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Performance On The Repeatable Battery For The Assessment Of Neuropsychological Status (rbans) In A Mild Traumatic Brain Injured Sample

Autumn Rose Arch

PERFORMANCE ON THE REPEATABLE BATTERY FOR THE ASSESSMENT OF NEUROPSYCHOLOGICAL STATUS (RBANS) IN A MILD TRAUMATIC BRAIN INJURED SAMPLE

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This thesis, submitted by Autumn Arch in partial fulfillment of the requirements for the Degree of Master of Arts from the University of North Dakota, has been read by the Faculty Advisory Committee under whom the work has been done and is hereby approved.

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ABSTRACT

The majority of individuals are believed to recover within several months following a mild traumatic brain injury (MTBI). However, some individuals may continue to experience persistent symptoms including cognitive, emotional, and behavioral problems. This study compared the performance of college students with self-reported MTBI to non-head injured peers on the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) index and subtest scores using independent-samples *t*-tests. The Beck Depression Inventory-II (BDI-II), State-Trait Anxiety Inventory (STAI) and Alcohol Use Disorders Identification Test (AUDIT) were also used to compare symptoms of depression, anxiety and alcohol use between groups. The results of this study did not support the hypotheses. Significant differences between groups were found for the RBANS Delayed Memory Index and the STAI trait subscale. This study contributed to MTBI research in that it gathered information regarding cognitive performance, symptoms of depression and anxiety, and alcohol use in a sample of college students with MTBI.

Key words: Mild traumatic brain injury, the Repeatable Battery for the Assessment of Neuropsychological Status, postconcussion disorder, college students.

CHAPTER I

INTRODUCTION

Approximately 1.5 million people in the United States suffer from a traumatic brain injury (TBI) each year of which 70% to 90% are estimated to be of mild severity (American Psychiatric Association [APA], 2013; Cassidy et al., 2004; Gerberding & Binder, 2003). TBI is caused by an external mechanical force causing acceleration, deceleration, and/or rotation of head neck. TBI may result in an altered mental state characterized by decrease or loss of consciousness (LOC), and/or amnesia, as well as other neurological deficits. TBI severity is classified along a continuum from mild to moderate to severe based on the presence and duration of LOC and amnesia (APA, 2013; Gerberding & Binder, 2003; McCrea, Janecek, Powell & Thomas; 2014; Stulemeijer, van der Werf, Borm & Vos, 2008).

Many individuals experience a combination of symptoms following MTBI, often referred to as postconcussion syndrome (PCS). The signs and symptoms of MTBI generally fall into four categories: physical, cognitive, behavioral, and sleep disturbance. For the majority of individuals, these symptoms resolve within days to months post-injury, however, a small subset of individuals may continue to report persistent symptoms, commonly referred to as postconcussion disorder, (McCrea et al., 2009; Stulemeijer et al., 2008). Previous research has suggested that the symptoms of MTBI may result in academic difficulties for college students with a history of MTBI (Kennedy, Krause & Turkstra, 2008). Some individuals who appear to have recovered from a MTBI may continue to experience subtle cognitive impairments. In addition, many of the commonly used neuropsychological measures may not be sensitive to these cognitive deficits making it difficult to determine whether an individual has fully recovered after MTBI (Iverson, 2010; Maruff et al., 2009; Ozen & Fernandes, 2012; Segalowitz, Bernstein & Lawson, 2001).

Mild Traumatic Brain Injury

Classification and Diagnostic Criteria

TBI refers to an alteration in brain function resulting from an external mechanical force causing in acceleration, deceleration and/or rotation of the head and neck. TBI is characterized by decrease or loss of consciousness, loss of memory of events before (retrograde amnesia) or after (anterograde or post-traumatic amnesia [PTA]) the injury, and neurological deficits, and/or alteration in mental state at the time of injury (APA, 2013; Gerberding & Binder, 2003; McCrea et al., 2014; Stulemeijer et al., 2008). The effects of the mechanical forces on the head during TBI often results in traumatic axonal injury (TAI) (also referred to as diffuse axonal injury (DIA)). TAI occurs when the forces from the injury cause axons to be stretched, resulting in a disruption of neural functioning. In MTBI, this neuronal dysfunction is usually temporary and typically does not result in structural injury to neurons, axons or measurable cell death. Clinical symptoms and recovery time are typically associated with the duration of neural disruption (McCrea et al., 2014).

The severity of TBI is classified along a continuum from mild to moderate to severe. Severity is often determined based upon the presence and duration of LOC and amnesia (APA, 2013; McCrea et al., 2014). One of the most commonly used methods for grading TBI severity is the Glasgow Coma Scale (GCS) which assesses motor function, verbal responding, and ability to open eyes voluntarily or in response to external commands and stimuli to provide a measure of gross neurological status (Jennett & Teasdale, 1981). In cases of MTBI however, LOC and (PTA), although important indicators of acute injury severity, are less indicative of recovery time and outcome (McCrea et al., 2014). Thus, other classification systems have been developed to grade milder TBI that include acute injury characteristics and other defining signs and symptoms of MTBI (McCrea et al., 2014; Stulemeijer et al., 2008). The present study used the World Health Organization (WHO) Collaborating Centre Task Force on MTBI criteria to define MTBI. Following this criteria, MTBI was operationally defined as a mechanical force resulting in physiological disruption of brain function as manifested by at least one of the following: (1) confusion or disorientation; (2) LOC for 30 minutes or less; and/or (3) PTA for less than 24 hours (Carroll, Cassidy, Holm, et al., 2004).

Epidemiology

Approximately 1.7 million people in the United States suffer from a traumatic brain injury (TBI) each year (APA, 2013). Based upon traditional case definitions, it is estimate that 70% to 90% of all treated TBI cases are of mild severity. The main causes of MTBI are motor-vehicle collisions and falls(Cassidy et al., 2004; Gerberding & Binder, 2003).. The risk of suffering a MTBI is greater in males than females and is highest in teenage and young adults (Cassidy et al., 2004). Across studies, the prevalence of college students with a history of MTBI has been estimated to be approximately 21% to 35% (Cassidy et al., 2004; LaForce & Martin-Mcleod, 2001; Segalowitz & Lawson, 1995; Triplett, Hill, Freeman, Rajan & Templer, 1996). It is important to note that, due to the variability of case definitions and methods for classifying MTBI across studies, these estimates may underrepresent the true incidence of MTBI. In addition, epidemiological studies that utilize hospital-based data, may underestimate the incidence of MTBI because many people who suffer a milder head injury do not seek medical attention (Gerberding & Binder, 2003; McCrea et al., 2014).

