Affective Influences on Physiological Arousal in Individuals With and Without MHI

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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 sympathetic nervous system (SNS) physiological arousal, or "gut feelings", from the viscera are disrupted with damage to the **Orbitofrontal cortex (OFC)** which 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]. Furthermore, music associated with both positive and negative valence of a fast tempo has been shown to improve cognitive performance[10].

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. Induction of music with both positive and negative valence is predicted to increase physiological arousal in persons with MHI.

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

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METHODS

Participants:
N = 44; 34% self-reported sustaining a MHI

Of those reporting an MHI:
- 46.7% were male and 53.3% were female
- 46.7% reported multiple MHI's
- 40% reported a loss of consciousness
- 60% reported sustaining a concussion

Procedure:
Arousal Manipulation
Randomly assigned to a "**No Music**" (Pink Noise) , "**Negative Music**", or "**Positive Music**" Condition (Classical music selections)

Dependent Measures:
- Self-report indices of MHI, affect, and arousal state
- Positive and Negative Affect Schedule (PANAS)[11]
- Continuous Physiological Electrodermal Activity (EDA)[12] recording
- Iowa Gambling Task (IGT)[13] performance

RESULTS

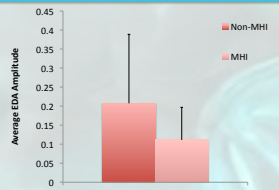

Figure 1. Baseline EDA Amplitude

Hypothesis I: Baseline Arousal
Individuals with MHI had lower levels of physiological arousal at baseline compared to non-MHI counterparts, as depicted by EDA amplitude, ***t*(42) = 2.33, *p* < .05.**

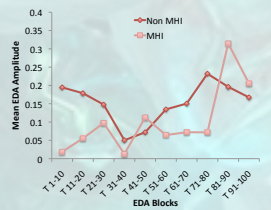

Figure 2. Blocks of EDA Amplitude in 10 trial blocks in the IGT for the "No Music" Condition

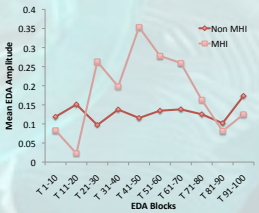

Figure 3. Blocks of EDA Amplitude in 10 trial blocks in the IGT for the "Music" Condition

Hypothesis 2: Induction of Music and Physiological Arousal
For the purpose of analyses, the "positive" and "negative" music/arousal conditions were collapsed and combined into a "Music" condition. **Figures 2 and 3** respectively depict the average EDA amplitude across 10 trial blocks of the IGT in the "No Music" and "Music" conditions for both non MHI individuals, and those reporting MHI status. The induction of music shows the expected pattern in individuals reporting MHI status such that an increase in physiological arousal is observable compared to non MHI counterparts (Figure 3), $F(9, 171) = 0.54$, $p = ns$.

RESULTS CONT.

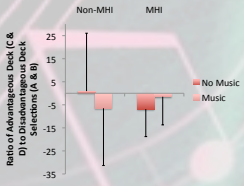

Figure 4. Overall Ratio of IGT Deck Selection

Hypothesis 3: Music and Cognitive Performance
Figure 4 depicts the influence of induction of music: persons with MHI demonstrate increased advantageous choices, whereas it results in a decrease in advantageous choices for Non MHI individuals, ***F*(1, 40) = .86, *p* = *ns*.** **Figure 5 and 6** show the trend for a significant 3-way interaction of MHI status x deck choice x Arousal ("No Music" vs. "Music") such that induction of music increases the selection of advantageous choices for persons with MHI compared to when music is not present, ***F*(1, 34) = 2.86, *p* = .10.**

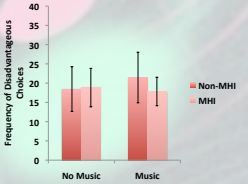

Figure 5. Frequency of Disadvantageous choices (Deck A) in both the "No Music" and "Music" Conditions for Non-MHI and MHI status.

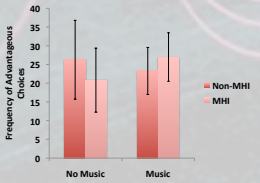

Figure 6. Frequency of Advantageous choices (Deck D) in both the "No Music" and "Music" Conditions for Non-MHI and MHI status

DISCUSSION

Levels of physiological arousal as measured by EDA Amplitude, differed significantly at baseline such that Individuals reporting MHI status demonstrated significantly lower levels of physiological arousal compared to their non MHI cohort. This result is consistent with previous findings demonstrating lower levels of physiological arousal in University students reporting an MHI status relative to their non MHI counterparts at baseline[7].

Further, an induction of music (associated with both positive and negative valence) did not significantly increase levels of physiological arousal (as demonstrated by EDA amplitude) in individuals with MHI status during the IGT. However, the pattern of results are in the predicted direction as shown in Figure 3, so this finding will be pursued in future studies such that an induction of music appears to be increasing levels of physiological arousal in persons with MHI compared to those without MHI status.

Finally, there was a 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 showed an increase in physiological arousal in the expected direction, demonstrated an accompanied increase in their frequency of advantageous decisions. Conversely, non MHI individuals, under the "Music" Condition, increased in their frequency of disadvantageous decisions. An increase in sample size and, thus, an increase in power may enhance this finding.

In summary, these results demonstrate the influence of arousal on, and could 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).

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