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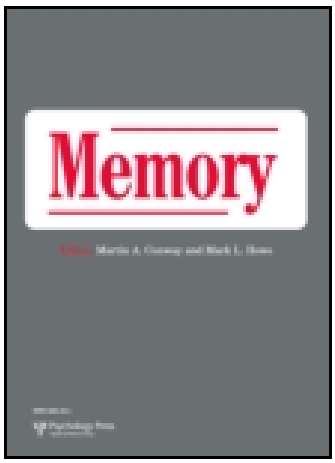

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Episodic and semantic components of autobiographical memories and imagined future events in post-traumatic stress disorder

Adam D. Brown[a], Donna Rose Addis[b], Tracy A. Romano[c], Charles R. Marmar[a], Richard A. Bryant[d], William Hirst[e] & Daniel L. Schacter[f]

[a] Department of Psychiatry, New York University School of Medicine, USA

[b] School of Psychology, The University of Auckland, New Zealand

[c] Center for Complex Systems and Brain Sciences, Florida Atlantic University, Boca Raton, FL, USA

[d] School of Psychology, University of New South Wales, Sydney, Australia

[e] Department of Psychology, New School for Social Research, New York, NY, USA

[f] Department of Psychology, Harvard University, Cambridge, MA, USA

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Adam D. Brown[1], Donna Rose Addis[2], Tracy A. Romano[3], Charles R. Marmar[1], Richard A. Bryant[4], William Hirst[5], and Daniel L. Schacter[6]

[1]Department of Psychiatry, New York University School of Medicine, USA
[2]School of Psychology, The University of Auckland, New Zealand
[3]Center for Complex Systems and Brain Sciences, Florida Atlantic University, Boca Raton, FL, USA
[4]School of Psychology, University of New South Wales, Sydney, Australia
[5]Department of Psychology, New School for Social Research, New York, NY, USA
[6]Department of Psychology, Harvard University, Cambridge, MA, USA

Individuals with post-traumatic stress disorder (PTSD) tend to retrieve autobiographical memories with less episodic specificity, referred to as overgeneralised autobiographical memory. In line with evidence that autobiographical memory overlaps with one's capacity to imagine the future, recent work has also shown that individuals with PTSD also imagine themselves in the future with less episodic specificity. To date most studies quantify episodic specificity by the presence of a distinct event. However, this method does not distinguish between the numbers of internal (episodic) and external (semantic) details, which can provide additional insights into remembering the past and imagining the future. This study employed the Autobiographical Interview (AI) coding scheme to the autobiographical memory and imagined future event narratives generated by combat veterans with and without PTSD. Responses were coded for the number of internal and external details. Compared to combat veterans without PTSD, those with PTSD generated more external than internal details when recalling past or imagining future events, and fewer internal details were associated with greater symptom severity. The potential mechanisms underlying these bidirectional deficits and clinical implications are discussed.

Keywords: Post-traumatic stress disorder; PTSD; Autobiographical memory; Future thinking; Mental time travel; Memory.

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Among the many disorders classified in the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV-TR; American Psychiatric Association, 2000), post-traumatic stress disorder (PTSD) is somewhat distinct in that its diagnosis is linked to a precipitating event. Since PTSD symptoms often persist long after exposure to the stressor, researchers elucidating the mechanisms of PTSD often focus their attention on memory as a key factor in the pathogenesis of the disorder (e.g., Brewin, 2007; Conway & Pleydell-Pearce, 2000; McNally, 2003; Rubin, Berntsen, & Bohni, 2008). In addition to studies examining memory-related symptoms in PTSD, such as intrusive memories, flashbacks, and amnesia (for a review see McNally, 2003), there has been increasing

Address correspondence to: Adam D. Brown, Department of Psychiatry, New York University School of Medicine, 50 First Avenue, OBV-Bldg A, # A645, New York, NY 10016, USA. E-mail: adam.brown@nyumc.org

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awareness that PTSD represents, in part, a problem with the retrieval of autobiographical memories (for a review see Moore & Zoellner, 2007). When asked to recall an autobiographical memory, individuals with PTSD tend to exhibit difficulties in recalling unique memories that took place on a specific time and day, producing what is often referred to as ''overgeneralised'' autobiographical memories.

