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Involuntary Memories and Dissociative Amnesia: Assessing Key Assumptions in Posttraumatic Stress Disorder Research

Dorthe Berntsen[1] and David C. Rubin[1,2]
[1]Center on Autobiographical Memory Research, Department of Psychology and Behavioral Sciences, Aarhus University; and [2]Department of Psychology and Neuroscience, Duke University

Abstract
Autobiographical memories of trauma victims often are described as disturbed in two ways. First, the trauma frequently is reexperienced in the form of involuntary, intrusive recollections. Second, the trauma is difficult to recall voluntarily (strategically); important parts may be totally or partially inaccessible—a feature known as dissociative amnesia. These characteristics often are mentioned by posttraumatic stress disorder (PTSD) researchers and are included as PTSD symptoms in the *Diagnostic and Statistical Manual of Mental Disorders* (*DSM-IV-TR* as well as *DSM-5*). In contrast, we have shown that both involuntary recall and voluntary recall are enhanced by emotional stress during encoding. We also have shown that the PTSD symptom in the diagnosis addressing dissociative amnesia—trouble remembering important aspects of the trauma—is less well correlated with the remaining PTSD symptoms than the conceptual reversal of having trouble forgetting important aspects of the trauma. Our findings contradict key assumptions that have shaped PTSD research during the past 40 years.

Keywords
autobiographical memory, posttraumatic stress disorder, memory, diagnosis

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Autobiographical memory is central to the understanding of posttraumatic stress disorder (PTSD). According to a prevalent view, autobiographical memory of trauma victims is disturbed in at least two ways. First, victims of trauma have intrusive recollections of the traumatic event in which they vividly and repeatedly reexperience disturbing sensory impressions and emotions associated with the event. Second, at the same time, they have difficulties remembering important parts of the event—a feature known as dissociative amnesia. These characteristics are not just observations made by PTSD researchers (for reviews, see Brewin & Holmes, 2003; Dalgleish, 2004). They also are included as PTSD symptoms in the *Diagnostic and Statistical Manual of Mental Disorders* (4th ed., text rev.; *DSM-IV-TR*; American Psychiatric Association, 2000; 5th ed.; *DSM-5*; American Psychiatric Association, 2013). Because the present work was completed and accepted for publication before the *DSM-5* was released, it is based on the diagnostic criteria for the *DSM-IV-TR*. However, the wording of the two memory disturbance symptoms of key relevance for the present work has not changed.

Substantial disagreement exists as to how these disturbances of memory should be understood at a theoretical level. Furthermore, some of the PTSD symptoms listed in the *DSM* have been criticized for being empirically unfounded, notably, the dissociative amnesia component (e.g., Kihlstrom, 2006; McNally, 2003, 2009; Rubin, Berntsen, & Bohni, 2008; Shobe & Kihlstrom, 1997). Here, we have examined two key assumptions in the PTSD literature. One is the assumption that emotional stress during encoding has differential effects on subsequent involuntary and voluntary recall, and the other is the assumption that voluntary recall of trauma is incomplete

Corresponding Author:
Dorthe Berntsen, Center on Autobiographical Memory Research, Department of Psychology and Behavioral Sciences, Aarhus University, Bartholins Allé 9, 8000 Aarhus C, Denmark
E-mail: dorthe@psy.au.dk

and fragmented. A brief historical review is needed to appreciate how these two tenets are related.

The diagnosis of PTSD was introduced in the *DSM-III* (American Psychiatric Association, 1980) as a result of substantial political and social pressure (e.g., E. Jones & Wessely, 2007; Scott, 1990; Young, 1995, for reviews). The theory outlined in psychiatrist Mardi J. Horowitz's (1976) seminal monograph *Stress Response Syndromes* had an enormous impact on how the diagnosis of PTSD was conceptualized and described in the *DSM-III* (see Berntsen, Rubin, & Bohni, 2008), as well as in subsequent revisions of the *DSM* (American Psychiatric Association, 1987, 1994, 2000).

Horowitz's (1975, 1976) model for stress responses has two main tenets concerning the role of memory. The first tenet is that the memory of the stressful event tends to repeat itself in an involuntary and uncontrollable fashion. The second tenet is that voluntary (strategic and controlled) remembering of the event is considerably reduced. This result leads to the paradoxical situation in which periods with vivid intrusive images of the event may be followed by partial or complete amnesia for the event. According to Horowitz, the underlying cause for both the enhanced involuntary remembering and the impaired voluntary access is incomplete cognitive processing of the traumatic event and defense mechanisms (e.g., repression and denial). Instead of a normal integration into the cognitive schemata of the person, the event is subsumed to an active memory storage—a hypothesized memory system that tends to repeat its own content until its processing has been completed. This memory system constitutes a direct explanation for the enhanced involuntary remembering, according to Horowitz's theory. The impaired voluntary memory, conversely, is caused by defense mechanisms serving to protect against reliving the emotional stress as well as by a poor cognitive match between the trauma and preexisting schema structures, which leads to faulty encoding of the event.

Although these ideas were formulated almost 40 years ago and (as we review later) have little empirical support, many current theories of PTSD share these two tenets. In other words, they share the assumptions that the encoding of the traumatic event is faulty and that voluntary memory access therefore is impaired, whereas involuntary remembering is enhanced. In Ehlers and Clark's (2000) theory of PTSD, as well as in Brewin's dual-representation theory (Brewin, Dalgleish, & Joseph, 1996; Brewin, Gregory, Lipton, & Burgess, 2010), a shallow encoding of the trauma, focusing on sensory, perceptual, and emotional aspects of the event at the cost of deeper conceptual processing and contextual integration, is posited to cause poor intentional recall on one hand and vivid involuntary recollection on the other hand. This view has been summarized by Halligan, Clark, and Ehlers (2002) as a "pattern of poor intentional recall and easy triggering of involuntary memories" (p. 74) and has been repeated frequently by other researchers. For example, Jelinek, Randjbar, Seifert, Kellner, and Moritz (2009) observed that "distorted trauma memories of trauma survivors with PTSD manifest in vivid and highly emotional unintentional recall, as well as incoherent intentional recall" (p. 288). Thus, as in Horowitz's (1975, 1976) original theory, the trauma is proposed to be incompletely processed, and this lack of completion and integration leads to reduced intentional memory access and enhanced involuntary remembering.

