Dissociation and Memory Fragmentation in Posttraumatic Stress Disorder: An Evaluation of the Dissociative Encoding Hypothesis

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Abstract

Several prominent theories of posttraumatic stress disorder (PTSD) posit that peritraumatic dissociation results in insufficient encoding of the trauma memory and that persistent dissociation prevents memory elaboration, resulting in memory fragmentation and PTSD. In this review, we summarize the empirical literature on peritraumatic and trait dissociation and trauma narrative fragmentation as measured by meta-memory and rater/objective coding. Across 16 studies to date, the association between dissociation and fragmentation was most prominent when examining peritraumatic dissociation and patient's own ratings of memory fragmentation. This relationship did not hold when examining trait dissociation or rater-coded or computer-generated measures of fragmentation. Thus, initial evidence points more toward a strong self-reported association between constructs that is not supported on more objective fragmentation coding. Measurement overlap, construct ambiguity, and exclusion of potential confounds may underlie lack of a strong association between dissociation and objective-rated fragmentation.

Keywords

trauma exposure; PTSD; dissociation; memory organization; narrative fragmentation

Prominent theorists posit dissociation as a key mechanism in the development and maintenance of posttraumatic stress disorder (PTSD; e.g., Brewin, 2001; Ehlers & Clark, 2000; van der Kolk, 1987). Dissociation, or a "disruption in the usually integrated functions of consciousness, memory, identity, or perception" (p. 519; APA, 2000), is common during and following trauma (e.g., van der Kolk, 1987). Indeed, in a meta-analysis of risk factors for PTSD, peritraumatic dissociation, or dissociation during or immediately following the traumatic event, was one of the strongest predictors of chronic PTSD (Ozer, Best, Lipsey, & Weiss, 2003).

It is thought that dissociative encoding, that is, incomplete initial processing of the traumatic experience, leads to the development and persistence of PTSD (Brewin, 2001; Brewin & Holmes, 2003; Ehlers & Clark, 2000; van der Kolk, 1987, 1994; van der Kolk, van der Hart, & Marmar, 1996). Specifically, dissociation during the event prevents elaboration during encoding, which disrupts both memory storage and retrieval, consequently leading to PTSD. Typically, the memory disruption implicated in these theories is memory fragmentation, or abnormalities of sequence, coherence, and content in the trauma narrative. Fragmentation is thought to result from a lack of elaboration of the memory due to high emotion and

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dissociation during the traumatic experience (e.g., van der Kolk, 1987). Furthermore, continued dissociation after the event may maintain PTSD by further inhibiting processing and memory elaboration (e.g., Ehlers & Clark, 2000; Foa & Hearst-Ikeda, 1996). Thus, dissociative encoding, persistent dissociation, and a lack of memory processing and organization are thought to be key mechanisms underlying the development and persistence of PTSD after various types of trauma. However, a thorough review of the empirical evidence linking these constructs has yet to be conducted.

At the heart of dissociation is memory disturbance (Carde□ña & Speigel, 1993), ranging from complete amnesia to impairments in organizing the memory, which subsequently lead to both disorganized, disintegrated intentional narrative recall and frequent, automatic memory intrusions (e.g., Brewin, Dalgleish, & Joseph, 1996; Ehlers, Hackmann, & Michael, 2004; Foa & Hearst-Ikeda, 1996; Foa & Riggs, 1993; Spiegel, 1997). This is consistent with general memory models which suggest that meaning-based encoding is necessary for adaptive, intentional memory recall (e.g., Schacter, 1996), that sensory-based encoding results in a perceptual memory trace that is involuntarily cued by perceptual stimuli (e.g., Roediger, 1990), and that elaboration of events in memory will prevent unintentional recall (e.g., Conway & Pleydell-Pearce, 2000). Based on these general memory models, dissociation and inadequate memory encoding and processing may play a causal role in the development of PTSD (e.g., Brewin, 2001; Foa & Riggs, 1993; Krystal, Southwick, & Charney, 1995; Terr, 1991; van der Kolk & Fisler, 1995). Specifically, dissociation, either during or following a trauma, may lead to fragmentation of the trauma memory, which in turn may contribute to PTSD. Despite the importance of dissociation and memory fragmentation to clinical conceptualizations of PTSD, the empirical link between dissociation and trauma memory fragmentation has been disputed (Giesbrecht, Lynn, Lilienfeld, & Merckelbach, 2008).

Focus of the Present Paper: Dissociation and Memory Processing

This review will explore the empirical support for the theorized relationship between dissociation and fragmentation. Dissociation and memory fragmentation are two constructs commonly linked together in a causal manner and yet a thorough review of the empirical evidence for this specific relationship has not yet been conducted. Fragmentation of the trauma memory is a phenomenon that is often clinically observed, and continues to be an important area of focus for those treating PTSD (e.g., Becker, Zayfert, & Anderson, 2004, van der Kolk et al., 2005). Indeed, the notion of fragmented memories figures prominently into many of our current treatment approaches (e.g., Shapiro & Maxfield, 2002). Many prominent theories suggest that peritraumatic, persistent, and trait dissociation inhibit encoding and processing of the trauma memory and thus are crucial to the development, maintenance, and recovery of PTSD.

There are a variety of theoretical models discussing the overlap among dissociation, trauma exposure, and memory processing including work on neurobiological underpinnings of dissociation and traumatic responses (e.g., Bremner, 2000, 2003; Krystal, Bennett, Bremner, Southwick, & Charney, 1996; Lanius et al., 2010). Specifically, neurobiological models of stress and memory suggest that stressful, traumatic experiences trigger increased release of cortisol. This is thought to contribute to hippocampal dysfunction, which is associated with deficits in declarative memory, and in particular memory fragmentation (e.g., Bremner, 1996; Elzinga & Bremner, 2002; Lanius et al., 2010). Furthermore, a dissociative subtype of PTSD has been proposed where hyperinhibition of limbic systems is associated with suppression of memories and overmodulation of emotions in response to trauma reminders (e.g., Lanius et al., 2010). Thus, these theories posit that dissociation, memory processing, and trauma-related symptoms are intricately connected and are related in a causal manner.

Dissociation is theorized as related to not only fragmentation but also other significant memory deficits including partial amnesia, repressed memories, and recovered memories (e.g., Lanius et al., 2010; Spiegel, 1997; Terr, 1991). It is suggested that the psychogenic amnesia and forgetting of emotional experiences that accompanies high levels of dissociation is a defense mechanism that enables the individual to avoid the traumatic experience (e.g., Ehlers & Clark, 2000; van der Kolk & Fisler, 1995). However, Giesbrecht and colleagues (2008; 2010) recently reviewed the empirical evidence linking dissociation to diverse cognitive processes including fantasy proneness, suggestibility, and avoidant memory processing (e.g., fragmentation, commission errors, overgeneralized memory) and concluded that evidence supporting the link between trauma, dissociation, and avoidant information processing is lacking. In contrast, a response by Bremner (2010) refutes this claim and asserts a persistent and convincing relationship between trauma, dissociation, and memory errors. Thus, this issue of the relationship between dissociation, trauma, and information processing remains contentious.

Considering the clinical and theoretical importance that is placed on the dissociation-memory fragmentation link, it is imperative that we have an understanding of the empirical support for this theorized relationship, as it influences both conceptualizations and treatments of PTSD. Several reviews have critically examined the relationship between memory fragmentation and PTSD (see O'Kearney & Perrott, 2006; Zoellner & Bittinger, 2004). However, a better understanding of the link between dissociation and memory fragmentation is also needed to fully appreciate the empirical support for several of the leading theories of PTSD and to better understand the mechanisms underlying memory of traumatic experiences. While we briefly comment where applicable on the relationship between dissociation, fragmentation, and PTSD a full review of this literature is outside the scope of this paper, and the goal of the present review is to critically examine the research regarding the first part of this proposed mechanism. Namely, is peritraumatic or trait dissociation associated with trauma memory fragmentation?

Conceptual and Measurement Issues

Prior to examining this hypothesis, several issues regarding how the constructs of dissociation and memory organization are operationalized need to be addressed.

Dissociation—Definitions of dissociation encompass diverse experiences including perceptual impairments, memory abnormalities, and emotional detachment (Cardena & Spiegel, 1993). Studies of dissociation, memory, and trauma often assume that dissociation is one unitary construct (Bryant, 2007). However, dissociation can be conceptualized as a trait or general regulation style (Bernstein & Putnam, 1986), as a temporary state cued by circumstances (e.g., Weiss, Marmar, Metzler, & Ronfeldt, 1995), or as a specific reaction during trauma (i.e., peritraumatic dissociation; e.g., Marmar, Weiss, & Metzler, 1997). Trait dissociation implies that the tendency to dissociate is a stable characteristic that exists similarly pre- and post-trauma and may be a vulnerability factor for PTSD (Bryant, 2007; Kihlstrom, Glisky, & Angiulo, 1994). In contrast, state dissociation occurs in response to situations and interferes with processing (e.g., Briere, Scott, & Weathers, 2005; Ehlers, 2006). Similarly, peritraumatic dissociation, a form of state dissociation, refers to dissociation that occurs during a trauma and is theorized as causal for PTSD (e.g., van der Kolk, 1987, 1994). Thus, dissociation may not refer to one single construct, and may relate as a predisposing, contributing, or causal factor to memory processing and PTSD.

