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The Influences of Event Centrality in Memory Models of PTSD

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Abstract

The consequences of events for well-being are influenced by individual and situational factors that are often studied in isolation. In the research reported here a large (N = 489) nonclinical sample of college students reported their most traumatic event, PTSD symptoms, depressive symptoms, personality traits, and characteristics of their event memory. This study achieved three major goals. First, we identified the highest types of stress event types in this population as disruptions of interpersonal relationships, homicides/assaults on others, and assaults/accidents involving themselves. Second, we established that the effects of memory characteristics such as vividness, belief, and impact, on PTSD symptoms are mediated by the centrality of the event to identity. Third, we affirmed the hypothesis that a structural model of the influence of personality factors on PTSD symptoms has a higher level of concurrent validity if event centrality is included as a mediator of those influences.

The Influences of Event Centrality in Memory Models of PTSD

Stressful life events, such as exposure to actual or threatened death or sexual violence, can exert a powerful and longstanding impact on a person's life. Following the event, the person may develop Posttraumatic Stress Disorder (PTSD). In order to be diagnosed with this disorder, the person must have encountered a severe, traumatic event (or series of events) and be currently suffering from intrusion symptoms (e.g., having involuntary intrusive memories of the trauma), avoidance symptoms (e.g., avoiding thoughts of the trauma), negative alterations in cognitions and mood (e.g., persistent negative emotional state) and increased levels of arousal (e.g., hypervigilance; American Psychiatric Association, 2013).

Although PTSD is conceptually understood as a sequela of a traumatic event, the prevalence of exposure to traumatic events is much higher than the prevalence of the disorder. Several studies have found the life time prevalence of stressful events satisfying the diagnostic trauma criteria to be in the range of 55-90 percent of the general population in the United States and Europe (Breslau et al., 1998; Darves-Bornoz et al., 2008; Kessler et al., 1995), whereas the life time prevalence of PTSD in the same populations is around 10 percent (Breslau et al., 1998; Darves-Bornoz et al., 2008; Kessler et al., 1995). In other words, many people encounter traumatic events without developing PTSD symptoms that are sufficiently severe and long lasting to qualify for a PTSD diagnosis.

Following the literature, the development of PTSD among people who have encountered traumatic events can be seen to depend on a complex interplay among three factors (Rubin, Berntsen & Bohni, 2008): the nature of the traumatic event, characteristics of the person in terms of predispositions and pre-trauma symptoms, and the representation of the traumatic event in memory. In the present study, we examine how these three factors work together to influence PTSD symptom outcomes. Because the present work was conducted and submitted for publication before the publication of the DSM-5 (American Psychiatric Association, 2013), we base our analyses on the DSM-IV PTSD criteria (American Psychiatric Association, 2000).

Characteristics of the Event

Among negative stressful events satisfying the DSM-IV diagnostic criteria for a trauma, certain categories of events tend to be more likely than others to be followed by PTSD symptoms. For example, Breslau et al., (1998) interviewed a large community sample in the Detroit area and found that assaultive violence was associated with the highest risk of PTSD, while unexpected death of a loved one was the most frequently encountered event. Darves-Bornoz et al., (2008) found that the most frequently encountered traumatic event in a large European sample was unexpected death of a loved one whereas risk of PTSD was most strongly associated with rape, having a child with serious illness, being beaten by one's partner, being stalked, being beaten by one's caregiver, and experiencing an event that one is unwilling to disclose. In a United States sample, Kessler et al. (1995) found that rape and molestation were most frequently associated with PTSD among women, whereas combat played this role for men. In a large sample of older Americans, Ogle, Rubin, Berntsen and Siegler (2013) also report that exposure prevalence was highest for events such as the unexpected death of a loved one, whereas higher levels of PTSD symptoms were associated with interpersonal events (e.g., sexual or physical assault, combat, childhood physical abuse, and witnessed family violence) as well as events happening early in life (See also Lancaster, Melka, Rodriquez, and Benjamin, 2009). Evidence also indicates that exposure to multiple traumas, rather than single traumatic events, entails a stronger risk for developing PTSD symptoms (e.g., Berntsen et al., 2012; Cloitre et al., 2009; Neuer et al., 2004).

Characteristics of the Memory

A number of theories have emphasized the importance of the traumatic memory for the development and maintenance of PTSD symptoms, in part because the intrusion symptoms of the disorder require memory for the traumatic event (e.g., Brewin et al., 1996, 2010, 2014; Ehlers & Clark, 2000; Halligan et al., 2004; Horowitz, 1986; Rubin et al., 2008). However, although there is general agreement that memory is important for PTSD, the theories differ markedly concerning the underlying mechanisms. According to one prevalent view, PTSD symptoms reflect a lack of integration of the traumatic memory in the person's life story and identity. This renders the memory for the event difficult to access through conscious and goal-directed retrieval strategies, whereas the memory repeatedly comes to mind involuntarily in terms of dreams and

intrusive recollections, which may prompt attempts at avoidance (e.g., Ehlers & Clark, 2000; Horowitz, 1986; van der Kolk & Fisler, 1995; for a review, see Dalgleish, 2004). Counter to this view, there is little evidence for the idea that PTSD symptoms are associated with reduced voluntary, intentional access to the traumatic event as well as for the claim that voluntary and involuntary recall of the trauma follow a different pattern, with the former being reduced and the latter being enhanced (see Berntsen & Rubin, 2013, for a review).