It is important that both tenets are reflected in the *DSM-IV-TR* diagnosis for PTSD on which we have based the present analyses. First, the idea of reduced strategic recall is present in the C3 symptom describing an "inability to recall an important aspect of the trauma" (American Psychiatric Association, 2000, pp. 467–468). This description is maintained in the *DSM-5* and explicitly linked to dissociative amnesia in terms of an "inability to remember an important aspect of the traumatic event(s) (typically due to dissociative amnesia and not to other factors such as head injury, alcohol, or drugs)" (American Psychiatric Association, 2013, p. 271). Second, the assumption that involuntary remembering has privileged access to traumatic and stressful material is reflected in the listing of involuntary (intrusive) recollection as a symptom of PTSD with no mention of voluntary remembering—except in terms of the C3 statement of impaired access (see Berntsen et al., 2008, for further discussion).

However, in spite of their long-lived influence on PTSD research, these assumptions are not well supported empirically. In the following, we review and discuss evidence for the claims that (a) emotional stress during encoding has differential effects on subsequent involuntary and voluntary recall and (b) voluntary recall of trauma is incomplete and fragmented, and more so in individuals suffering from higher levels of PTSD symptoms.

Does Emotional Stress Have Differential Effects on Involuntary and Voluntary Recall?

The claim that involuntary (compared to voluntary) remembering has privileged access to stressful/traumatic material, or the related point that PTSD increases that privileged access, has little empirical support. Instead, the data suggest that the memory enhancement associated with stressful/traumatic material concerns both involuntary and voluntary memory (e.g., Berntsen & Rubin, 2008; Hall & Berntsen, 2008) and that both involuntary and voluntary memories of the traumatic event are enhanced with higher levels of PTSD symptoms (Rubin,

Boals, & Berntsen, 2008; Rubin, Dennis, & Beckham, 2011). Hall and Berntsen (2008) conducted a diary study to examine the frequency of involuntary and voluntary memories of previously presented emotionally negative pictures in a student population. Their findings showed that the emotional distress associated with the pictures at the time of encoding strongly predicted the frequency with which the memories were retrieved both involuntarily and voluntarily in the subsequent diary study. Similar findings were reported by Ferree and Cahill (2009) in a study using emotional films as memory material.

Other studies have shown that involuntary and voluntary remembering are similarly affected by real-life traumatic events and that the accessibility of the trauma increases for both types of recall with increasing levels of PTSD. In a diary study of undergraduates with either high or low levels of PTSD symptoms, Rubin, Boals, et al. (2008) found that undergraduates with high levels of PTSD symptoms recorded more memories related to their traumatic events than did participants with low symptom levels. However, this effect was found to the same extent for both voluntary and involuntary recall; thus, the assumed duality between involuntary and voluntary recall was not found. Similar findings were obtained more recently in a sample of clinically diagnosed PTSD patients in comparison with a non-PTSD control group. The PTSD group had more trauma-related memories, and, again, this result was found for both voluntary and involuntary recall (Rubin et al., 2011). Thus, the findings from studies with student populations generalized to a clinical sample diagnosed with PTSD.

Evidence has accumulated during the past two decades showing that involuntary remembering is not specific to traumatic or stressful events. On the contrary, it is a common phenomenon in everyday life with a predominantly positive content (see Berntsen, 2009, for a review). Diary studies and survey studies have shown that involuntary remembering of personal events happens at least as frequently as voluntary recollections (Rasmussen & Berntsen, 2011; Rubin & Berntsen, 2009).

Are Trauma Memories Incomplete, Fragmented, and Not Well Integrated?

Incomplete processing and faulty encoding of traumatic events is assumed to lead to reduced intentional access to the traumatic event, and more so in individuals suffering from higher levels of PTSD symptoms. Researchers have explained this reduction in voluntary access to the trauma in at least two ways. First, the shallow processing of the traumatic event at encoding causes the trauma to be poorly integrated into the autobiographical knowledgebase (Conway & Pleydell-Pearce, 2000; Ehlers & Clark, 2000) because of "little elaboration of the contextual and meaning elements of the event" and "an inability to establish a self-referential perspective" (Halligan, Michael, Clark, & Ehlers, 2003, p. 420). This lack of integration is expected to be positively related to the level of PTSD symptoms. To examine this question, we previously developed the Centrality of Event Scale (CES), which measures the extent to which a traumatic event is perceived as central to the person's life story and identity and thereby, among other things, appreciated from a self-referential perspective (Berntsen & Rubin, 2006). The CES contains such questions as "I feel that this event has become part of my identity," "This event has become a reference point for the way I understand myself and the world," "I feel that this event has become a central part of my life story," and "I often think about the effects this event will have on my future."

In contrast to the disintegration view, several studies have shown that the CES correlates positively (not negatively) with the level of PTSD symptoms. These studies involved a variety of subject populations, including college students, combat veterans, women with a history of childhood sexual abuse, and community-dwelling adults with a diagnosis of PTSD (Berntsen & Rubin, 2006, 2007, 2008; Brown, Antonius, Kramer, Root, & Hirst, 2010; Lancaster, Rodrigueza, & Weston, 2011; Robinaugh & McNally, 2010, 2011; Schuettler & Boals, 2011; Smeets, Giesbrecht, Raymaekers, Shaw, & Merckelbach, 2010).

Second, researchers have argued that the shallow processing at encoding causes internally fragmented memories, for example, in terms of the remembered trauma missing important details and having an unclear temporal order. In a number of studies, researchers have compared the coherence of memories for the traumatic event between individuals who have developed PTSD (or acute stress disorder) and individuals in a no-PTSD (or no–acute stress disorder) group. Many such studies have shown the trauma memory to be less coherent in the clinical group compared to the control group when measured both objectively and through self-reports (Amir, Stafford, Freshman, & Foa, 1998; Halligan et al., 2003; Harvey & Bryant, 1999; C. Jones, Harvery, & Brewin, 2007; Murray, Ehlers, & Mayou, 2002). However, all of these studies suffer from the lack of a nontraumatic control memory, for which reason one cannot exclude the possibility that the reduced coherence observed in the clinical group reflects a general deficit, together or individually, in verbal and cognitive abilities or other factors in the clinical group relative to the control group. This concern is especially relevant for factors such as education and intelligence, which are lower in samples with PTSD (Brewin, Andrews, & Valentine, 2000), because Gray and Lombardo (2001) found that differences on

memory-coherence measures between individuals with PTSD versus individuals without PTSD disappeared once cognitive abilities were controlled for.