Postconcussion Syndrome

Many individuals who suffer from MTBI report a combination of symptoms occurring within the first few days following their injury commonly referred to as PCS (McCrea et al., 2014; Stulemeijer et al., 2008). These symptoms may be clustered into four categories: physical, cognitive, behavioral/emotional and sleep disturbance. Which also includes headache, blurred vision, dizziness and vertigo, sensitivity to light and sound, fatigue, concentration problems, forgetfulness, slowed thinking, drowsiness, difficulty falling asleep, sleeping more or less than usual, irritability, depression, and anxiety (Gerberding & Binder, 2003; McCrea et al., 2014). The potential consequence and severity of these symptoms are often underestimated by people who suffer MTBI and their health care providers. These symptoms may result in difficulties with daily activities and returning to work (Erez, Rothschild, Katz, Tuchner & Hartman-Maeir, 2009; Gerberding & Binder, 2003). These symptoms, however, typically recede over time with the majority of individuals recovering within the first few months postinjury (Carroll, Cassidy, Peloso, et al., 2004; Gerberding & Binder, 2003; Stulemeijer et al., 2008). If residual symptoms remain, they are generally mild and are mostly unnoticed by the individual creating little to no difficulties with everyday activities (Stulemeijer et al., 2008). A subset of individuals, however, may continue to report symptoms that persist beyond the duration expected for the recovery of neuronal dysfunction resulting from the injury (APA, 2013; McCrea et al., 2014). This is often referred to as postconcussive disorder (PCD) and is characterized by persistent symptoms following a MTBI lasting longer than three months (McCrea et al., 2014). These symptoms are often perceived as severe and distressing and may interfere with social and occupational functioning (Stulemeijer et al., 2008).

The biopsychosocial model of PCD suggests that PCD-related symptoms are contributed and maintained by multiple factors including cognitive, emotional, medical, psychosocial, and motivational factors (Carroll, Cassidy, Pelso, et al., 2004; Iverson, Zasler & Lange, 2007; McCrea et al., 2014). Pre-injury factors include demographic characteristics (e.g., female gender, older age), psychiatric problems (e.g., depression, anxiety), alcohol and substance abuse, and prior history of MTBI. Post-injury factors include psychosocial (e.g., limited social support systems, unstable relationships, poor coping strategies), medical (e.g., severe associated injuries, comorbid medical or neurological disorders), and situational (e.g., litigation or compensation claims, concurrent PTSD) factors (Carroll, Cassidy, Peloso, et al., 2004; Gerberding & Binder, 2003; Panayiotou, Jackson & Crowe, 2010; Ruff, Iverson, Barth, Bush & Broshek, 2009).

Several behavioral health interventions have suggested possible treatments for PCD. These include symptom management and cognitive restructuring of inaccurate, distorted, and/or misattributed symptoms (McCrea et al., 2014; Ponsford, 2006). In addition, providing brief education and cognitive-behavioral training to MTBI patients within hours or days following their injury has been suggested as an effective preventative treatment for PCD (McCrea et al., 2014; Silverberg et al., 2013).

MTBI in College Students

In regards to PCS in college students, research has indicated that students may endorse a greater number of physical symptoms followed by behavioral and emotional changes, problems with cognition, and social changes. The most common physical problems included dizziness, headaches, fatigue, and blurred vision. Changes in behavior and mood, characterized by increased irritability, frustration, aggressiveness, and lack of motivation, as well as increased anxiety and depression, are the most commonly reported behavioral symptoms. Cognitive symptoms include difficulties with attention, changes in thinking and memory, and problems with organization and decision making. Other problems included changes in peer relationships and extracurricular activities (Kennedy et al., 2008; LaForce, Jr. & Martin-Macleod, 2001). Also higher levels of emotional distress may be correlated with college students who had suffered a MTBI in childhood or adolescence (Marschark, Richtsmeier, Richardson, Crovitz & Henry, 2000).

These symptoms following MTBI may interfere with students ability to keep up with their academic demands. Specifically, research has suggested that students with MTBI experience academic difficulties characterized by having to review material more often, being nervous before tests, feeling overwhelmed while studying, difficulties attending to and remembering information from presented in class, and problems with time management (Kennedy et al., 2008).

College students who experience these difficulties following MTBI may require academic accommodations from campus disability services while they are recovering from their injury. Kennedy and colleagues (2008) have indicated that, although more than 80% of the students with TBI in their study reported academic difficulties, less than half of the students utilized campus disability services and 20% reported not knowing of these services. Students may need longer time to complete tasks, have increased difficulty paying attention during class, and have trouble remembering and learning new information. Furthermore, these symptoms may increase in response to more demanding tasks or other stressors (Gerberding & Binder, 2003). Students reporting symptoms following a MTBI may require extended time for assignments and exams or a reduced class load (Gerberding & Binder, 2003).

Neuropsychological Assessment of MTBI

Neuropsychological assessment has been used clinically and in research to identify and characterize cognitive, behavioral, and emotional deficits related to brain functioning. Assessment of MTBI is one of the most common diagnostic activities in clinical neuropsychology (Rabin, Barr & Burton, 2005). Brief neuropsychological testing following MTBI may be used to monitor recovery and facilitate treatment recommendations and to determine if a more comprehensive neuropsychological evaluation is appropriate. In addition, short neuropsychological batteries may be of particular use in guiding decisions about the presence, nature, and progression of cognitive impairment when performance must be measured repeatedly over short intervals to identify cognitive changes in a relevant time frame, as is the case in TBI. In addition, brief neuropsychological evaluations may also be used, in collaboration with other care providers, to provide patients and families with education about the normal course of recovery after MTBI. It may also be used to facilitate treatment of secondary issues such as sleep disturbance, emotional distress and pain, that may delay cognitive recovery (Carroll, Cassidy, Peloso, et al., 2004; Kosaka, 2006; McCrea et al., 2014).

Cognitive Performance Following MTBI

The cognitive effects of MTBI are highly variable and are related to how the injury occurred and other injury characteristics such as the presence and duration of LOC or PTA. Previous research has suggested that MTBI may result in cognitive impairment, characterized by difficulties with attention and concentration, information processing speed, recall of new information, working memory, and executive functions (Gerberding & Binder, 2003; Frencham, Fox & Maybery, 2005; Horton & Wedding, 2008; Kolb & Wishaw, 2009; LaForce & MacLeod, 2001; Maruff et al., 2009; Spitz, Maller, O'Sullivan & Ponsford, 2013). Research is mixed in regards to the duration of cognitive impairment after MTBI. Many conclude that the majority of individuals with MTBI will recover within several months post-injury (Carroll, Cassidy, Pelso, et al., 2004; McCrea et al., 2009; Rohling et al., 2011). Other researchers, however, have suggested that some individuals with MTBI may experience long-term cognitive impairment (Geary, Kraus, Rubin, Pliskin & Little, 2010; Iverson, 2010; Konrad et al., 2010; Miles et al., 2008; Ozen

& Fernandes, 2012; Vanderploeg, Curtiss, Luis & Salazar, 2007). In addition, normal performance on cognitive tests may be a result of adaptations to cognitive changes following MTBI rather than recovery to pre-injury levels of functioning (Chuah, Maybery & Fox, 2004; Ozen & Fernandes, 2012).