An alternative view derives from research on autobiographical memory; particularly work examining how certain important events can become landmarks in the organization of less salient memories. Following Rubin et al. (2008), we call this position the Autobiographical Memory Model (AMM). The basic tenet of the AMM is that PTSD symptoms increase with increased accessibility of the traumatic event, and that highly accessible events become central to life story and identity, thereby serving as a landmark for the organization of less salient memories of PTSD consistent with the results of Berntsen and Rubin (2006; 2007), Berntsen, Rubin and Bohni, (2008), Rubin, Boals & Berntsen (2008) and (Rubin, Dennis, & Beckham, 2011).

Cognitive researchers have clearly documented that distinctive and emotional events usually are highly accessible and vividly remembered compared to more mundane experiences (Hunt & McDaniel, 1993; McGaugh, 2003) and that highly accessible personal memories often serve as reference points for the organization of memories of less important events. Such memories are observed to structure our life narratives temporally and thematically by providing turning points and forming beginnings and ends of life time periods or chapters (e.g., Conway & Pleydell-Pearce, 2000; McAdams, 2001; Robinson, 1992). It has also been hypothesized that the memories anchor and stabilize our conceptions of ourselves (Pillemer, 1998; Singer & Salovey, 1993). Rather than being disintegrated and hard to remember, distinctive and emotional events are often central to the life story and identity, and therefore very accessible through both voluntary and involuntary recall (Rubin, Boals, & Berntsen, 2008; Hall & Berntsen, 2008). According to the AMM, this is the case for highly positive as well as highly negative emotional events. The consequences for well-being, however, are likely to differ dramatically for the two types of emotional events. When individuals respond with positive emotions to life events (e.g., graduation, child birth), the memories for the events are consistent with the positive self-

evaluations and worldviews that are culturally normative (Berntsen & Rubin, 2004; Orth, Trzesnewski, Robins, 2010). However, in those cases in which one or more highly adverse events becomes a key to identity, associated negative emotional content may distort perceptions of subsequent events that would otherwise be perceived as neutral or even positive. This may lead to ruminations, unnecessary worries, and increased levels of intrusions and avoidance (Berntsen & Rubin, 2006; 2007; Boelen, 2009). For example, if a memory for an assault that took place in the context of a family gathering became central to a child's identity, future opportunities to participate in such gatherings might be viewed with fear even if the perpetrator was not likely to attend.

Centrality of Events Scale. Berntsen and Rubin (2006) introduced the Centrality of Event Scale (CES) to examine the relation between the centrality of the traumatic memory and PTSD symptoms. An increasing number of studies in a variety of populations and with different types of traumatic events have shown that people reporting greater centrality of their most negative/traumatic event also score higher on measures of PTSD symptoms (e.g., Berntsen & Rubin, 2006; 2007; 2008; Boals, 2010; 2009; 2012; Brown et al., 2010; Lancaster et al., 2011; Perri & Keefe, 2008; Robinough & McNally, 2011; Rubin et al., 2008; Rubin, Berntsen & Hutson, 2009; Smeets, Giesbrecht, Raymaekers, Shaw, & Merckelbach, 2010; Thomsen & Berntsen, 2009). This positive relationship persists in regression analyses controlling for such factors as depression, thought control, anxiety, dissociation, Neuroticism, repressive coping, self-consciousness and severity of the trauma (e.g., Berntsen & Rubin, 2007; Rubin et al., 2008; Lancaster et al., 2011; Smeets et al., 2010). Researchers also have reported that centrality predicts PTSD symptoms in the context of negative events, such as widowhood, that do not satisfy the diagnostic criteria for trauma (i.e., the stressor criterion) (Boelen, 2009; 2012; Perri and Keefe, 2008; Pinto-Gouveia, Castilho, Matos, & Xavier, 2013; Robinaugh & McNally, 2010). Further, the predictive validity of the CES has been established in studies such as Boelen (2012) in which CES measured at 1-year post trauma and PTSD was measured at 2-years post-trauma.

The Role of Metamemory. Metamemory is used here to refer to judgments that individuals make about their memories at the time of recall. These include judgments about the vividness, clarity, belief in the accuracy, judgments about the importance and significance of the memory,

and estimate of the frequency with which the memory is rehearsed voluntarily or involuntarily. These judgments and ratings have been gathered together in various combinations to form the Autobiographical Memory Questionnaire (Rubin, Shrauf, & Rubin, 2007). Recently, Fitzgerald and Broadbridge (2013) demonstrated that many aspects of metamemory could be represented with four scales: Recollection (vividness, the presence of perceptual experience), Belief (coherence, confidence that the event took place as recalled), Rehearsal (voluntary and involuntary recall of the event), and Impact (significance, intensity). This model held for a variety of memory types including stressful memories. The results are consistent with the basic system model of Rubin (2005). Consistent with Rubin (2005), Fitzgerald and Broadbridge (2012) have argued that most distinctions that have been used to bifurcate the study of memory such as episodic v. semantic, or perceptual v. episodic (Brewin, 2014), are exaggerations of the properties of a single unified memory system.

Recently, Brewin (2014) suggested that the CES measures a semantic or factual aspect of a trauma event memory (e.g., knowing that the trauma occurred) but that the CES is unrelated to the “more episodic aspects” (p. 86) of the traumatic memory, such as its perceptual vividness and intensity of reliving. In contrast to this view, but in support of the AMM, a number of studies have explored the relationship between characteristics of trauma memories and event centrality, PTSD or PTSD symptoms, and memory vividness. In a study of memories from WW II, Berntsen and Rubin (2006b) reported that CES scores are correlated with vividness, and both centrality and vividness are correlated with self-reports of PTSD symptoms. Rubin, Boals, and Berntsen (2008) reported a more thorough study of metamemory, CES, and PTSD. In their study, participants completed a version of the AMQ with 18 items along with the CES and a self-report of PTSD symptoms, the PCL. They report significant correlations between valence, intensity, physical reaction, voluntary and involuntary rehearsal with the CES and the PCL. In addition, two sensory scales correlated with the PCL. Rubin et al. argue that the tendency to rate memories intensely may predispose individuals toward the development of PTSD, but did not evaluate the possible role of CES in the chain of events linking metamemory variables and PTSD symptoms.

