PPTRP 331—7/4/2008—RAJADURAI—297464

Psychology and Psychotherapy: Theory, Research and Practice (2008), in press

The British Psychological Society
www.bpsjournals.co.uk

A cognitive model of peritraumatic dissociation

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Purpose. Interacting cognitive subsystems (ICS; Barnard & Teasdale, 1991) is presented as a framework for understanding the impact of perceptual problems in peritraumatic dissociation.

Methods. This paper analyses two peritraumatic dissociation symptoms, attention being drawn to stimuli and the experience of time slowing. ICS is described. Information processes in peritraumatic dissociation are analysed.

Results. Peritraumatic dissociative symptoms are conceptualized as problems with early processing of sensory information that result from problems of sensory feature binding.

Discussion. These problems are discussed in relation to experiences of fragmented memories in trauma within the context of ICS. A role for mindful attention in psychological therapy is raised.

While post-traumatic stress disorder is recognized as a common reaction to trauma, the recurrence of dissociation to reminders of trauma is a poorly understood cognitive response that interferes with recovery from PTSD (Ehlers & Clark, 2000). Peritraumatic dissociation refers to a number of acute dissociative responses that occur at the time of the trauma (Marmar, Weiss, & Metzler, 1998). Marmar *et al.* describe these responses as including an altered sense of time, with time being experienced as slowed down or rapidly accelerated; experiences of depersonalization; profound feelings of unreality that the event is occurring or that the individual is the victim of the event; out-of-body experiences; confusion and disorientation; altered body image or feelings of disconnection from one's body; tunnel vision; altered pain perception; and other experiences reflecting immediate dissociative responses to trauma.

Conceptual models and research have focused on the relationship between peritraumatic dissociation and PTSD (Bryant, 2007). In his review, Bryant concludes peritraumatic dissociation is not an optimal predictor of PTSD and little is known about the mechanisms underpinning trauma-related dissociation. He relates the latter to the focus on the general construct of dissociation. He suggests future studies should

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DOI:10.1348/147608308X304484

evaluate responses such as time distortion and reduced awareness to obtain a better understanding of how traumatic experience influences information processing.

The aim of this theoretical paper is to apply an existing cognitive model, the interacting cognitive subsystems (ICS) framework (Barnard & Teasdale, 1991) to peritraumatic dissociation. In line with Bryant (2007) above, this analysis will focus on two specific peritraumatic dissociative symptoms: (a) narrowing of attention and attention being drawn to stimuli (Cardena & Spiegel, 1993) and (b) the experience of time slowing (Marmar *et al.*, 1998). Attention and perceived duration are linked in time research (Tse, Intriligator, Rivest, & Cavanagh, 2004) and time distortion under stress (Hancock & Weaver, 2005).

The structure of this paper is as follows. First, the above peritraumatic dissociative symptoms will be analysed to conceptualize their underlying information content and processes. Second, ICS will be described. Third, ICS will be used to suggest a possible mechanism for these two symptoms, fragmented memories in trauma, and the semantic encoding of the state of the world. Fourth, a role for attention and mindfulness in therapy will be discussed.

Peritraumatic dissociation

Problems with attention

Post-trauma, Cardena and Spiegel (1993) found narrowing of attention and attention being drawn automatically to stimuli was reported by 47 and 56% of non-clinical Q2 participants, respectively. Normally, attention is reflexively shifted to different parts of our environment. These shifts occur because there is an inhibition which slows the return of attention to the same location (see Klein, 2000, inhibition of return, IOR). When reflexive attention is lost, attention is said to be non-reflexive or voluntary. Both narrowing of attention and attention being automatically drawn to stimuli indicate a failure of reflexive attention and an engagement of voluntary attention. Given a relationship between peritraumatic dissociation and PTSD (Ozer, Best, Lipsey, & Weiss, 2003), the loss of reflexive attention in peritraumatic dissociation may be related to findings of an early stage deficit in filtering stimuli in PTSD participants which engages voluntary attention (Blomhoff, Reinvang, & Malt, 1998). The engagement of voluntary attention as an early filter implies a high perceptual load (Hopfinger & Mangun, 2001).

Load relates to the amount of sensory information being processed, difficulties selecting relevant information in unfamiliar circumstances (e.g. McFarlane, Weber, & Clark, 1993 in PTSD), and attention flicking among a large number of foci. For example, with the latter, during an accident, a participant reported being in the truck, seeing the truck from the air, seeing the truck from another angle, flying out the windshield, . . . (Noyes & Kletti, 1977).