For example, in a previous study, Ozen and Fernandes (2012) measured the accuracy and information processing speed of high functioning university students with a history of MTBI on a working memory task with differing levels of cognitive difficulty. Their results indicated that individuals with MTBI were as accurate as controls on working memory tasks of low cognitive demand and more accurate on tasks that were more demanding tasks. However, the MTBI group’s response time was significantly slower as the tasks became more demanding. The authors suggested that MTBI individuals may engage in compensation strategies to increase accuracy on working memory tasks resulting in reduced processing speed. These authors emphasized the importance of using assessment tools that are sensitive to the subtle cognitive deficits found in individuals with MTBI, especially when examining long-term cognitive changes (Ozen & Fernandes, 2012).

In another study, Beers, Goldstein and Katz (1994) attempted to identify neuropsychological and academic achievement variables that could differentiate college students with learning disabilities, college students with mild head injury, and a control group. Their results indicated that students with mild head injury have decreased performance on timed tests that required attention, visual-spatial ability, and abstract concept formation compared to students with learning disabilities. The authors suggested that neuropsychological measures testing processing speed are the most sensitive to mild head injury and that these students may need rehabilitation services to manage difficulties related to cognitive impairment involving memory, attention, and problem solving (Beers et al., 1994).

In another study, Segalowitz and colleagues (2001) examined subtle attention deficits in well-functioning university students with a history of MTBI. Performance on several standard cognitive assessment measures and auditory vigilance tasks were compared across the MTBI group and control group. Differences were found between groups on the auditory vigilance tasks requiring sustained and divided attention; however, no differences were found between groups on standard cognitive assessment measures. Given that the average length of time since the MTBI in the sample was approximately six years, the authors suggested that subtle attention deficits may persist even after the individual has been considered to be recovered from the injury (Segalowitz et al., 2001).

The Repeatable Battery for the Assessment of Neuropsychological Status

The Repeatable Battery for the Assessment of Neuropsychological Status (RBANS) is a brief assessment tool comprised of 12 subtests designed to measure cognitive domains of memory, visual-perceptual skills, attention and language (Randolph, 1998). It was initially designed for the assessment of dementia but has since been demonstrated as a useful screening tool in several different populations including Alzheimer’s Dementia, Huntington’s disease, Vascular Dementia, Schizophrenia, and mixed severity TBI and for screening cognitive status in younger adults (Duff et al., 2008; Gold, Queern, Iannone & Buchanan, 1999; McKay, Wertheimer, Fichtenberg &

Casey, 2008; Randolph, Tierney, Mohr & Chase, 1998). After a MTBI, follow-up assessments are recommended due to the possibility of symptoms persisting for several months or longer following the injury (Gerberding & Binder, 2003; Kosaka, 2006; McCrea et al., 2014). Because of this, batteries that allow for repeatable assessments such as the RBANS may be useful. The RBANS may be a beneficial screening tool in the assessment of individuals with MTBI due to its short completion time, ease of administration and alternative forms for repeated evaluations. In addition, the range of cognitive domains measured by the RBANS and its sensitivity to milder impairments may suggest that it could be useful in detecting the subtle cognitive deficits associated with MTBI (McKay et al., 2008; Randolph, 1998).

Several studies have examined the utility of the RBANS for assessing cognitive impairment in TBI samples. For example, McKay and colleagues (2008) examined the clinical utility of the RBANS in a mixed severity TBI sample. Their results yielded significant differences between the TBI and control group across all RBANS index scores. Specifically, the TBI group obtained the lowest scores on the Total Scale Index followed by the Attention Index, Delayed Memory Index, Immediate Memory Index and Language Index with Visuospatial/ Constructional Index resulting in the highest scores. Furthermore, results for the Attention Index indicated that it was the most sensitive to TBI. They suggested that this results may be due to the sensitivity of the coding subtest to processing speed deficits commonly seen in TBI. Overall, the McKay et al. (2008) concluded that the RBANS Total Scale score may be a good indicator of overall neurocognitive functioning and that RBANS in general would be a useful screening tool for TBI. These authors also suggested that future research may benefit from studies examining the clinical utility of the RBANS in MTBI samples.

In another study, McKay and colleagues (2007) examined the internal reliability of the RBANS Index scores as well as the construct validity of the RBANS subtest scores in a group of individuals who had experienced a moderate-severe TBI. Their results supported their hypotheses in that strong internal reliability was found in regards to the RBANS Total Scale Index, Immediate Memory Index, Delayed Memory Index and Visuospatial/ Constructional Index while the Language Index and Attention Index showed the weakest reliability. Strong correlations were found between the RBANS subtests and corresponding neuropsychological measures indicating good convergent validity. McKay and colleagues (2007) concluded that the RBANS would be a reliable and valid screening measurement for the assessment of neurocognitive problems in individuals with moderate-severe TBI. They suggested that, given the inconsistent sensitivity of the subtests comprising the Attention and Language Indexes, interpretation of these subtests may be useful in overall profile interpretation when assessing individuals with TBI.

Few studies have used the RBANS to measure cognitive impairment in MTBI samples. For example, Killam, Cautin and Santucci (2005) utilized the RBANS to compare neuropsychological impairment between athletes who had reported a recent concussion (within the last two years), athletes who had reported a non-recent concussion (at least two years prior to the study), athletes with no reported history of concussion, and non-athletes with no reported history of concussion. Their results indicated that, compared with the non-athlete group, the recently concussed group performed significantly worse on the Immediate Memory Index and the Delayed Memory Index. Scores on the Total Scale Index were significantly lower for both concussed groups regardless of time since injury. Killam and colleagues (2005) concluded that cognitive deficits associated with concussion were resultant of memory impairment due to the non-significant results on the other Indexes. They also concluded that memory impairment may be residual in that reduced performance was observed in a group of individuals who had sustained a concussion within the last two years.

In summary, research suggests that the cognitive domains most commonly affected by MTBI include attention, processing speed, and memory. Also, some individuals who suffer MTBI may continue to experience subtle cognitive deficits that may be detected using neuropsychological batteries that are sensitive to milder cognitive impairment. Currently, there is no standard assessment battery used to measure impairment following MTBI (Gerberding & Binder, 2003). The RBANS may be a useful neuropsychological battery for assessment of cognitive impairment in MTBI given the cognitive domains it measures and its sensitivity to milder cognitive impairments. In addition, it may be important to examine potential pre-injury and post-injury factors that may influence cognitive recovery following MTBI.

Purpose of the Present Study

The purpose of the present study was evaluate the use of a screening assessment to measure cognitive performance in college students with MTBI. Specifically, this study aimed to evaluate the ability of RBANS in differentiating a sample of individuals with a history of self-reported MTBI from a control group without a history of self-reported MTBI. In addition, this study had evaluated several factors (depression, anxiety, and alcohol abuse) that have been identified as secondary factors contributing to persistent symptoms of PCD in individuals with MTBI. The hypotheses of this study are as follows:

1. These two groups would differ in their performance on the RBANS Immediate Memory Index, Delayed Memory Index, and Attention Index.
2. The MTBI group's performance on the Attention Index's coding subtest would differ from that of the comparison group.
3. The MTBI group would endorse more depressive symptoms characterized by higher scores on the Beck Depression Inventory-II (BDI-II) than the non-MTBI group.
4. College students with MTBI would have higher levels of anxiety indicated by higher scores on the State-Trait Anxiety Inventory (STAI) than their peers without MTBI.
5. College students with MTBI would endorse more indicators of alcohol abuse than college students without MTBI, as assessed by the Alcohol Use Disorders Identification Test (AUDIT).

