the past month (from *not at all* to *severely bothered me*). Scores for the 21 items were summed to yield a single state anxiety symptom score.

Demographic information. Finally, participants completed a questionnaire that assessed their age, gender, race, and education level.

T2 Measures

At T2 participants completed the same measures described in *T1 Measures* from T1 followed by self-report measures of depression symptoms, PTSS severity, and physical symptom severity.

Depression symptoms. At T2 participants completed the PHQ-8 (Kroenke et al., 2009). The PHQ-8 is used to detect and measure the severity of depression symptoms primarily in research studies. Participants reported how often they were bothered by a list of symptoms over the past 2 weeks (e.g., "little interest or pleasure in doing things" and "feeling down, depressed, or hopeless"). Responses were given on a scale from 0 (*not at all*) to 3 (*nearly every day*). Responses to individual items were summed to yield a single score indicating the severity of depressive symptomatology.

PTSS. At T2, participants also completed the 17-item PTSD Checklist Civilian Version (PCL-C; Weathers, Litz, Herman, Huska, & Keane, 1994). The PCL-C measures PTSS severity over the past 30 days by prompting participants to indicate their level of distress for 17 symptoms on 5-point Likert scales ranging from 1 (*not at all*) to 5 (*extremely*). Example items include "repeated, disturbing memories, thoughts, or images of a stressful experience from the past" and "feeling distant or cut off from other people." The PCL-C does not include an assessment of Criterion A; thus, it reflects a measure of PTSS severity, not a PTSD diagnosis. A total score representing the severity of PTSS symptomology was created by summing responses across all 17 items.

Physical symptom severity. The Patient Health Questionnaire-15 (PHQ-15) measures the severity of nonspecific physical symptoms that commonly co-occur with psychiatric conditions (Kroenke et al., 1994) and are commonly elevated after major life stressors such as a combat deployment or other traumatic events (van den Berg, Grievink, Yzermans, & Lebret, 2005). At T2, participants were asked to rate the

severity of 15 physical symptoms (e.g., back pain, stomach pain) over the past 4 weeks on a scale from 0 to 2, in which 0 = *not bothered at all*, 1 = *bothered a little*, and 2 = *bothered a lot*. Responses were summed to yield a total physical symptom severity score.

Analyses

To examine how inconsistency in participants' recall of the emotional impact of the Boston Marathon bombings over time related to mental health outcomes at T2, we created a difference score by subtracting each participant's recall of emotional impact at T1 from their recall of emotional impact at T2. Because we were primarily interested in whether any inconsistency in recall, whether increased or decreased, might be related to mental health outcomes, we used the absolute value of this difference score as an overall measure of inconsistency in recalled emotional impact from T1 to T2. We refer to this variable as "recall inconsistency."

We then conducted analyses in two phases. First, a series of correlational analyses were conducted to examine relationships between recall inconsistency and the mental and physical health outcomes. Second, although our primary interest was in the relationship between inconsistency in recalled emotional impact and mental health, we also directly examined the alternative hypothesis—that direction of recall inconsistency would be an important determinant of these mental health outcomes. We assessed differences in the measured mental health outcomes across three groups of participants: the decreasing recall group (n = 17) consisted of participants who rated the recalled emotional impact of the bombings as higher at T1 than T2; the consistent recall group (n = 15) consisted of those who rated the recalled emotional impact of the bombings the same at T1 and T2; and the increasing recall group (n = 12) consisted of those who rated the recalled emotional impact of the bombings as higher at T2 than T1. Only participants who rated their recalled emotional impact as exactly the same at T1 and T2 were in the consistent recall group; all others were assigned to the increasing or decreasing recall group. We then conducted a series of one-way analyses of variance (ANOVAs) and examined the quadratic and linear contrasts. If a quadratic contrast across the three recall groups was statistically significant, then it would suggest that the means for the inconsistent groups were similar to each other and different from the consistent recall group for that outcome. However, if a linear contrast across the three groups was significant, it would suggest that the pattern of results for the two inconsistent groups was not similar, such that the specific direction of recall change (i.e., increases vs. decreases in recalled impact) predicted lower or higher means in comparison to respondents in the consistent recall group. Bonferroni corrections with reduced significance levels of $p \leq .025$ were used to correct for multiple comparisons for the outcome measures assessed at both T1 and T2 (anxiety, social support, and current distress).[1]

Results

Bivariate correlations among variables collected at T1 and T2 are in Table 1, and means and standard deviations are in Table 2 (see online supplemental materials for discussion).

