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The Organization of Autobiographical and Nonautobiographical Memory in Posttraumatic Stress Disorder (PTSD)

Lena Jelinek, Sarah Randjbar, Dragana Seifert, Michael Kellner, and Steffen Moritz
University Medical Center Hamburg-Eppendorf

Disorganized trauma memory seems to play an important role in the pathogenesis of posttraumatic stress disorder (PTSD). However, it is unclear whether memory organization of nonautobiographical material (i.e., sequence memory) is also impaired in PTSD. A novel task designed to assess nonautobiographical memory for content and order information was administered to trauma survivors with ($n = 26$) and without PTSD ($n = 55$) as well as to nontraumatized healthy adults ($n = 30$). In addition, traumatized participants were asked to give a detailed narrative of the traumatic event and an unpleasant autobiographical event. Transcripts of both types of narratives were analyzed with regard to disorganization. Results indicated that trauma memories were more disorganized than memories of an unpleasant event in the PTSD group in comparison with the non-PTSD group. However, no differences were found for memory organization of nonautobiographical material among trauma survivors with and without PTSD and nontraumatized controls. With regard to memory accuracy of nonautobiographical material, group differences were more strongly associated with trauma exposure than with PTSD.

Keywords: PTSD, narrative memory, attention, depression, sequence memory

Altered memory functioning is a key feature of posttraumatic stress disorder (PTSD; Golier & Yehuda, 2002; McNally, 2003a). In particular, trauma memories appear to differ significantly from other autobiographical memories in content and structure. Distorted trauma memories of trauma survivors with PTSD manifest in vivid and highly emotional unintentional recall, as well as incoherent intentional recall (e.g., Ehlers, Hackmann, & Michael, 2004). As the unintentional reliving of the trauma is a core symptom of PTSD, it is the focus of much research. However, the disturbed intentional recall of the traumatic experience has rarely been investigated; often it is referred to as *fragmented* and/or *disorganized,* describing a lack in narrative coherence, confused temporal order, and the inability to recall important details (e.g., Brewin, Dalgleish, & Joseph, 1996; Ehlers & Clark, 2000; Foa, Molnar, & Cashman, 1995; van der Kolk & Fisler, 1995).

Memory Disorganization in PTSD

From a theoretical perspective, disturbed intentional recall of the traumatic event has been linked to the development of PTSD and is part of many etiological illness models (Brewin et al., 1996; Ehlers & Clark, 2000; Foa & Rothbaum, 1998; for an overview on cognitive models of PTSD, see Dalgleish, 2004, or Brewin & Holmes, 2003). Contrary to these theories, other authors have argued that traumatic memories may be recalled as well as or even better than nontraumatic autobiographical events (e.g., Berntsen, Willert, & Rubin, 2003; Kihlstrom, 2006; Porter & Birt, 2001; Shobe & Kihlstrom, 1997).

However, the debate regarding whether or not traumatic memories are more disorganized or fragmented in PTSD is hampered by the inconsistent use of concepts and methodological approaches across studies (Ehlers et al., 2004; O'Kearney & Perrott, 2006). Approaches based on participants' self-report to assess memory organization range from questionnaires to interviews using one single question or multiple items. Methods relying on the analysis of narratives produced by participants vary from content analysis to levels of reading ease, of which the latter has mostly been criticized (e.g., Gray & Lombardo, 2001; for a review, see O'Kearney & Perrott, 2006). Despite this diversity, a substantial overlap in assessment of memory disorganization may be seen in studies that have rated trauma narratives on the basis of the method introduced by Foa et al. (1995). When ratings were based on this method and certain methodological standards were met (such as including participants with and without PTSD), findings indicated that trauma memories are more disorganized in PTSD (Halligan, Michael, Clark, & Ehlers, 2003; Jones, Harvey, & Brewin, 2007; acute stress disorder: Harvey & Bryant, 1999). However, measures and the concept of memory disorganization have been criticized (e.g., Ehlers et al., 2004; Gray & Lombardo, 2001). It has been noted, for example, that incomplete encoding might be not specific to trauma memory but a general feature of autobiographical memory (McNally, 2003b). Addressing this criticism by including disorganization ratings (self-report) for an unpleasant but nontrau-

Lena Jelinek, Sarah Randjbar, Michael Kellner, and Steffen Moritz, Department of Psychiatry and Psychotherapy, University Medical Center Hamburg-Eppendorf, Hamburg, Germany; Dragana Seifert, Institute of Legal Medicine, University Medical Center Hamburg-Eppendorf, Hamburg, Germany.

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Correspondence concerning this article should be addressed to Lena Jelinek, University Medical Center Hamburg-Eppendorf, Department of Psychiatry and Psychotherapy, Martinistr. 52, 20246 Hamburg, Germany. E-mail: l.jelinek@uke.uni-hamburg.de

matic control event, the study by Halligan and colleagues (2003) may be considered a promising approach. The authors found that the quality of trauma memories was rated more disorganized compared with unpleasant memories. This effect was particularly enhanced in participants who developed PTSD. However, autobiographical control events were not externally rated.

Moreover, a number of confounding variables have not been satisfactorily addressed by prior research. First, disorganized trauma memories in PTSD may be secondary to lower intelligence (representing a risk factor for the development of PTSD; see Macklin et al., 1998). A relationship between memory disorganization and intelligence has been inferred, for example, through the findings of a close relationship between reading level as an index of fragmented and disorganized trauma memories and writing skills, as well as overall cognitive ability (Gray & Lombardo 2001). Yet the influence of (verbal) intelligence on memory disorganization as assessed with a rater-based approach has not been established.