The majority of cross-sectional, retrospective studies suggest that peritraumatic dissociation predicts PTSD (Berg, Grieger, & Spira, 2005; Bremner et al., 1992; Hetzel & McCanne, 2005; Marmar et al., 1994; Tichenor, Marmar, Weiss, Metzler, & Ronfeldt, 1996; Weiss et

al., 1995). However, recollections of peritraumatic reactions are often inconsistent over time and are potentially biased by current symptoms (Harvey & Bryant, 2000; Southwick, Morgan, Nicolaou, & Charney, 1997; Zoellner, Sacks, & Foa, 2001). Indeed, some prospective studies suggest that peritraumatic dissociation predicts PTSD over time (e.g., Birmes et al., 2003; Ehlers, Mayou, & Bryant, 1998; Holen, 1991; Marmar et al., 1999; Murray, Ehlers, & Mayou, 2002; Schafer, Barkmann, Riedesser, & Schulte-Markwort, 2004; Shalev & Freedman, 2005; Ursano et al., 1999); however, others do not (Freedman, Brandes, Peri, & Shalev, 1999; Holeva & Tarrier, 2001; Marshall & Schnell, 2002; Marx & Sloan, 2005; Mellman, David, Bustamante, Fins, & Esposito, 2001). Consistent with these later findings, although acute stress disorder (ASD), a disorder characterized by dissociative symptoms during or immediately following a traumatic event, is associated with PTSD (e.g., Creamer, O'Donnell, & Pattison, 2004; Harvey & Bryant, 2000; Murray et al., 2002), it does not exhibit good specificity for predicting PTSD (see Bryant, 2003; Harvey & Bryant, 1998; 1999; Zoellner, Jaycox, Watlington, Foa, 2003).

In light of questions about the predictive ability of peritraumatic dissociation, focus has shifted toward trait and persistent dissociation. Growing evidence suggests a tendency to dissociate (trait) and continued dissociation in response to reminders (persistent) may be more predictive of PTSD than peritraumatic dissociation (Briere et al., 2005; McFarlane, 1997; Murray et al., 2002; Pansetis & Bryant, 2003). Persistent or trait dissociation may interfere with accessing and elaborating trauma related emotions and memories (Foa & Hearst-Ikeda, 1996). By hindering processing, persistent dissociation, similar to other types of cognitive and behavioral avoidance (Foa & Hearst-Ikeda, 1996; Panasetis & Bryant, 2003; Wagner & Linehan, 1998) may contribute to both memory fragmentation and PTSD development.

Thus, in this review, we will examine the association between both peritraumatic and trait dissociation, and trauma memory fragmentation. We focus on trait dissociation due to a lack of research that measures persistent dissociation (e.g., in response to specific trauma or emotional cues). In this review, the term trait dissociation refers to a general tendency to dissociate while persistent dissociation refers to dissociation in response to specific trauma-related cues.

Memory organization—Various definitions of trauma memory fragmentation exist including increased sensory components (Hopper & van der Kolk, 2001), abnormal chronology (Byrne, Hyman, & Scott, 2001), and memory confusion (Foa, Molnar, & Cashman, 1995; Halligan, Michael, Clark, & Ehlers, 2003). The terms fragmentation and disorganization are often used interchangeably, although they may refer to different constructs. For example, Foa and colleagues (1995) distinguish between fragmentation and disorganization by defining fragmentation as unnecessary repetitions and disorganization as confused or disjointed thoughts in the narrative. In this review, we primarily use fragmentation to refer to both fragmentation and disorganization for simplicity and because the terms are not well distinguished. However, when reviewing studies, we will be consistent with the specific term that the original authors used.

Typically, memory fragmentation is investigated using one of two approaches: meta-memory or narrative recounting. Meta-memory refers to self-report and involves either thinking about or actually recalling an event and making self-report ratings on its quality. Commonly used meta-memory measures include multi-item scales that assess recall of sensations, emotions, surroundings, and other details, and one-item rating scales, such as "Are your memories in any way unclear or jumbled?"(p. 364, Murray et al., 2002), that assess global memory quality.

In contrast, coding measures use either trained raters or objective indices to assess the style and content of the narrative. Typically, an individual recounts the trauma memory, in written or verbal form, including details of thoughts, feelings, and sensations. The narrative is then analyzed using subjective coding schemes, rater judgments, or objective coding programs. When raters are employed, the narrative is subjectively analyzed using coding schemes for sensory components, organization, and other indicators of fragmentation. Alternatively, raters may provide global judgments of quality, such as a one-item rating of "degree of fragmentation" (Murray et al., 2002). In contrast to subjective approaches, standardized coding programs are used to objectively quantify narrative content and structure. These objective indices, such as the Linguistic Inquiry and Word Count program that counts words (LIWC; Pennebaker, Francis, & Booth, 2001), have the advantage of avoiding the potential bias of a subjective rater.

In this paper, we broadly define meta-memory measures as any individual items or measure scales that ask for self-reported memory quality (e.g., degree of clarity) or content (e.g., degree of sensory components) related to fragmentation. We define narrative coding measures as any individual items or measure scales that utilize either a trained rater or objective methods (e.g., computerized programs) to capture style or content indicative of fragmentation.

Review of the Empirical Literature

Studies were found through extensive searches of PsychInfo and PubMed using the following key words for dissociation: "dissociation" "peritraumatic" "repression" "dissociative encoding"; for memory organization: "memory", "narrative", "fragmentation", "organization", "disorganization", "coherence" "narrative recall", "perceptual memory", "sensory memory"; and for trauma exposure: "trauma", "criterion A event", "sexual assault", "motor vehicle accident", "disaster", "torture", "crime", "combat", "childhood abuse." To ensure a comprehensive search, reference lists of relevant articles were also searched. Studies that explored dissociation, memory organization (meta-memory or narrative recounting), and trauma exposure (or an analogue) in adult samples were included. Studies with adolescents/children were excluded because memory processes, especially narrative memories, may be different in children (e.g., Kenardy et al., 2007; Pynoos, Steinberg, & Aronson, 1997), warranting a separate analysis. However, we did include adult samples reporting childhood trauma because fragmentation is hypothesized to be pervasive, and excluding based on trauma type would restrict conclusions. Using these procedures, we identified 20 articles. Four studies (Buck, Kindt, van den Hout, Steens, & Linders, 2006a; Geraerts et al., 2007; Halligan, Michael, Wilhem, Clark, & Ehlers, 2006; Porter & Birt, 2001) did not report direct relationships between dissociation and fragmentation and were excluded. Therefore, 16 studies were included in this review. Table 1 presents study characteristics.

In addressing whether dissociation is associated with fragmentation, we ask two specific questions. First, given that peritraumatic dissociation may result in memory fragmentation, we examined whether there is an association between peritraumatic dissociation and fragmentation. Second, we examined whether there was an association between trait dissociation and fragmentation. Table 2 presents a summary of findings. Studies are listed by the type of design, cross-sectional, prospective, and analogue, and an effect size (*r*) for the relationship between fragmentation (meta-memory, objective/rater coded) and dissociation (peritraumatic, trait) is presented. Studies that assess multiple constructs are included in more than one section. Studies with trauma-exposed samples, multiple measures, and prospective analyses will be discussed first followed by cross-sectional and analogue studies. When discussing strengths of association, we will use terminology consistent with

Cohen (1988, 1992), where *r* = .1 reflects a weak, .3 a moderate, and .5 or higher a strong association.

Peritraumatic Dissociation and Meta-Memory Fragmentation

We first review studies examining peritraumatic dissociation and meta-memory fragmentation followed by studies examining peritraumatic dissociation and coded or objective fragmentation. Seven studies have investigated peritraumatic dissociation and meta-memory fragmentation (Buck, Kindt, & van den Hout, 2005b; Engelhard, van den Hout, Kindt, Arntz, & Schouten, 2003; Halligan et al., 2003; Hardy, Young, & Holmes, 2009; Kindt & van den Hout, 2003; Kindt, van den Hout, & Buck, 2005; Murray et al., 2002).