Inconsistency of Recalled Impact and Mental Health Outcomes

Table 1 shows that greater recall inconsistency was associated with significantly greater anxiety symptoms at T2, $r(42) = .35$, $p = .02$; greater depression symptoms at T2, $r(42) = .30$, $p = .05$; greater current distress at T2, $r(42) = .36$, $p = .02$; and greater, albeit not significant, physical symptom severity at T2, $r(42) = .26$, $p = .08$. The relationship between recall inconsistency and PTSS severity was also positive, but it was not significant, $r(42) = .16$, $p = .29$, although this may have been due in part to a restriction of range because most of our sample reported few or no PTSS (mean PCL-C score = 24.05; possible range 17–85).

[1] An alternative analytic approach to addressing these same hypotheses involves regressing each mental health outcome variable on measures of recall bias and recall consistency. Results from this alternative analytic approach are largely consistent with those reported here and can be found in the online supplemental materials.

Table 1
Bivariate Correlations of Study Variables

Study variables	1	2	3	4	5	6	7	8	9	10	11
1. Recalled impact T1											
2. Recalled impact T2	.47****										
3. Recall inconsistency	.18	−.39***									
4. SS T1^	−.10	.24	−.45***								
5. BAI T1^	.31*	.20	.10	−.25†							
6. IES T1^	.70****	.43***	−.04	−.04	.53****						
7. SS T2^	.01	.30*	−.45***	.76****	−.26†	.02					
8. BAI T2^	.23	−.12	.35**	−.35**	.37**	.28†	−.27†				
9. IES T2^	.56****	.09	.36**	−.09	.32*	.55****	.03	.51****			
10. PHQ-8 T2	.18	−.07	.30*	−.28†	.45***	.18	−.32*	.83****	.43***		
11. PCL T2	.55****	.20	.16	−.11	.29†	.36**	−.10	.58****	.62****	.57****	
12. PHQ-15 T2	.23	−.02	.26†	−.03	.18	.18	−.08	.58****	.40***	.58****	.38**

Note. SS = Social Support; BAI = Beck Anxiety Inventory; IES = Impact of Event Scale; PHQ-8 = Personal Health Questionnaire Depression Scale; PHQ-15 = Personal Health Questionnaire Physical Symptoms Scale; PCL = Post Traumatic Stress Disorder Civilian Checklist; T1 = Time 1; T2 = Time 2. Variables with symbol ^ represent Bonferroni-corrected variables in which a $p < .025$ significance level was applied.
$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .025$. $^{***}p < .01$. $^{****}p < .001$.

Direction of Recall Inconsistency and Mental Health Outcomes

Quadratic contrasts revealed that participants in the inconsistent recall groups (increasing and decreasing recall groups) reported more anxiety symptoms at T2, $F(2, 41) = 4.39$, $p = .04$, $\eta^2 = .18$, and more depression symptoms at T2, $F(2, 41) = 3.74$, $p = .06$, $\eta^2 = .15$, compared with those in the consistent recall group (see Table 2). Although these quadratic contrasts reached traditional levels of significance, they failed to meet the Bonferroni-corrected α level. Results also revealed a significant linear contrast for PTSS severity at T2, $F(2, 41) = 4.34$, $p = .04$, $\eta^2 = .18$, and a similar, although nonsignificant,

Table 2
Means, SDs, and Linear and Quadratic Contrast F Values for Examining Impact of Recall Bias on Outcome Measures

	Recall inconsistency group							
	Decreased recall (n = 17)	Consistent recall (n = 15)	Increased recall (n = 12)	Total	Quadratic	Effect	Linear	Effect
Outcome measure	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*M* (*SD*)	*F*	size, η^2	*F*	size, η^2
Recalled impact T1	5.18 (1.07)^{a}	4.73 (1.71)	3.92 (1.08)^{a}	4.68 (1.39)				
SS T1^	68.38 (24.53)^{b}	87.50 (11.51)^{b}	73.44 (27.84)	76.28 (23.15)	5.52**	0.21	.37	0.02
BAI T1^	7.00 (8.39)	9.73 (7.70)	8.33 (7.37)	8.30 (7.80)	0.67	0.03	.20	0.01
IES T1^	27.76 (16.44)	26.00 (18.86)	17.92 (11.29)	24.48 (16.31)	0.37	0.02	2.61	0.11
Recalled impact T2	3.35 (1.22)^{cd}	4.73 (1.71)^{d}	5.17 (1.12)^{c}	4.32 (1.57)				
SS T2^	60.29 (29.91)^{e}	82.71 (19.58)^{e}	66.93 (28.69)	69.74 (27.65)	5.09*	0.20	0.44	0.02
BAI T2^	9.06 (9.32)	3.20 (3.28)	6.25 (4.98)	6.30 (6.97)	4.39*	0.18	1.26	0.06
IES T2^	18.88 (16.21)	10.27 (11.18)	9.25 (10.01)	13.32 (13.58)	0.82	0.04	3.79†	0.16
PCL T2	27.76 (13.85)	23.33 (8.80)	19.67 (4.50)	24.05 (10.62)	0.31	0.01	4.34*	0.18
PHQ-15 T2	5.47 (5.89)	2.87 (2.42)	4.50 (3.37)	4.32 (4.36)	2.37	0.10	0.36	0.02
PHQ-8 T2	5.47 (5.13)	2.13 (3.18)	3.92 (3.58)	3.91 (4.29)	3.74†	0.15	0.99	0.05