Problems with high perceptual load suggest problems could occur with binding features such as colour and contour. Colour and contour are two distinct systems in human vision (Rogers-Ramachandran & Ramachandran, 1998). When attentional demands are high, illusory conjunctions can occur in normal people (Friedman-Hill, Robertson, & Treisman, 1995). Given a red X and a blue O, an illusory conjunction occurs when the participant reports seeing a Red O or a blue X. Mather *et al.* (2006) found emotional arousal can impair binding between visual items and their location in the environment. They suggest disruption of binding occurs because arousal recruits attention to high-arousal visual items. Briand (1998) found spatial attention plays a greater role in detecting conjunction of features than in detecting simple features, when spatial attention is oriented exogenously (reflexively), and not when it is oriented endogenously (voluntarily). Traumatic situations involve high attention demand, emotional arousal, attention being drawn to stimuli and non-reflexive attention. This suggests problems binding features such as colour and shape could occur during traumatic situations.

The content of sensory information being processed is also affected by oculomotor activity. Oculomotor activity is a prerequisite for IOR (Klein, Munoz, Dorris, & Taylor, 2001). This suggests reflexive attention requires reflexive eye-movements. Loss of reflexive eye-movements means the eyes could fixate on one part of the environment. This could produce an image that is stabilized or stays on one part of the retina. With stabilized images, Ditchburn (1973) reports the following can occur: (a) normal vision; (b) loss of pattern perception leaving a grey or faintly coloured field; (c) total loss of visual perception leaving a black field; or (d) intermittent and partial loss of pattern perception.

The effects of fixated attention and eye-movements appear to be variable. However, where problems with visual perception occur, the individual may learn to consciously or unconsciously recreate these problems by fixating eye-movements or stabilizing the image on one part of the retina. For example, Loewenstein (1991) reports a client saying ‘I can make that coat rack disappear if I want. All I have to do is stare at it long enough, and it’s gone . . . . If I want, I can turn off the audio, or the video. Either one’. This ability to avoid sensory inputs is consistent with findings that participants with a high level of peritraumatic dissociative symptoms are more likely to use avoidance strategies to deal with trauma than participants with a low level of dissociation (Griffin, Resick, & Mechanic, 1997). In their study on anxiety-related attentional biases, Derryberry and Reed (2002) found participants with good attentional control were better able to shift attention from threatening information than participants with poor attentional control. They conclude that skilled control of voluntary attention may allow anxious persons to limit the impact of threatening information. Thus, it is possible that fixated attention or fixated eyes can be consciously or unconsciously used to avoid threatening information.

Problems with temporal processing

During trauma, time can be experienced as slowing or speeding. Shalev, Peri, Canetti, and Schreiber (1996) report time distortion was the most frequently endorsed peritraumatic dissociative symptom (41.2% of participants). During survival training, 45 and 69% of military cadets reported the experience of time slowing when under mild and high stress conditions, respectively (Eid & Morgan, 2006).

During trauma, somehow, the experience of ‘now’ slows. During this ‘now’, a certain amount of sensory information is received and integrated. The perceptual overload raised in the last section suggests a greater than normal amount of sensory information is processed in this time period. According to Poppel (1988), if the amount of information content being processed is high then the time duration appears long and time appears to slow down. This suggests perceptual overload is related to the experience of time slowing. According to McCrone (1997), dopamine is released when we are frightened and this increases the speed of the internal clock. If the time clock speeds up, then time is subjectively experienced as slowing down. A role for a time clock regulator is consistent with Noyes and Kletti’s (1977) participant’s report of his mind speeding up during his experience of slowed time.

Noyes and Kletti (1977) report participants referred to a slowing of time, with few exceptions. Most of their participants had experienced short episodes of trauma. Terr (1984) also reports time slows in short episodes of trauma. However, Terr also reports experiences of time speeding in cases of prolonged traumatic episodes. Time speeds if the amount of information content is low (Poppel, 1988) or the time clock regulator slows (McCrone, 1997). This suggests that less information is being processed in cases of prolonged traumatic episodes. It raises the possibility that avoidance is being used to reduce the amount of information being processed. This is consistent with Derryberry and Reed's (2002) point that skilled control of voluntary attention may allow anxious persons to limit the impact of threatening information. Alternatively, prolonged episodes may be associated with low rates of salient change in the world and hence low amounts of information collection. Short episodes may be typified by rapid changes in event structures and hence high amounts of information collection.