The phenomenon of greater overgenerality in PTSD has been documented across multiple trauma-exposed population including Vietnam veterans (McNally, Lasko, Macklin, & Pitman, 1995; McNally, Litz, Prassas, Shin, & Weathers, 1994), cancer survivors (Kangas, Henry, & Bryant, 2005), and injured individuals with acute stress disorder (Harvey, Bryant, & Dang, 1998). Overgenerality does not appear to be a consequence of trauma exposure alone (Moore & Zoellner, 2007), is found independently of depression (McNally et al., 1995), and does not seem to be a marker of overall psychopathology (e.g., Wenzel, Jackson, & Holt, 2002; Wilhelm, McNally, Baer, & Florin, 1997). Overgeneralised autobiographical memory has been shown to be an important predictor in the time course of PTSD. A prospective study of firefighters identified overgenerality as a risk factor for PTSD, as firefighters exhibiting greater overgenerality before trauma exposure were found to be at greater risk for developing PTSD following trauma exposure (Bryant, Sutherland, & Guthrie, 2007). Overgenerality in PTSD has also been linked with deficits in social problem solving, suggesting a role in symptom maintenance (Sutherland & Bryant, 2008). Furthermore, a decline in overgeneralised memories may be a marker of recovery. For example, the remission of PTSD symptoms following cognitive behavioural therapy (CBT) appears to correspond with a reduction in overgeneral memories (Sutherland & Bryant, 2007).

More recently, Brown et al. (2013) have shown that not only autobiographical memories are characterised by overgeneralisation, but so too are the projections that PTSD individuals make about possible future events. Relatedly, Blix and Brennen (2011) found that PTSD symptom severity was positively associated with decreased specificity for autobiographical memories and imagined future events among a sample of sexual assault victims. These findings accord with growing evidence that retrieving episodic memories involves many of the same neural and cognitive processes as imagining and projecting one's self into the future (for reviews, see Schacter, Addis, & Buckner, 2008; Suddendorf & Corballis, 2007; Szpunar, 2010). According to the *constructive episodic simulation hypothesis* (Schacter & Addis, 2007), imagining future episodic events engages a constructive memory system that facilitates the flexible recombination of elements from past events in order to project and simulate novel events in to the future. In other words, imagining the future depends on remembering the past. From this perspective, individuals with PTSD may report overgeneralised episodic simulations because these future simulations are constructed around overgeneralised recollections of past episodes. The close link between overgenerality in autobiographical memory and future thinking suggests that those with PTSD face a problem not only in remembering their past in specific terms, but also in imagining an episodically rich future, a difficulty that may contribute to the persistence of the disorder.

Conway and Pleydell-Pearce (2000) propose a hierarchical representation of autobiographical memory based on the temporal specificity of the memories, with event-specific knowledge (ESK; e.g., eating dinner in Montmartre while watching the sun set over Sacré Coeur) lower in the hierarchy than general events that are repeated or ''categorical'' (e.g., commuting to a particular job) or extended (e.g., my trip to Paris) in time. Within this hierarchy, retrieval of autobiographical memories typically begins at the general event level, and from there ESKs are accessed (Haque & Conway, 2001). According to Williams et al. (2007), ruminative thinking at a categorical level, avoidance of the distressing affect associated with ESKs, or limitations of executive control caused by competing demands of cognitive resources can truncate retrieval prior to accessing ESKs. When these disruptions occur, as is believed to be the case in PTSD, retrieval does not progress beyond the level of general events, resulting in memories that lack the rich sensory details associated with ESK (Conway & Pleydell-Pearce, 2000) and comprise primarily conceptual information (Williams et al., 2007). The same factors also appear to truncate episodic simulations, producing simulations that share many of the characteristics of the affected autobiographical memories.

