

# Memory of the Traumatic Event as a Risk Factor for the Development of PTSD: Lessons from the Study of Traumatic Brain Injury

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## ABSTRACT

Traumatic memories, and the mechanisms by which they operate, continue to occupy a central role in the scientific investigation of risk factors for the development of post-traumatic stress disorder (PTSD). However, empirically based studies are constrained by practical and ethical considerations and are limited to naturalistic models. Consequently, the paradigms most appropriate for the exploration of the relationship between traumatic memories and PTSD have been identified in conditions involving traumatic events where memories may be compromised. Indeed, traumatic brain injury, a condition that is commonly associated with memory impairment, has often been utilized as a naturally occurring model for the study of traumatic memory and its contribution to the development of PTSD. This article presents a critical review of these research efforts and discusses their theoretical and clinical implications.

*CNS Spectr.* 2006;11(8):603-607

### Needs Assessment

Posttraumatic stress disorder (PTSD) is a debilitating psychiatric condition that is rather prevalent among individuals exposed to a traumatic event. Identification of the predictors and risk factors for PTSD is a crucial step in the development of prevention and intervention programs. Memory of the traumatic event is a key factor in both the phenomenology and the etiology of PTSD and, as such, draws the attention of researchers and clinicians alike.

### Learning Objectives

At the end of this activity, the participant should be able to:

- Be familiar with the important role of memory of the traumatic event as a predictor and risk factor for posttraumatic stress disorder.
- Understand the problems embedded in the relationship between traumatic memories and the development of posttraumatic stress disorder.
- Describe research findings supporting conflicting views on the issue and their theoretical and clinical implications.

**Target Audience:** Neurologists and psychiatrists

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Disclosures: The authors do not have an affiliation with or financial interest in any organization that might pose a conflict of interest.

Submitted for publication: March 23, 2006, and accepted on June 22, 2006.

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## INTRODUCTION

The development of posttraumatic stress disorder (PTSD), as defined by current psychiatric classification systems, is contingent on exposure to a traumatic event. Yet, only ~10% to 30% of people who experience such an event subsequently develop the disorder.<sup>1,2</sup> Consequently, the currently held view is that the event itself is only one of several determinants responsible for the transition from a normal response to PTSD.<sup>3</sup> Accordingly, considerable research has been devoted to the identification of predictors and risk factors that may enhance the likelihood of developing PTSD following exposure to a traumatic event. These factors may be classified in three temporal domains: pre-traumatic, peri-traumatic, and posttraumatic factors.

Pre-traumatic factors exist prior to the traumatic event and are viewed as predisposing vulnerability factors in those exposed, such as previous experiences of traumatic events, history of psychiatric disorder, personality traits, and demographic variables.<sup>3,4</sup> Peri-traumatic factors are those linked to the actual traumatic occurrence, including type and severity of the event, degree of exposure, the magnitude of the initial response, presence of physical injury, and dissociation.<sup>5</sup> Posttraumatic factors are related to the long-term course of the trauma response, including the coping abilities of the survivors and their support network.<sup>3,5</sup>

Despite the large body of research on predictors and risk factors for PTSD, a comprehensive understanding of the development of the disorder remains elusive. In part, this is due to the methodological constraints inherent in the field and the difficulty in identifying trauma victims prior to their exposure. As a result, most studies have used either retrospective or cross-sectional designs with unrepresentative samples drawn from chronic populations seeking treatment, many of whom also suffer from other psychiatric disorders.<sup>3</sup> Conclusions from such studies are therefore limited. On the other hand, longitudinal studies that identify the subjects in the immediate aftermath of the traumatic occurrence are scarce.<sup>3,4</sup>

## MEMORY AND POSTTRAUMATIC STRESS DISORDER: THEORETICAL ASSUMPTIONS

The intricate system of memory is commonly viewed as comprising two primary pathways.