An information processing conceptualization of peritraumatic dissociation

Inherent within the processing of sensory information is the need to bring together different sources of information into one cohesive experience. The failure to have a cohesive experience during peritraumatic dissociation suggests the failure to integrate and synchronize sensory information.

The slowing of temporal experience suggests the time clock regulator is speeding. Ivry and Richardson (2002) report findings that support the existence of multiple timers with unique timing elements for each motor effector and separate timing systems for the two sides of the body. Their multiple timer model includes different processing units for the motor system and perceptual systems. This highlights the complexity of temporally bringing different sources of information together. The slowing of time indicates at least one time clock regulator is speeding. With multiple timers, it is possible that a time clock regulator could become out of step with other timers. Temporal binding of information requires 'extreme precision of timing' (Geissler & Kompass, 2001) and any problems with timing could produce problems integrating sensory information.

From an information processing point of view, the problems in peritraumatic dissociation are about the kinds and amounts of information collected, and the correct temporal binding and synchronization of this information. Therefore, a cognitive model of peritraumatic dissociation needs to separately identify different sources of sensory information and include processes to temporally bind these different sources of sensory information. This requirement for multimodal integration is a fundamental process in ICS.

A cognitive model of peritraumatic dissociation

ICS models high level cognitive functions of the mind (see Figure 1 for a subset of ICS). The ICS structure reflects some aspects of the brain's structure in terms of having subsystems for processing sensory inputs as well as subsystems for higher cognitive functions. ICS provides early processing of sensory data (visual, acoustic, and body-state subsystems) and later stages of processing of sensory data (object and morphonolexical subsystems). It includes interactions between these sensory subsystems and higher cognitive functions (implicational and propositional subsystems). This allows analysis of consequences of problems occurring early within sensory processing on later stages of processing.