Two important differences distinguish the current study from the prior studies. First, rather than looking at the correlation between single items and PTSD, we are using the four multi-item scales of the AMQ identified by Fitzgerald and Broadbridge (2013) to assess the memory

attributes. Second, we will employ a mediation analysis to investigate the role of the CES as a mediator of the influence of each of the four memory attributes on PTSD symptoms.

Personality

While Extraversion has been found to increase the risk of exposure to traumatic events (Breslau, Davis, Andreski & Peterson, 1991), other personality traits are associated with risk of developing PTSD after the exposure. One important disposition is a general tendency to react with strong negative affect. Such a disposition is likely to affect not just the emotional arousal at the time of encoding but also the emotional arousal associated with later re-experiencing the event in memory as well as the appraisal of this re-experience (Rubin et al., 2008). Thus, people with a tendency to experience negative affect and a tendency to focus on emotionally negative information would have a greater risk of developing PTSD. This is consistent with a robust relation between Neuroticism and PTSD across several studies (Rubin et al., 2008, for a review). Further support comes from research on the comorbidity of depression and PTSD. For instance, individuals previously diagnosed with depression have been shown to be at increased risk of developing PTSD following exposure to a traumatic event (Breslau, Davis, Peterson, & Schultz, 2000), and rumination has been shown to be involved in the maintenance of depression (Papageorgiou & Wells, 2003).

Predictive and Concurrent Validity. The majority of the research on the relationship between neuroticism and psychopathology has been cross-sectional in nature. Some have criticized this approach based on the premise that only longitudinal research can establish a causal role of personality traits. In this vein, Engelhard, van den Hut, and Lommen (2009) report that although pre-trauma neuroticism scores are correlated with both pre-trauma and post-trauma PTSD symptoms in combat veterans, pre-trauma neuroticism does not predict post-trauma PTSD scores after controlling for pre-trauma PTSD scores. This study challenges the predictive validity of neuroticism. This situation is complicated, however, by issues surrounding the measurement properties of instruments like the PCL, which may change over time (Lommen, van de Schoot, & Engelhard, 2014).

In contrast, trait Agreeableness is associated with positive affect (Gilboa & Revelle, 1994) and may therefore buffer the individual from negative effects of trauma, although this has

been little studied. Finally, Openness to experience has been found to correlate positively with a tendency to view autobiographical events as being central to one's life story and identity (Rasmussen & Berntsen, 2010), and may therefore be indirectly related to PTSD symptoms by enhancing CES scores (Berntsen & Rubin, 2006).

The Present Study

The present study had three goals. The first was to document the nature of the stressful events reported by non-clinical college students. As noted earlier, event properties do influence the accessibility of memory for events. Often the events in the PTSD literature have been limited to a specific type of event such as accidents and war trauma, and events are included only if A1 and A2 criteria are met (American Psychiatric Association, 2000). In contrast, in some studies the events have not been recorded at all. Such studies are open to the criticism that the students are not reporting trauma events. Alternative approaches have proved fruitful. As noted earlier, working with event lists, a number of studies have found that interpersonal events were related to higher levels of PTSD symptoms. Participants in the present study provided brief descriptions of the event that was currently creating the most stress in their life. They then completed a symptom checklist using that event as the reference point. We categorized each event using a system developed by Thorne and McClean (2001), McClean and Thorne (2003). The system is sufficiently broad to allow for inclusion of the majority of events and the categories are distinct enough to allow for reliable coding. In addition, events were categorized along a temporal dimension of duration from very brief to enduring or repeated events. Each event type is characterized in Table 1 in terms of several PCL (PTSD symptoms), and CES (centrality of the event to identity).

The second goal of the study was to explore the relationship between the ratings of memory experience (metamemory), centrality of event, and PTSD symptoms reports. We employed the four established scales of the AMQ (Recollection, Belief, Impact, and Rehearsal (Fitzgerald & Broadbridge, 2013). The AMM and some empirical studies imply that these memory scales will be related to PTSD symptoms. But it is not entirely clear whether this influence is direct, indirect (mediated through centrality), or both. We tested mediational models

using the Process Control Analysis approach (Hayes, 2013) in which CES was the mediator and one of the AMQ scales was the independent variable.

The third goal of the current study was to evaluate the role of personality characteristics in the context of a memory model of PTSD. Figure 1 presents the structural path model that examines the relationship between a measure of event centralization (CES) and a measure of stress symptoms associated with PTSD (PCL). The issue is whether the path from the Centrality of Events Scale (CES) adds value to the model. In Figure 1 we represent the path with a dotted line and a question mark. We test two models, one that did not include a direct pathway from the CES to the PCL and one that did not. We tested whether the fit to the data was better in a model with such a pathway.

Structural paths were included to Figure 1 based on prior research using regression approaches (e.g., Rubin et al., 2008). Neuroticism was hypothesized to elevate PCL score both directly and indirectly through its influence on depression symptoms and centrality; Conscientiousness and Openness were hypothesized to increase the level of centrality of the trauma event and in that way indirectly increase PCL scores by increasing centrality scores. In contrast, trait Agreeableness was hypothesized to negatively influence (lower) PTSD symptoms. Finally, we hypothesized that a strong negative emotional reaction, measured in terms of the A2 criterion of the DSM-IV, PTSD diagnosis, would be associated with a positive (higher) direct effect and a positive indirect effect on PCL score through centrality.

