

PTSD, Attention Bias, and Heart Rate After Severe Brain Injury

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Does “partial” posttraumatic stress disorder (PTSD) occur after head injury? The authors found that attention bias to trauma-related threat stimuli and higher heart rate during trauma interview were not associated with PTSD symptom severity in 42 participants with severe head injury. They found no evidence for “partial” PTSD.

(The Journal of Neuropsychiatry and Clinical Neurosciences 2011; 23:454–456)

There has been debate about whether posttraumatic stress disorder (PTSD) can occur after severe head injury (SHI), when there is usually little or no recollection of the actual traumatic event.¹ Head injury impairs memory for trauma as a result of loss of consciousness, posttraumatic amnesia (PTA), and retrograde amnesia. Hence, the basis for reexperience is limited, and this limitation might provide protection from psychological trauma. Fear associated with traumatic experiences may be mediated by subcortical structures, allowing development of reexperience phenomena after SHI, as represented by emotional and physiological reactivity, and damage might explain the lower incidence of intrusive phenomena.² Indeed, several studies on PTSD after SHI report low frequencies of intrusive symptoms, and some report an absence of “reexperience” symptoms.^{2–5} A protective effect of SHI might, for some patients, prevent PTSD from arising and, for others, result in “partial” PTSD, where all symptom criteria are not met.⁶ There is interest in “partial” PTSD after non-head-injury-related trauma,⁷ but, as yet, this is not reflected in studies on head injury.

Diagnosis of PTSD after head injury is complicated by symptoms that are common to both. Also, the cognitive sequelae of head injury often include impairment of attention and inflexible thinking, and these factors can also lead to errors in diagnosis.⁸ Furthermore, people with head injury are often curious about the “amnesic gap” in their lives during the traumatic event. This curiosity can have an intrusive quality, without associations associated with anxiety or fear, but can be confused with reexperience.⁴ If PTSD occurs after SHI in “partial” form, this phenomenon might explain the wide range of occurrence of PTSD (0–27%) reported after SHI,^{2,3,8} and there are implications for diagnosis and treatment after head injury.

Here, we investigate whether partial PTSD occurs after SHI. If partial PTSD is common after SHI, then emotional responses associated with PTSD (attention bias to trauma-related threat stimuli and heart rate reaction) when asked to remember the trauma would be associated with PTSD symptom severity.

HYPOTHESES

Evidence for partial PTSD after SHI will be supported if higher PTSD symptom severity scores are associated with 1) attention bias toward trauma-related words; and 2) increase in heart rate when discussing the traumatic event.

METHOD

Participants were recruited from a neurorehabilitation unit and from a brain-injury charity organization. Ethics approval was granted by NHS Lothian. Inclusion criteria were the following: over age 17 years, IQ over 79, not color-blind, SHI (PTA > 1 day),

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≥3 months post-injury (DSM-IV criterion for PTSD), and living independently.

Measures Participants were administered the Clinician-Administered PTSD Scale (CAPS)⁹ and the Traumatic Memory Inventory (a structured interview assessing memory for the event; only current memory was assessed, as described previously;⁶ see Van der Kolk BA: Traumatic Memory Inventory [TMI]; Boston, MA, 1990; unpublished report obtained directly from the author). Severity of brain injury was estimated by retrospective assessment of PTA.¹⁰ The Wechsler Test of Adult Reading yielded a pre-injury estimate of IQ.¹¹

The Stroop Test was modified to assess attention bias. It consisted of traumatic, negative, neutral, and positive words that were selected on the basis of a pilot study (details available from corresponding author). Fifteen words of each type were repeated four times (once in red, blue, yellow, and green ink). A practice trial consisted of numbers 1, 2, 3, 4, and 5 presented randomly in red, blue, green, and yellow ink. The test was presented electronically, by laptop, using Superlab V4.0 with a Cedrus RB-730 response box,¹² with automatic recording of errors and response times. Words were presented pseudo-randomly, with the same word or color never appearing consecutively. Heart rate was estimated using the Garmin-Forerunner 50 Heart Rate Monitor.

Statistical Analysis

Tests were two-tailed. Nonparametric statistics were used if data were not normally distributed.

RESULTS

All 42 participants sustained a severe head injury (PTA 1–7 days: 41%; 8–28 days: 26%; >28 days, 33%). Causes of injury were road traffic accident (47%), fall (36%), and assault (17%). On the TMI, 39 (93%) reported some recall of the event (mean score 2.74; standard deviation [SD]: 1.73).

On the CAPS, the proportion with no re-experience symptoms (88%) was much greater than for avoidance (48%) or hypervigilance (45%). Two people (5%) achieved PTSD “caseness” on the CAPS (DSM-IV criteria B–F); both had some memory of the trauma. CAPS symptom severity scores were not associated with age, time since injury, or PTA duration; higher CAPS scores were associated

TABLE 1. Demographic and Injury Factors: Correlations Between Stroop Response Times or Heart Rate With CAPS Total Symptom Severity Scores