In this study we explore a new approach to examining the relationship between the retrieving personal memories of the past and imagining future events in individuals with PTSD based on

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the Autobiographical Interview (AI) developed by Levine and colleagues (Levine, Svoboda, Hay, Winocur, & Moskovitch, 2002). A key idea integral to the AI is that even if a remembered event occurs at a specific time and place—meeting the definition of ESK—the representation itself may contain both the rich *episodic* details typical of ESK, as well as more generic information such as personal or general *semantic* memory. Indeed, Conway and Pleydell-Pearce (2000) explicitly acknowledged that a combination of ESK with the "personal" semantic knowledge of general events provides a transitory representation that is roughly equivalent to the construct of episodic memory (Tulving, 1972). Given that episodic and semantic memory are thought to rely on different neural processes (Moscovitch et al., 2005), Levine et al. (2002) sought to distinguish episodic and non-episodic details comprising a memory by analysing the quality of each detail comprising the verbalised memory. In their AI coding scheme, episodic details—referred to as *internal* details (e.g., details regarding the central event, including, perceptual, emotional, spatial, and temporal details)—are scored using categories adapted from the Memory Characteristic Questionnaire (Johnson, Foley, Suengas, & Raye, 1988). Non-episodic details—referred to as external details—include primarily personal and generic semantic information, as well as repetitions and metacognitive statements. Traditionally, clinical studies investing episodic specificity employ the coding scheme developed by Williams and colleagues (1996) in which response to a cue word were give a score of "3" (specific) if the event took place, or could take place, within a 24-hour time period, included people, and a specific location; a "2" (intermediate) if the response was a repeated event or a past or future event that took place or could take place over a period of more than 1 day; a "1" (general) if it did not contain specific details or was something other than a memory; and a "0" if the individual did not generate a response.

The AI coding scheme differs in several ways from the Williams et al. (1996) approach. The Williams approach distinguishes at a fairly broad level between specific events and general events by determining the temporal specificity of the event, without examining the episodic or semantic nature of the details comprising the memory. In contrast, Levine et al.'s coding scheme focuses on the qualitative nature of the details that make up a recollection rather than on classifying whole autobiographical memories as specific or general. Importantly for the present study, the AI coding scheme can successfully detect tendencies of different populations to generate more or less of one detail type. For instance, younger adults generate more internal details when generating past and future events compared with older adults, whereas older adults generate past and future events with more external details (Addis, Wong, & Schacter, 2008; Levine et al., 2002).

Given that the AI coding scheme provides a more nuanced profile of the types of details comprising past and future events than has yet been produced for PTSD, we reasoned that it would be a useful tool to characterise further the autobiographical memories and episodic simulations of those with PTSD. From a clinical perspective, the analysis may provide therapists with a more nuanced view of how those with PTSD imagine their future. To account for their results showing that older adults generated fewer internal details, but more external details for both past and future events, Addis et al. (2008) proposed that the pattern found with older adults might reflect, at least in part, deficits associated with hippocampally dependent relational memory, making it difficult for these participants to either retrieve or link together elements of episodic memory during both the memory and the episodic simulation tasks. Recent neuroimaging evidence with older adults provides some support for this view (Addis, Roberts, & Schacter, 2011). Similar difficulties might arise in individuals with PTSD because PTSD is associated with poor performance on assessments sensitive to hippocampal functions, such as the Verbal Pairs Associate I (VPA; Golier et al., 2002; Yehuda et al., 2006). Moreover, individuals with PTSD show reductions in hippocampal volume (e.g., Apfel et al., 2011; Felmingham et al., 2009; for reviews see Geuze, Vermetten, & Bremner, 2005a, 2005b; Karl et al., 2006).