Note. SS = Social Support; BAI = Beck Anxiety Inventory; IES = Impact of Event Scale; PHQ-8 = Personal Health Questionnaire Depression Scale; PHQ-15 = Personal Health Questionnaire Physical Symptoms Scale; PCL = Post Traumatic Stress Disorder Civilian Checklist; T1 = Time 1; T2 = Time 2. Means followed by the same letter are statistically different ($p < .05$) according to Tukey's HSD test. Variables with symbol ^ represent Bonferroni-corrected variables in which a $p < .025$ significance level was applied.
$^{\dagger}p < .10$. $^{*}p < .05$. $^{**}p < .025$.

trend for current distress related to the bombings at T2, $F(2, 41) = 3.79$, $p = .06$, $\eta^2 = .16$. PTSS severity and current distress related to the bombings were highest among those with decreasing recall for the initial emotional impact of the bombings followed by those with consistent recall and increased recall, in that order (see Table 2).

Inconsistency of Recalled Impact and Social Support

Results revealed that greater recall inconsistency was associated with significantly lower perceived social support at T1, $r(42) = -.45$, $p < .01$, and T2, $r(42) = -.45$, $p < .01$ (see Table 1). In addition, quadratic contrasts demonstrated that participants in the inconsistent recall groups reported significantly less social support compared with participants in the consistent recall group at T1, $F(2, 41) = 5.52$, $p = .02$, $\eta^2 = .21$, and T2, $F(2, 41) = 5.09$, $p = .03$, $\eta^2 = .20$ (see Table 2). However, the quadratic contrast on social support at T2 failed to reach the Bonferroni-corrected α level.

Discussion

Past work has typically shown that increases over time in recalled exposure and recalled emotional impact after potentially traumatic events is related to higher risk of PTSD, depressive, and anxiety symptoms (Bernet & Stein, 1999; McFarlane, 1988; Schwarz et al., 1993), although not uniformly (see Zoellner et al., 2001). However, in the current study, we demonstrated that decreases in recalled emotional impact over time are also related to increases in problematic mental health outcomes. Individuals whose recall of the emotional impact of the Boston Marathon bombings decreased or increased over time reported significantly greater anxiety symptoms and marginally greater depressive symptoms 9 months after the initial exposure relative to individuals with consistent recall. Moreover, contrary to predictions based on most of the existing literature, PTSS severity was highest among individuals who exhibited decreased recall of the emotional impact of the bombings over time (relative to those with consistent and increased recall over time), although findings for PTSS severity should be interpreted with caution because of the very low level of PTSS in our sample. Taken together, our results suggest that inconsistency in recall is important, regardless of the direction of change; decreases in recall over time may be related to poorer mental health outcomes just as increases have been shown to be.

Interestingly, we found evidence of decreased recall in a much larger proportion of our sample than most previous studies (e.g., Garvey Wilson et al., 2010; King et al., 2000; Koenen et al., 2007; Roemer et al., 1998; Southwick et al., 1997; Wessely et al., 2003). We believe this dissimilarity may be driven by any number of differences between the methods of the current study and most previous literature on exposure recall and mental health (e.g., type of potentially traumatic event, sample population, recall of exposure vs. recall of emotional impact). For instance, there is evidence that recall for unexpected or "flashbulb" events (e.g., natural disasters) may decrease over time (cf., van Giezen et al., 2005), although this literature has yet to examine the relationship between such changes in recall and mental health. Likewise, past research suggests that recall for the subjective impact of an exposure may be more variable than recall for more objective counts of exposures. For instance, research on relief workers at the World Trade Center disaster site after 9/11 found that recall for a subjective experience (e.g., being disturbed by the smell at the WTC site) was more variable than recall for more objective experiences (e.g., seeing a dead body; Giosan et al., 2009). Finally, recall consistency may also depend on whether one directly experienced or witnessed a potentially traumatic event. For example, one study found that male military Veterans had more consistent recall when they directly experienced an event compared with those who had witnessed the event (Krinsley, Gallagher, Weathers, Kutter, & Kaloupek, 2003). Future research should examine how differences in the type of exposure and traumatic event impact the relationship between recall consistency and mental health.