Studies including nontraumatic control memories indeed have shown that a pattern of reduced coherence (or increased fragmentation) in the PTSD group is not specific to the memory for the traumatic events but generalizes to nontraumatic memories (Gray & Lombardo, 2001; Rubin, 2011; Rubin et al., 2011). Halligan et al. (2003; Study 2) interviewed assault victims about their trauma memory and a nontrauma memory within 3 months of their being assaulted and did follow-up assessments of PTSD at 3, 6, and 9 months later. The trauma and nontrauma memories were generally quite coherent, with a mean of 0.69 and 0.42, respectively, on a 0 to 4 rating of incoherence. Participants who qualified for PTSD at any of the follow-up assessments rated their traumatic memory as subjectively less coherent than their nontraumatic control memory, whereas this difference was not present for participants who did not qualify for PTSD at any of the follow-up assessments. In addition to all memories being fairly coherent, a shortcoming of the Halligan et al. study is that the diagnostic status of the participants at the time of the memory interview is unclear.

We have been able to identify only one study showing the expected interaction between group (PTSD vs. no PTSD at the time of testing) and type of memory (traumatic vs. other personal events). In a study of assault victims, Jelinek et al. (2009) found that the trauma memories were less coherent in the PTSD group than in a control group of healthy adults and that this reduced coherence was relatively more pronounced for the traumatic memories than for memories of a nontraumatic unpleasant control event. However, Jelinek et al. found this effect for only one of their three measures—an objectively coded, combined measure that included repetitions and disorganized thoughts minus organized thoughts (Halligan et al., 2003). They did not find the effect for their two remaining coherence measures that are closer to the concept of dissociative amnesia: an objective measure of global coherence and coherence as measured subjectively through questions designed to tap an experience of having difficulties with intentionally accessing the event and remembering key details (Halligan et al., 2003). It also should be noted that the traumatic memory and the memory for the nontraumatic unpleasant event in both groups were found to be more coherent than memory for three nonautobiographical narratives in the Jelinek et al. study. In general, the level of incoherence reported in these studies was low and not in a range to be invoked as a causal factor of clinical significance. For further discussions on the relation of dissociation and memory fragmentation, see Giesbrecht, Lynn, Lilienfeld, and Merckelbach (2008).

In spite of this poor empirical support, the C3 symptom in the *DSM-IV-TR* PTSD diagnosis, as well as its inclusion in the *DSM-5*, is consistent with the idea of impaired integration and fragmentation of trauma memories in PTSD. It holds that there is an inability to recall an important aspect of the trauma. However, meta-analyses of studies reported in the PTSD literature have shown that the C3 symptom is not as clearly associated with this disorder as are the other PTSD symptoms in that it has considerably lower loadings in factor analyses than the other 16 symptoms that make up the *DSM-IV-TR* diagnosis. Rubin, Berntsen, et al. (2008, Table 4) reviewed studies containing 35 separate analyses investigating the underlying factor structure of the 17 symptoms. The studies involved a wide variety of subject populations, including populations both with and without a clinical diagnosis of PTSD. In addition, different types of symptom measures were used, including both self-report measures and structured clinical interviews. The factor analyses likewise were varied with both exploratory and confirmatory analyses and 2-, 3-, and 4-factor solutions. Across the studies, the results for the C3 symptom were similar: The magnitude of the loading of the C3 symptom in the majority of analyses had a rank of 15, 16, or 17 among the 17 symptoms. The C3 often had the lowest loading, often much lower and out of the range of the rest of the items.

A study by Foa, Riggs, and Gershuny (1995) could not be included in the set of 35 analyses because the C3 initially loaded on its own factor and, thus, Foa et al. (1995) removed it from their factor analysis. In 1 of the 35 studies reviewed (Stewart, Conrod, Pihl, & Dongier, 1999), the C3 ranked highest among the 17 symptoms. However, in the Stewart et al. (1999) study, the participants were selected because of substance abuse rather than PTSD, which provides another explanation for the C3's success and suggests that studies that do not exclude substance abuse or other disorders, such as borderline personality disorder, that might lead to endorsing the C3 may have inflated its loading. In a recent meta-analysis of 40 studies including 14,827 participants, Yufik and Simms (2010, Figs. 1 and 2) found the same results for the C3's loadings on their two preferred models. For both models, the C3 loaded at .53, whereas the remaining 16 symptoms loaded between .71 and .87, indicating that roughly half as much of the C3's variance could be attributed to the underlying factor in each analysis.

In short, across different analytical strategies—including analyses of the accessibility and rated self-relevance of trauma memories and their internal organization, as well as psychometric analyses of PTSD measures—little

evidence exists for the claim that trauma memories are fragmented and poorly integrated. Of special note, the evidence reviewed exists both for studies using analog samples and for studies including participants with clinically diagnosed PTSD.

The Present Studies

In the present studies, we examined the idea of a dissociation between voluntary and involuntary access to traumatic or stressful events as well as the related idea of dissociative amnesia as reflected in the description of the C3 symptom in the *DSM-IV-TR* diagnostic criteria for PTSD. In Study 1, involving a large, representative sample, we examined the proposed dissociation between involuntary and voluntary remembering for important events, analyzed in terms of their self-rated emotional content.