The aim of this study was to examine whether individuals with and without PTSD differ in their generation of internal and external details when remembering past events and simulating future events. We predicted that a diagnosis with PTSD will be associated with more external, and fewer internal, details for both the generation of past and future events, and that the number of observed external details would be associated with PTSD symptom severity.

METHOD

This study is based on a re-analysis of data that were collected by Brown et al. (2013).

Participants

A total of 28 Operation Iraqi Freedom and Operation Enduring Freedom combat veterans between the ages of 19 and 50 years participated in the study. Participants were recruited from the New York metropolitan area (via craigslist.com, advertising) and were required to demonstrate proof of military identification (e.g., DD-214) in order to participate in the study. Individuals were pre-screened and excluded if they met criteria for Traumatic Brain Injury (TBI; Hoge et al., 2008) or had endorsed prior behavioural or psychopharmacological treatment for PTSD.

The Clinician-Administered PTSD Scale (CAPS; Blake et al., 1995), a semi-structured interview, was used to determine the presence of PTSD. The CAPS possesses good sensitivity (.84), specificity (.95), and test–retest reliability (.90) relative to the SCID PTSD diagnosis (Blake et al., 1995). Individuals were assigned to the PTSD group if they met DSM-IV-TR PTSD Criteria A1 (exposure to an event involving actual or perceived life threatening or serious injury) and A2 (a subjective response of fear, helplessness, or horror during or immediately after the event) and exhibited at least one re-experiencing symptom, at least three avoidance symptoms, and at least two hyperarousal symptoms (Blake et al., 1995). Based on these criteria, 12 individuals did and 16 individuals did not meet criteria for PTSD. In addition participants completed a battery of demographic and clinical self-reports. For the purposes of this study we have included self-report data concerning demographic information, depression, combat exposure, and executive functioning (see Table 1 for description of the measures and findings).

TABLE 1
Demographic and clinical summary for OEF/OIF veterans

	Veterans with PTSD		*Veterans without PTSD*		
Variable	*M*	*SD*	*M*	*SD*	*t*
Age	30.25	6.03	31.38	8.69	8.69
Gender% male	92%		82%		
Years of education	14.08	1.78	14.94	1.52	1.52
Months deployed	15.55	11.75	14.38	6.29	6.29
Months since combat	54.50	28.91	45.56	25.52	25.52
CAPS	70.17	25.15	14.06	9.52	8.22***
Combat exposure	17.25	3.84	10.13	3.69	4.94***
BDI-II	13.58	7.08	9.47	6.87	1.71
COWAT	37.25	9.38	39.94	10.14	0.72

CAPS = Clinician Administered PTSD Scale; Combat Exposure = Combat Exposure Scale; BDI – II = Beck Depression Inventory – Second Edition (Beck, Steer, & Brown, 1996); COWAT = Controlled Oral Word Association Task. ** $p < .001$. *** $p < .0001$.

Stimulus material, design, and procedure

The stimulus material and methodology are based on a recently modified autobiographical memory task (Crovitz & Schiffman, 1974) and the AI (Levine et al., 2002), as has previously been employed in earlier studies examining autobiographical memory and episodic future thinking (e.g., Addis et al., 2008). Individuals were presented with 20 cue words and were instructed to generate close (past month) or distant (past 5–20 years) memories and close (next month) and distant (next 5–20 years) imagined future events. Temporal distance (close/distant) was manipulated because previous work shows that past and future event phenomenology, such as personal significance and level of event detail, vary as a function of time (Addis et al., 2007; D'Argembeau & van der Linden, 2004). Previous research has used similar time frames; that is, distant temporal distance of 5–20 years (e.g., Addis et al., 2007). All cue words were neutral nouns selected from Clark and Paivio's extended norms (Clark & Paivio, 2004). Although autobiographical memory studies in clinical disorders often use positively and negatively valenced word cues, neutral words cues were employed because we were closely adhering to the paradigm used by Addis et al. (2007). In addition we were reluctant to explicitly ask this clinical population to recall or imagine negative events (for a more detailed rationale, see Brown et al., 2013).