Second, difficulties in concentration are part of the diagnostic criteria of PTSD (American Psychiatric Association [APA], 1994) and are likely to lead to less organized recall and poor memory performance. It cannot be fully excluded that a rater may misinterpret difficulties in expressing oneself (e.g., searching for words or hesitation due to lower verbal intelligence or poor concentration of the participant) as memory disorganization. Third, comorbid substance abuse and comorbid depression are frequent in PTSD (APA, 1994). Substance use disorders (e.g., Svanum & Schladenhauffen, 1986), as well as comorbid depression (Burt, Zembar, & Niederehe, 1995; Moritz, Kloss, Jahn, Schick, & Hand, 2003), are known to compromise cognitive performance and, thus, may impair memory organization. To provide a more pristine investigation of memory disorganization, these potentially confounding variables should be considered when investigating autobiographical as well as nonautobiographical memory in PTSD (for nonautobiographical memory, see also Brandes et al., 2002; Gilbertson, Gurvits, Lasko, Orr, & Pitman, 2001; Jelinek et al., 2006).

Deficits in Nonautobiographical Memory Functioning in PTSD

One recent psychological theory on the etiology of PTSD (dual representation theory, Brewin, 2008; Brewin et al., 1996) allows hypotheses about nonautobiographical memory performance that can be tested. In his theory, Brewin (2008; Brewin et al., 1996) differentiated two kinds of traumatic memories. One subset of trauma memories is verbally accessible, voluntarily retrievable, and linked to other autobiographical memories, but requires higher cognitive resources (verbally accessible memories). Another subset of trauma memories consists of isolated images unavailable to consciousness, which are processed at a lower level and triggered by trauma-related cues (situationally accessible memories). According to this theory, PTSD is caused by a prolonged imbalance in encoding and storing between verbally (impoverished and impaired) and situationally (intact or enhanced) accessible memories. In particular, it is argued that one key factor in the development of PTSD is the failure of the verbal memory system to inhibit intrusions produced by the image-based memory system (cf. Brewin, 2008).

With regard to nonautobiographical memory, Brewin (2008) suggested in a recent description of the theory that "PTSD is likely to be associated with impaired verbal memory but a wellfunctional sensory memory system" (p. 221). Such impairment might contribute to the proposed failure of the verbal system to inhibit intrusions, which then leads to disturbed intentional recall of the trauma. "A relative weakness of verbal memory-related abilities" (Brewin, Kleiner, Vasterling, & Field, 2007, p. 457) was supported by the conclusions of a recent meta-analysis on nonautobiographical memory in PTSD (Brewin et al., 2007). If the ability to remember and process verbal information is generally weakened or impaired in PTSD, poor verbal memory for information (verbal content memory) as well as information order (verbal sequence memory) can be predicted. So far, the question whether or not the disorganization of verbal memory for nonautobiographical material is heightened in PTSD has not been addressed.

Although the dual representation theory does not propose any explicit assumptions about the organization of autobiographical material beyond traumatic material, a general deficit in verbal memory should also be reflected in the organization of any narrative of an autobiographical event. However, as stated above, Brewin (2008) suggested that the imbalance of representation between memory systems will lead to a particularly disorganized trauma narrative in PTSD because some information about the trauma will only be represented initially in the situationally accessible memory and not in the verbally accessible memory. Consequently, not all relevant information will be available for constructing a verbal narrative. Also, spontaneous intrusions containing new information may be triggered from the situationally accessible memory, causing the narrative to be incoherent and disorganized. Thus, the dual representation theory proposes that beyond the supposed more general impairment of verbal memory, trauma narratives will be particularly disorganized in PTSD (C. R. Brewin, personal communication, October 13, 2008).

The Present Study

The present study aims to address central qualitative and quantitative aspects of memory functioning in PTSD and to combine research on autobiographical and nonautobiographical memory to examine whether or not memory disorganization of the traumatic event exceeds general impairment of verbal memory. This question is highly relevant for the improvement of the current understanding of the disorder and to evaluating to what extent memory functioning is impaired in PTSD. The following hypotheses were made:

1. On the basis of cognitive models of PTSD (e.g., Brewin et al., 1996; Ehlers & Clark, 2000), it was expected that the trauma memory is more disorganized than the memory of an unpleasant but nontraumatic control event in participants with PTSD in comparison with traumatized participants without PTSD. Thus, a significant Group (PTSD vs. non-PTSD) × Event (traumatic event vs. unpleasant event) interaction was hypothesized for memory disorganization. Furthermore, it was assumed that memory disorganization is observable when verbal intelligence, concentration (selective attention), depression,

and alcohol consumption are considered as covariates in the analysis.

2. Regarding nonautobiographical memory, it was hypothesized that traumatized participants with PTSD perform worse in verbal content memory than traumatized participants without PTSD and nontraumatized participants. Moreover, it was assumed that these deficits are also present when concentration, verbal intelligence, alcohol consumption, and depression are entered as covariates in the analysis.

3. On the basis of accounts of reduced verbal memory functioning in PTSD, as well as neuropsychological findings, it was hypothesized that verbal sequence memory is impaired in traumatized participants with PTSD in comparison with traumatized participants without PTSD and nontraumatized participants.

Method

Participants

Eighty-one victims of single traumatic events (Trauma Type I according to Terr, 1989) were recruited. Traumatized participants were either victims of interpersonal trauma (victims of assaults, $n = 45$) or noninterpersonal trauma (victims of traffic accidents, $n = 36$). Participants were recruited by means of advertisement in the media or contacted through the University Medical Center Hamburg-Eppendorf, Germany. All traumatic events fulfilled the Trauma Criteria A1 and A2 according to the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed. [*DSM–IV*]; APA, 1994). Participants were screened for inclusion and exclusion criteria via telephone and invited for assessment if they were fluent in German and between 18 and 70 years of age. Those with a history of psychotic symptoms (hallucinations, delusions), neurological disorder, traumatic brain injury (TBI), alcohol or substance dependence, or current suicide ideations were excluded.

For the control group, 30 nontraumatized participants were recruited via an established subject pool and word-of-mouth advertisement. The trauma checklist of the Posttraumatic Diagnostic Scale (PDS; Foa, Cashman, Jaycox, & Perry, 1997) was used to screen for absence of traumatic lifetime experiences as defined by the *DSM–IV* trauma criteria. As in the traumatized sample, all nontraumatized participants were fluent in German, were between 18 and 70 years of age, and did not suffer from a neurological disorder (including TBI).