In Study 2, we replicated and extended this line of research to memory for self-nominated highly negative events. In Study 2, we also examined the idea of dissociative amnesia as reflected in the description of the C3 symptom of PTSD in the *DSM-IV-TR*. We directly examined the hypothesis that a reversal of C3 wording to having "trouble forgetting important parts of the trauma" would be better correlated with the remaining PTSD symptoms than the actual C3 referring to "trouble remembering important parts." We used large samples of the general population and of undergraduates because such populations are needed to answer general questions about involuntary versus voluntary memories and because they show a large variability in the level of PTSD symptoms as well as in the other measures relevant to the present studies. Moreover, following the spirit of the numerous trauma-analogue studies (e.g., Brewin & Saunders, 2001; Davies & Clark, 1998; Halligan et al., 2002; Holmes, Brewin, & Hennessy, 2004; Horowitz, 1969, 1975; Pearson, Ross, & Webster, 2012; Verwoerd, Wessel, & de Jong, 2012) as well as analyses of the latent structure of PTSD (Ruscio, Ruscio, & Keane, 2002), we have rested on the assumption that differences between PTSD and subclinical manifestations of this disorder are quantitative, not qualitative, in nature.

Study 1

Method

Participants. As part of a larger study we performed on the effects of age on involuntary memories (Rubin & Berntsen, 2009), members of a representative sample of 1,013 Danes were asked about an important event from the previous week. Of these, 978 (538 female, 440 male) provided answers to four questions of interest. Their mean age was 44 years (*SD* = 17, range = 15–96). In Denmark, for research not involving sensitive topics, 15 year olds providing anonymous data can give consent and participate in survey research and are routinely sampled. Permission to include the data of the younger respondents was provided by the Duke University Institutional Review Board for the Protection of Human Subjects in Non-Medical Research.

Procedure. Data were collected as part of a telephone survey by TNS Gallup, Denmark. The response rate for the entire survey was 58%. The questions relevant to the present study were preceded only by demographic questions in the survey. Respondents were read the following introductory instructions:

> The following questions are part of research on how memory works. I will ask you some questions on how you remember. I will not ask about what you remember. Thus, I will not ask you to describe the contents of your memories. I will ask you to think back upon an important event that you can remember from last week. It has to be an event that you personally experienced on a particular day. If you do not think that you have had an important event within the last week, please choose a somewhat important event from the last week. Try to remember the event as well as you can. When you have brought the memory to mind, we will continue [here the interviewer paused for a few seconds].

Following the instruction, all respondents were asked to rate their memories on 5-point scales. Four ratings are relevant here: (a) "The emotions I have when I recall the event are" (*not at all intense / vaguely intense / somewhat intense / intense / very intense*); (b) "The emotions I have when I recall the event are" (*extremely negative / negative / neutral-mixed / positive / extremely positively*); (c) "Since it happened, I have willfully thought back to the event in my mind and thought about it or talked about it" (*never / seldom / sometimes / often / very often*); and (d) "Has the memory of the event suddenly popped up in your thoughts by itself—that is, without your having attempted to remember it?" (*never / seldom / sometimes / often / very often*).

Results

There were 43, 112, 175, 339, and 309 memories at the five valence ratings of −2, −1, 0, 1, and 2, respectively. Thus, consistent with previous work, results showed a clear dominance of emotionally positive events (Walker, Skowronski, & Thompson, 2003). There also was a dominance of memories rated as intense with 37, 112, 241, 316, and 272 memories at the five intensity ratings.

Figures 1a and 1b show the frequency ratings of involuntary and voluntary recall as a function of the valence and intensity ratings. An analysis of variance corresponding to the means shown in Figure 1a had a main effect of valence, $F(4, 973) = 27.92$, $p < .0001$, $\eta^2 = .08$, and voluntary versus involuntary recall, $F(1, 973) = 28.32$, $p < .0001$, $\eta^2 = .01$, but no interaction, $F(4, 973) = 1.30$, $p = .27$, $\eta^2 = .00$. Linear contrasts across the five levels of valence for the voluntary and involuntary retrieval showed no effect, $F(1, 973) = 0.00$, $p = .95$, and $F(1, 973) = 0.15$, $p = .70$. Quadratic contrasts across the five levels of valence for the voluntary and involuntary retrieval supported the claim that emotional intensity, as measured by the absolute level of valence (i.e., a valence of 0 became an intensity of 0, and a valence of ±1 and ±2 became an intensity of 1 and 2), results in more frequent recall, $F(1, 973) = 32.71$, $p < .0001$, and $F(1, 973) = 49.35$, $p < .0001$. An analysis of variance corresponding to the means shown in Figure 1b had a main effect of intensity, $F(4, 973) = 55.22$, $p < .0001$, $\eta^2 = .15$, and voluntary versus involuntary recall, $F(1, 973) = 18.08$, $p < .0001$, $\eta^2 = .00$, but no interaction, $F(4, 973) = 1.14$, $p = .49$, $\eta^2 = .00$. Linear contrasts across the five levels of intensity for the voluntary and involuntary retrieval resulted in more frequent recall, $F(1, 973) = 150.75$, $p < .0001$, and $F(1, 973) = 118.50$, $p < .0001$, with smaller quadratic contrasts, $F(1, 973) = 11.12$, $p < .001$, and $F(1, 973) = 2.65$, $p = .10$.

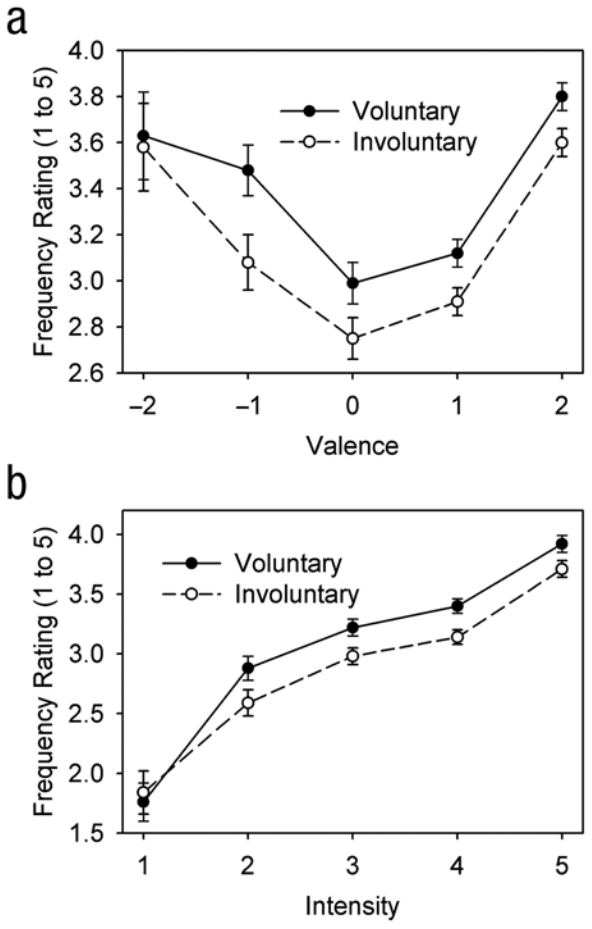

Fig. 1. Frequency rating of voluntary and involuntary memories as a function of (a) valence and (b) intensity (Experiment 1). Error bars represent standard errors.