The conditions were blocked, the 20 words were randomly divided into four lists (one list per temporal condition) of 5 words, and the order of presentation and temporal direction were counterbalanced. Participants were instructed to either recall or imagine a personal event in as much detail as possible in response to each cue word. In addition to being personally relevant, participants

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were told that each event, past or future, should occur within a 24-hour time period, be realistic, and for future events, not previously experienced by the participants. Four practice trials were completed before beginning each task.

Word cues were presented in the centre of an Apple desktop computer with a 21.5-inch monitor, with the task (recall past event or imagine future event) and temporal distance (month or 5–20 years) displayed underneath the cue, as well as a reminder to describe as much detail about the event as possible. Participants then described the event in detail into a tape recorder. There were no time constraints on the verbal description. Responses were later transcribed.

Scoring

For each response the central event was identified. Each response was segmented into distinct details and these details were then labelled as internal (episodic details related to the central event, e.g., "It was dark", "I jumped out of the way", "He was standing to my left") and external details (semantic information: "Paris is the capital of France"; repetitions: "They liked what I did", "They liked my work"; information unrelated to the event: "That doesn't matter", "That was amazing"; and information for extended periods or facts about the person: "I always hated yams" "I worked as an engineer"). The numbers of internal and external details for each event were totalled and averaged across all trials in each condition, creating total Internal and External scores for each of the four conditions. Two scorers were blind to the hypotheses of the study and group membership. Based on the scoring of 20 responses, scorer inter-rater reliability using interclass correlations was high for Internal ($\alpha = .91$) and External ($\alpha = .88$) scores.

RESULTS

In order to obtain a rough estimate of the level of detail of the reported autobiographical memories and episodic future thoughts, we calculated the total number of details (combined internal and external details) contained in the responses. For autobiographical memories, individuals with PTSD generated 55.01 ($SD = 9.84$) details, whereas individuals without PTSD generated 54.65 ($SD = 9.34$), $t(26) = .09$, $p = .92$, $d = .04$. In terms of episodic future thoughts, individuals with PTSD generated 48.81 ($SD = 15.96$) details and individuals without PTSD generated 52.32 ($SD = 10.24$), $t(26) = .71$, $p = .49$, $d = .26$.

In order to assess our claims about internal and external details, separate repeated-measure ANOVAs were conducted for internal and external AI scores, in which Group (PTSD + or no-PTSD) served as the between-participants variable, and Time (Close or Distant) and Task (Memory or Future) were the within-participant variables (see Figure 1). Participants with PTSD produced fewer internal details than individuals without PTSD, $F(1, 26) = 10.79$, $p = .003$, $\eta = .29$. Main effects were also found for Time, $F(1, 26) = 7.73$, $p = .01$, $\eta = .23$, and Task, $F(1, 26) = 20.24$, $p = .001$, $\eta = .44$. The main effect of Time arose because close events contained more internal details than distant events (Close: $M = 56.70$, $SD = 17.62$, Distant: $M = 50.64$, $SD = 17.59$), $t(27) = 2.83$, $p = .009$, $d = .34$). As for the main effect of Task, it reflects that fact that remembered past events contained more internal details than imagined future events (Memory: $M = 57.83$, $SD = 14.25$, Future $M = 49.52$, $SD = 20.33$), $t(27) = 3.99$, $p = .000$, $d = .47$). In addition there was an interaction between Group and Task, $F(1, 26) = 4.54$, $p = .04$, $\eta = .15$. Follow-up t-tests revealed that participants with PTSD generated more internal details for memories than future events, (PTSD: $M = 86.89$, $SD = 32.51$; No PTSD: $M = 122.70$, $SD = 35.25$), $t(26) = 3.29$, $p = .003$, $d = 1.05$. Furthermore the number of internal details for past and future events were significantly correlated for both participants with PTSD, $r = .80$, $p = .001$ and without PTSD, $r = .81$, $p = .001$.

