Physiological and Affective Underarousal as a function of Mild Head Injury in University Students

Department of Psychology
Centre for Neuroscience
500 Glenridge Ave.
St. Catharines, Ontario
Canada

Julie Baker[1], Ph.D. Candidate & Dawn Good[1,2], Ph.D., C. Psych.
[1]Department of Psychology, Brock University, St. Catharines, Ontario, Canada
[2]Centre for Neuroscience, Brock University, St. Catharines, Ontario, Canada

Department of Psychology
Centre for Neuroscience
500 Glenridge Ave.
St. Catharines, Ontario
Canada

Introduction

◆ The prefrontal cortex (PFC), especially the ventromedial PFC (vPFC), has been implicated in the modulation of emotional and autonomic responses[1]. This region is particularly vulnerable in head trauma[2] and, therefore, emotional responses may be at risk in this population. Consistent with this, research (see Tranel & Damasio, 1994[3]) has shown that persons with moderate to severe traumatic brain injury (TBI) to the vPFC present with underarousal as evidenced by reduced electrodermal activation (EDA) responses and flattened affect. Furthermore, it has been suggested that individuals with moderate to severe neurological compromise are particularly vulnerable to the adverse effects of stress [4,5].

◆Until recently, little research has been conducted to examine the persistence of emotional and cognitive sequelae following mild head injury (MHI) – injuries which can be subtle and involve alterations in consciousness without extensive neural loss[6]. Further, the findings regarding arousal have been, at best, variable [7], and, at worst, inconclusive.

◆Previous research from our lab[8,9] has demonstrated that persons with a history of mild head injury (MHI) reported lower arousal and performed better on memory and attentional tasks with increased arousal. Despite reports of lessened self-perceived stress, students with MHI reported experiencing a greater level of life stressors compared to their no-MHI cohort[9].

◆Furthermore, it has been typically suggested that post-concussive symptoms (i.e., cognitive difficulties, altered affect, and physical complaints) subside after a three month period and functioning is assumed to return to previous abilities [10, 11]. Yet, for some, 5% - 10%[12,13], these difficulties may *not* be transient [14,15,16].

Purpose

◆ Therefore, the purpose of the current study was to:

◆ investigate the affective (both self-report and physiological indices [e.g., electrodermal activation, heart rate]) status of students with self-reported MHI

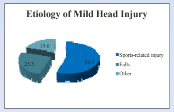
◆examine possible differences in responsivity to the experimental manipulation of arousal (psychosocial stressor or relaxation) as a function of MHI history

◆ investigate effects of experimentally manipulated arousal on cognitive performance in university students with and without MHI

◆Explore post-concussive-like symptom reports in this high-functioning population as a function of MHI history

Demographics

◆ 56% (n = 51) reported a previous MHI
◆ 86% (n = 44) were past the post-acute stage (i.e., > 3 mos)
◆ injuries occurred approximately 2 years previous



Indicators of Severity for Self-reported MHI

N = 51	n	Percentage
Loss of consciousness (LOC)	15	29.40
Less than 5 mins	14	**93.33**
More than 5 mins but less than 30 mins	1	6.67
Altered State of Consciousness (no LOC)	36	**70.59**
Concussion	24	47.10
Received medical treatment	20	39.20

Method

Participants
University students (N = 91); 56% self-reported MHI history

Measures and procedure

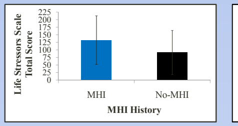
▪ **Neuropsychological measures** (memory[17, 18]; attention[19]; planning[19]; abstract reasoning[18,19, 20]; and standard intelligence[18]); indices of arousal/anxiety[21]; manipulated arousal (via psychosocial stressor[22] or relaxation)

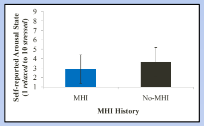
▪**Post-concussive symptoms** (Post-concussive Symptom Checklist [PCSC])[16]

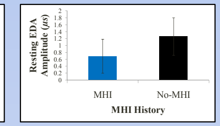
▪ **Indices of Anxiety**
  ▪physiological recordings of electrodermal activity [EDA] and heart rate[23]; STAI[21]; self-reported arousal levels; Everyday life stress [24]

Results

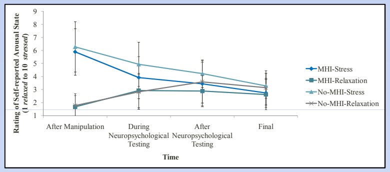
◆ University students with self-reported MHI endorsed experiencing significantly more life stressors such as financial or relationship difficulties than their no-MHI cohort, t (89) = 2.51, p = .014.