CHAPTER II

METHODS

Participants

Seventy college students attending the University of North Dakota participated in this study. Participant recruitment was designed to minimize sampling biases and expectation effects (Ozen & Fernandes, 2011). Participants were screened through a brief online questionnaire administered through Sona Systems Ltd.; a website that allows students enrolled in selected psychology courses to locate research participation opportunities. A total of 739 students completed the screening questionnaire. Of that total, 229 reported a history of head injury. Of those screened, 691 were invited to participate in the second part of the study which took place in a research room on campus. Of those invited, a total of 70 volunteered. The 70 participants were divided into two groups based upon selfreported history of head injury. A clinical group consisting of 22 self-reported head injury cases meeting criteria for MTBI and a comparison group of 48 participants with no self-reported history of head injury. Forty-eight participants had been excluded from the study due to a self-reported history of neurological illness or disease that may compromise brain functioning.

Materials

All participants were administered the several questionnaires and assessments in the following order: the Repeatable Battery for the Assessment of Neuropsychological Status (RBANS; Randolph, 1998) to assess cognitive performance, the Beck Depression Inventory-II (BDI-II; Beck, Steer & Brown, 1996) to assess endorsement of depressive symptoms, the State-Trait Anxiety Inventory (STAI; Spielberger, Gorsuch, Lushene, Vagg & Jacobs, 1983) to assess the presence of current and general anxiety symptoms, and the Alcohol Use Disorders Identification Test (AUDIT; Saunders, Aasland, Babor, de la Fuente & Grand, 1993). Participants who reported a history of head injury were also asked to complete a head injury questionnaire to gather information regarding the characteristics and symptoms of their injury.

Screening questionnaire

This questionnaire asked participants if they have a current or past history of psychological illness, serious medical condition, neurological disease, head injury, and learning disability. Response options for this questionnaire included “yes”, “no”, “not sure”, and “decline to answer” (see Appendix A).

Demographic questionnaire

Participants were asked to complete a demographic questionnaire asking their age, gender, ethnicity, level of education, and current grade point average (GPA; see Appendix B).

Repeatable Battery for the Assessment of Neuropsychological Status (RBANS)

The RBANS (Randolph, 1998) is comprised of 12 subtests measuring five cognitive domains: Immediate Memory (List Learning, Story Memory), Visuospatial / Constructional (Figure Copy, Line Orientation), Language (Picture Naming, Semantic Fluency), Attention (Digit Span, Coding) and Delayed Memory (List Recall, List Recognition, Story Memory, Figure Recall). Scores from each of these domains contributes to an overall Total Scale Index Score. The Immediate Memory Index was designed to measure the participant's ability to immediate recall information. The Visuospatial/ Constructional Index measures the participant's spatial relations perceptual ability and ability to accurately copy a drawing. The Language Index measures the participant's ability to name or retrieve learned material verbally. The Attention Index requires the participant to remember and manipulate information in short-term memory. The Delayed Memory Index was designed to measure the participant's anterograde memory ability. Reliability coefficients range from .75 to .92 in a U.S. representative sample of individuals aged 16 to 19 years and .76 to .94 in a sample of individuals aged 20 to 39 years.

The Beck Depression Inventory-II (BDI-II)

The BDI-II (Beck, Steer & Brown, 1996) is a 21-item self-administered questionnaire designed to measure the presence and severity of symptoms of depression in clinical and normal individuals within the past two weeks. Each item consists of four statements with varying levels of severity that pertain to a specific symptom of depression consistent with the depression criterion from the Diagnostic

Statistical Manual – Fourth Edition (DSM-IV). The BDI-II demonstrates good reliability ($\alpha = .92$).

The State-Trait Anxiety Inventory (STAI)

The STAI (Spielberger et al., 1983) is a self-administered questionnaire comprised of two 20-item subscales (State Anxiety Scale and Trait Anxiety Scale) designed to measure symptoms of anxiety. The State Anxiety Scale (S-Anxiety) evaluates the presence and severity of current symptoms of anxiety by asking the participant to rank the intensity of anxiety symptoms “at this moment” on a 4point likert scale ranging from (1) not at all to (4) very much so. The Trait Anxiety Scale (T-Anxiety) evaluates the participant’s general predisposition to experience symptoms of anxiety by asking the participant to rank the frequency of anxiety symptoms “in general” on a 4-point likert scale ranging from (1) almost never to (4) almost always. Internal consistencies range from .90 to .93 for a college student sample (Spielberger et al., 1983).

The Alcohol Use Disorders Identification Test (AUDIT)

The AUDIT (Saunders et al., 1993; see Appendix C) is a 10-item self-reported, screening questionnaire designed to measure the frequency and quantity of alcohol use within the past year. It evaluates alcohol use across four domains including alcohol consumption, drinking behavior, adverse reactions, and alcohol-related problems. Participants are asked to choose from a set of responses the one response that describes them best. Each response is scored a scale from 0 to 4 and all responses are added to develop a total score. Total scores of 8 or greater are interpreted as indicators of harmful alcohol use and possible alcohol dependence. The AUDIT has demonstrated good reliability ($\alpha = .88$).

Head injury questionnaire

This questionnaire is derived from the Acute Concussion Evaluation (ACE) form provided in the CDC's "Heads Up: Brain Injury in Your Practice" tool kit (CDC, 2007). The ACE was designed to evaluate three components of MTBI (characteristics of the injury, type and severity of symptoms, and risk factors for protracted recovery) both immediately following injury and throughout recovery. Participants were first asked to provide details regarding the characteristics of their injury such as the time in which the injury occurred, how the injury occurred, loss of consciousness, and memory of events before and after the injury (amnesia).

The type and severity of symptoms was assessed by asking participants to indicate, from a list of symptoms, which they had experienced following the injury and the duration of each symptom. The symptom check list consisted of four symptom categories: physical, cognitive, emotional, and sleep. Physical symptoms included headache, nausea, vomiting, balance problems, dizziness, visual problems, fatigue, sensitivity or noise, and numbness or tingling. Cognitive symptoms included feeling mentally foggy or slowed down, and difficulty concentrating or remembering. Emotional symptoms included irritability, sadness, more emotional, and nervousness. Sleep symptoms included drowsiness, sleeping less or more than usual, and trouble falling asleep.

Participants were also asked to indicate how different any reported symptoms made them feel and whether the symptoms seemed to worsen with physical or cognitive activity. Assessment of risk factors for protracted recovery included questions regarding history of multiple head injuries, headache or migraines, learning disability, or psychological illness. The ACE symptom checklist has demonstrated evidence of good internal consistency ($\alpha = .82$) and validity (Gioia, Collins & Isquith, 2008; see Appendix D).