Summary and discussion

Involuntary and voluntary recall followed the same pattern with regard to the effects of emotion: For both kinds of recall, frequency ratings were higher for emotionally intense events. No effects on the frequency of recall for negative versus positive valence and no interaction effects were found. Overall, voluntary recall was rated as slightly more frequent than involuntary recall. Our goal in Study 2 was to examine these questions more closely in relation both to measures of self-nominated most-negative events and to measures of PTSD symptoms.

Study 2

In Study 2, we examined the rated frequency of voluntary and involuntary recall of a self-nominated most negative memory as well as a recent self-nominated important event in a large sample of undergraduates. We included self-rated measures of PTSD symptoms and whether the stressful event satisfied the diagnostic A1 and A2 criteria for a traumatic event to examine whether these measures would show different relations with voluntary and involuntary recall, which we predicted they would not.

In addition, Study 2 was conducted to examine directly the idea that voluntary recall of trauma memories is hampered as reflected in the C3 symptom in the *DSM-IV-TR* diagnostic criteria for PTSD, which describes an "inability to recall an important aspect of the trauma" (American Psychiatric Association, 2000, pp. 467–468). This description is maintained in the *DSM-5* and is explicitly linked to dissociative amnesia, as noted earlier in the introduction. However, previous studies have shown that the C3 symptom has a much lower loading in factor analyses than the other PTSD symptoms. This result has been shown across different psychometric measures and across different (clinical and nonclinical) populations (see Rubin, Berntsen, et al., 2008, for a review). Here, we examined the hypothesis that a conceptual reversal of C3 wording in the symptom checklist to having "trouble forgetting important parts of the trauma" would be better correlated with the remaining PTSD symptoms than the actual C3 referring to "trouble remembering important parts." Such a reversal is in line with the view that emotional arousal at the time of the event enhances subsequent memory access for both voluntary and involuntary recall (e.g., McGaugh, 2003, 2004)

and that this enhanced memory accessibility is central to the understanding of PTSD (Berntsen & Rubin, 2006, 2007).

The trouble-remembering and trouble-forgetting measures are conceptually opposite with respect to the underlying issue of dissociative amnesia. On an empirical level, however, there is reason to expect a modest positive correlation between these measures in the present context in part because both are similarly worded items in a test that has no reverse-scored items. In addition, the more one cannot forget important parts of an event, the more likely it is that the event has been repeatedly recalled and thought about. Such repeated recall can produce an illusion of partial amnesia stemming from an availability heuristic in that a prolonged retrieval activity may lead people to realize that there are several details that they are unable to remember fully. This result would be true for all events, including positive ones, consistent with previous work (Read & Lindsay, 2000). Finally, by probing cognitive difficulties, both measures may be positively related to an underlying dimension of negative affectivity.

Method

Participants. During the course of four semesters, 1,325 Duke University undergraduates (860 female, 465 male; mean age = 18.92, *SD* = 1.04, range = 18–23) completed the study.

Procedure. As part of a Web-based testing procedure used at the beginning of each semester to screen students for later experiments in the Department of Psychology and Neuroscience, participants were asked to "please take a moment to think of what negative event or experience from your life is most troubling and stressful to you now." In relation to that event, they completed the 17-item Posttraumatic Stress Disorder Checklist (PCL; Weathers, Litz, Huska, & Keane, 1994), the 7-item version of the CES, and a self-report of whether their negative event satisfied the *DSM-IV-TR* A1 and A2 trauma criteria, that is, whether the event involved (A1) "actual or threatened death or serious injury, or a threat to the physical integrity of self or others" as well as (A2) "intense fear, helplessness, or horror" (American Psychiatric Association, 2000, p. 467).

Immediately after the standard PCL items, we added one scale in exactly the same form as those on the PCL. This added scale is based on the C3, which asks participants to rate their "trouble remembering important parts of a stressful experience from the past" on a 5-point scale from 1 (*not at all*) to 5 (*extremely*). In contrast, our question asked participants to rate their "trouble forgetting any important parts of the stressful experience from the past."

The participants were then asked to respond with a number between 0 and 99 to the following two questions about the event: (a) "In the last week, I have willfully thought back to the event and thought about it or talked about it about ___ times" and (b) "In the last week, the memory of the event suddenly popped up in your thoughts by itself—that is, without your having attempted to remember it about ___ times." The questions were always asked in this order to present a clear contrast between involuntary recall and voluntary recall.

Later in the session, participants were asked to "please think back to the most important event of the previous week" and to answer the same two questions that were used for their negative event, except that the frequency was for occurrence during the past 24 hr. They then responded to the question "Was the event positive, neutral, or negative?" using a 7-point scale ranging from −3 (*extremely negative*) to 3 (*extremely positive*) and with a middle anchor of 0 (*neutral*).

Thus, we sampled two very different events: the most bothersome event from anytime in the participant's life and the most important event from the past week.

Results

The mean (*SD*) on the PCL was 30.03 (10.98) with a median of 27 and a range of from 17 to 72. Of the 1,325 participants, 270 indicated that they had both an A1 traumatic event and an A2 emotion, 1,039 did not, and 16 did not answer at least one of these items.

The raw frequencies reported by the participants are shown in Figure 2. Because of the skewed nature of the frequency data, all calculations with the frequency data were made on the base 10 logarithm of 1 plus the frequency so that frequencies of 0, 9, and 99 were analyzed as 0, 1, and 2, respectively. The reported means and standard deviations were transformed back from these logarithms.