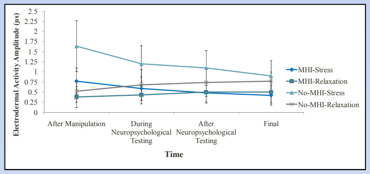




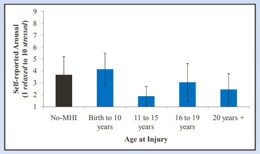


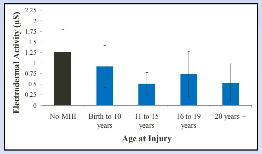
◆ Despite reports of increased life stress, university students with history of a previous MHI self-reported significantly lower arousal, F (1, 89) = 5.60, p = .020, and produced significantly fewer EDA responses, F (1, 89) = 28.06, p < .001, as compared to their no-MHI cohort.





◆ Overall, university students with self-reported MHI had a diminished EDA response to the arousal manipulations as compared to their no-MHI counterparts. The no-MHI group had more extreme and larger range of EDA responses than the MHI group (ps < .05).

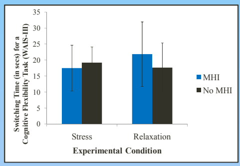


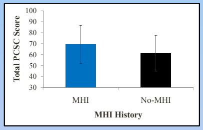


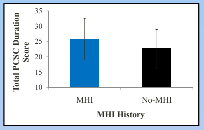
◆ Post-hoc analysis revealed significant differences between students with no-MHI and those with MHI across age at injury groups with respect to self-reported, F (4, 86) = 3.95, p = .005, and physiological (electrodermal activity) responses, F (4, 86) = 7.95, p < .001. In short, those who sustained their head trauma at 11 to 15 years of age reported and elicited more dampened arousal than students who sustained their injury at other ages or the no-MHI group.

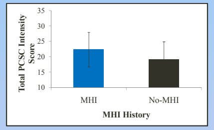
◆ As expected, prior to any arousal manipulation (i.e., baseline) students with MHI performed more poorly on tasks of working memory (WAIS-III, 1997; DKEFS, 2002) and attention (DKEFS, 2002).

◆ **However**, when arousal state was manipulated *students with MHI tended to perform better on a cognitive flexibility task* (WAIS-III, 1997) *when stressed* than when relaxed in contrast to their no-MHI counterparts who performed better when relaxed than when stressed, F (1, 87) = 3.17, p = .079.









◆ Overall, competent university students who acknowledge a history of MHI but have not complained of persistent effects or concerns regarding the MHI nonetheless endorsed significantly more post-concussive symptoms (e.g., headaches, concentration difficulties, irritability), t (89) = 2.29, p = .024, experienced the symptoms with greater intensity, t (89) = 2.62, p = .010, and for longer durations, t (89) = 2.24, p = .028, than their no-MHI counterparts.

Discussion

Persons with mild head trauma who have not complained of, or self-identified as experiencing any neurocognitive challenges, **present with a profile similar to that of persons with moderate to severe injury to the vPFC region**. Despite reports of experiencing significantly more life stressors than their no-MHI cohort, ***students with MHI are relatively emotionally and physiologically underaroused compared to their no-MHI counterparts***. Students who acknowledged a history of sustaining a MHI were significantly less physiologically responsive to the arousal manipulations of stress and relaxation and may be less responsive to stressors in their environment—which may suggest *dysregulated stress responsivity.* Further, cognition is advantaged by increased arousal, rather than decreased arousal, for students with MHI in contrast to those with no-MHI. Finally, increased post-concussive symptom reports were heightened for those reporting a MHI as a function of the more qualitative (i.e., intensity and duration of symptoms), as opposed to quantitative (i.e., frequency) aspects of PCS. Our findings are suggestive of persistent and subtle effects of neural disruption following mild head trauma. Lastly, age at sustaining the MHI, especially during the early teenage years as compared to other ages, may also play a role in arousal levels.