This study was approved by the Ethics Committee of the Medical Board Hamburg. Prior to participation, participants were informed in verbal and written form about the study rationale, the duration of assessment, and the different procedures involved. All participants provided full informed consent. Participants were compensated for their travel expenses.

Measures

Demographic variables and psychopathology. A short standardized sociodemographic interview (e.g., age, education, alcohol consumption) and a standardized interview about the traumatic event (e.g., date of trauma, injuries) were conducted with the participants. The PTSD section of the Structured Clinical Interview for *DSM–IV* (SCID; First, Spitzer, Gibbon, & Williams, 1996) was used to assess PTSD and to allocate groups (PTSD, non-PTSD). The PDS (Foa et al., 1997) was administered to measure the severity of PTSD symptoms. To verify absence of psychiatric disorders in nontraumatized controls and to determine comorbid diagnoses in all participants, the German version of the Mini-International Neuropsychiatric Interview (MINI; Sheehan et al., 1998) was conducted. Depression severity was assessed using the Beck Depression Inventory (BDI; Beck, 1995) and the Hamilton Depression Rating Scale (HDRS; Hamilton, 1960).

Autobiographical memory. To assess autobiographical memory, traumatized participants were asked to give a detailed verbal report of both the traumatic event and a nontraumatic but unpleasant event. The order of recall for these reports was randomized and followed the procedure outlined by Halligan et al. (2003): Participants were requested to recall the event as accurately and in as much detail as possible and to describe the incidents in chronological order. For the narration of the unpleasant event, participants were instructed to choose an unpleasant but nontraumatic autobiographical event that occurred shortly before the traumatic event. The study design introduced by Halligan and colleagues was followed, though modifications were made regarding time frame and randomization of traumatic and unpleasant events.

Narratives were transcribed verbatim on the basis of audiotapes and coded by a rater who was blind to diagnostic status and had not conducted any of the interviews. Narratives about traumatic and unpleasant events were rated independently and could not be related to one another. For comparability reasons, narratives were coded according to scoring rules first introduced by Foa et al. (1995) and modified by Halligan et al. (2003). Accordingly, the beginning and end of the narrative were defined, and narratives were then divided into chunks assigned to four different categories: *repetitions, disorganized thoughts, organized thoughts,* and *not coded*. Finally, after z transformation of each score, a *total disorganization score* was calculated as z(repetitions) + z(disorganized thoughts) − z(organized thoughts). In line with the study by Halligan et al., the same rater gave a *global rating of disorganization* on a scale from 0 (*not at all disorganized*) to 10 (*extremely disorganized*). In addition, the severity of events (traumatic as well as unpleasant) was assessed by the rater on the basis of the narratives (1 = *slightly unpleasant,* 6 = *severe life threat*). Fifteen trauma narratives and 15 unpleasant event narratives were coded by a second rater blind to diagnostic status to assess interrater reliability of scores. Interrater reliability (intraclass correlation [*ICC*]) was satisfactory for all indices (*ICC*s $> .84$).

Nonautobiographical memory. A new task was designed to assess nonautobiographical memory: the Narrative Memory Test (NMT), which measures both content memory and sequence memory performance in free recall and recognition. Three short stories were designed for this task. Two of the stories contained typical trauma-related material: One dealt with an interpersonal trauma focus (assault of a senior citizen by a group of three men), the other one with a noninterpersonal trauma focus (car accident of a parent). A third story dealt with a farmer and his activities on the farm, such as feeding the animals. This story was emotionally neutral. Each of the three stories consisted of 16 consecutive events.

Sentence and vocabulary complexity was determined using the Microsoft Word 2000 word-processing package. Reading level was computed with the Flesch Reading Ease index (Flesch, 1949). Stories were similar in word count, reading level, sentence complexity, and vocabulary complexity. Digital recordings were made of all three stories with a female speaker, fluent in German and reading in a clear and emotionally neutral manner. Recordings were digitally enhanced to remove background noise. Presentation time for each story was 120 s (±1 s).

Participants were presented all three stories using a pair of desk-mounted speakers. The order of presentation was randomized. The procedure followed the format of the Logical Memory subtest of the Wechsler Memory Scale (WMS; Wechsler, 1987) with the exception that participants were instructed to pay attention to the sequence of incidents in the stories: Participants were asked to listen to the stories carefully to remember as many details as possible in the correct order. Following the immediate recall of all stories, participants were informed about a delayed recall, which was requested after a 20-min interval. Participants' reproductions of the short stories were audiotaped and transcribed verbatim.

Immediately following the delayed recall task, two recognition tasks were presented. The first task, termed *content recognition,* consisted of six multiple-choice questions (two for each story). The second recognition task, the *seriation* task, consisted of nine items (three for each story). Each item contained four events of one story, and participants were required to write down the order in which they had originally appeared.

Self-reported memory disorganization. In addition to the rater-based assessments of memory disorganization, the Disorganization Scale of the Traumatic Memory Questionnaire (Halligan et al., 2003) was used to assess subjective memory disorganization of the traumatic event, the unpleasant event, and the (nonautobiographical) stories of the NMT. By additionally including a subjective measure to assess memory disorganization, we intended to assess facets of memory disorganization that may not be captured by narrative-based ratings or that may incorrectly be assigned to memory disorganization, such as gaps in narratives due to avoidance behavior (cf. Halligan et al., 2003). The Disorganization Scale consists of five items measuring deficits in intentional recall (e.g., "I cannot get what happened during the stressful event/unpleasant event/the stories straight in my mind") and has demonstrated good reliability and validity in previous studies (Halligan, Clark, & Ehlers, 2002; Halligan et al., 2003). In the present study, the internal consistency of the disorganization subscale was $\alpha = .86$ for the traumatic event, $\alpha = .89$ for the unpleasant event, and $\alpha = .90$ for nonautobiographical memory.

Concentration and verbal intelligence. The Test d2 (Brickenkamp, 2002) was employed to test concentration. This is a paper-and-pencil task that is composed of 14 lines built of the letters *d* and *p* with one, two, or three dashes arranged above or below the letters. Participants have to scan the lines and cross out as many *d*s with two dashes as they can find. All *p*s and the *d*s with more or less than two dashes have to be ignored. Participants are given 20 s to complete each of the 14 lines. For the present study, the index *concentration performance* (parameter KL) was computed. Validity of the test has been established (Brickenkamp, 2002).