Negative event. The reported frequency of voluntary memories and involuntary recall of the self-nominated most negative event were similar, with voluntary memories having a higher mean (*SD*) of 1.76 (1.81) versus 1.49 (1.86) for involuntary recall, $F(1, 1324) = 24.80$, $p < .0001$, $\eta^2 = .02$, and with both having medians of 1 and modes of 0. To ensure that the skewed distributions did not produce this effect, we examined the frequency distributions, which are plotted in Figure 2a. Because there were few responses above a frequency of 4 and with most of these occurring at multiples of 5 or 10, we grouped frequencies above 4 into bins of 5 and have shown the average for the bins. There were 3.70% voluntary and 3.25% involuntary responses of 25 or greater not shown in Figure 2a. The correlation between the voluntary and involuntary frequencies was .74, $p < .0001$. The PCL correlated

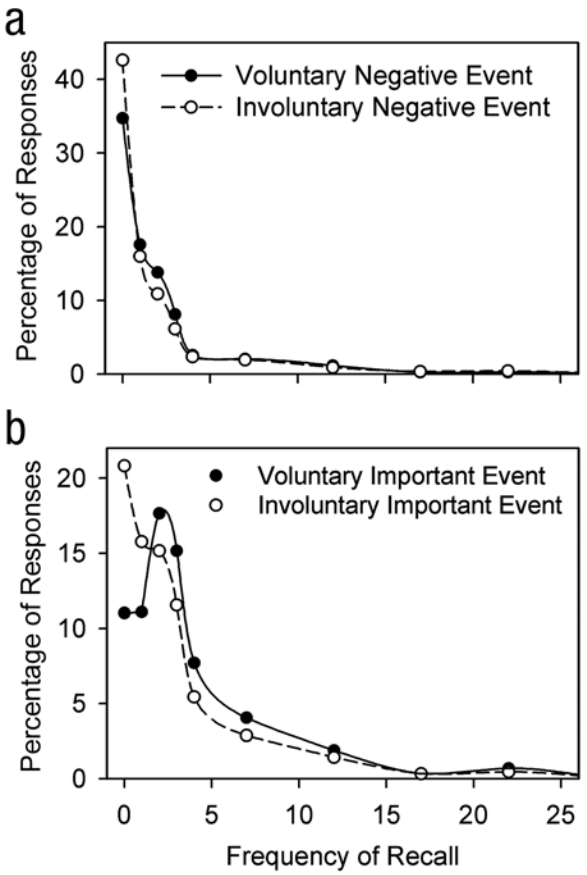

Fig. 2. Distribution of responses as a function of their reported frequency of recall in Experiment 2 for (a) negative events and (b) important events.

positively with the frequency of both voluntary and involuntary recall (*r*s = .41 and .49, respectively, *p*s < .0001), counter to the claim that the two kinds of recall follow different patterns and that voluntary recall is reduced with increased levels of PTSD symptoms. The correlations of the PCL with the frequency of voluntary and involuntary recall for those reporting a trauma, satisfying the A criteria, were .38 and .52, and for those not reporting an A trauma, the results were .41 and .48, *p*s < .0001.

Important event. As shown in Figure 2b, the reported frequencies of voluntary and involuntary recall of the same important event were largely similar, but consistent with Study 1, results showed that voluntary recall was more frequent than involuntary recall with means (*SD*s) of 3.33 (1.34) versus 2.47 (1.53), $F(1, 1324) = 145.84$, $p < .0001$, $\eta^2 = .10$, and with medians of 3 and 2 and modes of 2 and 0. There were 2.26% voluntary and 2.34% involuntary responses of 25 or greater not shown in Figure 2b. The correlation between the voluntary and involuntary frequencies was .72, $p < .0001$.

For the important memories, we used a 7-point rating scale of valence by which we could group the data. There were 60, 118, 160, 154, 134, 323, and 376 memories at the seven valence ratings of −3, −2, −1, 0, 1, 2, and 3. Thus, as in Study 1, results showed a clear dominance of memories rated as positive, consistent with previous work (Walker et al., 2003). As shown in Figure 3, there were clear results concerning how frequently the participants had recalled the events. There was an effect of the ratings of valence, $F(6, 1318) = 20.37$, $p < .0001$, $\eta^2 = .07$, and whether the recall was voluntary or involuntary, $F(1, 1318) = 77.29$, $p < .0001$, $\eta^2 = .01$, but there was no interaction of these factors, although a trend was observed, $F(6, 1318) = 2.07$, $p = .053$, $\eta^2 = .00$. Linear contrasts across the seven levels of valence for the voluntary and involuntary retrieval supported the claim that negative events result in more frequent recall, $F(1, 1318) = 10.38$, $p < .01$, and $F(1, 1318) = 27.89$, $p < .0001$. Quadratic contrasts across the seven levels of valence for the voluntary and involuntary retrieval supported the claim that intensity, as measured by the absolute level of valence (i.e., a valence of 0 became an intensity of 0, and a valence of ±1, ±2, and ±3 became an intensity of 1, 2, and 3), results in more frequent recall, $F(1, 1318) = 82.06$, $p < .0001$, and $F(1, 1318) = 85.02$, $p < .0001$, respectively.

Trouble forgetting. Table 1 presents the means, standard deviations, reliabilities of the instruments, and their correlations with the C3 item of the PCL and our added question. We also included the PCL and the Avoidance scale of the PCL without the C3 item to eliminate the

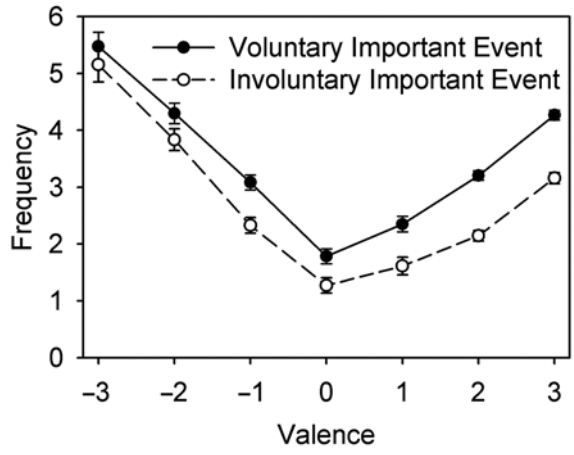

Fig. 3. The reported frequency of recall of voluntary and involuntary memories as a function of valence in Experiment 2. Error bars represent .05 confidence intervals.