References

[1]Barbas, H. et al. (2003). Serial pathways form primate prefrontal cortex to autonomic areas may influence emotional expression. *BMC Neuroscience, 4* (1), 25 (12pp.).
[2]Bigler, E. D. (1999). Neuroimaging in mild TBI. In N. R. Varney and R. J. Roberts (Eds.), *The evaluation and treatment of mild traumatic brain injury* (pp. 63-80). Mahwah, NJ: Lawrence Erlbaum Associates, Inc.
[3]Tranel, D., & Damasio, H. (1994). Neuroanatomical correlates of electrodermal skin conductance responses. *Psychophysiology, 31*, 427-438.
[4]Harvey, A. G., & Bryant, R. A. (1998). Acute stress disorder after mild traumatic brain injury. *Journal of Nervous and Mental Disease, 186*, 333-337.
[5]Harvey, A. G., & Bryant, R. A. (2000). Two-year prospective evaluation of the relationships between acute stress disorder and Post Traumatic Stress Disorder following Mild Traumatic Brain Injury. *The American Journal of Psychiatry, 157* (4), 626-628.
[6]Giza, C. C., & Hovda, D. A. (2001). The neurometabolic cascade of concussion. *Journal of Athletic Training, 36* (3), 228-235.
[7]Hanna-Pladdy, B., Berry, Z. M., Bennett, T., Phillips, H. L., & Gouvier, W. D. (2001). Stress as a diagnostic challenge for postconcussive symptoms: Sequelae of mild traumatic brain injury or physiological stress response. *The Clinical Neuropsychologist, 15* (3), 289-304.
[8]Jung, Y. H., & Good, D. E. (2007, June). *The effects of mild head injury and induced stress on cognitive performance.* Poster session presented at the 68th Annual Canadian Psychological Association Convention. Ottawa, Ontario.
[9]St. Cyr, J. & Good, D. (2007, March). *Memory performance as a function of anxiety in individuals with and without mild head injury.* Poster session presented at the 17th Annual Rotman Research Institute, Advances in Memory Research, Toronto, Ontario.
[10]Dikmen, S. A., McLean, A., & Temkin, N. (1986). Neuropsychological and psychosocial consequences of minor head injury. *Journal of Neurology, Neurosurgery, and Psychiatry, 49*, 1227-1232.
[11]Levin, H. S., et al. (1987). Neurobehavioral outcome following minor head injury: A three-center study. *Journal of Neurosurgery, 66*, 234-243.
[12] Alexander, M. P. (1995). Mild traumatic brain injury: Pathophysiology, natural history, and clinical management. *Neurology, 45*, 1253-1260.
[13] Iverson, G. L., & Lange, R. T. (in press). Post-Concussion syndrome. In M. R. Schoenberg and J. G. Scott (Eds.), *The black book of neuropsychology: A syndrome based approach.* New York: Springer.
[14]Hellawell, D. J., Taylor, R., & Pentland, B. (1999). Cognitive and psychosocial outcome following moderate to severe traumatic brain injury. *Brain Injury, 13* (7), 489-504.
[15]Raskin, S. A., Mateer, C. A., & Tweeten, R. (1998). Neuropsychological assessment of individuals with mild traumatic brain injury. *The Clinical Neuropsychologist, 12* (1), 21-30.
[16]Gouvier, W. D., Cubic, B., Jones, G., Brantley, P., & Cutlip, Q. (1992). Postconcussion symptoms and daily stress in normal and head-injured college populations. *Archives of Clinical Neuropsychology, 7*, 193-211.
[17] Wechsler Memory Scale - Third Edition. (1997). United States of America: The Psychological Corporation.
[18] Wechsler Adult Intelligence Scale-Third Edition. (1997). San Antonio, Texas: Harcourt Assessment.
[19] Delis Kaplan Executive Function System (2002). San Antonio, Texas: Harcourt Assessment.
[20] Comprehensive Test of Non Verbal Intelligence (1996). San Antonio, Texas: Harcourt Assessment.
[21] Spielberger, C. D. (1983). State-Trait Anxiety Inventory (STAI) Form Y. Menlo Park, CA: WHS Inc.
[22] Shostak, B. B., & Peterson, R. A. (1990). Effects of anxiety sensitivity on emotional response to a stress task. *Behavioral Research Therapy, 28* (6), 513-521.
[23] Polygraph Professional Suite (2008). Limestone Technologies Inc.
[24] Holmes, T. & Rahe, R. (1967). Holmes-Rahe life changes scale. *Journal of Psychosomatic Research, 11*, 213-218.

Presented at the 20th Annual Rotman Research Institute Conference: The Frontal Lobes, March 22-26, 2010, Toronto, ON, Canada

Social Sciences and Humanities Research Council of Canada
Conseil de recherches en sciences humaines du Canada
Canada