A multiple-choice vocabulary test (*Mehrfachwahl-Wortschatz-Intelligenztest*; Lehrl, 1995) was employed to assess verbal intelligence. In this task, participants are presented 37 lines. Each line contains only one correct German word and four distractor words, which are phonological similar to the target word and designed to appear orthographically plausible. The participant is requested to mark the correct word. Age-adjusted normative scores provided by Russ (2003) were used to estimate verbal intelligence level.

Procedure

At the beginning of the assessment, a short sociodemographic interview was conducted, followed by a standardized interview about the traumatic event. Subsequently, the PTSD section of the SCID was administered. Afterward, participants were asked to describe the traumatic event as well as a nontraumatic unpleasant event (in randomized order). Immediately following each narrative (traumatic and unpleasant events), participants completed the corresponding Disorganization Scale. Then, a neuropsychological assessment was conducted, starting with verbal intelligence. This was followed by the assessment of the nonautobiographical memory (NMT). During the 20-min retention interval between immediate recall and delayed recall, the Test d2 and two filler questionnaires unrelated to the present study were administered. Delayed free recall was followed by recognition tasks and the Disorganization Scale for nonautobiographical material. Afterward, further diagnostic instruments were administered, such as MINI, PDS, BDI, and HDRS.

It was assured that the activation of the trauma memory was unlikely to influence performance on subsequent cognitive assessment as a prior study (Jelinek et al., 2008) had shown that levels of working memory impairment remained unchanged before and after trauma-related tasks (trauma-related interview, narration of the trauma).

Data Reduction and Strategy of Data Analysis

For the analyses of the NMT, measures of content memory and sequence memory were extracted from the data. Two measures were calculated for content memory: detail memory and content recognition. Detail memory scores were obtained following the procedure of the Logical Memory subtest (Wechsler, 1987). Accordingly, transcripts were compared to original stories by a rater blind to diagnostic status, and participants received credit for each correctly remembered chunk (according to scoring criteria defined in a manual). Content recognition was derived from the multiple-choice recognition task and constituted the number of correctly recognized items.

Sequence memory was conceptualized and assessed according to Wegner, Quillian, and Houston (1996), Kindt and van den Hout (2003), Kindt, van den Hout, and Buck (2005), and Halligan et al. (2002): Each participant's free-recall transcript was compared to a master list by a rater blind to diagnostic status. The master list comprised the correct sequence of the 16 events for each story. For the first sequence memory index, correctly sequenced events and incorrectly sequenced events were identified. A participant received credit for correctly sequenced events if he or she reported an event in the correct order based on the previously reported event. If the event was sequenced incorrectly, it was marked as an incorrectly sequenced event. The two scores (correctly and incorrectly sequenced events) were then combined in a sequence-recall ratio (SRR; Wegner et al., 1996; also see Halligan et al., 2002)

denoting the proportion of correctly sequenced events. Accordingly, events not recalled by the participant were not included in the calculation of the SRR score. In this manner, recall of content and recall of sequence are not confounded (Pellegrino & Hubert, 1982).

The second index of sequence memory (termed *seriation*) was derived from the seriation task. For this index, recalled event orders were correlated with correct event orders for each item utilizing Spearman correlations (ρ; following Kindt & van den Hout, 2003; Kindt et al., 2005; Wegner et al., 1996). Mean rank correlations were then calculated across items with a possible range from −1 to 1 for each participant. As correlations are not normally distributed, mean correlations were calculated using Fisher's *z* transformation: Spearman correlations were transformed to Fisher's *z* scores and averaged, and finally, correlation coefficients were reassigned. Fisher's *z* scores were also preferred for statistical analyses (Cohen & Cohen, 1983). For clarity, all values reported in the Results section are mean ρ.

Statistical Analyses

Pillai's trace is reported for multivariate analyses as it is regarded as the most robust measure (Tabachnick & Fidell, 2006). An alpha level of .05 (two-tailed) was used for all statistical tests. Effect sizes (η^2) were calculated for analyses of variance (ANOVAs) and multivariate ANOVAs (MANOVAs) following Cohen's (1988) conventions for small ($.01 < \eta^2 \leq .09$), medium ($.09 < \eta^2 < .25$), and large ($\eta^2 \geq .25$) effects.

Results

Sample Description

At the time of testing, 26 of the traumatized participants fulfilled *DSM–IV* criteria for PTSD as assessed with the SCID. Accordingly, the remaining 55 traumatized participants formed the non-PTSD group. As can be seen in Table 1, the three groups (non-trauma, PTSD, non-PTSD) did not differ with regard to gender, age, or verbal intelligence. Groups differed with regard to alcohol consumption, levels of self-assessed and clinician-rated depression, and concentration as measured by the Test d2.

As can be seen in Table 1, the two traumatized groups did not differ in type of trauma, time since the trauma event, injuries sustained, or rater-assessed severity of the unpleasant event. However, differences in severity of traumatic events could not be entirely ruled out ($p < .1$) and were therefore considered as an additional covariate in the according analyses. As we expected, the PTSD group displayed significantly higher levels of PTSD severity than the non-PTSD group, as measured with the PDS.

Autobiographical Memory Performance

Differences in length of recalled narratives, as indexed by number of chunks, could not be excluded between the PTSD (trauma: $M = 55.12$, $SD = 35.26$; unpleasant event: $M = 24.73$, $SD = 20.74$) and non-PTSD groups (trauma: $M = 71.76$, $SD = 45.93$; unpleasant event: $M = 30.25$; $SD = 22.78$), $F(1, 79) = 2.76$, $p = .1$. Moreover, trauma narratives were longer than narratives of the unpleasant event, $F(1, 79) = 60.69$, $p < .001$. To control for these group differences, count scores of coding categories were transformed to proportions of the narrative (cf. Harvey & Bryant, 1999).