In one of three studies that use Criterion A trauma-exposed samples, Halligan and colleagues (2003) examined a moderate-sized cross-sectional sample (*n* = 81) with current PTSD, recovered PTSD, or no PTSD and a moderate-sized prospective sample (*n* = 73) at initial, three-month, and six-months post trauma, both comprised of assault survivors. In the cross-sectional analyses, individuals reporting higher peritraumatic dissociation on the State Dissociation Questionnaire (SDQ) also reported higher meta-memory disorganization on the five-item Trauma Memory Questionnaire (TMQ; Halligan, Clark, & Ehlers, 2002). Prospectively, higher peritraumatic dissociation predicted higher disorganization assessed six months after assault. Although it is not the focus here, it is interesting to note that in the prospective study although those with PTSD reported higher disorganization compared to those without PTSD, individuals with PTSD had similar disorganization to those who recovered from PTSD. Similarly, in the cross-sectional findings, higher disorganization at initial and six month time points moderately predicted higher PTSD at six months, but change in disorganization did not predict symptom change. Taken together, higher peritraumatic dissociation was moderately associated with meta-memory disorganization; however, these results cast doubt on disorganization as a mechanism of PTSD development.

Murray and colleagues (2002) conducted a prospective analysis using two samples of motor vehicle accident (MVA) survivors, a small inpatient (*n* = 27) and a large outpatient (*n* = 176) sample. Consistent with the findings of Halligan et al. (2003), individuals in the outpatient sample who reported higher peritraumatic dissociation on the SDQ also reported moderately higher single item meta-memory fragmentation ("Are your memories of the accident in any way unclear or jumbled?") immediately after trauma. In the inpatient sample, relationships between meta-memory fragmentation, coded fragmentation and peritraumatic dissociation were not reported, even though they were assessed. Meta-memory fragmentation assessed soon after trauma modestly predicted PTSD at four weeks and six months following trauma in both samples.

In a third trauma-exposed sample, Hardy et al. (2009) investigated the relationship between peritraumatic dissociation and meta-memory fragmentation in a small sample of 22 individuals who reported a sexual assault to police within the previous 18 months. Self reports of peritraumatic dissociation, assessed using the Peritraumatic Dissociative Experiences Questionnaire (PDEQ; Marmar et al., 1997), were moderately to highly positively associated with two single items of meta-memory fragmentation, assessing "fragmented pieces" and "account incoherence".

Taken together results of Halligan et al. (2003), Murray et al. (2002), and Hardy et al. (2009) generally suggest that, in Criterion A trauma-exposed samples, individuals with higher peritraumatic dissociation consistently show higher meta-memory ratings of fragmentation.

In addition to clear Criterion A events, studying more common, potentially lower severity stressors can allow for broader sampling and assessments pre-trauma exposure. However, it should be noted that these analogue events may fail to capture the full range of emotional and physiological fear responses that accompany personally experienced life threatening events. Engelhard and colleagues (2003) prospectively investigated a large sample of women ($n = 118$) before and after pregnancy loss. Meta-memory fragmentation was measured at one-month post loss, and at this time point retrospective report of higher peritraumatic dissociation on the PDEQ was associated with higher meta-memory fragmentation and greater sensory elements, assessed with two single-item ratings, at a weak to moderate level. Meta-memory fragmentation at one-month post loss mediated the relationship between peritraumatic dissociation and PTSD severity at one month, but not four months, post pregnancy loss. Overall, this study further confirms a positive moderate association between peritraumatic dissociation and meta-memory fragmentation.

When studying actual traumatic events the encoding of the event cannot be controlled, which introduces potential bias such as environmental factors impacting encoding (e.g., attention, brain injury, substance use) and unstandardized event recall (e.g., disclosure of the event to other people). Analogue studies can more tightly control encoding and retrieval and may help examine the relationship between dissociative encoding and memory fragmentation, although by their very nature cannot capture the personal threat seen in DSM Criterion A events. Kindt and colleagues conducted three analogue studies (Kindt & van den Hout, 2003; Kindt et al., 2005) using a single-item rating of meta-memory fragmentation for an aversive film. Translated from Dutch, the fragmentation item in these studies specifically assessed "How much does your memory of the film exist of loosely related pieces or images?", the same assessment previously used by Englehard et al. (2003; M. Kindt, personal communication, November 16, 2011). Participants rated responses on a 100-mm VAS, with 0 corresponding to no fragmentation and 100 to a lot of fragmentation of their recollection. In the first study ($n = 40$), participants who reported higher peritraumatic dissociation, using the PDEQ, during the film also tended to report, at a moderate level, a higher fragmentation quality to their film memory (Kindt & van den Hout, 2003). In two replication studies (Kindt et al., 2005, Study 1, $N = 50$; Study 2, $N = 50$) with the same film used by Kindt and van den Hout (2003), individuals reporting higher peritraumatic dissociation during the film also reported higher fragmentation of their memory perception of the film immediately after (Study 1) and also one-week later (Study 2). Taken together, these studies support the notion that higher peritraumatic dissociation is related to higher fragmentation, when assessed as loosely related elements in the memory, using a one-item index.

The last analogue study examining peritraumatic dissociation and meta-memory used an *in vivo* exposure session as an analogue traumatic event, a potentially closer proxy for trauma than a film. Buck and colleagues (2006b) investigated 34 individuals with spider phobia and found that those with greater peritraumatic dissociation (PDEQ) during an *in vivo* session reported greater fragmentation in the memory for the experience at a moderate level. Similar to the above analogue studies (Kindt & van den Hout, 2003; Kindt et al., 2005), this study is limited by the same single-item measure and again suggests that when assessed with analogue designs that greater peritraumatic dissociation is related to greater meta-memory fragmentation.

Summary—Across studies, individuals reporting higher peritraumatic dissociation reported higher meta-memory fragmentation. Of seven studies (Buck et al., 2005b; Engelhard et al., 2003; Halligan et al., 2003; Hardy et al., 2009; Kindt & van den Hout, 2003; Kindt et al., 2005; Murray et al., 2002) only one prospective study (Engelhard et al., 2003) did not produce consistent positive relationships, instead showing mixed results. All

four investigations in trauma-exposed samples showed some relationship. Similarly, all three analogue studies, using a single item measure (Buck et al., 2006b; Kindt & van den Hout, 2003; Kindt et al., 2005), also suggest an association between peritraumatic dissociation and meta-memory fragmentation. Thus, the vast majority of studies show a link between peritraumatic dissociation and meta-memory fragmentation, including three studies that used Criterion A samples and three analogue studies, consistently showing a positive moderate association.

Peritraumatic Dissociation and Rater-based or Objective Indices of Fragmentation

Nine investigations, to date, have assessed peritraumatic dissociation and rater or objectively coded fragmentation (Buck et al., 2006b; Kindt & van den Hout, 2003; Kindt et al., 2005; Halligan et al., 2003; Harvey & Bryant, 1999; Jones, Harvey, & Bryant, 2007; Moulds & Bryant, 2005; Murray et al., 2002; Zoellner, Alvarez-Conrad, & Foa, 2002).

Only two studies included both meta-memory and coded fragmentation (Halligan et al., 2003; Murray et al., 2002), allowing for direct comparisons between types of fragmentation. Consistent with meta-memory findings above, Halligan and colleagues (2003) found in their cross-sectional and prospective samples that individuals reporting higher peritraumatic dissociation had higher subjective rater-coded disorganization, using blind raters on both a single-item rating and multi-item coding. Similar to meta-memory, those with current and recovered PTSD only differed on coded disorganization from those with no PTSD. Prospectively, change in coded disorganization did not predict change in PTSD. The authors interpreted findings to suggest that higher peritraumatic dissociation relates similarly to higher meta-memory and coded disorganization.

Similar to Halligan et al. (2003), Murray et al. (2002) also included multiple measures of fragmentation. They used a single-rater item to code global fragmentation of narratives for their small inpatient sample. However, they did not report results on peritraumatic dissociation and coded fragmentation, although both were assessed. Interestingly, their global rating of narrative fragmentation at initial assessment was a stronger predictor of PTSD than coded fragmentation at both one and six months post trauma, at a moderate level. Taken together, only the Halligan et al. (2003) study suggests that peritraumatic dissociation is related to rater-coded fragmentation.