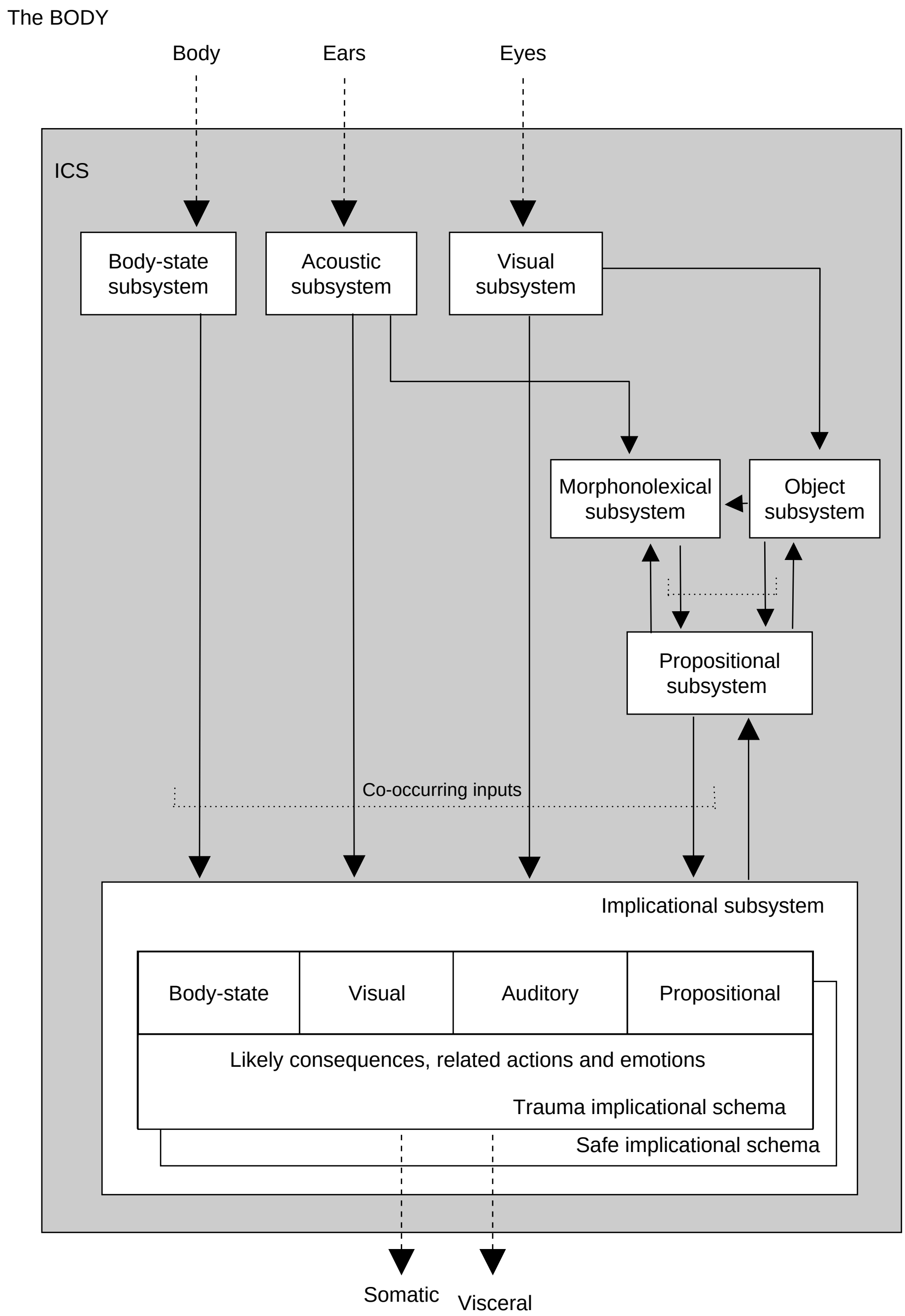

Figure 1. A subset of the ICS architecture. Co-occurring inputs to the implicational subsystem provide the basis for components of implicational schemas shown within the implicational subsystem.

The basic ICS architecture

In ICS, each subsystem processes a different type of information. The visual subsystem processes visual sensory inputs from one's eyes; the Acoustic subsystem processes auditory sensory inputs from one's ears, and so on. The implicational subsystem produces an emotional response to sensory information sent directly to it from sensory subsystems. There is also a longer indirect path where visual and auditory information are further processed by the respective object and morphonolexical subsystems and then by the propositional subsystem. Information in a sensory format is not passed beyond the object and morphonolexical subsystems. Hence, the indirect pathway only sends inferences (e.g. appraisals of danger) derived from sensory inputs to the implicational subsystem.

The ICS transform processes in the implicational subsystem encode 'schematic models of experience' of the world, the body and the mind (Teasdale & Barnard, 1993, p. 54). To simplify terminology, the transform processes within a subsystem will be referred to as the schemas within that subsystem. Thus, the implicational subsystem will have a set of implicational schemas; the visual subsystem will have a set of visual schemas, and so on.

ICS implicational schemas

The implicational subsystem produces emotional responses. The lower half of Figure 1 shows two implicational schemas for trauma and safety within the box representing the implicational subsystem. Implicational schemas have two parts. The first 'what goes with what' part is created by processing of co-occurring visual, acoustic, body-state, and propositional inputs. These co-occurring inputs can be considered to represent a pattern of inputs about a particular point in time. They form the semantic pattern of information about the state of the world at that moment in time.

Given the perceptual nature of peritraumatic dissociation, inherent information processing problems will impact the information content of the 'what goes with what' part of a trauma implicational schema. The indirect path to the implicational subsystem via the propositional subsystem provides inferences from sensory inputs. Hence, it does not affect the sensory component of implicational schemas. It is only through the direct path from sensory subsystems that incoherent sensory information can reach the implicational subsystem and so be encoded within trauma implicational schemas.

The fit between ICS and peritraumatic dissociation

The concept of temporal binding

In section (Peritraumatic dissociation), it was suggested that peritraumatic dissociation involved problems temporally binding and synchronizing sensory information. The need for synchronizing different sources of information is inherent in ICS. Sensory and propositional inputs to the implicational subsystem must be synchronized so they are perceived as information about the 'now'. Sensory inputs arrive by the shorter direct path and propositional inputs arrive by the longer indirect path. Barnard (2003) hypothesizes propositional inputs have a characteristic lag time behind sensory inputs. This characteristic lag time is used to identify the link between the late arriving propositional inputs with the prior arrival of sensory inputs. He suggests disruption of neurotransmitter production could change the lag time such that propositional inputs do not temporally belong to the pattern of co-occurring sensory inputs. These incoherent inputs produce an incoherent experience and become the basis for new implicational schemas which can recreate such experiences.