To investigate the first hypothesis, a multivariate analysis of covariance (MANCOVA) was calculated whereby several confounding variables were considered as covariates. However, neither severity of the trauma, verbal intelligence, nor current alcohol consumption correlated significantly with disorganization indices ($|rs| < .16$, $ps > .14$). Thus, these covariates were dropped from the analysis, and only severity of depression (BDI and HDRS) and concentration (as measured by the concentration index of the Test d2) were included as covariates in a repeated-measures MANCOVA with group (non-PTSD, PTSD) as between-subjects factor and event (traumatic event, unpleasant event) as within-subject factor. Indices of autobiographical memory disorganization served as dependent variables (global rating of disorganization, total disorganization score, and self-reported disorganization; for group means and standard deviations, see Table 2). The main effects of group, Pillai's trace, $F(3, 72) = 1.55$, and event, Pillai's trace, $F(3, 72) = 0.11$, were nonsignificant. However, the expected Group × Event interaction was significant, Pillai's trace, $F(3, 72) = 3.16$, $p < .05$, $\eta^2_{partial} = .12$.

To follow up the significant interaction, repeated-measures analyses of covariance (Group × Event) were calculated for each of the dependent variables, revealing a significant Event × Group interaction for the total disorganization score, $F(1, 74) = 8.20$ $p < .01$, $\eta^2_{partial} = .10$, and an interaction on trend level[1] for global rating of disorganization, $F(1, 74) = 2.87$, $p < .1$, $\eta^2_{partial} = .07$. In contrast, with respect to self-reported disorganization, the interaction was nonsignificant, $F(1, 74) = 0.38$, $p > .5$, $\eta^2_{partial} = .01$. The Event × Group interactions for the total disorganization score and the global rating of disorganization were followed up by calculating single comparisons. For the global rating of disorganization, these comparisons showed that trauma memories were more disorganized in the PTSD group than in the non-PTSD group, $t(79) = 2.48$, $p = .02$, whereas groups did not statistically differ in disorganization of the unpleasant event ($p > .1$). For the total disorganization score, trauma memory (although nonsignificant) also tended to be more disorganized in the PTSD group, $t(79) = 1.65$, $p = .10$. Whereas groups did not statistically differ in disorganization of the unpleasant event, memories of the unpleasant event were numerically less disorganized in the PTSD group, as can be seen in Table 2. Overall, memories of the trauma, but not of the unpleasant event, were more disorganized in participants with PTSD compared with participants without PTSD.

Nonautobiographical Material

Content memory. To test the hypothesis that traumatized participants with PTSD perform worse in nonautobiographical content memory in comparison with traumatized participants without PTSD and nontraumatized participants, a repeated-measures MANOVA was calculated with detail memory and content recognition as dependent variables. Group (non-PTSD, PTSD, non-trauma) formed the between-subjects factor, while story (accident, assault, neutral) formed the within-subject factor (see Figure 1). As anticipated, groups differed in content memory performance, Pil-

[1] When covariates were excluded, this interaction was significant, $F(1, 79) = 6.00$, $p < .05$, $\eta^2_{partial} = .07$.

Table 1
Demographic Variables in Participants With and Without PTSD and Nontraumatized Participants: Number or Mean (Percentage or Standard Deviation)

Variable	PTSD ($n = 26$)	Non-PTSD ($n = 55$)	Nontrauma ($n = 30$)	Statistics
Gender: female/male	17 (65.4%)/9 (34.6%)	26 (47.3%)/29 (52.7%)	19 (63.3%)/11 (36.7%)	$\chi^2(2, N = 111) = 3.28$, *ns*
Age (in years)	40.73 (12.90)	39.24 (14.13)	39.67 (11.32)	$F(2, 108) = 0.11$, *ns*
Verbal intelligence[a]	53.96 (11.35)	57.75 (8.59)	59.60 (7.74)	$F(2, 108) = 2.77$, *ns*
Alcohol (g per week)	24.21 (41.29)	36.21 (36.97)	81.33 (52.15)	$F(2, 108) = 15.22^{**}$ Nontrauma > PTSD, Non-PTSD
HDRS	15.00 (7.44)	4.11 (4.39)	2.73 (2.33)	$F(2, 108) = 54.67^{**}$ PTSD > Non-PTSD, Nontrauma
BDI	16.81 (7.91)	4.70 (5.71)	4.28 (3.77)	$F(2, 105) = 42.66^{**}$ PTSD > Non-PTSD, Nontrauma
Concentration	148.65 (38.51)	165.78 (37.30)	188.20 (45.60)	$F(2, 107) = 6.95^{*}$ Nontrauma > PTSD, Non-PTSD
Type of trauma				
Assault	15 (57.7%)	30 (54.5%)		$\chi^2(1, N = 81) = 0.07$, *ns*
Accident	11 (42.3%)	25 (45.5%)		
Time since trauma (months)	20.93 (26.44)	23.12 (18.93)		$t(79) = 0.43$, *ns*
Injury severity score[b]	5.04 (7.17)	5.87 (6.28)		$t(79) = 0.53$, *ns*
Severity of traumatic event (1–6)	5.19 (0.63)	4.89 (0.66)		$t(79) = 1.95$, $p < .1$
Severity of unpleasant event (1–6)	1.96 (1.08)	1.87 (0.94)		$t(79) = 0.38$, *ns*
PDS				
Total score	27.62 (8.48)	5.29 (5.24)		$t(34.32)^{a} = 12.36^{**}$
Intrusions	8.62 (3.34)	1.75 (2.01)		$t(33.87)^{a} = 9.70^{**}$
Avoidance	10.19 (4.39)	1.45 (2.25)		$t(31.37)^{a} = 9.57^{**}$
Hyperarousal	8.81 (3.10)	2.09 (2.39)		$t(79) = 10.71^{**}$

Note. PTSD = posttraumatic stress disorder; HDRS = Hamilton Depression Rating Scale; BDI = Beck Depression Inventory; PDS = Posttraumatic Diagnostic Scale; *ns* = nonsignificant.
[a]Assessed with a vocabulary test (MWT-B; Lehrl, 1995), age-adjusted *T* scores according to Russ (2003). [b] According to Baker, O'Neill, Haddon, and Long (1974).
$^{*}p < .01$. $^{**}p < .001$.

lai's trace, $F(4, 214) = 4.82$, $p = .001$, $\eta^2_{partial} = .08$. Although recall differed between stories, Pillai's trace, $F(4, 104) = 14.65$, $p < .001$, $\eta^2_{partial} = .36$, this was not specific for group, as indicated by a nonsignificant interaction, Pillai's trace, $F(8, 210) = 0.85$, $p > .5$.