Although the two studies discussed above are the only ones to simultaneously investigate both meta-memory and coded fragmentation, two studies (Jones et al., 2007; Moulds & Bryant, 2005) prospectively investigated coded disorganization in clinical samples. Jones and colleagues (2007) conducted cross-sectional and prospective analyses of 131 men and women with and without ASD following MVA, utilizing objective (LIWC sensory and emotion) and rater coding of disorganization (multi-item repetitions, non-consecutive chunks, confusion, and global incoherence). Given that ASD requires dissociation during or immediately after a trauma, comparing those with and without the diagnosis may be assessing peritraumatic dissociation, although it should be noted that the use of ASD is a proxy for peritraumatic dissociation and that it is possible to not meet ASD criteria and still report peritraumatic dissociation. In cross-sectional analyses, ASD and no ASD groups did not consistently differ on objective or rater-coded disorganization, with an exception for one of their six variables (global incoherence), immediately or six weeks post-trauma. However, at three months post-trauma individuals with PTSD showed more disorganization quantified by both subjective and objective coding than those without PTSD. Thus, the authors suggest that coded disorganization may be more associated with PTSD than with dissociation. In the prospective analyses, although disorganization at initial assessment predicted PTSD three months post-trauma, it did not predict over and above peritraumatic dissociation (i.e., ASD diagnosis). Furthermore, decreases in narrative disorganization were related to PTSD

recovery. Taken together, these findings question the association between peritraumatic dissociation and disorganization and in particular suggest that disorganization may be related more to PTSD than to dissociation.

Moulds and Bryant (2005) compared pre- and post- cognitive-behavioral treatment changes in subjectively coded narrative disorganization in a small sample ($n = 15$) immediately following MVA or non-sexual assault. At pre-treatment, dissociative content in the trauma narrative, a potential indicator of peritraumatic dissociation, did not correlate with any of the three ratings of disorganization, disjointedness, confusion, or repetition. In addition, there were no pre- to post-treatment differences for disorganization despite symptom decreases, suggesting that symptom changes were not associated with changes in disorganization. Interestingly, individuals showing increased organization over the course of treatment also showed less dissociative content at post-treatment, at a relatively high level. Thus, following treatment, individuals who recalled more organized memories also recalled less peritraumatic dissociation. The authors suggest that as trauma memories become more cohesive "individuals are less likely to employ dissociative mechanisms to account for amnesia for trauma details" (p. 13, Moulds & Bryant, 2005). This intriguing result also may support the notion that memory organization is confounded with peritraumatic dissociation, as it would be impossible to change actual peritraumatic dissociation, which by definition occurred pre-treatment. Thus, decreases in subjectively coded peritraumatic dissociation may be an artifact of the changes in coded narrative organization, and peritraumatic dissociation was not associated with fragmentation.

Looking at cross-sectional studies, two studies to date examined coded fragmentation using trauma-exposed samples (Harvey & Bryant, 1999; Zoellner et al., 2002). Harvey and Bryant (1999) compared a small sample of MVA survivors with ($n = 14$) and without ($n = 15$) ASD on the same subjective disorganization coding system used by Moulds and Bryant (2005), finding that individuals with ASD had more rater-coded disorganization than those without ASD. Consistently, individuals with higher disorganization ratings also reported higher ASD severity and specifically higher peritraumatic dissociation, at moderate levels. This study is strengthened by the inclusion of rater-coded dissociation in the narrative, and individuals with ASD evidenced higher peritraumatic dissociation in their narratives than those without, thus confirming that those with ASD recalled greater peritraumatic dissociation as expected of their diagnostic status.

Extending cross-sectional narrative analyses to a PTSD sample, Zoellner et al. (2002) conducted a study with 28 women diagnosed with chronic PTSD following assault, comparing those who reported either high or low peritraumatic dissociation, assessed with the PDEQ. Using both subjective and objective coding, narratives of individuals with high peritraumatic dissociation had more sensory components and lower reading ease than those low in peritraumatic dissociation; however, inconsistent with fragmentation, individuals with high peritraumatic dissociation recounted narratives with higher-grade levels and more negative emotions. In addition, indices of fragmentation were inconsistently related to PTSD. Although the authors suggest a possible link between peritraumatic dissociation and coded fragmentation, peritraumatic dissociation was not consistently related to coded fragmentation and the mixed pattern of results is inconclusive.

Analogue studies have also examined peritraumatic dissociation and objective or rater-coded fragmentation. In the three analogue studies described earlier (Kindt & van den Hout, 2003; Kindt et al., 2005), peritraumatic dissociation during film viewing was not significantly related to either performance on a sequential memory task (Kindt & van den Hout, 2003; Kindt et al., 2005) or to rater-coded narrative recall using a one-item rating (Kindt et al., 2005). Although the authors (Kindt & van den Hout, 2003) suggest the memory task may be

too limited in its assessment of chronological recall to capture fragmentation, the fact that both the sequential memory task and rater coding were not significantly associated with dissociation (e.g., Kindt et al., 2005) is accumulating evidence for a lack of strong relationship between objectively defined memory quality and dissociation. Similarly, Buck et al. (2006b), also described above, found no significant relationship between peritraumatic dissociation and rater-coded fragmentation in individuals with spider phobia, using the same one-item rating as Kindt et al. (2005). Thus, in analogue studies, peritraumatic dissociation was not significantly related to sequential memory performance (Kindt & van den Hout, 2003) or subjectively coded fragmentation (Buck et al., 2006b; Kindt et al., 2005). This is inconsistent with meta-memory for snapshot quality, suggesting that peritraumatic dissociation predicts perception of memory quality, but not recounting or memory performance, after an analogue traumatic event.

Summary—Overall, higher peritraumatic dissociation was inconsistently associated with rater-coded or objective fragmentation (Buck et al., 2006b; Jones et al., 2007; Kindt & van den Hout, 2003; Kindt et al., 2005; Moulds & Bryant, 2005; Zoellner et al., 2002), with only two studies out of seven finding consistent positive relationships (Halligan et al., 2003; Harvey & Bryant, 1999). Yet, it should be noted that the study by Halligan and colleagues is one of the most rigorous and comprehensive studies to date, and their results should be given considerable weight. However, this study needs replication, and the bulk of the studies are not consistent with their findings. Other clinical samples produced either mixed findings (Jones et al., 2007; Zoellner et al., 2002) or findings actually in the opposite direction (Moulds & Bryant, 2005; Murray et al., 2002). Further, the non-clinical, analogue studies (Buck et al., 2006; Kindt & van den Hout, 2003; Kindt et al., 2005) also show no significant relationship between peritraumatic dissociation and rater-assessed or objective narrative coding. Taken together, these finding suggest that peritraumatic dissociation is related to individuals' perception of their memories but is not consistently related to how others' perceive and rate these trauma memories or other more objective coding of these memories as fragmented.

Trait Dissociation and Meta-memory, Rater-based, or Objective Indices of Fragmentation

As discussed above, trait dissociation may be representative of persistent dissociation after a traumatic event, thus contributing to fragmented trauma memories. In this section, studies examining trait dissociation and meta-memory and rater-coded fragmentation will be reviewed. We are aware of no studies that have examined the association between trait dissociation and objectively-coded fragmentation.

Trait dissociation and meta-memory fragmentation—Eight studies (Byrne et al., 2001; Engelhard et al., 2003; Kindt & van den Hout, 2003; Kindt et al., 2005; Peace, Porter, & ten Brinke, 2008; Rubin et al., 2004; van der Hart, Bolt, & van der Kolk, 2005b; van der Kolk & Fisler, 1995) have examined trait dissociation and meta-memory fragmentation. Engelhard et al. (2003) examined trait dissociation pre-event, uniquely investigating it as a vulnerability factor, by using a community sample exposed to pregnancy loss. In their large sample, trait dissociation, assessed with a modified version of the PDEQ, was not significantly related to single item meta-memory fragmentation or sensory aspects. However, trait dissociation did moderately predict PTSD symptoms at one- and four-months post pregnancy loss. Thus, a general tendency to dissociate before the stressful event did not predict meta-memory fragmentation.

Although no other studies examined trait dissociation and meta-memory prospectively, two studies used cross-sectional designs. Rubin and colleagues (2004) examined post-trauma trait dissociation, using the Dissociative Experiences Questionnaire (DES; Bernstein &

Putnam, 1986), and meta-memory fragmentation, using a multi-item scale (Autobiographical Memory Questionnaire, AMQ), in 50 veterans with combat-related PTSD. Individuals with higher trait dissociation reported higher meta-memory for only one ("coming back in pieces") of the four fragmentation indices, at a moderate level. Trait dissociation was not significantly associated with sensory components, confusion about the setting, or incoherence of the story. In addition, higher meta-memory fragmentation was not consistently related to higher PTSD symptoms. This study suggests that higher trait dissociation post-trauma is not, for the most part, significantly related to higher meta-memory fragmentation of combat traumatic experiences.