	Mean or Frequency	Standard Deviation	Correlation With CAPS
Age, years	42.52	12.58	–0.080; NS
Gender (Male/female)	32/10		
Pre-injury VIQ (WTAR)	103.21	8.95	–0.305; <i>p</i> =0.049
Time since injury, months	111.69	99.60	–0.085; NS
PTA, days	20.43	20.45	0.031; <i>p</i> =0.085
PTSD Interview (CAPS)	15.19	15.90	
RT Stroop trauma words	567.89	1,956.63	0.140; NS
RT Stroop negative words	574.46	1,904.43	0.153; NS
RT Stroop neutral words	565.90	2,006.60	0.166; NS
RT Stroop positive words	556.45	2,003.42	0.162; NS
HR during consent-giving	82.83	13.46	0.104; NS
HR during TMI	73.47	12.12	–0.035; NS
HR during CAPS	75.15	12.06	0.010; NS

Attention Bias: A repeated-measures ANCOVA, (covarying verbal IQ [VIQ]) revealed no significant within-subjects difference in response times on the Stroop Test among trauma, negative, neutral, or positive words (*F*=1.493; NS). Between-subject differences in Higher and Lower CAPS symptom score groups were non-significant (*F*=2.519; NS). Partial correlations among response times for each Stroop word condition and CAPS scores, controlling for verbal IQ, were non-significant.

Heart Rate: Associations between CAPS scores and heart rate during a neutral task (consenting to the study), the CAPS interview, or the TMI were non-significant. Associations between change in heart rate during the consent process and CAPS interview (*r*=0.180; NS) or TMI interview (*r*=0.109; NS) were non-significant.

WTAR: Wechsler Test of Adult Reading; PTA: posttraumatic amnesia; CAPS: Clinician-Administered PTSD Scale; TMI: Traumatic Memory Inventory.

with estimates of lower pre-injury verbal IQ (Table 1). For ANCOVAs, two PTSD symptom severity groups were divided by median split as “higher” (mean: 27.14; SD: 14.35) or “lower” (mean: 3.24; SD: 14.35).

DISCUSSION

The sample was demographically representative of people with severe head injury.^{4,13} Evidence for attention bias or heart rate response might be expected if “partial” PTSD is common after SHI,⁵ and, in turn, PTSD symptoms might be expected in this SHI sample because 93% reported some memory of the traumatic event. However, associations between PTSD symptom severity and attention bias or heart rate were not found. Consistent with other reports, few participants reached the DSM-IV criterion for reexperience.^{3,4} In fact, the frequency of PTSD “cases” is lower than reported in the general population in victims of road traffic accidents or assaults.⁵ These findings support the view that SHI protects against the development of PTSD.^{3,6,8,14} Clearly,

symptoms of avoidance and arousal can arise independently of PTSD in people who suffer a brain injury. These include anxiety and adjustment issues associated with the trauma and its consequences, memory impairment, difficulty concentrating, sleep difficulties, and irritability.⁴ Hence, the low rates of re-experience symp-

toms after SHI found here are more likely to reflect a low true rate of PTSD, rather than PTSD in a "partial" form.

This research was part funded by NHS Education Scotland.

References

1. Klein E, Caspi Y, Gil S: The relationship between memory of the traumatic event and PTSD: evidence from studies of traumatic brain injury. *Can J Psychiatry* 2000; 48:27–33
2. Bryant RA, Marosszeky JE, Crooks J, et al. Posttraumatic stress disorder after severe traumatic brain injury. *Am J Psychiatry* 2000; 157:629–631
3. Warden DL, Labbate LA, Salazar AM, et al: Posttraumatic stress disorder in patients with traumatic brain injury and amnesia for the event. *J Neuropsychiatry Clin Neurosci* 1997; 9:18–22
4. Sumpter R, McMillan TM: Errors in self-report of PTSD symptoms after severe TBI. *Brain Inj* 2006; 20:93–100
5. Glaeser J, Neuner F, Lutgehmunn R, et al: Posttraumatic stress disorder in patients with traumatic brain injury. *BMC Psychiatry* 2004; 4:5
6. Chalton L, McMillan TM: Can "partial" PTSD explain differences in diagnosis of PTSD by questionnaire self-report and interview after head injury? *Brain Inj* 2009; 23:77–82
7. Harvey AG, Brewin CR, Jones C, et al: Co-existence of post-traumatic stress disorder and traumatic brain injury: towards a resolution of the paradox. *J Int Neuropsychol Soc* 2003; 9:663–676
8. Sumpter RE, McMillan TM: Misdiagnosis of post-traumatic stress disorder following severe traumatic brain injury. *Br J Psychiatry* 2005; 186:423–426
9. Blake, DD, Weathers, FW, Nagy, et al. The development of a clinician-administered PTSD scale. *J Traumatic Stress* 1995; 8:75–90
10. McMillan TM, Jongen EL, and Greenwood RJ: Assessment of post-traumatic amnesia after severe closed head injury: retrospective or prospective? *J Neurol Neurosurg Psychiatry* 1996; 60:422–427
11. Weschler D: Weschler Test of Adult Reading, 2001. San Antonio, TX, The Psychological Corp.
12. Cedrus Corporation: Superlab 4.0, P.O. Box 6309, San Pedro, CA 90734
13. Thornhill S, Teasdale GM, Murray GD, et al: Disability in young people and adults one year after head injury: prospective cohort study. *BMJ* 2000; 320:1631–1635
14. Gil S, Caspi Y, Ben-Ari IZ, et al: Does memory of a traumatic event increase the risk for post-traumatic stress disorder in patients with traumatic brain injury? a prospective study. *Am J Psychiatry* 2005; 162:963–969