To further investigate the significant main effects of group and story, repeated-measures ANOVAs were calculated for each of the dependent variables. In each of the analyses, groups differed in memory performance, detail memory: $F(2, 107) = 6.18$, $p < .01$, $\eta^2_{partial} = .10$; content recognition: $F(2, 107) = 6.34$, $p < .01$, $\eta^2_{partial} = .11$. Post hoc tests (uncorrected *t* tests) indicated that the nontrauma group performed significantly better than the PTSD and non-PTSD groups ($ps < .05$). A significant effect of story also emerged, detail memory: $F(2, 214) = 16.36$, $p < .001$, $\eta^2_{partial} = .13$; content recognition: $F(2, 214) = 14.26$, $p < .001$, $\eta^2_{partial} = .12$. As in the global model, the Group × Story interaction was nonsignificant, detail memory: $F(4, 214) = 0.65$, $p > .6$; content recognition: $F(2, 214) = 1.67$, $p > .16$, $\eta^2_{partial} = .03$.

Content memory performance correlated positively with verbal intelligence (detail memory: $r = .22$, $p < .05$; content recognition: $r = .20$, $p < .05$), current alcohol consumption (detail memory: $r = .25$, $p < .01$; content recognition: $r = .28$, $p < .01$), and concentration (detail memory: $r = .49$, $p < .001$; content recognition: $r = .26$, $p < .001$). With regard to depression, only detail memory correlated with the HDRS (detail memory: $r = -.22$, $p < .05$), and no relationship was apparent for content recognition or the BDI ($ps > .1$). When comorbid depression (HDRS total score), verbal intelligence, alcohol consumption, and concentration were entered as covariates in a MANCOVA model, the main effect of group was nonsignificant, Pillai's trace, $F(4, 204) = 1.38$, $p > .2$.

Sequence memory. To test the hypothesis that memory for nonautobiographical material is more disorganized in participants with PTSD than in traumatized participants without PTSD and nontraumatized participants, three scores indexing memory organization of nonautobiographical memory, that is sequence memory, were entered in a MANOVA as dependent variables: SRR total score (derived from the free-recall task), seriation (derived from the recognition task), and self-reported memory disorganization.[2] However, no main effect of group (non-PTSD, PTSD, nontrauma) was revealed, Pillai's trace, $F(6, 212) = 1.38$, $p > .2$. The

[2] Self-reported memory disorganization was aligned with other dependent variables. That is, smaller numbers indicated higher memory disorganization and higher numbers indicated less memory disorganization, respectively, for all dependent variables.

Table 2
Autobiographical and Nonautobiographical Memory Measures: Mean (Standard Deviation)

Variable	PTSD (n = 26)	Non-PTSD (n = 55)	Nontrauma (n = 30)
	Autobiographical memory		
Trauma			
Global rating of disorganization	4.23 (2.39)	3.05 (1.78)	
Total disorganization score	0.44 (1.62)	−0.21 (1.69)	
Self-reported disorganization	10.69 (5.24)	7.89 (2.89)	
Unpleasant event			
Global rating of disorganization	2.69 (1.54)	2.93 (1.68)	
Total disorganization score	−0.45 (1.26)	0.22 (1.86)	
Self-reported disorganization	10.15 (5.50)	9.13 (4.56)	
	Nonautobiographical memory		
Content memory			
Detail memory	106.52 (31.24)	114.51 (28.42)	131.67 (23.03)
Content recognition	5.04 (1.02)	4.83 (1.00)	5.57 (0.57)
Sequence memory			
Sequence-recall ratio	1.84 (0.13)	1.86 (0.06)	1.87 (0.08)
Seriation (ρ)[a]	.93 (.55)	.95 (.52)	.97 (.31)
Self-reported memory disorganization	12.48 (4.99)	11.27 (4.66)	9.70 (4.49)

Note. For results, see text. PTSD = posttraumatic stress disorder.
[a] Calculations were based on Fisher's z scores.

strength of the relationship between sequence memory and group was considered weak with $\eta^2_{partial} = .04$.

Self-Reported Memory Disorganization

For a direct comparison of autobiographical and nonautobiographical memory organization, an ANOVA was calculated for self-reported memory disorganization. It was expected that participants with PTSD would rate their memory as more disorganized than participants without PTSD and that this difference would be most pronounced for the trauma memory. As expected, a repeated-measures ANOVA with group (PTSD, non-PTSD) as between-subjects factor and memory type (traumatic event, unpleasant event, nonautobiographical memory) as within-subject factor, revealed a significant main effect for group, $F(1, 79) = 4.66$, $p < .05$, $\eta^2_{partial} = .06$, showing that participants with PTSD rated their memory as more disorganized than participants without PTSD. Moreover, a significant effect for memory type was found, $F(2, 158) = 8.65$, $p < .001$, $\eta^2_{partial} = .10$, indicating that all participants rated their memory for the NMT stories as more disorganized than their memories of the two autobiographical events (trauma, unpleasant event). The expected Group × Memory Type interaction was nonsignificant, $F(2, 158) = 1.19$, $p > .3$, $\eta^2_{partial} = .02$.

Discussion

The aim of the current study was to, for the first time, integrate research on autobiographical and nonautobiographical memory in PTSD and to investigate whether memory disorganization of the traumatic event exceeds the level of general verbal memory impairment. In line with our assumption, the results showed that memories of the trauma were more disorganized than memories of an unpleasant control event in participants with PTSD versus participants without PTSD when calculated across all relevant measures. Furthermore, significant group differences remained when several confounding variables such as verbal intelligence were entered as covariates in the analysis.