The first, referred to as explicit or declarative memory, relates to conscious awareness of facts and requires focal attention for processing. It is assumed to be mediated by the medial temporal lobe system, including the hippocampal formation and related structures that enable verbal representation.<sup>6,8</sup> The second pathway, referred to as implicit or non-declarative memory, relates to memories acquired during skill learning, habit formation, and simple, classical conditioning. It also refers to knowledge expressed through performance rather than recollection. These memories are assumed to be less accessible to consciousness.<sup>9</sup>

Memory of the traumatic event (MTE) is considered a central component of trauma-related disorders, including PTSD. It has been suggested that the psychopathology of PTSD is closely related to abnormal memory processes, namely, that in PTSD victims, traumatic events create pathogenic ("toxic") memories. These memories, rather than the events themselves, are responsible for generating the characteristic symptoms of the disorder.<sup>10</sup> Traumatic memories share both explicit and implicit features and are believed to be processed differently than ordinary memories.<sup>11</sup> This results in a failure to organize the traumatic event into a coherent verbally represented narrative.<sup>11,12</sup> The abnormal nature of traumatic memories is considered to be a central feature of PTSD. This is manifested by two well-documented and seemingly contradictory observations of traumatized individuals: hypermnesic symptoms, such as reexperiencing, intrusive thoughts, nightmares, and flashbacks, on one hand and, impaired memory for certain aspects of the traumatic event in the form of amnesia and delayed recall, on the other hand.<sup>13</sup> Furthermore, it appears that traumatic memories tend to be disorganized and fragmented. Patients with PTSD provide less coherent memories, exhibiting extra repetitions and non-consecutive memory chunks.<sup>14</sup> Their memories are characterized by dissociation and sensory verbal representation, namely, frequent use of sensory symbols.<sup>15</sup> These abnormal features of memory (ie, repetition and non-consecutive chunks) were found to predict PTSD severity<sup>14</sup> as well as to contribute to the preservation of PTSD by impeding the processing and resolution of the traumatic memory.<sup>16</sup> On the other hand, Foa and colleagues<sup>17</sup> found that participants who exhibited a decrease in narrative fragmentation over time reported a reduction in trauma-related anxiety.

## **MEMORY AND POSTTRAUMATIC STRESS DISORDER: EMPIRICAL EVIDENCE**

In recent years, researchers have focused on traumatic memory and the mechanisms by which it operates in order to better understand its role in the formation of PTSD. However, the study of differences in trauma-related memories between those who develop PTSD and those who do not, following similar traumatic exposure, are not easily feasible. Simulating true trauma in the laboratory is a complex undertaking that involves ethical constraints and has only limited conclusive power.<sup>18</sup> Consequently, the systematic examination of memory processes in acutely traumatized individuals was done mainly in studies that focused on the co-occurrence of traumatic brain injury (TBI) with the trauma. TBI is commonly associated with loss of consciousness or impaired memory (retrograde amnesia) and thus potentially serves as a natural model for the study of memory and its role in the development of PTSD. Findings, however, are inconclusive, showing differing and sometimes conflicting results, with some studies supporting the view that TBI protects against PTSD and other studies supporting the view that TBI and PTSD are not mutually exclusive.

### ***Studies Supporting the View that Traumatic Brain Injury Protects Against Posttraumatic Stress Disorder***

Some of the studies that focused on TBI have provided evidence that traumatic events involving TBI are associated with reduced prevalence of PTSD, consistent with the view that TBI and PTSD are incompatible and that amnesia for the traumatic event may play a protective role in this regard.<sup>19-21</sup> Although there is indication that head injury is associated with a myriad of other psychiatric problems,<sup>22,23</sup> it appears to elicit only partial symptoms of PTSD that do not meet the full criteria for the disorder. Comparison of acute stress reaction in road accident victims with and without head injury indicated that while both groups reported high rates of anxiety, the head-injured group reported fewer intrusive symptoms, such as recurrent memories, images, thoughts, or feelings about the traumatic event; or strong emotional or physiological reactions to reminders of the event.<sup>24</sup> It has been suggested<sup>3-24</sup> that amnesia for the traumatic event minimizes the possibility of establishing any cognitive representation of the trauma, thus reducing the likelihood of intrusive symptoms.