Methods

Participants and Procedures

Participants were 489 undergraduate psychology students from Wayne State University (270 female), ranging in age from 18-55 years ($M = 20.77$, $SD = 4.96$). They received 1 hour of credit toward a research participation requirement for completion of an anonymous online set of questionnaires covering psychological characteristics and symptoms. Participants recalled and briefly described their memory for the most stressful event that had taken place more than one month prior to the survey. Participants dated the memory and selected an estimate of event duration on a scale ranging from seconds to several weeks or months. They completed the set of

five questionnaires described below. They completed the first two measures, the CES and the AMQ, while keeping in mind the stressful event. They then completed the PCL, the CES-D, and the IPIP-NEO.

Measures

Posttraumatic stress disorder checklist (PCL-S). The PCL is a 17-item self-report measure based on the symptoms presented in the *DSM-IV-TR* definition of PTSD (Adkins, Weathers, McDevitt-Murphy, & Daniels, 2008). In the current study, the specific version of the PCL was used (PCL-S). Participants reported the event that was currently serving as the source of greatest stress in their life. They next rated the current impact of that event on each of 17 symptoms on a Likert scale (1 to 5); higher ratings indicate greater symptom severity. The measure possesses high internal consistency ($\alpha = 0.91$) and test-retest reliability ($r = 0.87$) (Adkins and colleagues, 2008). The available evidence indicates a high correlation between PCL scores and clinical diagnosis of PTSD using the Clinician Administered PTSD Scale ($r = 0.65$) and the Davidson Trauma Scale ($r = 0.74$). Issues of false positives and false negatives limit the clinical utility of the PCL. Additionally, participants were asked two yes/no questions regarding the event criteria of PTSD. These questions assessed the A1 criterion, the event was such that it threatened the physical integrity of the person or of another person, and the A2 criterion, the person responded with fear, helplessness, or horror (APA, 2000).

Centrality of events scale (CES). The CES measures the extent to which the memory of an event has become central to personal identity; individuals rate their agreement with statements such as the following: "This event has become a reference point for the way I understand myself and the world," "This event permanently changed my life," and "I feel that this event has become part of my identity" (Berntsen & Rubin, 2006). High scores indicate centralization of the

stressful event. The seven-item version of the CES has high reliability (Cronbach's $\alpha = 0.88$) and is correlated with PCL scores (Berntsen & Rubin, 2006).

Autobiographical memory questionnaire (AMQ). The AMQ is a questionnaire that examines the characteristics of retrieved memories such as sensory experiences (e.g. visual, auditory), contextual features (e.g. time, setting), and feelings of reliving and belief. Additional questions focus on impact, as well as voluntary and involuntary rehearsal. All items are rated on various Likert-type scales ranging from 1 to 7. For example, one item, "As I remember the event, I feel as though I am reliving the original event," is rated from 1-not at all to 7-as clearly as if it were happening right now. Structural analyses identified four scales: Recollection, Belief, Impact, and Rehearsal-Contemplation (Fitzgerald & Broadbridge, 2013). Standard (z -) scores were calculated and converted to T-Scores with a mean of 50 and a standard deviation of 10 to facilitate comparison. In addition to the standard AMQ items, participants were asked to rate the event on a 7-point scale describing the duration of the event. The 7-point scale was reduced to the four categories listed in the lower portion of Table 1. This was done to reduce the number of very low frequency categories. Participants also rated their memories on the field-observer distinction. The memory is rated on a 7-point scale describing whether the memory is experienced as an outsider as if watching a play (observer) or experienced from the viewpoint of a participant (field).

Event Coding. The brief event descriptions were rated using a manual developed by Thorne (Thorne & McClean, 2001). This system focuses on the prominent theme of the event description. The system was not used to categorize the level of trauma. For example, if the event description emphasized the context of a relationship, most likely it was categorized as a relationship event whether it includes abuse or pleasant activities. In the present study, most relationship events were negative, frequently divorce, conflict, fighting, and abuse.

One author (CLB) and a student assistant coded the events into the categories listed in the Table 1; JMF reconciled discrepancies. A generalizability analysis of the initial ratings reflected a high level of agreement ($\alpha = .87$). Note that the death category includes events in which terms such as *death*, *passing*, or *loss* of were used, as in "the death of my grandmother." References to accidents of others, homicide, or suicide were initially coded into individual

categories such as homicide; given the small number of events in each these categories, we combined them into the Other category. References to illnesses, accidents, and assaults on the self, were grouped into the category Self.

Center for epidemiologic studies depression inventory (CES-D). The CES-D is a 20-item self-report depression measure designed for use in general populations (Radloff, 1977). The scale has high internal consistency ($\alpha = 0.85$, normal sample; $\alpha = 0.90$, clinical sample), as well as convergent validity with clinical measures (Radloff, 1977).

International personality item pool-NEO (IPIP-NEO). The IPIP-NEO is a 300 item, open source measure of personality facets and factors similar to those developed in the Big Five Theory of Personality (Buchanan, Johnson, & Goldberg, 2005). The factors of the inventory are Neuroticism, Extraversion, and Openness to Experience, Agreeableness, and Conscientiousness. The form used here has 6 facets for each of the five factors with an average of 10 items per facet.

Data Analysis

The analyses associated with the first goal were primarily descriptive. We report the frequencies of the event categories developed by Thorne and McLean (2001). We then report on the relationship between these categories and the duration of the events and PCL scores.

