Decision-making Strategies in Persons with and without Mild Head Injury

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Background

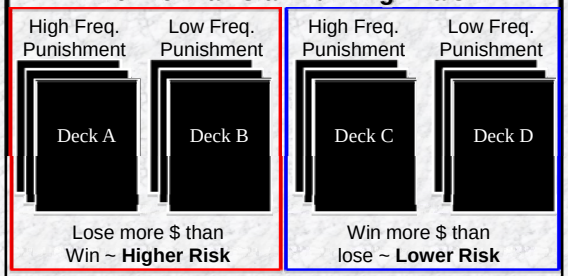
It is estimated that approximately one third of all individuals will sustain a head injury before the age of twenty-five[1], and of this, 90% of these injuries will be classified as mild (i.e., concussion)[2].

The orbitofrontal/ventromedial prefrontal cortex (OFC/VMPFC):

- Is particularly susceptible to biomechanical injury due to its close proximity to bony protrusions that surround the orbits [3, 4], even in persons with MHI [3]
- Is associated with impaired social decision-making and socio-emotional processes, despite preserved intellectual capacity [5]

According to the Somatic Marker hypothesis, bio-regulatory visceral states provide additional contextual information during these social-decisions in the form of sympathetic nervous system (SNS) physiological arousal or "**gut-feelings**" [6, 7, 8].

The Iowa Gambling Task



Individuals with OFC lesions have illustrated:

- Reduced physiological arousal, and lower arousal prior to make socially relevant decisions has been associated with riskier choices [6, 7, 9]
- A pattern of decision-making with less attention devoted to prior losses [10]

Lastly, the literature is still unclear about the role of explicit knowledge in the development of these markers [11, 12].

Hypotheses

1. Individuals who have experienced a previous MHI will demonstrate riskier decision making than their non-MHI cohort by making a slower transition from disadvantageous (higher risk) to advantageous (lower risk) deck selections.

2. Persons in the non-MHI group will demonstrate more explicit knowledge about the strategies they applied during deck selection than those with MHI.

3. MHI will be physiologically underaroused prior to making a decision in comparison to their non-MHI cohort.

Methods

Measures

Neuropsychological:
- Iowa Gambling Task (IGT)[7]

Physiological
- Electrodermal Activity (EDA) [13]

Questionnaire Based:
- Explicit Knowledge/Strategy [12]
- Demographics (i.e., MHI History, etc)

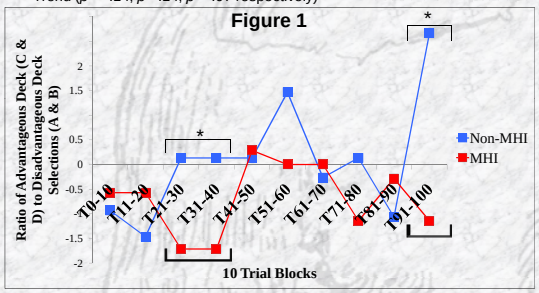
Participants

22 Brock University Students (8 pending)
- 7 individuals reporting a MHI (32%)
  - 3 males and 4 females
  - 3 had a LOC greater than 5 minutes
  - 2 had more than one injury
  - 4 treated medically but did not stay over night
- 15 individuals not reporting a MHI (68%)

Results

* = Trend (p = .14, p =.14, p = .07 respectively)

Figure 1



Hypothesis 1: IGT Performance

Figure 1: MHI subjects illustrate a slower tendency in shifting from disadvantageous to advantageous deck selections (as a function of ratio) than their non-MHI cohort (F (4.51, 90.17) = 1.06, p = ns).

This is despite the two groups not differing in number of cards chosen from each deck (F (1, 20) = 0.30, p = ns).

Hypothesis 2: Explicit Knowledge

Figure 2

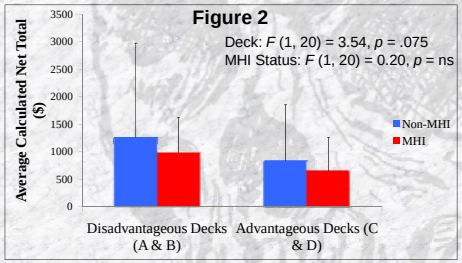


Figure 2: Participant's explicit knowledge is insufficient to account for their learning to differentiate between advantageous and disadvantageous decks mimicking the **dissociation between knowing and doing**.

Hypothesis 3: Physiological Arousal

Figure 3

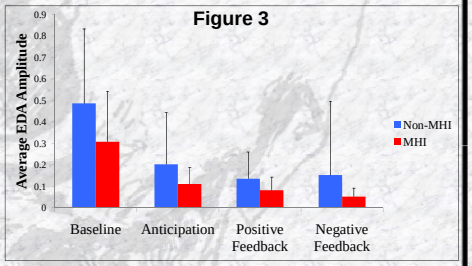


Figure 3: MHI present physiologically underaroused relative to their cohort at baseline and throughout the study (as predicted; F (1,20) = 2.31, p = .14).