Procedure

Screening procedure

Participants were told the purpose of the study was to investigate factors that may influence cognitive performance of college students and consisted of two parts, the first of which asked them to complete a 5 minute online questionnaire for which they would receive 0.5 extra course credit. Participants were provided with an electronic consent letter prior to completing to the screening questionnaire. After completing the screening questionnaire, eligible participants were invited, via email, to complete the second part of the study which they were informed would take place in a research room on campus and require the completion of several tests of cognitive ability as well as questionnaires about their mood and would take approximately 1 to 1 ½ hours to complete after which they would receive 1.5 extra-course credit.

Data collection procedure

Data collection sessions were led by the lead researcher and assigned research assistants. Participants were provided informed consent, then asked to complete several questionnaires and assessments in the order that follows: a demographic questionnaire, the RBANS, the BDI-II, the STAI, and the AUDIT. Participants were then asked to briefly state what they believed the purpose of the study was. They were then asked if they had ever had a head injury. Those who respond yes, were asked to complete the head injury questionnaire. Finally, participants were debriefed as to the purpose of the study. Participants were not informed that the purpose of this study was to compare cognitive performance of MTBI students to those without MTBI until after they had completed all questionnaires and assessments to reduce the risk of expectation bias (diagnosis threat). Also, test administrators were kept blind as to the group identity of the participant until after administration and scoring of the RBANS, BDI-II, STAI, and AUDIT to control for experimenter bias.

Data Analysis

Independent-samples *t*-tests and Fisher's exact tests of independence were calculated to compare the MTBI and control groups on age, gender, education, and GPA. Pearson's product-moment correlation coefficients and point biserial correlations were calculated to evaluate associations between injury characteristics including time since injury, presence of LOC or PTA, and risk factors for protracted recovery and the total number of symptoms reported, as well as the number of symptoms reported across each symptom domain (physical, cognitive, emotional, and sleep disturbance). To assess the clinical utility of the RBANS in differentiating performance of participants with a self-reported history of MTBI from performance of participants without a self-reported history of head injury, the data were analyzed as follows. The MTBI group and comparison group were compared on each of the RBANS 5 Index scaled scores and 12 subtest raw scores as well as the Total Scale score. Data analysis was conducted using independent *t*-tests rather than multivariate analysis of variance (MANOVA) because the analysis concerned results at the individual subtest and index scores. Independent-samples *t*-tests were also calculated to compare the two groups' scores on the BDI-II, STAI S-Anxiety and T-Anxiety scales, and the AUDIT. Pearson's product-moment correlation coefficients were calculated to evaluate associations between time since injury and the MTBI groups' scores on the 5 RBANS Index scaled scores as well as scores on the BDI-II, STAI S-Anxiety and T-Anxiety scales, and the AUDIT.

Data were screened to ensure that the assumptions of independent-samples *t*-test were fulfilled. Any extreme outliers (*z*-scores greater than or less than 3.00) were removed from analysis. Due to unequal sample group sizes, all *t*-test comparisons were interpreted using the Welch's *t*-test for unequal variance with adjusted degrees of freedom were used (Howell, 2010). An α level of .05 was maintained for all statistical analyses.

To assess the magnitude of any significant differences between groups, *Cohen's d* with a correction for unequal sample sizes (d_{Cohen}) was calculated for any analysis that yielded a significant result. Sattler's (2008) critical difference method was also calculated for any significant *t*-test comparisons on the RBANS index scores. This equation produces a value which may be interpreted as the minimal difference required between two scores to determine if the difference between the two scores may be considered "real" or if it is likely due to measurement error. This was calculated by first attaining the standard error of measurement (SEM) for the RBANS indexes from the RBANS manual (Randolph, 1998). The SEM was then used to calculate the standard error of the difference (SED), which was used to calculate the difference required at the 95% confidence level to establish if differences between the groups' scores was reliable at $p<.05$.

CHAPTER III

RESULTS

Demographic Analyses

Demographic characteristics for each participant group is presented in Table 1. The MTBI and comparison groups did not differ significantly with respect to age, $t(25) = 1.04$, $p = .31$, gender, ($p = .25$, Fisher's exact test), education ($p = .45$, Fisher's exact test), GPA $t(28) = .28$, $p = .78$, or number of credits enrolled at the time of assessment $t(26) = -1.06$, $p = .30$.

Table 1. Demographic Characteristics of the MTBI and Comparison Groups

	MTBI Group (n = 22)				Comparison Group (n = 48)			
Variable	*(n)*	%	Mean	(*SD*)	*(n)*	%	Mean	(*SD*)
Age	22		21.0	5.7	48		19.7	2.6
Gender								
Male	4	18.2			4	8.3		
Female	18	81.8			44	91.7		
Education								
Freshman	10	45.4			24	50.0		
Sophomore	3	13.6			12	25.0		
Junior	4	18.2			8	16.7		
Senior	4	18.2			3	6.3		
Graduate	1	4.5			1	20.8		
GPA	17		3.5	.40	46		3.5	.39
Credits	20		14.5	3.1	48		15.3	2.1

Injury characteristics for the MTBI group are presented in Table 2. The primary mechanism of injury was participation in sports followed falls and MVA. Other types of mechanisms of injury accounted for 23% of the MTBI sample. The average time between injury and study participation was 56.4 (SD = 52.4) months, or 4.7 years. Six participants were hospitalized for their injury and the majority did not report any duration of LOC or PTA.

Table 2. Injury Characteristics of the MTBI Group

Variable	(n)	%	Mean	(SD)
Months post injury (Mean/SD)	22		56.4	52.4
Mechanism of Injury				
MVA	1	4.5		
Fall	4	18.2		
Sport-Related	12	54.5		
Other	5	22.7		
Hospitalized for Injury	6	27.2		
LOC <30 minutes	6	27.2		
PTA <24 hours	6	27.2		
Risk Factors	10	45.5	.73	.93
Prior Head Injury	5	22.7		
History of Headaches/Migraines	6	27.2		
Learning Disability	1	4.5		
ADHD	2	9.1		
Psychiatric History	2	9.1		

Symptom characteristics of the MTBI group are presented in Table 3. The symptoms college students with MTBI had endorsed most frequently were physical and cognitive symptoms followed by sleep disturbance. Emotional symptoms were endorsed least frequently.

Pearson’s product-moment correlation coefficients and point biserial correlations were computed to assess relationships between injury characteristics including time since injury, and the presence of LOC, PTA, and one or more risk factors for protracted recovery, and the number of symptoms endorsed across each symptom domain and the total number of symptoms endorsed. The duration of time between the MTBI and study participation was moderately positively correlated with the number of behavioral symptoms endorsed, $r(22) = .44$, $p = .04$. The presence of PTA was strongly positively correlated with the total number of symptoms endorsed, $r_{pb}(22) = .70$, $p < .001$. PTA was moderately positively correlated with the number of physical symptoms, $r_{pb}(22) = .66$, $p < .001$, cognitive symptoms, $r_{pb}(22) = .60$, $p = .003$, and symptoms of sleep disturbance, $r_{pb}(22) = .47$, $p = .03$, endorsed by MTBI participants.