For the second goal, the relationship among the five AMQ, CES, and PCL scores were analyzed using the Process program developed by Hayes (2013) and implemented for SPSS. For each of the four AMQ scales a mediation analysis was conducted. The Process program yields estimates of direct and indirect effects. Indirect effects are effects of the independent variable that are mediated by CES, the mediator in the current study. The statistical significance of the effects was assessed using bootstrapping (20000 samples) to identify confidence intervals set at the 99 per cent confidence level. We also report a statistic (κ^2) that estimates the magnitude of the indirect effect in terms equivalent to R^2 .

In the third set of analyses, two nested path models were compared using structural equation modeling with maximum likelihood estimation in LISREL8.80 (Jöreskog & Sörbom, 1993). The goal of this comparison was to examine event centrality as an integral factor in the

prediction of PTSD, as hypothesized in the AMM. The nested models were identical in every way except for one path, the causal path that links CES and PCL. This path is indicated by the dotted line representing the path from CES to PCL in Figure 1.

Two points about the structural analyses should be noted. First, while no directional pathways were estimated for Extraversion in either model, Extraversion was allowed to correlate with all of the other individual difference variables. Second, cases with missing data (smallest $N = 448$) were deleted from the correlation matrix in a pairwise fashion. In each model, we estimated the error terms for each multiple item scale using the following formula: $\text{error} = (1 - \alpha_x) * \sigma_x^2$ (Williams & Hazer, 1986).

Overall model fit was assessed using the following four indices: chi-square, root mean square error of approximation (RMSEA), comparative fit index (CFI), and non-normed fit index (NNFI). Chi-square values were expected to be significant, indicating poor fit, for both models due to the large sample size (Bentler & Bonett, 1980). RMSEA, CFI, and NNFI values were expected to indicate good fit for only the model estimating the path from CES to PCL. RMSEA values below .08 (Browne & Cudeck, 1992) and CFI/NNFI above .95 (Bentler & Bonett, 1980) are indicative of good fit. The RMSEA is a valuable tool for assessing fit because it takes into account degrees of freedom in the model (Williams & O'Boyle, 2011). The models were compared using both statistics that can be evaluated for significance (change in χ^2) and more subjectively evaluated indices of fit (change in RMSEA and CFI). When comparing nested models, a significantly lower chi-square represents a better fitting model. Changes in RMSEA and CFI values that exceed .01 represent meaningful changes in fit, with the less restrictive model showing the better fit (Byrne, Shavelson, & Muthen, 1989). Both models were further evaluated based on the direction and significance of the hypothesized pathways.

Results

Event Type Analysis

As noted earlier, the events were classified using the descriptive categories developed by Thorne and McClean (2001). The frequency of each category, along with the mean and standard deviation of PCL and CES scores are reported in Table 1. Only events that were categorized in the Thorne and McClean (2001) manual are included in the following analyses. Some participants declined to provide a description, and some responses were too vague to be coded. Additionally, some individuals did not provide responses to all the PCL items creating unequal N's across the analyses. The sizeable number of participants not reporting classifiable events precluded using this variable in other analyses.

The effect of Thorne category on total PCL score was significant, $F(4,322) = 2.62, p = .035, \eta_p^2 = .031$. Overall, the Death category was associated with the lowest PCL total. The Self and Relationship categories were associated with the highest PCL scores, significantly higher than Death ($p = .001$). Achievement and Other did not differ from Self, Relationship, or Death. There was no significant effect of event category on event centrality. Also, as indicated in Table 1, the correlation between PCL and CES was consistent across event category and was significant and moderate in size for all categories except Achievement.

Event type was associated with two other PTSD related variables, self-reported A1 and A2. As noted above, the A1 variable refers to the presence of threat of personal harm during the event. The association with A1 was significant, $\chi^2(4, N=328) = 80.82, p < .001$. Events categorized as Death (63%), Self (67%), and Other (83%) were more likely to be rated Yes on the A1 variable than Relationship (22%) or Achievement (19%). The Death events most often were deaths following a long illness. The Self and Other events involved threatened or actual harm, violation, or violence. The A2 variable refers to the experience of specific emotional responses including horror. Event type was also related to the A2 category, $\chi^2(4, N=328) = 45.21, p < .001$ with event in the Self (82%) and Other (86%) categories most frequently responding yes on A2.

AMQ Analyses

The AMQ variables were analyzed in a series of mediational analysis. The basic model is illustrated in Figure 2. PCL was the dependent variable and CES the mediator in all analyses. One of the AMQ scales was the independent variable in each. The first four analyses were on the scales of the AMQ: Recollection, Belief, Rehearsal, and Impact. The analyses were all conducted using the Process model of Hayes (2013). Rather than examining all four scales in a single analysis, as in hierarchical linear regression, we examined each scale independently, because our interest was not to find the best/most efficient prediction equation, but rather we sought to evaluate the issue of whether the influence of each on PCL was mediated by event centrality.

The results, as presented in Table 2, point clearly to the mediating role of centrality for all four variables. For each independent variable, the path from the independent variable to centrality of events was positive, as was the path from centrality to PCL score. And in all four cases the indirect effect was significant. All tests of significance were evaluated using bootstrapping with 20000 samples set to the .01 level. Thus, each scale is associated with higher centrality, and higher centrality was associated with higher PTSD scores. The k^2 in Table 2 evaluates the indirect effect relative to its maximum value in the observed data (Preacher & Kelley, 2011) and can be interpreted according to the standards used to evaluate R^2 . In each case, the value of k^2 exceeds the .09 level Cohen (1988) refers to as a moderate effect. The strongest direct effects were for Recollection and Impact, and only the direct effect of Belief failed to reach significance. The results support a model in which metacognitive processes are associated with PTSD symptoms both directly and indirectly through enhanced centralization of events.