In another study of meta-memory and trait dissociation in a PTSD sample, van der Kolk and Fisler (1995) explored meta-memory in 46 adults diagnosed with PTSD from childhood or adult trauma using a 60-item semi-structured interview (Traumatic Memory Inventory; TMI) designed by the authors to assess memory retrieval through sensory modalities (e.g., images, sounds) or as a narrative story. Qualitatively, all individuals retrospectively reported initially remembering their trauma as an incoherent representation lacking structure and dominated by sensory elements, based on one item of memory quality and several sensory items. At the time of interview, only 11% of participants reported a continued lack of structure to their memory, but most participants still reported a memory dominated by sensory elements. Reports of more post-trauma trait dissociation on the DES were strongly related to the one-item report of a lack of narrative memory for the trauma. The relationship between meta-memory and PTSD was not reported. In contrast to Rubin et al. (2004), this study suggests that a tendency to dissociate after a traumatic event is related to perceptions that the trauma memory lacks narrative structure, although this is based on a single-item qualitative assessment of narrative quality.

In a second investigation also using the TMI to assess meta-memory fragmentation, van der Hart, Bolt, and van der Kolk (2005) investigated a sample of 30 individuals referred by treatment providers for having a diagnosis of dissociative identity disorder (DID) and a history of childhood abuse. Thus, this study used a traumatized sample that by definition has high trait dissociation. All individuals reported initial inability to recall the event story and over half (53%) continued to report a lack of narrative memory at the interview. However, trait dissociation, assessed by the DES, was not significantly correlated with self-reported memory loss, suggesting that severity of trait dissociation was not strongly associated with perceived memory quality. Moreover, individuals with DID recalled non-traumatic memories similarly to traumatic memories. The authors concluded that individuals with DID have difficulty constructing and integrating all memories. This investigation suggests that although the majority of individuals with DID reported a lack of narrative memory, high trait dissociation was not specifically related to fragmented meta-memory and memory disturbance may not be unique to traumatic events, at least in a severe clinical sample.

In a trauma-exposed treatment-seeking sample of 44 adult women with childhood or adult sexual assault, Peace and colleagues (2008) investigated meta-memory fragmentation using the Emotional Memory Survey (EMS), a multi-item self-report measure assessing vividness, quality, sensory elements, repression, and emotional intensity. Participants provided meta-memory ratings for both a sexual and non-sexual trauma. For the sexual traumatic experience, higher trait dissociation, as assessed by the DES, was significantly associated with more reported emotion and memory repression, and less reported memory quality, at a moderate to strong level. For the non-sexual traumatic experience, individuals reporting higher trait dissociation were significantly more likely to report less memory vividness at a moderate level; however, inconsistent with meta-memory findings for sexual traumatic events, associations between trait dissociation and emotion were not significant, and associations between trait dissociation and repression or memory quality were not reported.

For both sexual and non-sexual experiences sensory aspects were also not reported. Furthermore, meta-memory for emotional intensity (sexual and non-sexual events), memory quality (sexual events only) and memory vividness (non-sexual events only) were strongly positively associated with PTSD, assessed with a self-report measure, while the sensory components were again not reported. Overall, the mixed pattern of results for this study and the lack of reported findings make it difficult to draw strong conclusions; but, in general, the pattern of findings does not suggest a consistent relationship between meta-memory fragmentation and trait dissociation.

Moving away from clinical samples, Byrne, Hyman, and Scott (2001) assessed meta-memory and trait dissociation, using an undergraduate sample where the majority reported a potentially traumatic event (77 of 113 participants; 68%). Individuals in this subsample completed the multi-item meta-memory fragmentation measure (MCQ) discussed above. Trait dissociation, assessed with the DES, was not significantly associated with fragmentation indices on this measure. Further, higher fragmentation on this meta-memory measure, indicated by higher reports of sensory elements and lower reports of clarity, structure, and coherence, was not significantly associated with higher PTSD symptoms. Overall, in a sample with varied trauma exposure, trait dissociation assessed post-event was not meaningfully associated with meta-memory fragmentation.

The analogue studies reviewed above (Kindt & van den Hout, 2003; Kindt et al., 2005) also assessed trait dissociation and meta-memory for fragmentation of a stressful film. In two of the three studies higher fragmentation was not significantly associated with higher trait dissociation (DES). In contrast, in the third study (Kindt et al., 2005), higher fragmentation ratings tended to be related to higher trait dissociation at a moderate level, and in follow-up analyses trait dissociation only marginally accounted for the previously discussed positive relationship between meta-memory and peritraumatic dissociation. Thus, trait dissociation was not significantly related to meta-memory fragmentation in these analogue studies.

Overall, in contrast to findings for peritraumatic dissociation, individuals with higher trait dissociation do not consistently report higher meta-memory fragmentation (Byrne et al., 2001; Engelhard et al., 2003; Kindt & van den Hout, 2003; Kindt et al., 2005; Peace et al., 2008; Rubin et al., 2004; van der Hart et al., 2005). Only one study (van der Kolk & Fisler, 1995) reported higher trait dissociation as consistently related to higher meta-memory fragmentation. The one study that investigated trait dissociation as a mechanism of meta-memory fragmentation by assessing it pre-trauma (Engelhard et al., 2003) found no significant relationship. Thus, a general tendency to dissociate may not be related to perceptions of traumatic events as fragmented.

Trait dissociation and rater-based indices of fragmentation—To our knowledge, only one study (Peace et al., 2008) included trait dissociation and rater-coded fragmentation. In the same sample as above, Peace et al. investigated rater-coded fragmentation, using the memory assessment procedure (MAP) which uses trained raters to assess coherence, detail, and emotion in written narratives. In contrast to the meta-memory findings, associations between rater-coded indices and trait dissociation (DES) were not reported. Similarly, relationships for rater-coded fragmentation and PTSD symptoms were not reported. Thus, it remains unclear if trait dissociation is related to either higher rater-defined narrative fragmentation or PTSD.

Summary—Higher trait dissociation was not reliably associated with higher meta-memory fragmentation in most studies (Byrne et al., 2001; Engelhard et al., 2003; Kindt & van den Hout, 2003; Kindt et al., 2005; Peace et al., 2008; Rubin et al., 2004). Only one study found consistent positive relationships (van der Kolk & Fisler, 1995), while four studies, three with

clinical samples, produced mixed findings (Kindt et al., 2005; Peace et al., 2008; Rubin et al., 2004; van der Hart et al., 2005) and three studies produced no significant findings or findings opposite to prediction (Byrne et al., 2001; Engelhard et al., 2003; Kindt & van den Hout, 2003). Further, the one study (Peace et al., 2008) that looked at trait dissociation and subjective rater-coded fragmentation did not report associations.

Summary and Discussion of Empirical Findings

Overall, although reports of peritraumatic dissociation appear to be associated with perceptions of fragmentation, it was not consistently associated with rater or objectively-coded fragmentation. In addition, trait dissociation was not consistently associated with meta-memory fragmentation. There is a notable lack of studies looking at trait dissociation and rater or objective fragmentation measures. Potential explanations for these findings are reviewed below.

Dissociation and Fragmentation: Measurement

Meta-memory versus rater-based or objective indices of fragmentation— Diverse approaches to fragmentation measurement, such as meta-memory versus coding, may account for discrepant findings. Specifically, meta-memory assesses perception (Schwartz, Benjamin, & Bjork, 1997), rather than actual memory. It is an individual's own judgment about the quality of the memory and thus may be biased by familiarity of cues, related information, and past recall of experiences (e.g., Schwartz et al., 1997). Given that much of the evidence for an association between peritraumatic dissociation and fragmentation was seen in meta-memory, dissociation during trauma may be contributing more to perception of disorganization rather than actual disorganization. Dissociative experiences during trauma may be intricately linked to the perception that the event memory is difficult to comprehend and thus perceived as fragmented.

Another issue potentially underlying the association between peritraumatic dissociation and meta-memory fragmentation may be measurement overlap. Many measures of dissociation and fragmentation contain similar items. For example, statements on the PDEQ (Marmar et al., 1997) assess confusion (e.g., "I felt confused; that is, there were moments when I had difficulty making sense of what was happening."). Similarly, typical meta-memory fragmentation items (e.g., "Are your memories of the event in any way unclear or jumbled?" Murray et al., 2002) also assess confusion. Thus, relationships between these two constructs may be elevated due to overlap, not necessarily reflecting the impact of peritraumatic dissociation on trauma memory fragmentation. This may also help account for the failure to find a consistent relationship with more objective indices of fragmentation and between trait dissociation and meta-memory.

