Affective Influence on Physiological Arousal in Individuals With and Without MHI

Katie Peck, Hons. BA Candidate, & Dawn Good, Ph. D., C. Psych.
Brock University, St. Catharines, Ontario

INTRODUCTION

Mild head injury has been demonstrated to have a 30-37% prevalence rate among a sample of University students[1], and its incidence is predominantly a result of falls, sports-related injuries, and motor vehicle accidents.[2]

Evidence from clinical populations demonstrates that individuals with damage to the Ventromedial Prefrontal Cortex (VMPFC) present with deficits in decision making and physiological arousal[3]. Further, according to the Somatic Marker Hypothesis emotions and SNS physiological arousal, or "gut feelings", from the viscera are disrupted with damage to the orbitofrontal cortex (OFC) can be associated with more disadvantageous decision making.[4,5]

According to the Yerkes-Dodson Law[6], cognitive performance is directly proportional to one's level of physiological arousal such that very low and high levels of arousal correspond to low levels of cognitive performance, and an optimal level of arousal corresponds to optimal cognitive performance. Given that individuals who have reported a history of MHI also present with physiological underarousal (compared to non-MHI cohorts at baseline)[7], decision making may be expected to be affected in this population.

Affective stimuli such as music have been shown to evoke strong emotional responses and physiological arousal[8], and levels of arousal in turn, have been shown to influence cognitive performance[9]

Research Question:
Will music influence arousal levels and impact the cognitive performance in persons with MHI?

HYPOTHESES

I. Individuals with MHI will be more physiologically underaroused compared to their non MHI cohort at baseline.

II. An induction of music with negative valence is predicted to increase physiological arousal in persons with MHI.

III. Increased physiological arousal will benefit individuals with MHI and, therefore, permit increased cognitive performance and advantageous decision making.

REFERENCES

[1] Segalowitz, S. J., & Lawson, S. (1995). Subtle symptoms associated with self-reported mild head injury. *Journal of Learning Disabilities, 28*, 309-319.
[2] Cassidy, D. J., Carroll, L. J., Peloso, P. M., Borg, J., van Holst, H., & Holm, et al. (2004). Incidence, risk factors and prevention of mild traumatic brain injury: Results of the WHO collaboration centre task force on mild traumatic brain injury. *Journal of Rehabil. Med, Suppl. 43*, 28-60.
[3] Bechara, A., Tranel, D., Damasio, H., & Damasio, A. R. (1996). Failure to respond autonomically to anticipated future outcomes following damage to prefrontal cortex. *Cerebral Cortex, 6*, 215-225.
[4] Damasio, A. R. (1996). The somatic marker hypothesis and the possible functions of the prefrontal cortex. *Philosophical Transactions: Biological Science, 351*, 1413-1420.
[5] Bechara, A., Damasio, H., & Damasio, A. R. (2000). Emotion, decision making and the orbitofrontal cortex. *Cerebral Cortex, 10*, 295-307.
[6] Anderson, K. W. (1990). Arousal and the inverted-U hypothesis: A critique of Neiss' "Reconceptualizing arousal". *Psychological Bulletin, 107*, 96-100
[7] Baker, J. S., & Good, D. (2009). Investigating the effects of arousal state on cognitive performance in individuals with and without mild head injury. Frontiers of Human Neuroscience. doi: 10.3389/conf.fnins.2010.14.00176.
[8] Rickard, N. (2004). Intense emotional responses to music: A test of the physiological arousal hypothesis. *Psychology of Music, 32*, 371-388.
[9] Jefferies, L. N., Smilek, D., Eich, E., & Enns, J. T. (2006). Emotional valence and arousal interact in attentional control. *Psychological Science, 19*, 290-295.
[10] Watson, D., Clark, L. A., & Tellegen, A. (1988). Development and validation of brief measures of positive and negative affect: The PANAS scales. *Journal of Personality and Social Psychology, 54*, 1063-1070.
[11] Polygraph Professional Suite. Limestone Technology Inc., Odessa, On, Canada.
[12] Bechara, A., Damasio, A. R., Damasio, H., & Anderson, S. W. (1994). Insensitivity to future consequences following damage to human prefrontal cortex. *Cognition, 50*, 7-15.