Additionally, we examined the association of field-observer scale; this scale asks the individuals to rate whether they experience their memories from the field perspective (recalling the event from the same perspective as they did when the event took place). The results of the mediational analysis for field indicated no significant direct effect and a significant indirect effect on PCL through CES. The field perspective had a positive effect on CES scores.

Personality, PTSD Symptoms and Centrality

As noted earlier, the AMM proposes that the centralization of events into identity is crucial to the onset of PTSD; clearly the constructs are correlated as seen in Table 1. In this study, the relationship between centralization and PTSD is analyzed in the context of personality traits and depression. A path analysis was conducted to address two issues: (a) the statistical fit of two models in which centrality of the trauma memory either *is or is not* hypothesized to statistically have a direct effect on PTSD symptoms, and (b) the significance of the hypothesized pathways between the personality variables, centrality, and PTSD symptoms. This is a mediational model like that seen in Figure 2 illustrating the mediational model for the AMQ analyses. Figure 3 represents a more complex model and was evaluated with more global criteria of fit. The results are presented in Figure 3 and Tables 3 and 4.

Table 3 presents the statistical evaluation of Figures 3, the centrality model, as well as the non-centrality model. The most important elements of Table 3 are the RMSEA statistics and the change in χ^2 statistic, as discussed previously. The degree of change in the χ^2 statistic indicates that the centrality model provides a significantly better fit than the non-centrality model. While RMSEA statistics indicate that a centrality model fits the data well, the fit for the non-centrality model is marginal. The additional statistics in Table 3 are in agreement with the conclusion that a centrality model is both acceptable and a better fit than the alternative. Additionally, modification indices did not suggest that the estimation of additional paths would substantially benefit the fit of the centrality model.

The observed results for direct paths (See Figures 3) and indirect (see Table 4) paths reflect and refine the results of earlier regression studies. All of the hypothesized direct pathways to PCL scores were significant. We note the following points of emphasis: (1) The path from the CES to the PCL represents a significant direct effect; (2) Both Neuroticism and a positive score on the A2 criteria influence PCL scores directly and indirectly; (3) The effect of Neuroticism on PCL scores is mediated through self-reported depression symptoms and CES scores, as indicated by the significance of both indirect effects shown in Table 4; (4) CES also mediated the effect of A2, Openness, and Conscientiousness on PCL scores. Thus, CES, A2, Neuroticism, Openness, and Conscientiousness are all either directly or indirectly associated with a higher number of

self-reported PTSD symptoms. In contrast, Agreeableness has a protective relationship with PTSD symptoms, that is, more agreeable individuals have lower scores on the PCL.

A number of variables had an effect on event centrality: direct effects of self-reported depression symptoms, A2, Openness and Conscientiousness, as well as the indirect effect of Neuroticism mediated by self-reported symptoms of depression. The results are consistent with a model in which self-rated depression symptoms are a correlate of PTSD. The observed relationship is strong. The structural modeling results provide no indication that would support a direct effect of depressive symptoms on PTSD; however, a small indirect effect of depression on PTSD through centrality was also observed. As we discuss below, hypotheses of any predictions over time require time series data.

Discussion

In the introduction of this paper we tried to convey the complexity of the phenomenon that is referred to as PTSD. Clearly, the existing research indicates that any comprehensive account of the emergence of PTSD symptoms must take a multidimensional approach. Our review emphasized the following three areas of research: the nature of the trauma event, the representation of the trauma event in memory, and underlying dispositions that increase risk of PTSD. As anticipated, we found correlational evidence for the important contribution of each of these domains for models of PTSD.

Event Category

Although our emphasis is on memory for events, there is ample evidence that characteristics of events influence memory representations of those events. In perhaps the most striking recent study, New Yorkers who had witnessed the destruction of the World Trade Center on 9/11/2001 recalled their experiences. Those who witnessed the event in very close proximity showed greater activation of the amygdala and reported more emotionally enhanced recollections than those who had experienced the event from a greater distance (Sharot, Martorella, Delgado, & Phelps, 2007).

Our first goal for this study was to document the variety of experiences reported in a non-clinical sample of college students. We first looked at events in terms of overall event type using a system put forward by Thorne and McLean (2001). The results of the Thorne analysis indicate that events related to violence and assaults on the self along with relationship events were associated with the highest levels of PTSD symptoms. This is consistent with the findings of Breslau et al. (1998), who also collected their data in the Detroit metropolitan area. As with other studies, the death of others was frequently reported as the most stressful event, but this category was associated with relatively low levels of PTSD symptoms.

One of the clearest results in the present study was the number of participants who identified their trauma event as parental divorce, fighting, and emotional distress in the family. Even though these events often had taken place in childhood and adolescence, many participants identified these events as the life event currently creating the most stress in their lives. Those results are consistent with Lancaster et al. (2009). Also, the finding of a high level of PTSD for events involving assaults and accidents involving the self is consistent with a recent report by Arnetz and colleague (2014) that physical trauma to the self accounted for more variance in PTSD scores than any other subtype of trauma in a sample of Iraqi refugees. These two categories of event (i.e., divorce and assault) include many experiences that relate to the theme of betrayal. Parents who divorce or relatives who assault can both be seen as betraying the trust of a young child or teenager. The perceived violation may engender a greater reliance upon the type of better safe than sorry decision-making discussed in previous research (Lommen, Engelhard, Sijbrandij, van den Hout, & Hermans, 2013; Lommen, Engelhard, & van den Hout, 2010)

While some event categories are more closely associated with high levels of PTSD symptoms, events from all categories can achieve similar levels of event centrality. The mean CES scores for the different event categories fell within a relatively narrow range and no significant differences were seen between the event categories. However, it is premature to conclude that the type of trauma is unrelated to centrality. First, there were many events that either could not be coded or were missing. The mean CES score for the missing data was 3.04, which is lower than any of the coded event categories. Second is the related point that the classifications used here were not designed to detect such potential differences. This is an area

requiring further work. Our main point is that given that centrality is associated with PTSD for the sample as a whole and for all event categories, the use of event categories to a priori eliminate categories of events, such as the use of A1, appears open to question.