Although participants with PTSD performed worse in nonautobiographical content memory than nontraumatized controls, numerical differences compared with traumatized participants without PTSD were nonsignificant. Moreover, there was no evidence that organization of nonautobiographical memory (i.e., sequence memory) was impaired in PTSD.

Autobiographical Memory

Using an established methodology of integrating externally rated narratives and self-report measures, our findings of increased disorganization of trauma memories in PTSD are in line with previous studies using a similar methodology (e.g., Halligan et al., 2003; Harvey & Bryant, 1999; Jones et al., 2007) when relevant measures were pooled in a multivariate analysis. However, when calculating each measure separately, not all findings yielded significance. Presumably, the heterogeneity and apparent differential sensitivity of measures explain these inconsistencies. This is also a likely explanation for differences across studies (cf. Ehlers et al., 2004). Although all measures largely pointed in the same direction, only the results for narrative-based assessment of disorganization were statistically significant: With respect to self-reported memory disorganization, the expected Group × Event interaction was not identified. As already discussed by other authors, self-report measures may particularly rely on introspection (Ehlers et al., 2004), whereas narrative-based ratings may be more influenced by avoidance or distress (Halligan et al., 2003). Moreover, with regard to narrative-based ratings, the conceptualization of confused thinking and nonconsecutive chunks/memory gaps as a combined score of disorganized thinking used for the coding of narratives has recently been criticized (Jones et al., 2007). Corre-

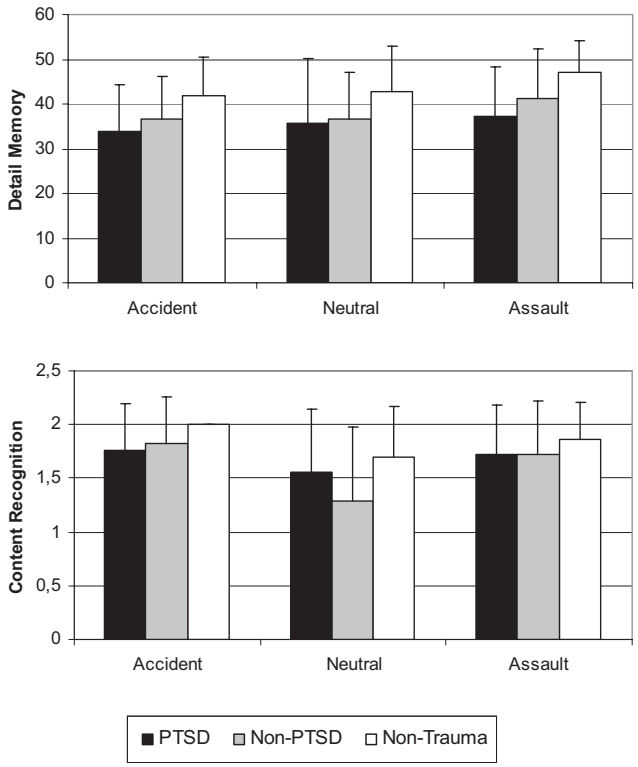

Figure 1. Performance of traumatized participants with and without posttraumatic stress disorder and nontraumatized controls with regard to content memory performance in the narrative memory test. For results, see text.

spondingly, scores cannot differentiate between these two mechanisms, which are both likely to reflect memory disorganization. A separation of these mechanisms has been found to be particularly important when including participants with TBI in the study design, as confusions in thinking seem to be more related to TBI than to PTSD (Jones et al., 2007). However, this concern does not seem to be relevant to the current findings as TBI was an exclusion criterion in this study. Nevertheless, future studies would benefit from a more fine-grained content analysis to disentangle mechanisms involved in disorganized trauma memories.

Still, there is consensus that none of the available measures for indexing memory disorganization is satisfactory (cf. Ehlers et al., 2004). Bearing that in mind, we made an effort to guard our findings against several shortcomings that have received little attention in prior studies. First, we included several confounds also associated with disorganized narratives. We found that disorganized trauma memory in PTSD was also observable when severity of trauma, general intellectual functioning, concentration, depression, and alcohol abuse were entered as covariates in the analysis. This result appears to be inconsistent with Gray and Lombardo's (2001) findings indicating that general cognitive functioning accounts for differences between trauma narratives. However, Gray and Lombardo's study investigated the reading level of narratives. The present study does not imply that cognitive functioning accounts for more disorganized trauma memories in PTSD when measured with a rater-based approach. The second shortcoming addressed was to extend content analysis from traumatic to unpleasant (nontraumatic) event narratives. Third, the recall of traumatic and unpleasant events was randomized to rule out order effects. Finally, the time frame of unpleasant events was specified; participants were instructed to choose an unpleasant event that happened shortly before the traumatic event, as opposed to "around the time" of the trauma (cf. Halligan et al., 2003, p. 425). This was done for several reasons: We aimed to standardize time points to prevent unpleasant events being somehow related to the trauma (e.g., dealing with injuries, making a report at the police station) and to rule out prolonged impairment of cognitive functioning after the traumatic experience possibly extending to later (unpleasant) episodes. The latter is likely to occur as heightened distress and dissociative symptoms are part of an acute stress reaction and may impair encoding.

Despite the advantages of our approach, limitations of the method need to be noted. First, by including an autobiographical control event that happened shortly before the trauma, we introduced a systematic time difference between the events. This may have affected the results. However, as the direction of time differences was against our hypothesis with control events dating back (shortly) before traumatic events (thus potentially reducing memory organization in control events), we consider our results somewhat more conservative. Second, only one unpleasant nontraumatic control event was included. More reliable results may be produced with the analysis of a second positive control event, for example.

Nonautobiographical Memory

For the first time, verbal nonautobiographical memory for information (content memory) and for information order (sequence memory) was investigated in traumatized participants with and without PTSD and nontraumatized controls using a newly designed story recall task (the NMT). The indication of impaired verbal nonautobiographical memory in PTSD was inferred from neuropsychological findings (Brewin et al., 2007) and accounts of a comprehensive verbal (vs. nonverbal) memory impairment in PTSD (Brewin, 2008; Brewin et al., 1996).