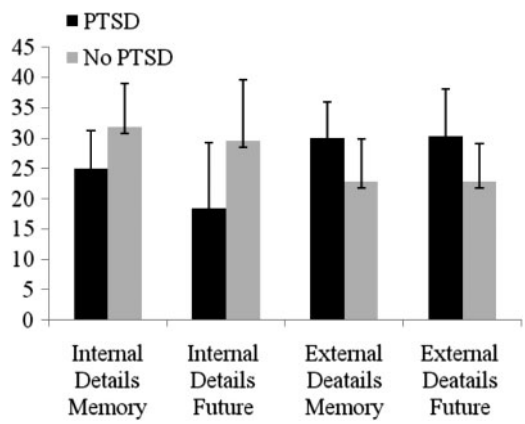

Figure 1. Mean number of internal and external details for autobiographical memories and imagined future events. Data collapsed across temporal distance.

In contrast, a repeated-measures ANOVA for external details revealed that PTSD-diagnosed individuals generated more external details than individuals without PTSD $F(1, 26) = 11.89$, $p = .002$, $\eta = .31$(PTSD: $M = 119.17$, $SD = 22.68$; No PTSD: $M = 87.53$, 24.96), $t(26) = 3.45$, $p = .002$, $d = 1.32$. A main effect of Time was observed in which distant events contained more external details than close events, $F(1, 26) = 9.99$, $p = .004$, $\eta = .28$ (Close: $M = 45.69$, $SD = 17.42$, Distant: $M = 55.39$, $SD = 14.97$), $t(27) = 3.27$, $p = .003$, $d = .60$). The number of external details for past or future events were also significantly correlated in participants with PTSD, $r = .74$, $p = .006$ and approached significance among participants without PTSD, $r = .71$, $p = .002$.

A series of correlations among individuals with PTSD were conducted examining the relation between AI scores and PTSD symptom severity, as measured by the Clinician Administered PTSD Scale (CAPS). Internal details were negatively correlated for both past and ($r = -.41$, $p = .03$) and future ($r = -.47$, $p = .01$) events with PTSD symptom severity. Thus individuals with more severe PTSD symptoms generated fewer internal details when describing past and future events. In contrast, the generation of external details for past events were positively correlated with total scores on the CAPS, $r = .48$, $p = .01$.

Although group differences did not emerge on the word fluency task, given the importance of executive functioning in overgeneralised memory (e.g., Williams et al., 2007), a series of correlations were conducted between the FAS and scores on the AI. These correlations were not significant when conducted for the total sample (Memory Internal: $r = .03$; Memory External, $r = .03$; Future Internal: $r = .08$; Future External, $r = .13$) or when examined separately for PTSD (Memory Internal: $r = .12$; Memory External, $r = .36$; Future Internal: $r = .10$; Future External, $r = .38$) and non-PTSD individuals (Memory Internal: $r = .16$; Memory External, $r = .11$; Future Internal: $r = .14$; Future External, $r = .01$).

DISCUSSION

Retrieval deficits are commonly observed in PTSD (Moore & Zoellner, 2007), and recent work has shown that these patterns also occur for imagined future events (Brown et al., 2013). To date these studies have employed a coding method that is based on whether an individual recalls or imagines an event that is temporally specific, taking place within a 24-hour time period. Although this technique has been a useful means of observing this phenomenon in PTSD (Moore & Zoellner, 2007) and other clinical disorders (Williams et al., 2007), this method does not make a clear distinction between the use of internal (episodic) and external (semantic) details within responses. This report provides evidence that individuals with PTSD were more likely to generate personal past and future events with a greater proportion of external details, whereas individuals without PTSD generated responses with a greater proportion of internal details. Inasmuch as we failed to find any difference in the level of depression across these two groups, the deficit we observed can probably be traced to the PTSD itself.