The Experience of Trauma Memory

Our second goal was to develop an understanding of the between memory attributes for the events and both PCL and CES scores. This goal was achieved in the context of the mediational model presented in Figure 2. Three of the scales, Recollection, Rehearsal, and Impact had both direct and indirect effects on PCL. The analyses consistently indicated that influences of the four major dimensions of the AMQ, Recollection, Belief, Rehearsal, and Impact are mediated by centralization of the event, and the kappa² statistics all indicate moderate indirect effects.

The present results extend the basic systems memory model proposed by Rubin (2005) in which distinctions between types of memories such as episodic and semantic or special mechanisms for trauma memories are viewed as neither conceptually useful nor consistent with the empirical data (Fitzgerald & Broadbridge, 2012). We have shown that the relationships among memory attributes, event centrality, and symptoms of psychological distress are consistent for a data set including a wide range of traumatic events, levels of trauma experience, and considerable individual differences. These findings are consistent with the AMM proposed in Rubin et al., (2008), and contradict the two system model proposed in Brewin (2014).

More specifically, the present findings document that high centrality of traumatic events is associated with a stronger sense of reliving the traumatic event in memory, which is counter to the suggestion that the CES measures a more abstract and less 'episodic' aspect of the memory that is unrelated to perceptual vividness and other "more episodic" aspects of the remembered event, as suggested by Brewin (2014, p. 86). In contrast, the present findings provide strong evidence that the CES is positively related to the accessibility of many components of the traumatic memory, including sensory-perceptual components, such as visual imagery.

Although it is possible to examine the four AMQ scales as simultaneous predictors, we feel that at this point, it is most useful to examine them individually. As Hayes (2013) notes, it is

important to consider the value of different approaches to data at different points in the study of a psychological phenomenon.

The Role of Memory and Individual Dispositions.

Our third major objective was an examination of PTSD in the context of both the centrality accorded to the event and underlying predispositions of the individual. The distinctive features of the AMM are the incorporation of memory variables, particularly centralization of the trauma event into identity in the context of individual differences. Previous studies have examined some features of the model, but only a limited number (e.g. Lancaster et al, 2011) have taken a hypothesis testing approach to the crucial role of event centralization in the context of other individual differences variables. We support the hypothesis that a model that includes the direct effect of event centralization on PTSD symptoms provides a better fit to the data than a model that does not include this effect. Thus, the comparative analyses of the centrality and non centrality models provide clear support for the core role of centralization in the onset and maintenance of PTSD symptoms.

The model also reflects the complexity of various influences. We begin by discussing the direct and indirect effect of neuroticism. Clearly, there is a strong direct effect, with a smaller indirect effect routed through event centralization and depression. As expected there was evidence of a correlation between depression and PTSD. The path analysis suggests that depression exerts an indirect effect on PTSD symptoms. Although depression correlates with symptoms, there were no indications in the analyses of a direct effect of depression on PTSD or PTSD on depression. Neuroticism may facilitate the repetitive thought patterns of rumination, which are characteristic of depression (Papageorgiou & Wells, 2003), thereby further increasing event centralization. As noted earlier, Boelen (2012) has demonstrated that the effects of centralization on PTSD are themselves mediated by rumination, depressive avoidance, and memory intrusiveness.

Our results add to the consistent cross-sectional evidence of a relationship between neuroticism and PTSD symptoms. A recent meta-analysis of English and Spanish language research articles (Soler-Ferrera, Sanchez-Meca, Lopez-Navarro, & Navarro-Mateu, 2014)

indicates an effect size of .37 for the relationship between PTSD and neuroticism. The present study indicates that neuroticism both directly and indirectly impacts PTSD symptoms. Additionally, there is an indirect effect of neuroticism on event centrality, suggesting that we cannot discount this variable when examining the individual differences that contribute to PTSD. The portrait of PTSD must include the impact of enduring individual differences contributing to the maintenance of *high levels* of psychological distress along with changes in the cognitive representation of the self through the incorporation of trauma events. Similarly, Pinto-Gouveia et al. (2013) have pointed to alteration of the self through self-criticism in PTSD.

The Value of Cross-Sectional Data

The role of time in models such as those presented in Figures 2 and 3 is complex, and depends as much on good theory and conceptualization, as it does on the design and method of data collection. It is common for authors presenting cross-sectional data to reflexively apologize for the lack of longitudinal data, and for those presenting longitudinal data to dismiss contradictory cross-sectional data. But such data are no panacea. The study of change over time has been discussed in developmental psychology for decades, eventually leading to agreement that time is not a causal variable, but is simply an index variable. Establishing the nature of a relationship between any two variables across time is difficult, because statistically researchers must find a significant interaction, which means differences in the slopes over time are significant. Few researchers have collected the multiple time point data needed for latent growth modeling that is most appropriate for the analysis of time-series data (e.g., Berntsen, Johannessen, Thomsen, Bertelsen, Hoyle & Rubin, 2012; see Bonanno, Westphal, & Mancini, 2011, for a review). Emphasizing this point, Lommen et al. (2014) provided evidence that the structure of symptom checklists may change from pre-trauma to post-trauma. Such findings highlight the need to work with latent constructs.