Table 1. Means, Standard Deviations, Reliabilities, and Correlations in Experiment 2

				Correlation		
Variable	*M*	*SD*	α	C3	Trouble forgetting	Hotelling's *t* test
PCL B	9.82	4.15	.84	.21	.46	5.35***
PCL C without C3	10.71	4.43	.79	.26	.43	3.58**
PCL D	7.91	3.56	.80	.25	.42	3.53**
PCL without C3	28.45	10.67	.91	.27	.50	5.25***
CES	2.63	1.15	.93	.19	.34	2.87*
BDI-II	5.06	5.95	.88	.14	.31	3.16*
C3	1.59	0.98				
Trouble forgetting	1.67	1.01				

Note: $N = 1{,}325$. All correlations shown are statistically significant at $p < .0001$. Hotelling's *t* test represents the difference between the C3 and trouble-forgetting correlations. PCL = Posttraumatic Stress Disorder Checklist; PCL B = reexperiencing symptoms in the *DSM-IV-TR* posttraumatic stress disorder (PTSD) diagnosis; PCL C = avoidance symptoms in the *DSM-IV-TR* PTSD diagnosis; PCL D = arousal symptoms in the *DSM-IV-TR* PTSD diagnosis; CES = Centrality of Event Scale; BDI-II = Beck Depression Inventory–II.
*$p < .01$. **$p < .001$. ***$p < .0001$.

problem of predicting a measure with a sum score that includes it. The correlations of the PCL with the CES, the Beck Depression Inventory–II (BDI-II), self-reported A trauma, and the PCL without the C3 were .50, .53, .11, and .99, respectively. The correlation of the CES and the BDI-II was .29. The correlation of the C3 and the trouble-forgetting modified item was .29. The correlation of all measures shown in the table with the trouble-forgetting item was always higher than with the C3, as shown by the Hotelling's *t* test. If correlations were made separately for groups of participants reporting versus not reporting a stressful event satisfying the A trauma criteria, the average absolute difference between these groups in the correlations shown in Table 1 would be .05 (range = .01–.09) and no group difference would be significant (all *p*s > .10).

To investigate the two items related to accessing important parts of the memory, we predicted them both using multiple regressions with the CES, the BDI-II, self-reported A trauma, and the PCL with the C3 not included in the sum. We included all items using a best fit with no restrictions. The equations using standardized beta weights were C3 = .23 PCL + .14 Trauma + .05 CES − .01 BDI-II (R^2 = .10) and Trouble Forgetting = .41 PCL + .10 Trauma + .10 CES + .06 BDI-II (R^2 = .27).

In short, consistent with our predictions, results showed that a conceptual reversal of the C3 wording to having "trouble forgetting central aspects of the trauma" was significantly better correlated with the remaining PTSD symptoms than the actual C3 referring to "trouble remembering central aspects." This pattern was found across all categories of PTSD symptoms.

Summary and discussion

The self-nominated most negative event showed the same overall distributions of frequency ratings for involuntary and voluntary recall, although voluntary recall was rated as slightly more frequent. Both were positively correlated with level of PTSD symptoms. For the self-nominated important event, voluntary recall was rated as more frequent than involuntary recall. This result agrees with Study 1 and previous studies showing that voluntary compared to involuntary memories tend to favor more self-relevant events, presumably because of a more top-down schema-based search (Berntsen, 2009).

Participants' ratings of how frequently they had voluntarily versus involuntarily recalled the events were examined as a function of ratings of the emotional valence of the events. This analysis showed that the two forms of recall followed the same pattern, with emotionally intense events remembered more frequently than less intense events for both types of recall. In addition, negative events were remembered slightly more frequently than positive events for both types of recall. No interaction effects were observed.

The reversal of the C3 wording to "trouble forgetting" showed consistently higher correlations with the remaining PTSD symptoms as compared to the actual C3 referring to "trouble remembering central aspects" of a traumatic or stressful event. This result provided further evidence that traumatic events are easily accessed through both voluntary and involuntary recall.

General Discussion

We examined two key assumptions in the PTSD literature. One was the assumption that negative emotional stress during encoding has differential effects on subsequent involuntary and voluntary recall, and the other was the related assumption that voluntary recall of trauma is incomplete and fragmented, especially for individuals with higher levels of PTSD symptoms.

Our findings add to previous work that has shown that involuntary and voluntary recall follow the same pattern with regard to their ability to access emotional events. The findings contradict the idea that emotional arousal at the time of the event reduces voluntary while enhancing involuntary access. The methods used in the present studies differ from those used previously, but the conclusions are similar. For both involuntary and voluntary recall, the emotional intensity of the remembered events is the key predictor for how frequently the events are recalled.

In Study 1, we showed that a large, stratified population rated the frequency of voluntary and involuntary recall of their most important event as similar. When their most important life event was analyzed in terms of emotional valence, voluntary and involuntary recall ratings followed the same pattern: Extremely positive and extremely negative events were judged to be more rehearsed both voluntarily and involuntarily.

This finding was replicated and extended in Study 2, which involved a large sample of undergraduates who rated voluntary and involuntary recall of their most negative event as well as their most important event from the past week. We found again that voluntary and involuntary memories followed the same pattern, with emotionally intense events remembered more frequently than less intense events for both types of recall. In addition, we found that negative events were remembered slightly more frequently for both types of recall. Correlations with PTSD symptoms were similar for the two types of recall, and this pattern did not differ between participants who reported that their negative event satisfied, versus did not satisfy, the A trauma diagnostic criteria for PTSD.

