5-2015

Sport-related head injury and performance anxiety

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Sport-Related Head Injury And Performance Anxiety

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Departmental Honors Thesis

The University of Tennessee at Chattanooga
Psychology

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Examination Date: March 25, 2015

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Abstract

Head injury in sport is a highly individualized experience; the symptoms and persistence tend to differ widely between athletes. Neurocognitive deficits in head injury may be worsened by the emotional reaction of the athlete to the injury. Athletes that are removed from play due to musculoskeletal injuries tend to be anxious about becoming reinjured are more likely to be depressed and may have low attention and reaction time. Emotions that result from removal from play can have emotional, psychosocial, and career implications for the athletes. Despite this, there is a lack of literature directly examining the impact of head injury on mood, attention and anxiety about returning to play. The present study found that within 20 collegiate athletes (Head injured n=9; control n=11) there were few group differences on self-reported measures of anxiety, depression, self-regulation, or attention. This may suggest that athletes do not become more anxious, depressed, or inattentive as a result of head injuries or at least that they do not perceive any long-term impacts of their injuries. Future research should use larger sample sizes to examine this research question. Clinicians and researchers should also consider adding sport-specific measures of mood to baseline testing for athletes, and periodic updates of these attitudes as awareness, detection, and removal from play becomes more common for sport-related head injury cases.

Sport-Related Head Injury And Performance Anxiety

Head injury is prevalent, underreported, and misunderstood in sport. Coaches, athletes, and spectators alike define head injury differently. The common term “concussion” is often used in literature and media to refer to sport-related, often mild in severity, traumatic brain injury (mTBI). This is not a widely accepted use of the term, however, because concussion experience can range in severity from mild head injury to very severe head injury. The reference to loss of consciousness (Giza et al., 2013) in the definition of head injury is often the source of confusion in understanding when sport-related head injury occurs. McLeod, Schwartz, and Bay (2007) discovered that a significant proportion of youth coaches mistakenly believed loss of consciousness was necessary for the occurrence of concussion. However, Ellemberg et al. (2009) in their review of incidence reported that only 10% of athletes with concussion had loss of consciousness. Lack of education about sport-related head injury lays the foundation for mismanagement of injury recovery and misunderstanding of injury significance. This study will review sport-related head injury, and explore its cognitive, somatic, and emotional symptoms to understand performance implications in sport.

Head Injury and Sport

The American Academy of Neurology defines concussion as “a trauma-induced alteration of mental status that may or may not involve loss of consciousness” (Giza et al., 2013, p.2250). The symptoms of concussion are individualized and will not appear in the same manner or consistency for each patient. This is also one of the more confusing aspects of concussion, because symptoms do not follow a predictable pattern of appearance and recovery. They also can vary between somatic, cognitive, or emotional categorizations. According to the International Classification of Diseases, the common somatic symptoms of sport-related head injury are headache, nausea, vomiting, dizziness, vertigo, imbalance, change in vision or hearing, tinnitus, photophobia, phonophobia, fatigue (McCrory et al., 2009). The cognitive symptoms can be unclear thinking, difficulty concentrating, difficulty remembering, and hallucinations. Sadness is an emotional symptom that is commonly found with concussion. Symptoms occur anywhere from the first few hours to the first 4 weeks from injury. Ellemberg, Henry, Macciocchi, Guskiewicz, and Broglio (2009) reported that the most common symptoms are headache (83%), dizziness (65%), and confusion (57%; See Figure 1).

Box 1 Symptoms and signs of concussion[4-6]

Symptoms

Somatic: Headache, nausea, vomiting, dizziness or "wooziness", vertigo, imbalance, changes in vision or hearing, tinnitus, photophobia, phonophobia, fatigue
Cognitive: Unclear or "foggy" thinking, difficulty concentrating or remembering, hallucinations
Emotional: Sadness

Signs

Depressed conscious state: Loss of consciousness, drowsiness
Cognitive state: Disorientation or confusion (e.g., inability to recall score, opponent, game rules or play assignments), appearance of being dazed, slowed reaction time, slowed verbal responses, poor neuropsychological test scores, antegrade or retrograde amnesia
Physical state: Seizure, impairment of balance, coordination, gait
Psychological state: Emotional lability, irritability

Figure 1. Concussion Symptoms (Khurana & Kaye, 2012).