Cross-sectional studies are most relevant to understanding the current status of individuals. This falls within the domain of concurrent validity. Studies such as the present one demonstrating that neuroticism is highly correlated with PTSD suggest that individuals diagnosed with PTSD are likely to be well above average on neuroticism. Even within the high symptom group, there is variability in neuroticism, and the correlation between Neuroticism and

PCL score is $r = .199$ $p < .001$. Given the well-established link between high trait anxiety and the ineffectiveness of strategic inhibitory executive functions (Matthews, 2009; Shaw et al., 2010), there is value in knowing that neuroticism is a characteristic of individuals exhibiting PTSD symptoms. In fact, the use of a “better safe than sorry” avoidance strategy characteristic of highly neurotic individuals may be reflected in the emergence event centrality. Referring back to our earlier example, the survivor of a sexual assault may avoid family activities even if the probability of their assailant attending is low based upon the heavy reliance upon memory for the assault on decision-making. In a longitudinal study of soldiers, Lommen, Engelhard, Sijbrandij, van den Hout, & Hermans (2013) report that a more basic information-processing task predicts PTSD symptoms over time. Such tasks are less convenient for researchers, but may provide a bridge between behavioral, cognitive, and neuroscience research.

Agreeableness could be thought of as acting as a buffer by exerting only a negative (diminishing) direct effect on PTSD symptoms. The mechanism by which this effect is achieved is not clear; perhaps individuals high in Agreeableness generally have higher levels of positive affect which influences their experiences in life. It might be that when individuals develop PTSD they come to see themselves as less Agreeable. The latter view runs counter to the consistency of personality traits. Openness to Experience and Conscientiousness, which are generally regarded as positive personality characteristics, are associated with higher levels of event centralization and thus with higher levels of PTSD symptoms. One might predict that Openness to experience would generally foster adaptive responses to experience. When the experience is uncontrollable, repeated, and stressful, however, the individual may move too quickly to alter their identity in a negative direction. High conscientious individuals may be too willing to assume that they bear some responsibility for their negative experiences or may spend too much time trying to “figure out” a solution to a problem that they cannot actually solve and thus develop that sort of thinking that Ellis (1987) would regard as irrational. Such a maladaptive pattern would also increase the probability of negative changes in narrative identity.

Conclusions

Combined, the results of the present study suggest that the maladaptive response to a traumatic event that characterizes PTSD consists of a complex set of reactions that can be

predicted and understood using event, personality, and memory variables. In both the metamemory analyses and the individual differences model represented in Figure 3, we found evidence for the mediating role of event centrality. The present data highlight the importance of a multidimensional approach to PTSD in which characteristics of the event, mental representations of the event, and enduring predispositions are essential elements to be considered.

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Author note

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Table 1

Analyses of Event Type, Event Duration for PCL, CES and PCL/CES Correlation

Event Category	Frequency	Percent of Coded	PCL Scores	CES Scores	Correlation
Self	78	23	37.540 (15.11) ^a	3.319 (1.102)	.436*
Other	44	13	33.575 (12.337) ^{ab}	3.533 (1.112)	.449*
Relationship	70	20	38.656 (12.804) ^a	3.531 (1.037)	.414*
Death	95	28	32.670 (12.301) ^b	3.448 ((1.908)	.326*
Achievement	58	17	34.000 (14.228) ^{ab}	3.340 (1.121)	.203
Uncategorized	135	--	34.126(14.234	3.034	.326*

^{ab}Those items sharing the same subscript in the PCL column do not differ.

* $P < .001$

Table 2.

Result of the Mediation Analysis

Variable	Direct Effect	LCI	UCI	Indirect Effect	LCI	UCI	kappa ²
Recollection	3.160 ¹	1.87	4.45	1.590 ¹	1.042	2.760	.110 ¹
Belief	-0.493	-1.84	.857	2.46 ¹	1.732	3.256	.167 ¹
Rehearsal	1.576 ¹	.18	2.97	2.21 ¹	1.471	3.064	.141 ¹
Impact	3.131 ¹	1.56	4.70	1.90 ¹	.910	2.952	.110 ¹
Field	-0.518	-1.16	.127	.674 ¹	.393	1.053	.095 ¹
Typical	1.084 ¹	.444	1.72	.466 ¹	.230	.745	.064 ¹

¹ $p < .01$

Table 3

Fit Indices for Integrative Models

	df	χ^2	RMS EA	CFI	NNF I	Δ df	$\Delta\chi^2$
Model 1	16	54.27*	0.069	0.97	0.94	--	--
Model 2	17	102.32*	0.100	0.94	0.87	1	48.05*

Note: Model 1 contains the pathway from CES to PCL; * = $p < .001$

Table 4

Indirect Effects for the Centrality Model

	A2	CESD	N	C	O
CES	----	----	.19*	----	----
PCL	.03*	.07*	.05*	.03*	.05*

Note: Constructs are abbreviated as follows: N = Neuroticism, C = Conscientiousness, O = Openness to experience; * = $p < .05$

Figure 1. Conceptual Model Evaluated in the Current Study

Figure 2. Mediation Model for AMQ Analyses

Figure 3. Results of Structural Analysis of Mediation Model including a Direct Effect of Event Centrality on PTSD Symptoms

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