Table 3. Symptom Characteristics of the MTBI Group

Variable	*(n)*	%	Mean	(*SD*)
Physical Symptoms	22	100	3.7	1.9
Headache	19	86.4		
Nausea	5	22.7		
Vomiting	1	4.5		
Balance Problems	8	36.4		
Dizziness	17	77.3		
Visual Problems	6	27.3		
Fatigue	7	31.8		
Sensitivity to Light	9	40.9		
Cognitive Symptoms	12	54.4	1.5	1.6
Feeling Mentally Foggy	8	36.4		
Feeling Slowed Down	9	40.9		
Difficulty Concentrating	9	40.9		
Difficulty Remembering	6	27.3		
Behavioral/ Emotional Symptoms	4	18.2	.32	.78
Irritability	1	4.5		
Sadness	2	9.1		
More Emotional	3	13.6		
Nervousness	1	4.5		
Sleep Disturbance Symptoms	9	40.9	.73	1.03
Drowsiness	4	18.2		
Sleeping Less than Usual	3	13.6		
Sleeping More than Usual	5	22.7		
Trouble Falling Asleep	4	18.2		

Analysis of RBANS Performance

Index Score Comparisons

Welch's independent-samples *t*-tests for unequal variance were conducted to compare the MTBI group and comparison group on the RBANS Total Scale score, the 5

Indexes, and 12 subtests. A summary of results is presented in Table 4. This study hypothesized that college students with MTBI scores on the RBANS Immediate Memory, Delayed Memory, and Attention Index would differ from the scores of non-head injured peers. Comparison of the two groups mean scores on the RBANS Delayed Memory Index supported this hypothesis. Results yielded a significant difference in mean Delayed Memory Index scores between groups, $t(45) = 2.61$, $p = .01$, indicating that MTBI group's mean Delayed Memory Index score ($M = 96.45$, $SD = 6.72$) was higher than the comparison's group Delayed Memory Index score ($M = 91.38$, $SD = 8.43$). The mean difference of 5.07 (95% CI, 1.15 to 8.98) indicated a medium effect ($d_{cohen} = 0.64$). Sattler's (2008) critical difference method, however, did not reveal a significant difference ($\Delta_{\text{critical}} = 16.63$), indicating that the 5.07-point difference is not statistically reliable at $p<.05$ and is likely due to measurement error.

Comparison of the groups mean scores on the RBANS Immediate Memory Index and Attention Index did not support the hypothesis. Results did not yield a significant difference between the Immediate Memory Index mean scores of college students with MTBI ($M = 103.10$, $SD = 16.61$) and college students without MTBI ($M = 100.57$, $SD = 15.35$), $t(36) = .59$, $p = .56$. Mean scores on the Attention Index also were not significantly different between the MTBI group ($M = 102.55$, $SD = 16.49$) and the comparison group ($M = 106.15$, $SD = 102.55$), $t(39) = -.86$, $p = .40$.

Comparison of group scores on the other RBANS indices indicated that college students with MTBI ($M = 99.41$, $SD = 9.50$) scored significantly higher on the Visuospatial Constructional Index than college students without a MTBI ($M = 93.85$, $SD = 12.04$), $t(51) = 2.07$, $p = .04$. The mean difference of 5.56 (95% CI, 10.94 to .18) indicated a small effect (d_{cohen} = .49). Sattler's (2008) critical difference method, however, did not reveal a significant difference ($\Delta_{critical}$ = 19.93), indicating that the 5.56-point difference is not statistically reliable at p<.05 and is likely due to measurement error. Significant differences between the MTBI and comparison groups were not found for any other RBANS Index scores.

Pearson's product-moment correlation coefficients were calculated to assess relationship between the 5 RBANS index scores as well as the Total Scale score and the time since injury for the MTBI group. Results indicated that the duration of time between the MTBI injury and study participation was not associated with the RBANS index scores or Total Scale scores.

Subtest Score Comparisons

This study also hypothesized that college students with MTBI performance on the RBANS Coding subtest would differ from the performance of college students without MTBI. Results from Welch's independent-samples *t*-tests did not support this hypothesis. The mean Coding subtest score of the MTBI group (*M* = 58.64, *SD* = 11.19) did not significantly differ from the mean score Coding subtest score of the comparison group (*M* = 58.29, *SD* = 9.51), *t*(35) = .12, *p* = .90.

Comparison of the groups' performance on the remaining RBANS subtests, indicated that college students with MTBI (*M* = 18.23, *SD* = 1.11) scored higher on the Figure Copy subtest than college students without an MTBI (*M* 17.53, *SD* = 1.44), *t*(52) = 2.20, *p* = .03. The mean difference of .69 (CI, 1.33 to .06) indicated a medium effect (d_{cohen} = .52). A significant difference was also found on the Line Orientation mean scores between groups, *t*(65) = 2.58, *p* = .01. The MTBI group's mean Line Orientation score

(M = 18.09, SD = 1.82) was higher than the comparison group's mean Line Orientation score (M = 16.50, SD = 3.31). The mean difference of 1.59 (CI, 2.82 to .36) revealed a small effect (d_{cohen} = .49). The difference between college students with MTBI Figure Recall mean score (M = 16.64, SD = 1.87) was also significantly higher than the mean Figure Recall score of college student's without MTBI (M = 15.40, SD = 2.64), $t(56)$ = 2.25, p = 0.03. A small effect (d_{cohen} = 0.49) was found for the mean difference of 1.24 (95% CI, 2.34 to .14). No other significant differences were found between college students with MTBI and college students with MTBI on the other RBANS subtests.

Table 4. RBANS Descriptive Data for the MTBI and Comparison Groups

	MTBI Group (n = 22)		Comparison Group (n = 48)				
	Mean	(SD)	Mean	(SD)	t-score	p-value	d_{Cohen}
RBANS Indexes							
Total Scale	99.9	10.6	96.5	13.4	1.1	.27	
Immediate Memory	103.1	16.6	100.6	15.4	0.6	.56	
Visuospatial Constructional	99.4	9.5	93.9	12.0	2.1	.04	.49
Language	100.6	12.6	97.1	17.1	1.0	.33	
Attention	102.6	16.5	106.2	15.9	-.86	.40	
Delayed Memory	96.5	6.7	91.4	8.4	2.6	.01	.64
RBANS subtests							
List Learning	31.9	4.3	30.6	4.6	1.2	.24	
Story Memory	17.2	4.0	16.5	3.7	.67	.51	
Figure Copy	18.2	1.1	17.5	1.4	2.2	.03	.52
Line Orientation	18.1	1.8	16.5	3.2	2.9	.01	.49
Picture Naming	9.4	0.8	9.2	0.9	1.0	.31	
Semantic Fluency	21.6	4.8	20.7	4.6	.75	.46	
Digit Span	11.1	1.9	11.8	2.2	-1.4	.16	
Coding	58.6	11.2	58.3	9.5	.12	.90	
List Recall	7.6	1.9	7.1	1.8	1.0	.30	
List Recognition	19.9	0.3	19.9	0.3	.10	.92	
Story Recall	9.8	1.7	9.5	2.3	.58	.57	
Figure Recall	16.6	1.9	15.4	2.6	2.2	.03	.49

Analysis of Behavioral/ Emotional Variables

Welch's independent-samples *t*-tests for unequal variance were conducted to compare college students with MTBI and college students without MTBI on the BDI-II, STAI S-Anxiety and T-Anxiety scales, and the AUDIT. A summary of results is presented in Table 5. It was hypothesized that college students with MTBI would endorse more symptoms of depression characterized by higher scores on the BDI-II than their non-head injured peers. Comparison between groups mean scores on the BDI-II did not support this hypothesis. The MTBI group's mean score on the BDI-II (*M* = 5.91, *SD* = 5.16) was not significantly higher than the mean BDI-II score of non-head injured peers (*M* = 8.00, *SD* = 6.04), $t(48) = 1.47$, $p = .15$.