Because no concussion experience is the same, the amount and duration of concussion symptoms will be different for each individual. In fact, 87%-92% report no symptoms after three days, and 95% report no symptoms after seven days (Delaney, Lacroix, Leclerc, & Johnston, 2002). However, who want to return to play may hide their symptoms, which could influence these numbers. A portion of athletes experience symptoms beyond four weeks post-injury. Beyond those 4 weeks, the symptoms experienced fall under what is called post-concussive syndrome. Post-concussive syndrome is defined as symptoms from three of its defined six categories that persist beyond the four weeks, and can last for several months. The symptoms of post-concussive syndrome are found in the below table (See Figure 2).

Box 2 The International Classification of Diseases (10th revision) criteria for post-concussion syndrome[3,51]

Development of symptoms in at least three of the following categories within four weeks of the concussive event:

1. Headache, dizziness, fatigue, noise intolerance
2. Irritability, depression, anxiety, emotional lability
3. Subjective concentration, memory or intellectual difficulties without neuropsychological evidence of marked impairment
4. Insomnia
5. Reduced tolerance to alcohol or stress
6. Preoccupation with aforementioned symptoms and fear of brain damage, with hypochondriacal concern and adoption of a sick role

Figure 2. Post Concussion Syndrome Symptoms (Khurana & Kaye, 2012).

The symptoms of concussion tend to end after about two to ten days, but this is highly variable and probably related to severity of the injury. Furthermore, it is necessary to look at all implications of head injury because although the more obvious emotional symptoms may not occur or persist, the neurocognitive performance of the athlete may still be affected even after most of the outward symptoms have resolved (Brogolio, Macciocchi, and Ferrara, 2007).

Khurana and Kaye (2012) explain that head injury occurs either directly, through head impact, or indirectly, via impact to other parts of the body, which then transmit force to the head via strain or whiplash. Sport-related head injury doesn't necessary result in a loss of consciousness, however the rotational acceleration forces enacted on the brain through impact do cause injury at a neuronal level. The axons of the brain's neurons can become damaged in what is called diffuse axonal injury. When this occurs, neurotransmitter regulation is disrupted (Giza & Hovda, 2001). It is hypothesized that disruption and dysfunction at a neuronal level causes the cognitive deficits related to the concussion. It is also apparent that disturbance to the brain's energy regulation of blood, oxygen, and cellular metabolism is what makes the brain so vulnerable to a second head injury (Giza & Hovda, 2001). If a second head injury occurs before the brain has recovered from the neural damage of the first injury, the athlete may experience what is called second-impact syndrome, a severe and potentially life-threatening condition. In addition, the underdeveloped neuronal network and regulation of the brain in younger athletes may be also put this population at particular risk.

Repeated incidence of concussion may be related to a syndrome called chronic traumatic encephalopathy (CTE), resulting in delayed onset of biological effects that cause gradually progressive symptoms and cognitive/neuropsychiatric impairments (Khurana & Kaye, 2012). CTE has been found in a common string of cases in which athletes with repetitive concussions committed suicide (McCrory, 2011). The incidence of CTE is relatively unknown, but is clearly another serious reason for better concussion education and management.

Because the damage of sport-related head injury occurs on the neuronal level and not the gross structural level, magnetic resonance imaging (MRI) and computerized tomography (CT) imaging are less useful, but these methods may be relevant in more severe cases (Gonzalez & Walker, 2011). Instead, diffusion tensor imaging (DTI) can track diffusion of water molecules in the white matter of the brain and as such is commonly used to look at damage to the brain's connections (axons) in individuals with stroke and other neurological symptoms. There has been some interest in using electroencephalography (EEG) as a measure of physiological brain integrity as well. Testing for concussion is a somewhat complex process, and so far there is no one test that will prove its presence.