Global versus specific fragmentation measurement— Another issue to consider is the variability among measures of fragmentation, both meta-memory and narrative coding. Some studies use one-item global assessments of fragmentation (Buck et al., 2006b; Kindt & van den Hout, 2003; Kindt et al., 2005; Engelhard et al., 2003; Halligan et al., 2003; Hardy et al., 2009; Murray et al., 2002; van der Hart et al., 2005; van der Kolk & Fisler, 1995); whereas others use multi-item scales (Byrne et al., 2001; Halligan et al., 2003; Harvey & Bryant, 1999; Jones et al., 2007; Peace et al., 2008; Rubin et al., 2004; Zoellner et al., 2002). One-item assessments were more likely to show positive associations with dissociation (positive association: Buck et al., 2006b; Kindt & van den Hout, 2003; Kindt et al., 2005; Engelhard et al., 2003; Halligan et al., 2003; Hardy et al., 2009; Murray et al., 2002; van der Kolk & Fisler, 1995; van der Hart et al., 2005) than multi-item scales (no strong association: Byrne et al., 2001; Jones et al., 2007; Peace et al., 2008; Rubin et al., 2004; Zoellner et al., 2002). Single-items do not allow for mixed responses about memory quality, such as more

chronological confusion but clearer memory of some details. It could be that, when thinking globally about the trauma memory, respondents identify it as fragmented; but, when thinking about specific aspects, they notice more variability. A further disadvantage of one-item scales is a tendency to be unstable and vulnerable to random response error (e.g., Nunnally & Bernstein, 1994; Schmidt, Le, & Ilies, 2003). Thus, one-item assessments may be over estimating fragmentation. Given that some of the strongest evidence between dissociation and fragmentation comes from single-item measures, the association should be interpreted cautiously. These measures have potential utility, but conclusions drawn using these items may be best restricted to the global construct of fragmentation.

Interestingly, when operationalizing fragmentation as a construct comprised of specific tangible elements (e.g., repetitions, sensory aspects), whether rated by meta-memory, rater-based coding, or objective performance based indices, relationships between higher dissociation and fragmentation were illusive (e.g., Byrne et al., 2001; Kindt et al., 2005; Peace et al., 2008; Rubin et al., 2004; Zoellner et al., 2002). As mentioned above, perhaps fragmentation is most easily detected with global impressions. The problem with this is that an inability to precisely measure fragmentation results in it being inadequately defined; a "know it when you see it" phenomenon. Anecdotally, fragmentation is commonly reported in clinical observations (van der Kolk & van der Hart, 1989), however if fragmentation is indeed a ubiquitous experience after trauma, it is surprising that we would be able to *not* capture it when objectively assessing memory quality. It should also be noted that while this review looked at only studies that included dissociation and fragmentation measures, other reviews that have looked more broadly at fragmentation and PTSD have also failed to find overwhelming evidence for a crucial role of fragmentation in PTSD (e.g., O'Kearney & Perrott, 2006; Zoellner & Bittinger, 2004). These inconsistent relationships with specific fragmentation indices suggest that it either may not be as robust as clinical observation would suggest or that we have not yet devised a multiple-item assessment method that truly captures the clinical phenomenon of fragmentation. For example, to date, no studies have looked at trauma narratives in terms of their degree of integration into an individuals' overall autobiographical memory. As suggested by Ehlers and colleagues (2004) a lack of self-referent processing, specifically a failure to process experiences in regards to both one's self and to other autobiographical information, may be one of the key defining features of insufficiently processed trauma narratives. Our current assessments of fragmentation would not capture this feature of trauma narratives, which is assessed with self-reported aspects of how much the experience is incorporated into the context of both the self and of other autobiographical experiences (e.g., "I felt as if it was happening to someone else, I felt cut off from my past" pg. 421; Halligan et al., 2003).

Dissociation: Measurement issues—A variety of measures exist for dissociation, and there is not a "gold-standard" (Bryant, 2007; Foa & Hearst-Ikeda, 1996). In the studies reviewed here, three measures were used for peritraumatic dissociation: the PDEQ (Marmar et al., 1997), the State Dissociation Questionnaire (SDQ; Murray et al., 2002), and the Acute Stress Disorder Inventory (ASDI; Bryant, Harvey, Dang, & Sackville, 1998). As discussed, questions from the PDEQ overlap with fragmentation, potentially confusing constructs. The SDQ, although used in several studies, lacks published reliability or validity information. Finally, the ASDI is a measure of ASD and may be confounding peritraumatic and continued dissociation (Bryant, 2007).

In regard to trait dissociation, the DES (Bernstein & Putnam, 1986) is commonly used in traumatized samples and was used in the large majority of studies in this review that included trait dissociation (8 out of 12). However, the DES does not assess emotional numbing or avoidance (Foa & Hearst-Ikeda, 1996), omitting key constructs that are positively associated with dissociation and PTSD (Foa & Hearst-Ikeda, 1996; Foa & Riggs,

1993; Foa, Riggs, & Gershuny, 1995). Emotional numbing is often considered a key symptom of dissociation (e.g., Bryant, 2007; Foa & Hearst-Ikeda, 1996). Further, avoidance is thought to be associated with dissociation, as dissociation may help avoid painful memories and emotions (e.g., Foa & Hearst-Ikeda, 1996; Foa & Riggs, 1993; van der Kolk et al., 1996; Wagner & Linehan, 1998). Accordingly, both numbing and avoidance of the trauma memory may be related to it being poorly elaborated and processed (Foa & Riggs, 1993) and sole usage of the DES may miss particularly relevant dissociative constructs.

Chronology of assessment for dissociation—A failure to conceptualize trait, state, and peritraumatic dissociation as distinct, yet related, constructs may further be complicating conclusions on dissociation and fragmentation. Specifically, trait dissociation may be a vulnerability factor for peritraumatic dissociation (Kihlstrom et al., 1994), potentially mediating the relationship between peritraumatic dissociation and fragmentation; however, as evidenced by the studies reviewed above, the literature is based almost solely on assessments of dissociation following trauma exposure and not dissociation before trauma. The one exception, a prospective study of pregnancy loss (Engelhard et al., 2003), interestingly, found no significant relationship between trait dissociation and meta-memory fragmentation and only modest correlations between pre-event trait dissociation, peritraumatic dissociation, and PTSD symptoms.

Trait dissociation implies persistent post-trauma dissociation in that a higher general tendency to dissociate may indicate an increased likelihood to dissociate following a traumatic event and may contribute to higher memory fragmentation (e.g., Bryant, 2007; Ehlers & Clark, 2000). Dissociation in response to trauma reminders may be a stronger predictor of PTSD than either dissociation during the trauma (i.e., peritraumatic dissociation) or a general tendency to dissociate (i.e., trait dissociation; e.g., Briere et al., 2005) and may influence fragmentation by interfering with event recall. However, most studies did not show significant relationships between general trait dissociation and fragmentation (Byrne et al., 2001; Engelhard et al., 2003; Kindt & van den Hout, 2003; Kindt et al., 2005; Peace et al., 2008; Rubin et al., 2004), suggesting that either persistent dissociation is not meaningfully related to increased fragmentation or that trait dissociation measures are not capturing this reminder-cued dissociation. Conceptually, persistent dissociation may best be assessed as a tendency to dissociate in response to specific situations. Specifically, administering state dissociation measures during trauma-related tasks may better target this form of dissociation but has not been utilized in the literature to date.

Dissociation and Fragmentation: Abnormal versus Normal Processes

Dissociation may not be a universally maladaptive strategy. Thus, it may make sense that it does not consistently relate to fragmented memory. Dissociation is a ubiquitous and normative phenomenon, occurring in well-adjusted, healthy individuals as well as trauma survivors (e.g., Bernstein & Putnam, 1986; Kihlstrom et al., 1994; Bryant, 2007). Investigations of specificity and sensitivity find that, although dissociation is commonly reported in survivors of trauma, it is not necessary for the development of PTSD (Briere, 2006; Holen, 1993; Marshall & Schell, 2002). Furthermore, dissociation is reported after both aversive and pleasant events (Candel & Merckelbach, 2004), casting doubt on dissociation as unique to trauma. Indeed, contrary to some of the theories above, dissociation during or after a trauma may be adaptive.

To elaborate, dissociation during a trauma may help protect against encoding threatening, aversive memories (e.g., Horowitz, 1986) and may reduce distress and physiological arousal, although support for this hypothesis is inconsistent (Bryant, Harvey, Guthrie, &

Moulds, 2000; Fikretoglu et al., 2006; Griffin, Resick, & Mechanic, 1997; Kaufman et al., 2002; Nixon & Bryant, 2005). Distress or arousal during memory encoding has been posited to affect memory fragmentation (e.g., Shobe & Kihlstrom, 1997). Consistent with this, Zoellner and colleagues (2002) found increased distress during narrative recall to be associated with increased fragmentation. Indeed, it has been suggested that fragmentation may be an epiphenomenon resulting from increased distress during recall (Zoellner & Bittinger, 2004), where content and style that is considered typical of fragmentation (e.g., speech fillers, disorganization) is indicative of high anxiety while recounting the memory and not of actual poor memory quality. This has important implications for the relationships between both state and trait dissociation and fragmentation. In cases where dissociation during recall (state) decreases distress, we might expect lower fragmentation; whereas, in cases where dissociation does not decrease distress, it may result in either higher meta-memory fragmentation or narratives that look fragmented when recalled (e.g., contains uhs, ums, confusion), but may not actually be fragmented. This could explain conflicting findings between meta-memory and objective coding measures, with distress or arousal associated with state dissociation more directly impacting narrative recounting than self-reports of memory quality.