To date the CARFAX model is the most comprehensive model for conceptualising the mechanisms underlying retrieval specificity (Williams et al., 2007). This model proposes that capture and rumination, functional avoidance, and executive control deficits independently or interdependently underlie the well-established phenomenon of overgeneralised autobiographical memory in a range of clinical disorders. Although there is considerable empirical support for these mechanisms, recent reviews have suggested that additional research is needed to more fully understand the processes and characteristics linking overgeneralised autobiographical memory and psychopathology (Moore & Zoellner, 2007; Sumner, 2012). To that end, the primary aim of this study was to adopt a more fine-grained approach to examining the composition of details generated for past and future events. That is, although there now exists a robust body of work showing a consistent association between a lack of episodic specificity for autobiographical memory and imagined future events in a number of psychological disorders, the majority of research to date has focused on the inability of patients to generate events within a distinct spatiotemporal context, without quantifying the number of episodic and semantic details comprising the events. However, cognitive models of autobiographical memory suggest that autobiographical events, past and future, include episodic and semantic details (e.g., Conway & Pleydell-Pearce, 2000; Levine et al., 2002; Tulving, 1972). Therefore, although preliminary, these findings suggest that in addition to deficits in retrieving temporally distinct events, overgeneralised autobiographical memories are

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also characterised by the presence of numerous external details as well as few internal details.

Prior work in amnesic patients has demonstrated that impaired access to episodic details is associated with impaired construction of specific and detailed future simulations (e.g., Tulving, 1985; Klein, Loftus, & Kihlstrom, 2002; Hassabis & Maguire, 2007; Race, Keane, & Verfaillie, 2011; but see also Squire et al., 2010). In line with these findings we found significant correlations between the number of internal details generated for past and future events—a pattern previously observed in older adults (Addis et al., 2008) and patients with hippocampal damage (Race et al., 2011). Another important component process of simulation is the recombination of memory details into a coherent scenario. It is thought that this recombination process relies on hippocampally mediated relational processing (Addis & Schacter, 2012). Indeed, positive correlations between internal details for past and future events and deficits in performance on the VPA, a hippocampal-sensitive measure of relational memory (Addis et al., 2008). Consistent with these observations a recent fMRI study revealed that during the construction of remembered past events and imagined future events, older adults showed reduced hippocampal activation compared with younger adults (Addis et al., 2011). Deficits in hippocampal function are likely to impair one's ability to recombine past episodic details in order to generate future events, and may be associated with more fragmented simulations (Addis, Musicaro, Pan, & Schacter, 2010; Hassabis et al., 2007). Although we can only speculate, in light of the present findings and other evidence documenting decreased VPA performance (Golier et al., 2002; Yehuda et al., 2006) and hippocampal volume (Bremner, 2007; Geuze et al., 2005a, 2005b; Schaefer et al., 2006) in PTSD, it is possible that alterations in hippocampal functions in PTSD are associated with neuro-cognitive deficits in simulating detailed future scenarios. Future studies will need to examine this issue directly by examining whether performance on relational memory tasks in PTSD is associated with episodic past and future event specificity, and also by using fMRI to examine hippocampal activity in PTSD during episodic memory and future simulation. It will also be important to assess how findings from such studies bear on the mechanisms proposed by the CARFAX model. In particular, deficits in executive control have been associated with both overgenerality (e.g., Williams et al., 2007) and PTSD (e.g., Polak, Witteveen, Reitsman, & Olff, 2012). However, we did not observe a difference between the two groups on executive functioning using the word fluency task, nor did scores on the FAS correlate with internal or external scores for past or future events across the whole sample or when examined separately among individuals with and without PTSD.