This study also hypothesized that college students with MTBI would endorse higher scores on the STAI S-Anxiety and T-Anxiety scales. Comparisons of the groups' scores on STAI scales did not support this hypothesis. The STAI S-Anxiety mean score of the MTBI group (*M* = 28.95, *SD* = 6.97) was not significantly higher than the STAI S-Anxiety mean score of the comparison group (*M* = 33.13, *SD* = 10.84), $t(60) = -1.93$, $p = .06$. The STAI T-Anxiety mean score of the MTBI group (*M* = 32.77, *SD* = 9.20) was significantly lower than the mean STAI T-Anxiety mean score of non-head injured peers (*M* = 39.27, *SD* = 10.89), $t(48) = -2.59$, $p = .01$. The mean difference of -6.50 (CI, -1.45 to -11.55) indicated a medium effect size ($d_{cohen} = .67$).

Finally, this study hypothesized that college students with MTBI would endorse more indicators of alcohol abuse than college students with MTBI, characterized by higher scores on the AUDIT. Comparisons between groups' scores on the AUDIT did not support this hypothesis. The MTBI group's mean AUDIT score (*M* = 5.32, *SD* = 4.71) was not significantly higher than the comparison group's mean AUDIT score (M = 4.34, SD = 3.82), $t(34) = .85$, $p = .40$.

Pearson's product-moment correlation coefficients were calculated to assess relationship between scores on the BDI-II, STAI S-Anxiety and T-Anxiety, and the AUDIT, and the time since injury for the MTBI group. Results indicated that the length of time between the MTBI injury and study participation was not associated with scores on the BDI-II, STAI S-Anxiety and T-Anxiety, or the AUDIT.

Table 5. BDI-II, STAI, and AUDIT Descriptive Data for the MTBI and Comparison Groups

	MTBI Group (n = 22)		Comparison Group (n = 48)				
	Mean	(SD)	Mean	(SD)	t-score	p-value	*dCohen*
BDI-II	5.9	5.2	8.0	6.0	-1.5	.15	
STAI							
State	28.9	7.0	33.1	10.8	-1.9	.06	
Trait	32.8	9.2	39.3	10.9	-2.6	.01	.67
AUDIT	5.3	4.7	4.3	3.8	.85	.40	

CHAPTER IV

DISCUSSION

The purpose of this study was to examine the performance of college students with a self-reported history of MTBI to college students without a history of MTBI on a neuropsychological battery. This study had hypothesized that the performance of college students with MTBI on the RBANS Immediate Memory Index, Delayed Memory Index, and Attention Index would differ from college students without MTBI. As expected, results had indicated that the two groups' performance on the RBANS Delayed Memory Index differed, however, they did not differ on the Immediate Memory or Attention Index. In addition, the difference between the group's scores on the Delayed Memory Index may have been due to measurement error rather than an actual difference between the two scores. The hypothesis that the performance of college students with MTBI on the Coding subtest would differ from the performance of college students without MTBI was also not supported. These results are inconsistent with previous research that had found long-term impairments in the cognitive domains of attention, memory, and processing speed in MTBI samples (Chuah, Maybery & Fox, 2004; Geary, Kraus, Rubin, Pliskin & Little, 2010; Iverson, 2010; Konrad et al., 2010; Miles et al., 2008; Ozen & Fernandes, 2012).

Another goal of this study was to examine the difference between college students with MTBI and those without MTBI on measures of symptoms of depression and anxiety as well as alcohol abuse. Specifically, the study hypothesized that college students with MTBI would endorse a greater number of symptoms of depression and anxiety as well as a greater number of indicators of alcohol abuse. The results did not support these hypotheses. A significant difference was found between groups on the STAI trait subtest. However, college students with MTBI had endorsed less symptoms of anxiety than college students without MTBI. These results are also inconsistent with past research that had suggested individuals with MTBI may experience greater problems with depression, anxiety, and alcohol abuse compared to those without MTBI (Carroll, Cassidy, Peloso, et al., 2004; Kennedy et al., 2008; LaForce, Jr. & Martin-Macleod, 2001).

Limitations and Considerations

Several factors may have influenced the results of this study. First, the majority of MTBI participants had reported not experiencing any duration of LOC or PTA, suggesting that this MTBI group may have been representative of an uncomplicated MTBI sample with injuries that fall on the mild end of the MTBI spectrum. Also, the self-reported symptom duration of MTBI participants indicated that no participant had experienced symptoms persisting longer than three months, indicating that this MTBI group may represent a MTBI sample without PCD. In addition, the average duration of the time between the injury and study participation was 56 months (4.7 years). Since no MTBI participant had reported symptom duration beyond several weeks, it is likely their symptoms, as well as any cognitive impairment they may had experienced from their injury had resolved prior to study participation. All of these factors may have contributed to the lack of significant differences between groups.

This study, given the sample selected, was also limited in its external validity in that it may only be generalized to college students attending the University of North Dakota. In addition, this study had a high proportion of female participants to male participants, however no differences were found between genders across groups. The lower number of male participants may have contributed to the lower number of MTBI participants since males are more likely to suffer an MTBI than females (Cassidy et al., 2004).

Also, the MTBI sample may be overrepresented by sports-related MTBI since the most common cause of MTBI is MVA. This may have affected the results of this study given that past research has suggested that sports-related concussion may be associated with milder MTBI and shorter recovery time (McCrea et al., 2009). In addition, there may have been inaccuracies in participants' recall of the event that caused their injury given the nature of MTBI and time since the injury. Another limitation was the reliance on self-report which may be less valid than other objective measures.

This study was also limited by its small sample size. While the groups are unequal, they are consistent with prevalence rates of MTBI in college students from previous research. Of the 691 students who had been completed the screening questionnaire and were invited to participate in the second part of the study, only 70 had volunteered. This may have been due to several factors. First, this study required students to complete the second part of the study on campus and required 1 to 1 ½ hours of their time. Students may have chosen to earn extra course credit through participation in other studies that may have been more convenient for them such as online studies and those with shorter time requirements. Also, given the nature of neuropsychological assessment, data collection required each participant to be assessed individually in a separate room during the day to avoid effects of distraction and fatigue on cognitive performance. This limited the number of available time slots for data collection.

