Autonomic Arousal and Decision-Making in University Students: The Potential Long-term Consequences of Mild Head Injury

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Background

Across the globe, millions of individuals are hospitalized annually due to head trauma[1]. Although 80 to 90% of injuries are classified as "mild"[2,3], there is a paucity of research into the potential socio-emotional ramifications these injuries.

The orbitofrontal cortex (OFC), a region subsumed by the VPFC, is

- Particularly susceptible to functional disruption during a minor head injury (MHI) event due to its proximal relation to the orbital bones of the skull[4]
- Involved in processing socio-emotional information/decision-making, modulating affective arousal, and regulating goal-directed behaviour with respect to environmental demands[5,6]

Individuals with injury to the VPFC/OFC, despite being intellectually intact, have

- Difficulty making decisions which have affective and/or social consequences[7]
- Attenuated anticipatory somatic responses associated with the affective/motivational significance of future events[8,9]

Reports of milder injuries, not restricted to those involving a loss of consciousness, have been associated with

- Impaired neuropsychological performance and perceptions of socially unacceptable behaviour[10,11,12]
- Atypical neural responses during cognitive tasks, evidenced by electrocortical responses and functional neuroimaging data[13,14]

Purpose

To investigate the relationships between self-reported MHI, physiological arousal, and decision-making in order to determine if individuals with milder injuries have limited emotional markers and make riskier decisions.

Hypotheses

1. The MHI and non-MHI groups do not differ in their general cognitive performance.

2. History, and severity, of MHI will be related to poorer decision-making.

3. The MHI group will respond to rewards and punishments at comparable levels to their non-MHI counterparts; however, the MHI group will be underaroused relative to the non-MHI group when anticipating the potential consequences of future decisions.

Methods

Measures

Neuropsychological:
- Design Fluency[15]
- Iowa Gambling Task (IGT)[16]

Psychophysiological:
- Electrodermal Activity (EDA)[17]

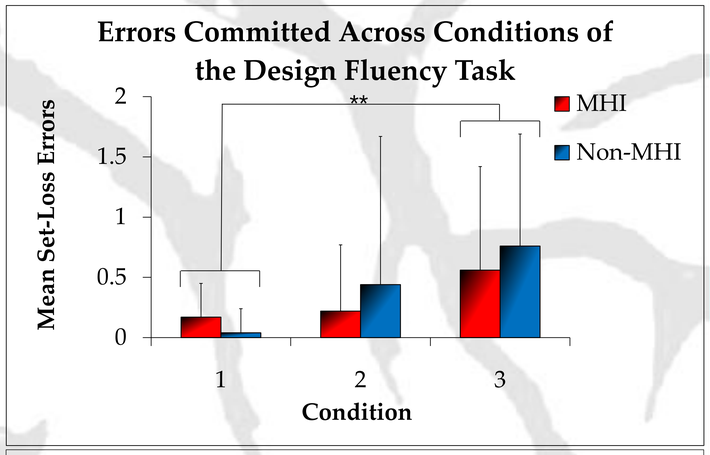
Questionnaire:
- Demographic information

Mild Head Injury criterion: *Have you ever had a head injury resulting in an altered state of consciousness (including: vomiting, dizziness, seeing stars, confusion)?*

Results

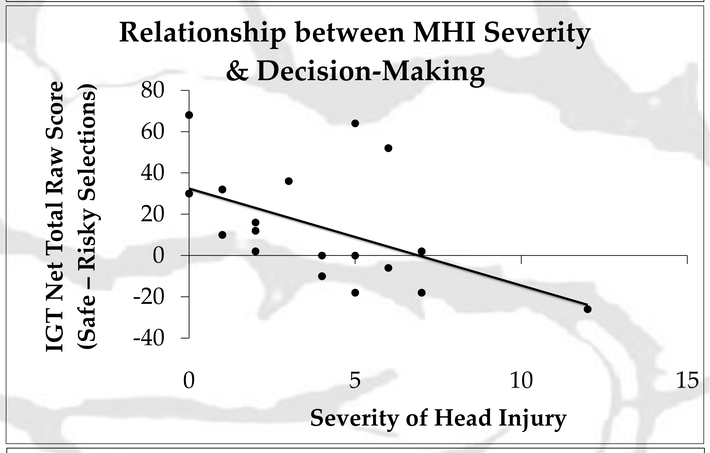
Hypothesis 1: Cognitive Performance

There was a main effect of Difficulty ($F(2, 82) = 6.17$, $p < .01$, $\eta^2 = .13$) with significantly more errors being made between the 1st and 3rd condition (**$p < .01$) for both groups. The number of errors made between the MHI and non-MHI groups did not differ and individuals in both groups made increasingly more errors as task difficulty increased



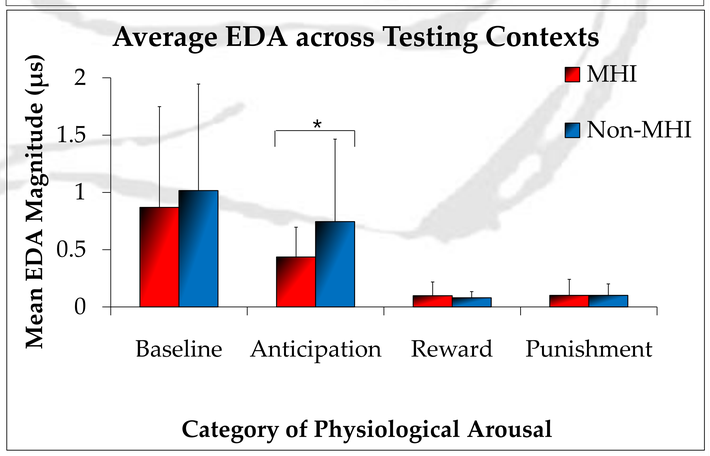
Hypothesis 2: Decision-Making

Overall decision-making performance did not vary as a function of MHI. However, self-reported injury severity was inversely related to decision-making performance – as injury status increased, decision-making efficacy decreased ($r = .51$, $p = .03$).



Hypothesis 3: Autonomic Arousal

Mean EDA magnitude was significantly different only for anticipatory arousal, during which the MHI group was significantly underaroused relative to the non-MHI group (*$p < .05$).



Discussion

- History of MHI did not relate to cognitive performance or overall decision-making capacity. These results could be explained , in part, by the subtlety of injury and/or the sample being comprised of university students.
- Self-reports on objective markers of injury severity indicated that increasingly more severe injuries were associated with the tendency to make fewer advantageous choices on a neuropsychological test of OFC dysfunction, often used in research with persons with known brain injury[16].
- The MHI group was also affectively underaroused prior to a choice event. In line with previous research involving moderate to severe cases of VPFC injury[7,8,9], our findings suggest that while individuals with a history of MHI have comparable physiological responses to feedback (rewards and punishments), they nevertheless have attenuated somatic activation when anticipating making a decision.
- This dysregulation of sympathetic arousal could compromise an individual's sensitivity to impending consequences because, in some cases, these emotional signals serve to guide/bias choices and behaviour.

Conclusions & Implications

- The neurophysiological and neuropsychological profile of MHI can mirror features of more severe injuries in that history of MHI relates to measurable differences in the mechanisms which maintain adaptive decision making.
- Examining patterns of neuropsychological/physiological limitations in university students who have sustained milder injuries provides insight as to the capacity of brain function which is not masked by more extensive and complicated traumatic injury.

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