ICS is a high level model. It does not define lower level representations such as colour and contour. These are both subsumed in the ICS visual subsystem, and are not separately identified within ICS. A failure to bind shape and colour is reported by one of Noyes and Kletti's (1977, p. 379) participants: 'my sight seemed filtered through a blue piece of tissue paper with spots of red and yellow'. The general principles of ICS can be applied to colour and contour. For example, the ICS visual subsystem could be considered to subsume two lower level modules for colour and contour. The contour system is faster than the colour system (Rogers-Ramachandran & Ramachandran, 1998), and the visual subsystem would use a characteristic lag time to temporally bind colour and contour. Changes in lag time would affect the ability to integrate colour and contour. A similar use of characteristic lag times for components of other sensory modalities could also apply. These lag times could be affected by perceptual overload and the processing of large quantities of information.

Attention, the slowing of time and incoherent experience

In section (Problems with attention), it was suggested that perceptual overload involves voluntary attention. ICS provides a mechanism for encoding the effects of attention. Focused attention uses buffered processing mode. As inputs arrive, they are accumulated in a buffer. This allows a greater quantity of information from the area on which attention is focused to be collected. In ICS, this greater quantity of information will provide a more intense subjective experience of that information. And following Poppel (1988), this greater quantity of information being processed could also create the experience of time slowing.

In ICS, the experience of time slowing is related to the subsystem in buffered processing mode. Where the visual subsystem is in buffered processing mode, then visual experience will be slowed. When the buffer dwells excessively on the visual subsystem, the speeding of the time clock necessary to collect greater quantities of visual information could change the lag time of visual information reaching the implicational subsystem. The loss of the characteristic lag time would result in visual information failing to temporally synchronize with other sensory and propositional information being sent to the implicational subsystem. If the buffer shifted to another sensory modality, similar problems could occur in that sensory modality. In ICS, buffered processing can dynamically shift between subsystems, and the production of incoherent experience during peritraumatic dissociation could result from the buffer dwelling on sensory subsystems for excessive periods of time (P. Barnard, personal communication, October 27, 2006).

In peritraumatic dissociation, narrowing of attention involves both focused attention and attention to a limited range of information from the environment. In ICS, the dwelling of fixated attention on limited areas of the environment would result in visual fragments being processed by the visual subsystem and sent to the implicational subsystem. Repeated co-occurrences of such patterns will be abstracted to form a trauma implicational schema with fragmented visual information which only provides a partial model of the state of the world. This model could be further limited by fragmented information from other sensory subsystems.

Fragmented trauma memories

Trauma tends to be recalled as memory fragments (e.g. van der Kolk & Fisler, 1995). Intrusions include sensory memory fragments. For example, a bright patch of sunlight can trigger a vivid intrusion of headlights coming towards a car crash victim (Ehlers & Clark, 2000). Halligan, Michael, Clark, and Ehlers (2003) found dissociation is associated with disorganized trauma memories and altered time sense was one of the dissociation factors with the closest relationship with chronic PTSD and, by inference, with disorganized trauma memories. Van der Kolk and Fisler found participants with PTSD initially retrieved trauma memories as dissociated visual, olfactory, affective, auditory, and kinaesthetic experiences. They suggest that trauma memories may be entirely organized on an implicit or perceptual level. In ICS, implicit knowledge is encoded within the schemas in each subsystem. And problems with synchronizing sensory inputs can create implicational schemas containing sensory fragments.

Excessive buffered processing and changes in time lags could create incoherent experience at two levels of processing. At the initial point of sensory processing, problems between inputs to the visual subsystem can result in problems binding components such as colour and contour. This problem would be encoded in a visual schema. Similar problems could occur in other sensory subsystems. The result of this binding problem would be sent to the implicational subsystem and encoded within trauma implicational schemas. Further down the line, problems between sensory modalities could create additional problems binding components such as visual experience and the related sounds produced by the objects within that experience. Again such problems would be encoded within trauma implicational schemas.