In Study 2, we also used a different strategy to test our predictions. We found that ratings of trouble forgetting important parts of the trauma, a conceptual reversal of the C3 symptom wording in the *DSM-IV-TR* PTSD diagnosis, was significantly better correlated with the remaining PTSD symptoms than the actual C3 referring to "trouble remembering important parts." This finding supports the view that traumatic events are easily accessed through both voluntary and involuntary recall. The finding adds to previous work with both clinical and nonclinical populations showing that the C3 symptom, which is the only symptom directly addressing dissociative amnesia, is relatively poorly related to the remaining PTSD symptoms (Rubin, Berntsen, et al., 2008; Yufik & Simms, 2010). Although both the C3 and the reversal of C3 were positively correlated with the remaining PTSD symptoms, the reversal of C3 showed consistently higher correlations than the actual C3 across all symptom groups, which indicates that having trouble forgetting (rather than trouble remembering) the traumatic event is a better conceptualization of the way memory works in relation to the other PTSD symptoms.

Although the actual C3 and the reverse C3 are conceptually opposite with respect to the underlying issue of dissociative amnesia, they correlated positively with one another. Such a correlation was expected for three reasons. First, both were similarly worded items in a test that has no reverse-scored items. Second, having trouble forgetting important parts is likely to imply prolonged retrieval activity (i.e., recurrent recall). Such prolonged retrieval activity has been found to produce an impression of partial amnesia by bringing people to the realization that there are still several details of the event that they are unable to remember fully or that they may have recovered details that previously were inaccessible. This effect reflects a normal heuristic in the ways we tend to think about memory and is not limited to trauma (Read & Lindsay, 2000). Third, the positive correlation between the two items, as well as the fact that they both correlate with PTSD symptoms, may reflect a broader tendency for participants with higher levels of PTSD to perceive themselves as having cognitive and emotional difficulties and therefore be inclined to provide confirmative answers to both having trouble remembering and having trouble forgetting. In this interpretation, the correlation would reflect an underlying dimension of distress or negative affectivity influencing answers to both questions. These three reasons also could account in part for the moderate loading of the C3 that remains in factor analyses.

The present studies involved large samples of undergraduates and of the general population. Such populations show a larger variability in the level of PTSD symptoms compared to clinical populations, in which everyone would be expected to show high (albeit varying) symptom levels. In the present study, the PCL scores ranged from 17 to 72 (maximum range on the PCL is 17 to 85). In individuals with a clinical diagnosis of PTSD, the range would be narrower, with most scores above 43 on the PCL (Blanchard, Jones-Alexander, Buckley, & Forneris, 1996). The variability in symptom levels in the present sample can be viewed as an advantage in relation to the correlational analyses employed here because the full range of the scale is being used.

Conversely, it may be suggested that the dissociation between involuntary and voluntary access to the traumatic event is seen only in extreme cases and, therefore, requires a clinical population. We consider this suggestion unlikely because the present findings coincide with what has been found in studies with clinical populations using a diary method for recording involuntary and voluntary memories as they occur in daily life (Rubin et al., 2011) as well as psychometric analyses of the C3 in relation to other PTSD symptoms (see Rubin, Berntsen, et al.,

2008, for a review). The finding that involuntary and voluntary recall accessed emotionally negative events with equal frequencies also has been replicated in a recent study involving clinically depressed individuals (Watson, Berntsen, Kuyken, & Watkins, 2012). In addition, psychometric analyses of the latent structure of PTSD support the view that PTSD reflects the high end of a continuum of stress response symptoms rather than a discrete clinical syndrome (Ruscio et al., 2002). Nonetheless, it is still possible that different levels of PTSD symptoms (e.g., mild, moderate, and severe) would be differentially associated with other external measures, following Flett, Vredenburg, and Krames's (1997) notion of phenomenological continuity. Future research therefore should extend the current methods to clinical populations.

In light of the present findings, how should we explain the clinical observation that some PTSD patients have difficulties accessing important aspects of their trauma while at the same time suffering from repetitive intrusive recollections of episodic details? First, given the many disorders that have strong comorbidity with PTSD, one possibility is that these observations are due to the presence of comorbid disorders because disorganized thought in relation to autobiographical events exists in many clinical disorders, such as borderline personality disorder (Jørgensen et al., 2012). This alternative explanation can be differentiated easily from disorganized memories of traumas because it would apply across different types of memories rather than just to trauma memories. Second, findings from research on overgeneral memories in depression and PTSD have suggested a possible explanation. Individuals with PTSD show a general reduced ability to retrieve specific autobiographical events in response to cue words (McNally, Litz, Prassas, Shin, & Weathers, 1994) similar to the deficits observed in depression (Williams et al., 2007). The most likely explanation for this deficit, according to Williams et al. (2007), is reduced executive processes, in part due to rumination and worry or attempts at avoiding painful memories. To the extent trauma victims show this deficit, their ability to access discrete episodic details of the trauma and other autobiographical events may be reduced. At the same time, recent findings with depressed individuals (Watson, Berntsen, Kuyken, & Watkins, 2013) have suggested that this deficit does not generalize to involuntary recall of past autobiographical events, for which stable depressed individuals show no difference in memory specificity compared with recovered and never-depressed individuals, presumably because the involuntary remembering involves less executive monitoring (Berntsen, Staugaard, & Sørensen, 2013). Thus, a PTSD patient with reduced executive functions may experience difficulties intentionally accessing concrete episodic details of any past events, including (but not limited to) the traumatic experience, while at the same time experiencing involuntary recollections of such details. More research on involuntary and voluntary autobiographical memories in PTSD is needed to examine this possibility.

In conclusion, the findings reported here contradict the view—dating back to the infancy of PTSD research—that involuntary remembering yields privileged access to traumatic events and that voluntary access is hampered by the trauma memory being fragmented and poorly integrated. Instead, our findings support the alternative view that involuntary and voluntary remembering follow the same pattern with regard to the effects of emotion; that is, both are enhanced by emotional stress during encoding. Although the duality view introduced by PTSD pioneers (e.g., Horowitz, 1976) almost 40 years ago has been extremely influential and productive, the time has come to reconsider this prevalent belief in light of the accumulating evidence from the wealth of research it has spurred.

Author Contributions

D. Berntsen and D. C. Rubin collaboratively designed and executed the study and drafted the manuscript.

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Declaration of Conflicting Interests

The authors declared that they had no conflicts of interest with respect to their authorship or the publication of this article.

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