Future studies using a wider range of neurocognitive tests, including other measures of executive functioning, would help to better detect the various neurocognitive processes contributing to this phenomenon. Furthermore, examining other aspects of past and future narratives, such as event quality, may help to link these findings with the CARFAX model. For example, recent work has shown that self-report ratings of reliving of past and future events were associated with rumination, a cognitive process highly associated with PTSD (Thomsen, Shneiber, & Olesen 2011).

We believe that the present findings further clarify how episodic specificity may differ between individuals with and without PTSD. Based on these findings, and in the context of the Brown et al. (2013) study, individuals with PTSD are less likely to generate temporally specific events, and are less likely to incorporate contextually rich episodic details when generating these events.

As noted earlier, this pattern is similar to that previously observed in older adults (Addis et al., 2008, 2010). In attempting to understand why older adults produce fewer internal and more external details than younger adults, Gaesser, Sacchetti, Addis, and Schacter (2011) conducted experiments in which older and younger adults were instructed to describe, one at a time, individual coloured pictures of natural scenes in as much detail as possible; a different set of pictures were then also used to cue simulations of imagined future events or memories of past events. The resulting protocols were scored for internal and external details with a version of the AI similar to the one used in the present study, except that it was further adapted to score internal and external details for the picture description task. Two experiments revealed that older adults produced fewer internal and more external details than younger adults in all three experimental conditions; picture description, memory, and imagination. It was also found that age-related changes in picture description performance could not fully account for all the changes observed on the memory and imagination tasks.

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Nonetheless, the finding that older adults produced fewer internal and more external details on the picture description task, which does not require access to episodic memory, led Gaesser et al. (2011) to argue that performance on the AI can be affected by non-episodic factors, such as age-related changes in narrative style or inhibitory control. In order to assess the possible contribution of non-episodic factors such as narrative style or inhibitory control to the pattern of results reported here, it will be important for future studies to determine whether PTSD patients also produce fewer internal and increased external details on a picture description task, and whether any such deficits fully account for the deficits in episodic memory and episodic simulation that we have documented.

Despite the need for additional studies to clarify the basis of the impairments we have observed, our findings may have implications for treatment. Studies suggest that less cohesive and more fragmented narratives may be an important predictor of symptom severity and treatment outcome (Foa, Molnar, & Cashmere, 1995). Although the presence of fragmented narratives in PTSD is not strongly supported through empirical studies (e.g., Porter & Birt, 2001) these findings suggest that the way in which ''fragmented'' was operationalised by Foa and colleagues (1995) may be similar to the types of content coded as external details in the AI. Thus, whether greater use of external details reflects ''fragmentation'' or ''narrative cohesion'', it may be a useful indicator of prognosis. Additionally, emerging evidence suggests that training programmes in which patients practise retrieving specific autobiographical memories corresponds with a reduction in depressive symptoms (e.g., Neshat-Doost et al., 2013; Raes, Williams, & Hermans, 2009). Such training programmes may also benefit PTSD patients. The findings from this study suggest that teaching individuals to generate more internal details may be particularly useful in this population. Furthermore, future interventions might seek to help PTSD patients to generate future events with greater episodic detail. Recent work by Brown, Dorfman, Marmar, and Bryant (2012) found that episodic specificity of future events predicted performance on two indices of a social problem-solving task, which if generalisable to PTSD, might aid in recovery.

A number of limitations must be acknowledged. First, as alluded to earlier, we can only speculate on the role of the hippocampus. Future studies would benefit from structural and functional neuroimaging data. Second, the sample size is small, and comprises almost entirely males who served in combat. Thus we must be cautious in generalising to other populations. The cross-sectional design does not allow us to demonstrate causality, thus we cannot say that the reduced specificity is the result of trauma exposure, especially in light of prospective studies showing functioning prior to trauma exposure is a risk factor for PTSD. However, this study does suggest that individuals with PTSD appear to have difficulty retrieving and imagining episodic details of past and future experiences, which may contribute to symptom maintenance

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