METHODS

Participants:
N = 27; 44.4% self-reported sustaining an MHI
Of those reporting an MHI, 50% were male and 50% were female.
Procedure:
Arousal Manipulation
Participants were randomly assigned to a "No Music" or "Negative Music" Condition.
Dependent Measures
- Self-report indices of MHI, affect, and arousal state
- Positive and Negative Affect Schedule (PANAS)[10]
- Continuous Physiological Electrodermal Activity (EDA)[11] recording
- Iowa Gambling Task (IGT)[12] performance

RESULTS

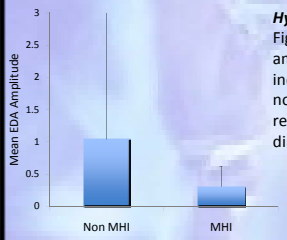

Figure 1. Baseline EDA Amplitude

Hypothesis I:
Figure 1 depicts the mean EDA amplitude of Non MHI and MHI individuals at baseline. There was not a significant difference, but the result is in the expected pattern direction, $t(24) = 1.13$, $p = .16$.

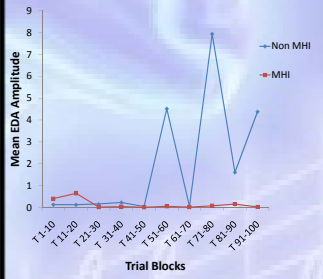

Figure 2. Deck A EDA in No Music Condition

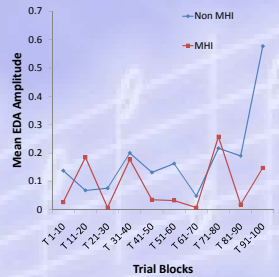

Figure 3. Deck A EDA in Negative Music Condition

Hypothesis II:
Figures 2 and 3 depict mean EDA amplitude across 10 blocks (of 10 trials each) on the IGT for MHI and non MHI individuals across the two arousal conditions (no music, negative music). A significant interaction effect was found of EDA x Arousal Condition (no music, negative music) x MHI status, $F(9,54) = 97.99$, $p < .001$. Whereas MHI remain physiologically underaroused across trials in the no music condition relative to the non MHI group, physiological arousal is increased when music is introduced, regardless of deck choice.

RESULTS CONT.

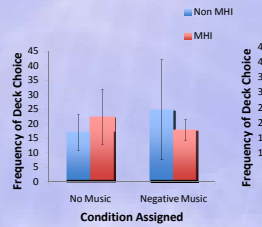

Figure 4. Frequency of Disadvantageous Deck A choices

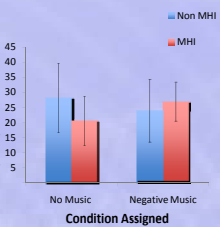

Figure 5. Frequency of Advantageous Deck D choices

Hypothesis III:
Figure 4 and 5 depict a significant trend with respect to a 3-way interaction of Deck Selection (A and D) x Arousal Condition (no music, negative music) x MHI, $F(1,23) = 3.27$, $p = .08$, such that MHI subjects are more likely to make advantageous deck selections when their arousal is increased, whereas non MHI perform optimally under control conditions.

DISCUSSION

Although the difference between individuals with and without a MHI was not statistically significant at baseline, the decreased physiological levels of arousal of MHI subjects as compared to Non MHI cohorts was in the expected direction. An increase in sample size and, thus, an increase in power may enhance this finding. Further, music (associated with negative valence) increased levels of arousal significantly in individuals reporting a MHI.

Finally, there was a significant trend for the 3-way interaction on IGT performance (i.e., frequency of overall deck choice). Individuals with MHI who were exposed to music, and demonstrated a consequent increase in physiological arousal, demonstrated an accompanied increase in their frequency of advantageous decisions. Conversely, non MHI individuals, under the negative Music Condition, increased in their frequency of disadvantageous decisions.

In summary, these results demonstrate arousal has an impact on, and may act as an important mediator in, social decision making and cognitive function in persons with and without MHI . Increases in attention and alertness can improve one's decision making (at least in situations of uncertainty) perhaps by making one more aware to both the social context and outcomes as well as to one's physiological feedback ('gut feeling').

This research also has implications for the possible therapeutic intervention of using music to ameliorate deficits in decision making, arousal, and emotional dysregulation which can persist in individuals with head injuries, even those that are mild in nature and in persons who are asymptomatic (i.e., University students).