Once a problematic trauma implicational schema has been created, stimuli such as a bright light could activate or maintain activation of the trauma implicational schema. The processing of such stimuli could activate the rest of the sensory pattern encoded within the implicational schema through pattern completion processes. Where the schema contains fragmented sensory information, this information would be activated and re-experienced as a fragmented sensory memory.

The creation of incoherent sensory information within an implicational schema stems from excessive dwelling of focused attention and, hence the ICS buffer, on inputs to a sensory subsystem, with dynamic shifting between sensory subsystems. This means that the buffer does not spend as much time on the wider range of sensory inputs to the implicational subsystem as would normally occur.

A role for attention and mindfulness in therapy

In section (Peritraumatic dissociation), the possibility was raised that, during peritraumatic dissociation, non-reflexive voluntary attention could be used to avoid sensory information. At the same time, disorganized sensory trauma memories might be encoded in implicational schemas as a result of such fixated attention. If attention is used to avoid threatening sensory information, then attention could be used in therapy to select and process avoided sensory information into organized implicit memories. Such use of attention needs to differ from the non-reflexive attention and problematic temporal processes used during peritraumatic dissociation.

Mindfulness is one form of attention which Teasdale (1999) defines in terms of buffered processing of the implicational subsystem. When buffered processing occurs in the implicational subsystem, instead of the sensory subsystems, there will not be a change in time lag for sensory information being sent from one or more sensory subsystems to the implicational subsystem. Hence, the maintenance of characteristic time lags from sensory subsystems will not produce incoherent experience when it reaches the implicational subsystem because such information will be temporally aligned to provide sensory information about a particular point in time.

Mindfulness engages voluntary attention. It differs from the voluntary non-reflexive attention of peritraumatic dissociation. In peritraumatic dissociation, attention can be captured and attentional focus limited. In mindfulness, voluntary attention is expanded Q3 to cover a greater range of sensory experience. For example, in Kabat-Zinn's (1990) raisin exercise (see Segal, Williams, & Teasdale, 2002), the raisin is mindfully touched, smelt, seen, and tasted. Reflexive attention collects sensory information from a wide range of sources. Similarly, the raisin exercise collects a wider range of sensory information.

Mindfulness involves staying present in the here and now. During therapy, loss of the ability to stay fully present can occur in response to reminders of trauma. With the bright sunlight example above, the capture of attention by this light can be interrupted by directing the client to look around the room. Like reflexive attention, this scanning of the environment collects sensory information from a wide range of sources about the client's current environment, and so would assist with binding the bright light to other features within their environment. This information would then enable the client to assess the light in the context of their current environment. Mindfulness can then be used to teach the client to overcome the use of fixated attention by expanding their attentional focus.

Conclusion

In this paper, peritraumatic dissociation symptoms of temporal distortion and attentional problems have been analysed using the ICS framework. This analysis suggests these symptoms are related to problems binding perceptual information and fragmented sensory memory in PTSD.

ICS also has the potential to explain other peritraumatic dissociation symptoms. For example, with bodily distortion, Wing Lun (2003) suggested Blanke, Ortigue, Landis, and Seeck (2002) findings on a limb appearing shortened resulted because visual information was interpreted without the perspective information needed to interpret the limb as being seen from an angle. Wing Lun discussed the issue of automatic pilot in terms of first person and third person perspectives. In ICS, implicational schemas encode the first person perspective.

This analysis suggests a role for mindfulness in dealing with some aspects of persistent dissociation. Where peritraumatic dissociation initially prevents selection of sensory information for processing, the subsequent use of mindfulness can ensure such missing information is actively and intentionally selected for processing. With persistent failures to temporally bind sensory information, ICS suggests focusing mindful attention on the implicational subsystem may assist with feature binding within a sensory modality and across different sensory modalities. This occurs by providing a wider range of inputs and by eliminating the problem of lag times that result from excessive dwelling on one or more sensory modalities.

Problems binding sensory information during peritraumatic dissociation are not easy to measure. Peritraumatic dissociation symptoms are transitory and rely on retrospective self-report. Memory fragmentation in PTSD has been measured using verbal utterances (Foa, Molnar, & Cashman, 1995) but it is more difficult to measure fragmentation of sensory memory. The future challenge for researchers will be to more accurately measure specific peritraumatic dissociation symptoms before specific relationships can be analysed.

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Received 12 May 2007; revised version received 7 March 2008

PPTRP 331—7/4/2008—RAJADURAI—297464

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