Similarly, fragmentation may not be abnormal. It is widely accepted that, during emotional events, memory for central details is enhanced though memory for peripheral details is impaired (see Christianson, 1992). As noted by Brewin (2007), assessment of central versus peripheral details in traumatic events, which are often complex and prolonged, is challenging. Defining what aspects of an event are expected to be recalled clearly versus those that will be more difficult to retrieve is idiographic. Furthermore, the reconstructive, changing nature of memory (e.g., Schacter, 1996) challenges the notion that fragmentation is unique to trauma, as it is expected that all memories will be recounted with varying detail and coherence over time (McNally, 2005). Indeed, fragmentation in trauma and comparison narratives often looks similar (e.g., Byrne et al., 2001; Porter & Birt, 2001; Rubin et al., 2004). Thus, it may not be necessary to posit dissociation as explanatory for fragmentation, as some degree of fragmentation is an expected, normal phenomenon.

Dissociation and Fragmentation: Additional related constructs

If dissociation and fragmentation are indirectly associated through related factors, then it may be these third variables that explain observed relationships. A parsimonious explanation might be that both are better accounted for by a third factor, such as arousal, time since trauma, disclosure, cognitive ability, or data driven processing (Briere, 2006; Bryant, 2007; Ehlers & Clark, 2000; Zoellner & Bittinger, 2004). Dissociation may be more of a consequence than a cause, related to high levels of arousal during trauma (Krystal, Woods, Hill, & Charney, 1991; Marmar et al., 1997). Indeed, the relationship between peritraumatic dissociation and chronic PTSD may be mediated by factors related to arousal such as fears of death and loss of control (Gershuny, Cloitre, & Otto, 2003) or initial symptom severity (Marshall & Schell, 2002; Marx & Sloan, 2005).

Related, time since trauma may be an important, often unaddressed factor. Memories change over time (e.g., Hepp et al., 2006; Southwick et al., 1997; Zoellner et al., 2001) and time since the trauma may degrade memory traces (e.g., McNally, 2005), resulting in recounting that appears fragmented. Dissociation is often assessed retrospectively, and several factors can affect accuracy including forgetting, attribution, and malingering (Candel & Merckelbach, 2004). Specifically, reports of dissociation may be a function of current symptoms (Southwick et al., 1997; Harvey & Bryant, 2000; Zoellner et al., 2001). Furthermore, self-report measures often assess dissociation that occurred months or years earlier, and retrospective reporting of trauma reactions are often inaccurate (e.g., Bryant,

2007). Thus, current functioning or the mere passage of time may be a more parsimonious explanation for higher fragmentation and dissociation.

Similarly, differences in general verbal ability may be confounded with both dissociation and fragmentation. At least one measure of trait dissociation (i.e., DES) has been shown to be related to intelligence, with greater dissocation being associated with lower intelligence (Freuh et al., 1996). In addition, individuals with less verbal ability may perceive or recount narratives in a way that seems fragmented but instead reflects low verbal ability. Gray and Lombardo (2001) showed that findings of greater fragmentation for trauma narratives of individuals with PTSD disappeared when controlling for this using a vocabulary task, suggesting that fragmentation may be an artifact of lower verbal ability. In addition, verbal processing is directly related to developmental stage (e.g., Kenardy et al., 2007; Pynoos, Steinberg, & Aronson, 1997). This is important in the context of fragmenation in that children who experience traumatic events are more likely to omit emotional elements of the experience as well as distort the chronology and time of events, due to under-developed memory systems (e.g., Pynoos et al., 1997). It is interesting to note that only two studies in this review looked specifically at childhood abuse (Peace et al., 2008; van der Hart et al., 2005) and both failed to find consistent significant relationships between trait dissociation and memory fragmentation. Peace and colleagues (2008) also looked at differences in memory quality for childhood and adult traumatic events and again found few consistent differences with the exception of less coherence and more repression association with childhood events. However, this is only one single investigation and they did not report on differences in dissociation for adult versus childhood trauma, which would be important to ascertain the role of development to memory quality and reports of dissociation. Related, it should be noted that none of the studies reviewed here looked at pre-existing memory impairments, head injuries, or medication use factors that might relate to both memory processing and dissociation. For example, benzodiazapines, a class of medications often used by individuals with PTSD, inhibit memory encoding when taken during an event but also paradoxically facilitate memory of traumatic events when taken during recall (e.g., Krystal, Bremner, Southwick, & Charney, 1998), suggesting that they could either increase or decrease fragmentation depending on context of use.

Finally, data-driven processing may also explain potential memory fragmentation, without evoking the construct of dissociation. Specifically, in Ehlers and Clark's (2000) cognitive processing model, data-driven processing, or a focus on sensory impressions during the event (Roediger, 1990), although similar to dissociation, stresses surface level perceptual processing as opposed to the altered perceptions, derealization, and depersonalization characteristic of dissociation. Indeed, there is overlap in many items on dissociation measures, such as the SDQ that was used in numerous studies reviewed here, and the construct of data-driving processing. Thus, it may not be dissociation specifically that is related to memory fragmentation. Similarly, other individual and environmental factors, such as a lack of meaning, increased mental defeat, or a lack of self-reference, may contribute to fragmentation to the extent that they interfere with incorporating the memory trace into the overall autobiographical memory store (Ehlers et al., 2004). These factors, which stress both encoding during an event and processing following an event, have been posited to explain the existence of both intrusions and fragmented memory in PTSD (Ehlers et al., 2004). These constructs may not be captured in the investigations reviewed here as many current measures of dissociation do not specifically assess them. Thus, similar to distress, time, and cognitive ability, the use of data-driven processing strategies may help account for both higher dissociation and fragmentation, suggesting that these important variables need to be carefully addressed in future studies.

Theoretical and Clinical Implications

As discussed, dissociation and memory fragmentation figure prominently into several current theories of PTSD (e.g., Brewin, 2001; Ehlers & Clark, 2000; Foa, 1997; van der Kolk, 1987). It is imperative that clinicians and researchers are aware of the empirical evidence supporting or contradicting these theories, as it guides treatment emphases. If, as suggested by some fragmentation-focused theories (e.g., Brewin, 2001; van der Kolk,1987), trauma memories are represented differently than other types of memories due to dissociative encoding then we might expect more robust findings regarding dissociation and fragmentation across measures and constructs. However, across studies the most consistent pattern is one showing a positive relationship between dissociation and the *perception* of fragmentation. This suggests that the focus should potentially be on beliefs about memory instead of actual memory quality. For example, Ehlers and Clark's (2000) cognitive processing model posits processes, such as avoidance and interpretations of the event, to account for unelaborated trauma memories and PTSD, and may provide a more parsimonious view of post-trauma psychological processes, and shift emphasis to beliefs and perceptions.

Regardless, theories arguing for a central role of dissociative encoding in producing fragmented trauma memories need to be more tentative in positing this as a hypothesized cause. It appears that dissociation during a traumatic event is more associated with increased meta-memory fragmentation in the trauma memory, suggesting a link between dissociative encoding and perception of memory quality. Theories can easily incorporate ideas of how and why perception of traumatic events may arise, both beliefs about peritraumatic dissociation and the nature of memory fragmentation. That is, why do individuals believe what they do about trauma memories? The finding that individuals who recall feeling disconnected during the traumatic experience also tend to recall the memory as more fragmented suggests that for some trauma survivors peritraumatic emotional reactions, such as dissociation, may function as avoidance and lead to a perception that the memory is unclear and difficult to recall. Clinically, this may be incredibly important in helping individuals approach the trauma memory to make sense of the experience.

Given the lack of strong consistent associations with more objective indicators of fragmentation, dissociation may be most clinically relevant to the extent that it functions as avoidance (e.g., Foa & Hearst-Ikeda, 1996; Wagner & Linehan, 1998). In other words, dissociation may serve the individual as an emotion regulation strategy that helps them avoid trauma-related thoughts and emotions as opposed to a process that contributes specifically to the quality of the trauma memory. From this perspective, dissociation is similar to other forms of cognitive and behavioral avoidance, and therapeutic techniques used to target trauma-related avoidance may be applicable to dissociation. This does not minimize the impact of dissociative reactions or that many clinicians are weary of highly dissociative presentations. Rather, it suggests that dissociation may be best conceptualized as one of many avoidant processes at play. In terms of clinical application, targeting dissociation may be similar, albeit particularly challenging, to intervening with other intentional and unintentional avoidance behaviors in PTSD, such as thought suppression and active behavioral avoidance of trauma reminders.