A recently published study<sup>25</sup> investigated the symptom profiles of acute stress disorder (ASD) and PTSD in participants who did and did not sustain TBI following a road traffic accident. The participants were assessed at three points in time: shortly after the trauma, at 6-weeks, and at 3-months post-trauma. At the first assessment, fewer participants from the TBI group recalled feeling fear and helplessness at the time of the trauma and fewer TBI participants reported recurrent intrusive thoughts compared to the non-TBI group. At the second assessment, fewer participants from the TBI group recalled feeling intense helplessness at the time of the trauma. Three-months posttrauma, there was no difference in PTSD symptom profile between the TBI and non-TBI groups. These findings indicate that the presence of TBI is likely to influence the temporal distribution of certain emotional symptoms but need not be a significant barrier to the development of ASD and PTSD.

### ***Studies Supporting the View that Traumatic Brain Injury Does Not Protect Against Posttraumatic Stress Disorder***

Several studies suggest that PTSD is fairly prevalent among TBI patients. These studies indicate that loss of consciousness may not guarantee protection from trauma-related intrusive memories or PTSD.<sup>22,23</sup> Although head injury seemed to be associated with a reduced frequency of fear, helplessness, and intrusive memories at 1-month posttrauma, there was no difference between trauma survivors with and without head injury in the likelihood for a diagnosis of PTSD at 6-month follow-up.<sup>22</sup>

A similar trend was observed in a study that explored the relationship between mild TBI, amnesia, and PTSD among 307 consecutive admissions to a Level 1 Trauma Center.<sup>26</sup> Over 10% of participants developed PTSD by 12-months post-injury, with no differences in prevalence between the TBI and non-TBI group. Non-significant differences in incidence of PTSD were apparent between those with full recall of the event (9%), partial recall (14%) and no recall (7%). These data highlight the fact that both ASD and PTSD may develop following trauma despite amnesia for the event.

## **MEMORY OF THE TRAUMATIC EVENT AND POSTTRAUMATIC STRESS DISORDER**

A significant limitation of many of these studies is the fact that they did not directly evaluate or control for actual memory for the traumatic

event. That is, the degree to which victims of TBI remember the traumatic event was not assessed. While it is reasonable to assume that TBI impairs MTE, there exists a significant variability among TBI patients with regard to the amount and quality of their MTE. It is possible that this variability provides an explanation for these apparently conflicting results.

In a recently published study, Gil and colleagues<sup>24</sup> examined the relationship between MTE and subsequent development of PTSD in a prospective design. One hundred twenty subjects, hospitalized for observation after sustaining a mild TBI, were assessed immediately after the trauma and were followed-up for 6 months. MTE was assessed 24 hours post-injury with a 9-item self-report questionnaire eliciting information about memory for various aspects of the trauma (ie, what was the event; where did the event take place; who [other else than you] was involved in the event; when did the event occur; sights from the event; sounds from the event; odors from the event; things you said during or after the event; and things other people said during or after the event). The results of this questionnaire yielded a bimodal distribution of MTE, with most participants reporting either very good MTE or total lack of MTE. As a result, a categorical approach using the median (2.1) of the ordinal scale as the cut-off point was applied identifying 45% of the participants (n=55) as having good MTE and 55% (n=65) as having none.

Overall, 17 (14%) of the participants met full criteria for PTSD at 6 months. However, participants with MTE were significantly more likely to develop PTSD than those without MTE (OR=4.6; 95% CI: 1.1-9.9), with the difference attributable primarily to the reexperiencing cluster. Logistic regression analysis revealed that MTE within the first 24 hours was a strong predictor of PTSD 6 months after the traumatic event.

These findings were further corroborated by a parallel retrospective study of 120 participants,<sup>27</sup> where MTE was found to be associated with an increased risk for PTSD (OR=2.8; 95% CI: 1.8, 8.9), particularly for the reexperiencing symptom cluster.