In line with prior studies showing impaired verbal memory functioning in PTSD, traumatized participants with PTSD differed from nontraumatized controls in content memory performance (cf. the meta-analysis by Brewin et al., 2007). However, traumatized participants with and without PTSD did not differ from each other in post hoc tests. While it is worth mentioning that the majority of non-PTSD participants also displayed PTSD symptoms, these were very minor and may not fully explain the results. Thus, one might argue that group differences reflect trauma exposure rather than PTSD diagnosis. Although findings of verbal memory impairment are considered rather robust (cf. the meta-analysis by Brewin et al., 2007), not all studies have found content memory deficits in individuals with PTSD when compared with traumatized individuals without PTSD, especially when story recall tasks were used (such as the Logical Memory subtest of the WMS; e.g., Pederson et al., 2004; Stein, Kennedy, & Twamley, 2002). In the present study, the story recall task included trauma-related material. In comparison to word lists as encoding material, trauma relatedness of narrative material is less subtle; information is interconnected and vivid. Therefore, rumination and reexperienc-

ing symptoms might have been triggered in both traumatized groups, thus reducing group differences between participants with and without PTSD. Moreover, these effects may have overshadowed the recollection of the neutral story, as differences between traumatized participants with and without PTSD were also not present for neutral material.

Several variables potentially confounding memory performance in PTSD (see Danckwerts & Leathem, 2003) were considered as covariates in the analysis. When comorbid depression, verbal intelligence, concentration, and alcohol consumption were entered as covariates in the same model, group differences disappeared. While this result does not support our hypothesis, it emphasizes the necessity of further investigating confounding variables. In particular, concentration, representing part of the PTSD diagnostic criteria and correlating with nonautobiographical memory performance in the range of $r = .26–.49$ in the present study, should be considered as a potential confound in future studies.

In contrast to results on content memory, traumatized participants with and without PTSD as well as nontraumatized participants differed neither in the sequence memory task (both free recall and recognition) nor in self-assessed disorganization of nonautobiographical memory. The disorganization of nonautobiographical memory was investigated in traumatized participants with and without PTSD and nontraumatized controls for the first time. However, whereas the group means indicated minimal differences in sequence memory, the present sample was not sufficient enough to establish significance. More than twice the sample size would have been required to achieve a significant group effect (Faul, Erdfelder, Lang, & Buchner, 2007), thus rendering our hypothesis unlikely and general deficits in memory organization clinically almost irrelevant. Nevertheless, further studies are necessary to allow firm conclusions.

According to the dual representation theory (Brewin, 2008; Brewin et al., 1996) and neuropsychological findings (Brewin et al., 2007), impaired recall and processing of verbal information are expected in PTSD. However, impaired content or sequence memory performance in comparison to traumatized individuals without PTSD could not be demonstrated in the story recall test (the NMT). This newly designed test presents a promising new measure for both content memory and sequence memory within a single assessment; however, it does not represent a task with high verbal specificity. As discussed in a previous study (Jelinek et al., 2006), verbal memory and nonverbal memory are often confounded in memory tasks: Verbal stimuli are easy to visualize and may thus be encoded nonverbally. This may also apply to NMT stories. Hence, it is possible that stories were also encoded via well-functioning nonverbal pathways, balancing impaired verbal memory. Whereas this study provides an important and valuable first attempt to investigate organization of nonautobiographical memory, future studies are needed that focus on material specificity (verbal vs. nonverbal material) in sequence memory.

Organization of Autobiographical and Nonautobiographical Memory

We attempted to compare the organization of autobiographical and nonautobiographical memory. As measures of the organization of autobiographical and nonautobiographical memory differed, it was not possible to combine major outcome parameters (expert ratings) in a single analysis. The self-report measure was the only measure allowing for direct comparison between autobiographical and nonautobiographical memory. Surprisingly, we found that all participants rated their memory for the stories of the NMT as more disorganized than their memory for the traumatic and unpleasant events.

As discussed earlier, different measures of memory disorganization may capture different facets of the construct, each having certain advantages and disadvantages (e.g., self-report may rely on introspection). It has been argued that subjective memory disorganization (self-report) in particular may not reflect disorganization of actual memory performance but rather serves as a measure of meta-memory (cf. Kindt & van den Hout, 2003). This may potentially explain our results showing a more disorganized nonautobiographical than autobiographical memory. In particular, this result may reflect that, compared with autobiographical memory, nonautobiographical memory involves reduced memory confidence, as the self-report measurement involved questions about feelings of incompleteness of memory and how muddled the memory was experienced as being. A less confident response pattern for nonautobiographical memory may have been enhanced by the way the memory material was constructed: Assessing sequence memory, it was required that the sequence of events could not be entirely deduced by means of logic. This may have additionally increased feelings of uncertainty in participants. Thus, the results are likely to represent a ceiling effect in participants' answers to such questions for the nonautobiographical information rather than for the autobiographical information.

General Limitations and Future Directions

Current theories on the etiology of PTSD postulate that trauma memories differ qualitatively from other autobiographical memories and have linked disturbed intentional recall of the traumatic event to the development of PTSD (Brewin et al., 1996; Ehlers & Clark, 2000; Foa & Rothbaum, 1998). Using a cross-sectional design, the present study was not conducted to shed light on the question whether disorganized trauma memory in PTSD is a consequence of the disorder or is involved in the development/maintenance of PTSD. Besides the cross-sectional design, other general limitations are noteworthy. First, although the sample size compares favorably with previous studies on declarative memory performance in PTSD, the subsample size for participants diagnosed with PTSD ($n = 26$) could still be considered medium or even small. Second, by including only victims of single traumatic events, our findings cannot be generalized to Trauma Type II, such as child abuse and combat experiences.

In summary, the present investigation has contributed to a refined study design increasing the reliability of findings of disorganized trauma memories in PTSD using a specific methodology. Still, future work is needed that would benefit from the employment of neuroimaging techniques examining the nature of brain processes potentially involved in the disorganization of memories.

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