Our results also highlight an interesting relationship between recall consistency and perceived social support. There are well-established connections between increased social support and various beneficial mental and physical health outcomes (for reviews see Coyne & Downey, 1991; Kaniasty, 2012; Uchino, 2006). Indeed, in the present study we find that greater

perceived social support is related to significantly fewer anxiety symptoms and marginally lower physical symptom severity (see Table 1). One possible mechanism driving these relationships might be that greater social support helps individuals reduce emotional distress by decreasing the recalled impact of the event over time. However, our findings suggest that individuals with greater perceived social support have more consistent recall of an event's emotional impact over time, not reduced recall. Thus, greater social support may temper the negative impact of a potentially traumatic event by helping individuals more successfully cope with a traumatic event despite consistent recall. Another possibility is that increased social support predicts more positive mental health outcomes and increased recall consistency. Individuals with more social support likely have a greater number of opportunities to discuss a traumatic event, and this rehearsal might improve recall consistency; thus, the relationship between emotional recall consistency and mental health outcomes here could be a specific result of this shared cause.

Other Potential Mechanisms

Several possible mechanisms may account for the present findings and offer exciting avenues for future inquiry. One possible interpretation is that inconsistency in recalled exposure is not necessarily indicative of poor mental health outcomes, but rather that consistency in recalled exposure is indicative of better mental health outcomes. This possible interpretation is grounded, in part, in the scientific literature demonstrating the positive benefits of accurate self-knowledge (cf., Jahoda, 1958). Previous studies have shown that accurate self-knowledge is related to better mental health outcomes compared with even overly positive self-evaluations (Colvin, Block, & Funder, 1995), including increased psychological adjustment and decision-making capabilities (Baumeister, Campbell, Krueger, & Vohs, 2003), decreased impulsive and destructive behavior (Ainslie, 1992), and other general positive health outcomes within trauma-exposed samples (Pennebaker, Kiecolt-Glaser, & Glaser, 1988). Another possible interpretation is that individuals with increased stress-related symptomatology have greater lability in their affect and affective responding, and this greater affective lability could drive more inconsistent reporting on the emotional impact of a past potentially traumatic exposure. Although past research on the relationship between current mood and recall accuracy/reliability has generally failed to reveal any consistent influence of mood on recall content (Brewin et al., 1993), there is some evidence that one's affective state or mood can influence how an individual reports the subjective impact of a recalled event (Raphael & Cloitre, 1994). A third possibility is that individuals may have differential repeated or ongoing indirect exposures via news coverage of the potentially traumatic event. This seems particularly likely for an event such as the Boston Marathon bombings, which was shocking, public, and covered heavily by the media. For example, Holman, Garfin, and Silver (2014) demonstrated that repeated media exposure to the Boston Marathon bombings was related to greater increases in acute stress responses than physical exposure to the bombings. Thus, to the extent that differences in media exposure also affect recalled impact, our findings may reflect differences in reexposure among individuals in our sample who either sought out or avoided media coverage of the Boston Marathon bombings between T1 and T2. These possible mechanisms all warrant further investigation in future research.

Limitations

Although we feel the present findings make a vital contribution to the existing literature, there are several important limitations of the current study to note. First, our sample was modestly sized ($N = 44$) and likely subject to some selection biases. For example, it is possible that differences in individuals' willingness to reflect on their experiences related to the Boston Marathon bombings may have resulted in an underrepresentation of participants who wished to avoid any discussion or recall of the incident. In addition, our attrition rate was higher than desired (46.4% did not complete the T2 survey), although not atypical for a longitudinal study examining recalled exposure to a potentially traumatic event (Garvey Wilson et al., 2010: 75%; King et al., 2000: 22%; Koenen et al., 2007: 24%; McFarlane, 1988: 33%; Mollica et al., 2007: 29.59%; and Roemer et al., 1998: 87%), particularly given that our sample was

not initially recruited with the expectation of a later follow-up. Although we did not see any differences between respondents and nonrespondents on measures collected at T1 (e.g., demographics, recalled emotional impact, current distress, current anxiety symptoms, social support), it is possible that important differences between respondents and nonrespondents were not captured. Most notably, PTSS and depressive symptoms were not collected at T1. Future studies should include a larger variety of mental health outcomes at both time points to mitigate concerns about biased attrition, and they should examine whether poorer mental health precedes or follows inconsistent recall or whether the two simply co-occur.