Concluding Comments and Future Directions

In this emerging literature, the associations between peritraumatic dissociation and meta-memory fragmentation were the most consistent; those who reported dissociating during the trauma also reported perceiving their traumatic memories as more fragmented. In contrast, when using objective measures of fragmentation, largely equivocal findings emerged.

Considering the importance placed on these mechanisms in our current conceptualization of PTSD, additional empirical investigation is needed to determine mechanisms underlying how traumatic events are encoded and processed and how these factors relate to the development of chronic PTSD.

More rigorous designs and precise definitions would greatly improve current understanding. First, comparison groups, both healthy control and other psychopathology, and comparison events, including varying emotional valence, are necessary to investigate dissociation and fragmentation. Second, prospective and experimental studies that allow for better systematic examination of pre-event and event processing and studies that more precisely and consistently define relevant constructs are needed. Incorporating multiple measures of each construct would clarify important mechanisms of the disorder, by allowing for further examination of measurement and construct overlap, controlling for measure limitations, and by looking for replications across measurement type (e.g., meta-memory and objective fragmentation). Specifically, delineating different types of dissociation and fragmentation would help investigators more clearly understand differences between peritraumatic and persistent dissociation and meta-memory and actual fragmentation. Finally, studies should incorporate factors that may potentially influence dissociation and fragmentation such as distress, arousal, time, and cognitive ability. The majority of current studies exclude these potential influences. This is problematic as it may be resulting in an incomplete picture of theorized mechanisms. Overall, given the emphasis on memory processing as important to PTSD development, maintenance, and recovery it is crucial that we understand potential mechanisms that may contribute to incomplete or maladaptive trauma memories to further understand reactions to trauma exposure and to continue to establish effective PTSD prevention and intervention efforts.

In particular, research exploring persistent dissociation is currently lacking in the literature and is needed to further our understanding of memory fragmentation. Better understanding of continued dissociation, specifically in response to trauma-related cues and emotions, would help tease apart dissociation and both perception and presence of memory fragmentation. As continued dissociation is an area where clinicians are able to intervene it is a potentially important process to understand in order to improve prevention and treatment strategies.

Overall, the results of this review did not find consistent relationships between memory fragmentation and dissociation, with the exception of peritraumatic dissociation and meta-memory fragmentation. These findings have important implications for theories which posit that dissociation negatively impacts memory processing and thereby contributes to the development and maintenance of PTSD. Considering the importance that is placed on memory processing, it is imperative that we better understand this relationship. Future research should assess memory quality in meaningful and consistent ways, to better understand the importance of both past and persistent dissociation to trauma memory.

Acknowledgments

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Table 1

Characteristics of Prospective, Cross-Sectional and Analogue Studies Examining Dissociation and Trauma Memory Fragmentation.

| Studies | N | Diagnosis | Trauma Type | Dissociation | | | Fragmentation | |
				Peritraumatic	Trait	Meta-Memory	Objective	Rater
Prospective Designs								
Engelhard, van den Hout, Kindt, Arntz, & Schouten (2003)	118	PTSD	Pregnancy loss	PDEQ	PDEQ modified	2-items		
Halligan et al. (2003)	73	PTSD	Assault	SDQ	TDQ	TMQ		Foa; 1-item
Jones et al. (2007)	131	ASD; PTSD	MVA	ASDI			LIWC	Foa
Moulds & Bryant (2005)	15	ASD	Non-SA; MVA	ASDI				NUD.IST
Murray, Ehlers, & Mayou (2002)	27 / 176	ASD; PTSD	MVA	SDQ	TDQ	1-item		1-item
Cross-sectional Designs								
Byrne, Hyman, & Scott (2001)	113	None	Worst Event		DES	MCQ		
Halligan, Michael, Clark, & Ehlers (2003)	81	PTSD	Assault	SDQ	TDQ	TMQ		Foa; 1-item
Hardy, Young, & Holmes (2009)	22	None	SA	PDEQ		2-items		
Harvey & Bryant (1999)	29	ASD	MVA	ASDI				NUD.IST
Jones, Harvey, & Brewin (2007)	131	ASD; PTSD	MVA	ASDI			LIWC	Foa
Peace, Porter, & ten Brinke (2008)	44	None	SA; CSA; Mixed		DES	EMS		MAP
Rubin, Feldman, & Beckham (2004)	50	PTSD	Combat		DES	AMQ		
van der Hart, Bolt, & van der Kolk (2005)	30	DID	CSA; CPA		DES	TMI		
van der Kolk & Fisler (1995)	46	PTSD	Mixed		DES	TMI		
Zoellner, Alvarez-Conrad, & Foa (2002)	28	PTSD	Assault	PDEQ	DES		BGL.; FRE	Foa
Analogue Designs								
Buck, Kindt, & van den Hout (2006)	34	Spider Phobia	1 session in-vivo exposure to spiders	PDEQ		1-item		1-item
Kindt & van den Hout (2003)	40	None	Analoguefilm	PDEQ modified	DES	1-item	Seq. memory task	
Kindt, van den Hout, & Buck (2005)	100	None	Analoguefilm	PDEQ modified	DES	1-item	Seq. memory task	

Note. Trauma Type: CSA = Childhood Sexual Abuse; CPA = Childhood Physical Abuse; MVA = Motor Vehicle Accident; Non-SA = Non Sexual Assault; SA = Sexual Assault

Peritraumatic dissociation measures: ASDI = Acute Stress Disorder Inventory; SDQ = State Dissociation Questionnaire; PDEQ = Peritraumatic Dissociative Experiences Questionnaire

Trait dissociation measures: TDQ = Trait Dissociation Questionnaire; DES = Dissociative Experiences Scale

Meta-memory measures: AMQ = Autobiographical Memory Questionnaire; EMS = Emotional Memory Survey; TMQ= Trauma Memory

Questionnaire; TMI = Traumatic Memory Inventory

Objective measures: BGL = Bormuth grade level; FRE = Flesch reading ease; LIWC = Linguistic Inquiry and Word Count; Seq. Memory Task = Sequential memory task

Rater measures: Foa = Foa et al. (1995) rater coding system; NUDIST = Non-numerical Unstructured Data Indexing Searching and Theorizing System; MAP = Memory Assessment Procedure

Table 2

Relationship Between Dissociation and Trauma Memory Fragmentation with Associations Reported Using Effect Sizes (r)

Studies	Peritraumatic Dissociation				Trait Dissociation			
	Meta-memory Fragmentation		Objective/Rater Fragmentation		Meta-memory Fragmentation		Objective/Rater Fragmentation	
	Pos Association	No Sig or Neg Associations	Pos Association	No Sig or Neg Associations	Pos Associatk	No Sig or Neg Associations	Pos : Association	No Sig or Neg Associations
Prospective designs								
Engelhard et al. (2003)	---	.19–.29	---	---	---	.10–.12	---	---
Halligan et al. (2003)	.25	---	.30–.34	---	---	---	---	---
Jones et al. (2007)	---	---	---	NS	---	---	---	---
Moulds & Bryant (2005)	---	---	---	---	---	.15	---	---
Murray et al. (2002)	.37	NR	---	NR	---	---	---	---
Cross-sectional designs								
Byme et al. (2001)	---	---	---	---	---	NS	---	---
Halligan et al. (2003)	.48	---	.34–.45	---	---	---	---	---
Hardy et al. (2009)	.49–.58	---	---	---	---	---	---	---
Harvey & Bryant (1999)	---	---	.38–.42	NR	---	---	---	---
Jones et al. (2007)	---	---	.27–.38	---	---	---	---	---
Peace et al. (2008)	---	---	---	---	.57	-.02– -.52	NR	---
Rubin et al. (2004)	---	---	---	---	.42	.02–.27	---	---
van der Hart et al. (2005b)	---	---	---	---	---	NS	---	---
van der Kolk & Fisler (1995)	---	---	---	---	.54	---	---	---
Zoellner et al. (2002)	---	---	---	.33 – .39	---	---	---	---
Analogue Designs								
Buck et al. (2006)	.34	---	---	---	---	-.10	---	---
Kindt & van den Hout (2003) [1]	.36	.05	---	---	---	.06	---	NS
Kindt et al. (2005) [1]	.24–.30	-.07– -.09	---	---	---	---	---	.10–.34

Note. All values were converted to *r* values as a measure of standardized effect size where *r* = .1 reflects a weak, .3 a moderate, and .5 or higher a strong association.

NS = non-significant relationship, statistic not reported

NR = statistic not reported, but constructs measured in study

[1] For these studies, fragmentation was measured on a 100-mm VAS assessing if the memory of the film exists of loosely related pieces or images.