Figure 4

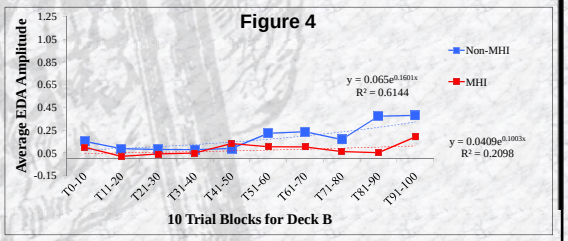
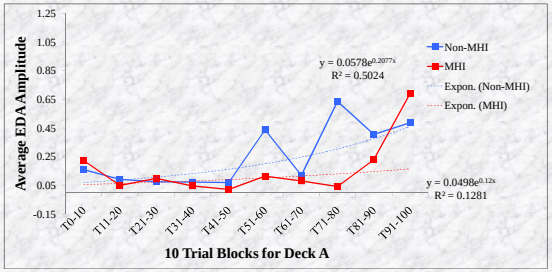
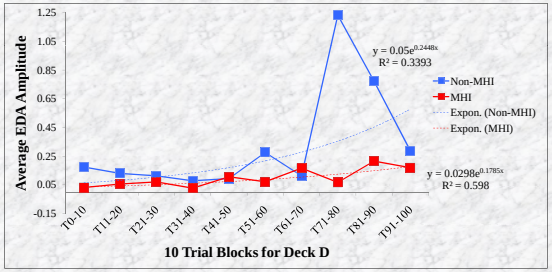


Figure 4: MHI subjects illustrate less physiological activation to Deck B, which has infrequent but highly costly punishment trials. MHI have lessened responses to prior losses, which in turn, leads to less avoidance of disadvantageous decks.

Results Cont'd

Anticipatory Physiological Arousal





Particularly during the later trials, MHI remain physiologically underaroused during anticipation of making a selection compared to the non-MHI group. Difficulties eliciting **somatic markers** that would typically guide decision-making processes[6, 7] may account for the alterations in IGT learning rate between MHI and non-MHI groups.

Conclusions & Implications

- Alterations in decision-making processes can occur even in mild forms of head injury. This has substantial implications for social decision-making (i.e., financial, interpersonal etc.)[7], whereby individuals who have sustained mild injuries may be more inclined to make riskier decisions which, in turn, may lead to adverse outcomes.

- Further, participants' knowledge about the outcomes associated with the various decks did not account for the choices they made, indicating that there is something other than rational monitoring guiding behaviour, such as implicit somatic markers. This mimics the dissociation between what participants know and how they behave.

- As expected, MHI were physiologically underaroused when making decisions as compared to their non-MHI cohort. This may reflect a neurally-based compromised affective sensitivity to consequences of decision outcomes (i.e., prior losses), resulting in lessened avoidance to disadvantageous decisions.

- Finally, observing behaviour in MHI individuals that mirror those with more severe trauma illustrates the neuropsychological continuum associated with traumatic acquired brain injury.

References

[1] McKinlay, A., et al.. (2008). Prevalence of traumatic brain injury among children, adolescences and young adults: Prospective evidence from a birth cohort. *Brain Injury, 22*(2), 175-181.
[2] Iverson, G. L., & Lange, R. T. (2009). Moderate and severe traumatic brain injury. In M. R. Schoenberg and J. G. Scott (Eds.), *The black book of neuropsychology: A syndrome based approach*. New York: Springer.
[3] Bigler, E. (2001). The lesion(s) in traumatic brain injury: Implications for clinical neuropsychology. *Archives of Clinical Neuropsychology, 16*, 95-131.
[4] Wallis, J. (2007). Orbitofrontal cortex and its contribution to decision-making. *Annual Review of Neuroscience, 30*, 31-56. doi: 0147-006X/07/0721-0031
[5] Bechara, A., Damasio, A., Damasio, H., & Anderson, S. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*, 7-15.
[6] Bechara, A. (2004). The role of emotion in decision-making: Evidence from neurological patients with orbitofrontal damage. *Brain and Cognition, 55*, 30-40.
[7] Bechara, A., Tranel, Damasio, & H. (2000). Characterization of the decision-making deficit of patients with ventromedial prefrontal cortex lesions. *Brain, 123*, 2189-2202.
[8] Damasio, A. (1994). *Descartes' error: Emotion, reason and the human brain*. New York: G.P. Putnam.
[9] Bechara, A., et al.(1996). Failure to respond autonomically to anticipated future outcomes following damage to prefrontal cortex. *Cerebral Cortex, 6*(2), 215-225.
[10] Yechiam, E., Busemeyer, J., Stout, J., & Bechara, A. (2005). Using cognitive models to map relations between neuropsychological disorders and human decision-making deficits. *Psychological Science, 16*(12), 973-978.
[11] Bechara, A., Damasio, H., Tranel, D., & Damasio, A. (1997). Deciding advantageously before knowing the advantageous strategy. *Science, 275*(5304), 1293-1295.
[12] Maia, T., & McClelland, J. (2004). A reexamination of the evidence for the somatic marker hypothesis: What participants' really know in the Iowa gambling task. *PNAS, 101*(45), 16075-16080.
[13] Polygraph Professional Suite. Limestone Technologies Inc.: Odessa, Ontario, Canada.