Two additional limitations concern the reliability and validity of the recalled emotional impact measure. This measure was used in prior research to assess the impact of the Boston Marathon bombings on members of the Boston community (see Wormwood et al., 2016), and it shows good convergent validity in the present investigation (i.e., it is related to measures we would expect, such as anxiety and current distress; Table 1). Still, reliance on single-item measures can reduce measurement reliability. Moreover, the survey was purposefully designed to force participants to thoughtfully reflect on their experiences and emotions the week of the bombings via multiple open-ended questions before responding to the single item used in analyses. Although this was done to increase the validity of this final measure by reducing the impact of potential sources of noise variance (e.g., current emotional state, distraction, etc.), this survey structure may have also unintentionally altered responding in other ways. For example, individuals who recalled greater exposure in the open-ended questions may have reported greater recalled emotional impact because it seemed socially desirable to do so.

Future Directions and Translational Potential

Despite these limitations, these data add to a growing literature on the psychological impact of mass violence events and suggest important avenues for future pursuits in research and clinical practice. Because reports of emotional responses are critical to mental health diagnosis and treatment, in particular for mental health disorders such as major depression and PTSD, inconsistency in reporting over time may have important consequences for diagnosis, treatment, and intervention. For example, patient reports are used by clinicians to determine whether a patient should continue with a treatment regimen and by researchers to examine whether an intervention is efficacious. In addition, in the United States, changes in whether reports of objective occurrences or subjective responses to a potentially traumatic event are the most important have been a source of shifting diagnostic criteria for PTSD, a disorder requiring exposure to a traumatic event. In the *Diagnostic and Statistical Manual of Mental Disorders* (third edition [*DSM–III*]; American Psychiatric Association, 1980), in which PTSD was first designated, critics raised concerns about how to determine whether an individual met diagnostic criteria for a traumatic event (i.e., an event that "would be markedly distressing to almost anyone" and is "usually experienced with intense fear, terror, and helplessness"). This led to what was intended to be a clearer statement about the subjective response needed to meet diagnostic criteria for PTSD in the *DSM–IV* (American Psychiatric Association, 1994), in which a potentially traumatic event that led to a diagnosis of PTSD had to meet a Criterion A1 (objective event occurrence) and a Criterion A2 (an emotional response of fear, helplessness, or horror). With the advent of *DSM–5* in 2013 (American Psychiatric Association, 2013), the subjective Criterion A2 was removed from the diagnostic criteria for PTSD in part because its addition did not greatly impact the prevalence of a PTSD diagnosis (Breslau & Kessler, 2001; Schnurr, Spiro, Vielhauer, Findler, & Hamblen, 2002). However, failure to report Criterion A2 in the presence of a potentially traumatic event (i.e., occurrence of A1) was predictive of failing to develop PTSD (Breslau & Kessler, 2001; Weathers & Keane, 2007), suggesting that the recalled emotional response can be useful for excluding a PTSD diagnosis in those who do not recall an intense emotional reaction to a potentially traumatic event. The finding that a subjective emotional response criterion was not a useful positive predictor of diagnosis of PTSD may be related to the considerable variability or inconsistency in subjective reports of emotional experiences in some of those exposed to poten-

tially traumatic events, as we observed in community participants.

Emotional responses are also critical features of successful psychotherapy, with the evocation of emotional responses during therapy serving as a key feature of successful treatment (Foa, 2011). Specifically, prolonged exposure therapy (PET), a common evidence-based treatment for PTSD (Bisson & Andrew, 2005), involves repeated recall of a traumatic event over time. In PET, the therapist attempts to assist the client to engage emotional experience while recalling the traumatic events and to eventually habituate or reduce emotional distress associated with the recall of the events. During treatment, clients are encouraged to maintain a high but tolerable level of distress during each repeated telling of the trauma narrative in a process known as systematic desensitization (Astin & Rothbaum, 2000). As the initial material becomes less distressing with repeated exposure, the focus of the treatment shifts from less distressing memories to more distressing memories so that the level of distress experienced during the retelling remains high but tolerable. Therefore, in this treatment a reduction in the overall level of distress over time is an indicator of success. Our study suggests that, beyond reducing distress in therapy over time, it also may be useful to monitor the variability of recalled distress across time as an additional indicator of treatment effectiveness. Whether variability in recalled distress can track therapeutic changes will require additional evidence.

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