Clinical Implications and Future Directions

This study contributed to previous research in several ways. First, previous research examining the RBANS in TBI has primarily used moderate to severe TBI samples or samples with mixed-severity TBI. This study had examine the ability of the RBANS in identifying cognitive impairment in a MTBI sample. Although the results had indicated that the RBANS may not be useful in identifying differences between college students with MTBI and those without MTBI, this may have been influenced by the long duration since injury of this particular sample. Future research should examine the ability of the RBANS to detect differences between MTBI and non-head injured groups within the acute or sub-acute injury phase. This study had also gathered information regarding the symptoms college students who suffer MTBI experience. Consistent with previous research, the college students with MTBI in this sample had reported experiencing physical and cognitive symptoms most frequently, followed by sleep disturbance with emotional difficulties endorsed less frequently. This information may be useful in determining the impact of MTBI on college students.

APPENDICES

Appendix A

Screening Questionnaire

This questionnaire asks you to answer basic questions about your current and past health history. Please read each question carefully and circle the answer that best describes yourself.

Have you ever had a psychological illness?

(1) Yes
(2) No
(3) Not sure
(4) Prefer not to answer

2.) Do you **currently** have a psychological illness?
(1) Yes
(2) No
(3) Not sure
(4) Prefer not to answer

3.) Have you ever suffered from a serious medical condition?
(1) Yes
(2) No
(3) Not sure
(4) Prefer not to answer

4.) Do you **currently** suffered from a serious medical condition?
(1) Yes
(2) No
(3) Not sure
(4) Prefer not to answer

5.) Have you ever had a neurological disorder or disease?
(1) Yes
(2) No
(3) Not sure
(4) Prefer not to answer

6.) Do you **currently** have a neurological disorder or disease?
(1) Yes
(2) No
(3) Not sure
(4) Prefer not to answer

7.) Have you ever been diagnosed with a learning disability?

(1) Yes
(2) No
(3) Not sure
(4) Prefer not to answer

Appendix B
Demographic Questionnaire

Please read the following questions and answer them as accurately as possible. All information is confidential.

1.) What is your age? ________________

2.) What is your gender? (circle one)
    a. Male
    b. Female

3.) What is your current grade level? (circle one)
    a. Freshman
    b. Sophomore
    c. Junior
    d. Senior
    e. Graduate
    f. Other (please specify): ___________________________

4.) What is your current GPA? ________________

5.) How many credits are you currently enrolled in? ________________

Appendix C

Head Injury Questionnaire

Directions: This part of the questionnaire asks you to answer several questions about your **most current** head injury. Please read each question carefully and write your response in the space provided. Answer each question as accurately as possible.

1.) What was the date and/or age of your injury?

____

2.) Where you hospitalized following the injury?

____

3.) Please describe how the injury occurred? (e.g., car accident, fall, sports, etc.)

____

____

____

4.) Please describe what you remember just before the injury. Be sure to include only those events that you yourself remember (Not what others may have told you had happened)

____

____

____

5.) Were there any events before the injury that you cannot remember?

____

6.) Please describe what you remember just after the injury. Be sure to include only those events that you yourself remember (Not what others may have told you had happened)

____

____

____

7.) Were there any events after the injury that you cannot remember?

____

8.) Did you lose consciousness from the injury? _________________________________

    a. If yes, how long were you unconscious?

    ____

Directions: This part of the questionnaire asks you to answer questions about symptoms you have experienced after your head injury. Circle yes only if the symptoms was (a) not present before the injury or (b) became worse or occurred more often than usual after the injury. If yes, please indicate how long the symptom was present. If you did not experience the symptom following your head injury or if you are not sure, please circle no.

1.) Headache	No	Yes	How Long ______________________
2.) Nausea	No	Yes	How Long ______________________
3.) Vomiting	No	Yes	How Long ______________________
4.) Balance problems	No	Yes	How Long ______________________
5.) Dizziness	No	Yes	How Long ______________________
6.) Visual Problems	No	Yes	How Long ______________________
7.) Fatigue	No	Yes	How Long ______________________
8.) Sensitivity to light	No	Yes	How Long ______________________
9.) Sensitivity to noise	No	Yes	How Long ______________________
10.) Numbness/Tingling	No	Yes	How Long ______________________
11.) Feeling mentally foggy	No	Yes	How Long ______________________
12.) Feeling slowed down	No	Yes	How Long ______________________
13.) Difficulty concentrating	No	Yes	How Long ______________________
14.) Difficulty remembering	No	Yes	How Long ______________________
15.) Irritability	No	Yes	How Long ______________________
16.) Sadness	No	Yes	How Long ______________________
17.) More emotional	No	Yes	How Long ______________________
18.) Nervousness	No	Yes	How Long ______________________
19.) Drowsiness	No	Yes	How Long ______________________
20.) Sleeping less than usual	No	Yes	How Long ______________________
21.) Sleeping more than usual	No	Yes	How Long ______________________
22.) Trouble falling asleep	No	Yes	How Long ______________________

Do/Did these symptoms worsen with:

Physical activity such as exercise?

No Yes Not Sure

Cognitive activity such as school work?

No Yes Not Sure

Overall, how different did you feel or behave after the injury in comparison with before the injury? (Please circle the number that best fits your response with 1 indicating no difference and 6 indicating very different).

1 – No noticeable difference
2 – Few changes, mostly unnoticeable by self, family, or friends
3 – Few changes, occasionally noticed by self, family, or friends
4 – More than a few changes, occasionally noticed by self, family, or friends
5 – More than a few changes, commonly noticed by self, family, or friends
6 – Many changes noticed by self, family, or friends

Directions: This part of the questionnaire asks you to answer several questions about your health history. Please read each question carefully and write your response in the space provided. Answer each question as accurately as possible.

1.) Have you had a head injury prior to this one?
   ____

   If yes,

   a. How many?
      ____
   b. When?
      ____
   c. Were the symptoms from the previous head injury(s) different in any way from your most recent injury? (You may circle as many that apply)
      i. No differences
      ii. Increase in the number of symptoms
      iii. Decrease in the number of symptoms
      iv. Increase in symptom severity or intensity
      v. Decrease in symptom severity or intensity
      vi. Increase in how long the symptoms lasted before returning to normal
      vii. Decrease in how long the symptoms lasted before returning to normal

2.) Do you have a history of headaches or migraines? __________________________
3.) Have you ever been treated for a learning disability? ________________________

   If yes,

   a. When? ____
   b. What type of learning disability? ___________________________________
   c. For how long? ____
   d. Are you currently being treated for a learning disability? ______________

4.) Have you ever been treated for ADHD? ___________________________________

If yes,

a. When? ____
b. For how long? ____
c. Are you currently being treated for ADHD? _____________________

5.) Have you been ever been treated for or are you currently being treated for any other psychological disorder? _____________________________________

If yes,

a. When? ____
b. What type of psychological disorder? __________________________
c. Are you currently being treated for a psychological disorder? _________

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