Taken together, the results of two studies<sup>4,24,27</sup> support the view that MTE along with other factors, such as history of previous trauma, previous psychiatric morbidity, and physical injury,<sup>3,4,28</sup> is a strong predictor of PTSD and a potential risk factor for its subsequent development.

Finally, another important finding from our study was the stability of MTE over the first 6 months following the trauma. It is, thus, apparent that the initial report of MTE within the first

24 hours after the event is a consistent indicator of traumatic memory over time and, thus, a reliable predictor of the risk for PTSD 6 months later. It should however be mentioned that, albeit less frequently, PTSD was nonetheless present even in the absence of explicit memory of the event (6% of the participants in the prospective study and 8% in the retrospective study), indicating that TBI and PTSD are not mutually exclusive, even in the absence of MTE.

## CONCLUSION

The question pertaining to the role of traumatic memory as a risk factor for the development of PTSD can be answered positively yet not without caveats. This puzzle involves the mechanisms of information processing and storage in the brain and it should not be viewed as an "all or none" phenomenon. Rather, it may require the intricate and piecemeal deconstruction of the human response to trauma.

It is clear that, at least to the degree that the naturally occurring trauma of TBI is an adequate model for the exploration of this issue—memory of the trauma albeit being a solid predictor of PTSD, is not an absolute prerequisite, as its absence does not rule out the development of the disorder.

One possible mechanism by which the findings that PTSD occurs without explicit memory of the event could be explained is that emotionally charged traumatic memories are initially processed via brain circuits that bypass cortical structures and are mediated primarily through the amygdale and related brain structures, resulting in the formation of implicit (unconscious) memories. In addition, stress-induced secretion of glucocorticoids, which have been shown to impair hippocampal functioning, may disrupt the formation of explicit memory.<sup>29-31</sup>

Another challenge resulting from these findings is the exploration of the clinical significance of the evidence that lack of MTE does have a protective value. These findings seem to be in contrast with the theoretical assumptions underlying many of the therapeutic interventions with patients suffering from PTSD (eg, exposure, abreaction, hypnosis), that highlight the importance of eliciting traumatic memories as part of the recovery process. However, it seems that at least for TBI survivors without MTE, amnesia may be protective, in which case the process of deliberate recollection and remembering may be harmful rather than beneficial.

The generalizability of these findings beyond TBI to other conditions that are associated with impaired or reduced MTE is, at this point, speculative and should be addressed with caution. In addition, an assessment of PTSD post-TBI that relies on a questionnaire may lead to false-positive diagnoses<sup>32</sup> due to the effects of brain injury and the overlap that exists between symptoms related to both TBI and to PTSD, including amnesia, insomnia, irritability, and impaired concentration.

As evidence that further supports the protective role of attenuated memory processes following traumatic exposure, Kaminer and colleagues<sup>33</sup> showed in a study of Holocaust survivors that a decrease in dream recall serves as a defensive adaptive function and that subjects who had poorer dream recall experienced less emotional distress and fewer posttraumatic symptoms.

Taking this even further, one may question whether "deliberate disruption" of MTE might prove therapeutically beneficial in trauma survivors. This possibility was addressed in a double-blind study that examined the severity of acute PTSD symptoms among 18 subjects who received propranolol 40 mg (this is believed to interfere with memory consolidation) 6-hours posttrauma compared with with the severity of symptoms among 23 participants who received placebo.<sup>34</sup> Results showed that participants in the experimental group tended to exhibit lower levels of PTSD symptoms 10 days following the traumatic event. If further corroborated, these findings may support the notion that not only does lack of MTE protect against the development of PTSD, but also that the pharmacologically induced disruption of the consolidation of traumatic memories can be therapeutically beneficial for some trauma survivors.

The evidence reviewed in this article clearly suggest that the intactness of MTE is an important factor in the development of PTSD. Early assessment of MTE may serve as a predictor for subsequent PTSD. Interventions that interfere with the consolidation of newly formed (and possibly old) traumatic memories deserve further exploration as potential therapeutic strategies. **CNS**

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