Initially, if a player is suspected of having a sport-related head injury, a medical professional should pull the player off the field and assess him or her, even if the player does not show obvious symptoms of concussion or insists he/she has none (Khurana & Kaye, 2012; Lang, Chitale, & Judy, 2013)). The medical professional should check for medical components of an injury, like breathing, blood circulation, consciousness, and spinal integrity. The medical professional should then collect self-report data on any symptoms of concussion (Khurana & Kaye, 2012). If there are any symptoms, or the medical professional suspects the athlete is hiding symptoms, the athlete should be taken out of the game and not returned to play that day (Khurana & Kaye, 2012). The clinical symptom inventory should be redone at intervals throughout the day and on subsequent days. The medical professional should also test for the athlete's stability, given that coordination and dizziness are some of the symptoms of concussion that can be quantitatively evaluated. In addition, the athlete should undergo neuropsychological assessments of attention, working memory, and speed of information processing (Khurana & Kaye, 2012; Kontos et al 2004). The athlete might be asked questions related to orientation, memory deficits, and how well he/she can concentrate. However, these measures may not be especially helpful in detecting deficits if there is no baseline level of ability to compare the post-injury data to. For this reason it is vital that all athletes have baseline testing at the beginning of the season and periodically throughout the season to check for changes (Khurana & Kaye, 2012).

Treatment for sport-related head injury is physical and mental rest for the duration of the symptoms. This means no exercise, schoolwork, videos, computers, or other stimulating activities (Khurana & Kaye, 2012). This is difficult to enforce in athlete populations, and is commonly foregone. There are many variables with differing individualized effects on recovery time, but it is helpful to manage and check on hydration, sleep, mood, headaches, and cognitive functioning. Because the damage of a head injury does not just stop after impact, it is important that the athlete rests and allows all symptoms to recover before resuming normal activity. It is especially important to make sure another head injury does not occur in the next seven to ten days, at the risk of second-impact syndrome. This is the most vulnerable time for the athlete to receive another head injury. In the long-term, athletes with history of concussion are more likely to be at risk for Alzheimer's, Parkinson's, depression, dementia, and CTE, especially for multiple concussion incidences (Khurana & Kaye, 2012; Lang, Chitale, & Judy, 2013).

The seriousness of these complications and their implications for the athlete's wellbeing give reason for the need for more concussion education and better detection.

Lack of symptoms does not necessarily denote the resolution of a sport-related head injury. Return to play should progress gradually and be carefully monitored. This process should be managed by a medical professional whose priority is the athlete's health. The best return to sport outcome will result from honest athlete reporting and unbiased management by the health professional. The medical professional should be strict about ensuring proper progress so as to minimize the possibility of second impact syndrome (McCrory et al., 2008).

The crucial component of these return-to-play guidelines is that no head injury related symptoms should occur during any stage, and if they do, the athlete must revert back to a lower level until symptoms have resolved. Though most symptoms will appear the day of or in the few days following concussion, it is possible that symptoms are not as noticeable at first, or may not even affect the athlete in a meaningful way until they are put in a demanding situation (Center for Disease Control, 2010). This is why the return to play process should be gradual; to make sure there are no missed symptoms and to prevent the athlete from entering a demanding situation before they are ready. The recovery process will vary for each individual, but it should not be rushed and no steps should be skipped. The general assumption is that for adults, it should take at least seven days after resolution of all symptoms before return to play can occur, and for adolescents and children, this may need to be longer (Khurana & Kaye, 2012; Lang, Chitale, & Judy, 2013).

If post-concussive syndrome appears, the return to sport process will be much longer and may warrant a complete absence from activity until it has resolved (Khurana & Kaye, 2012). It has also been suggested that until the athlete has returned to their baseline scores on the balance, neurocognitive, and other measures, they should not return to sport, even if symptoms have resolved. Baker and Patel (2000) suggested that reaction time, executive function, and spatial processing would be good tests for head injury baselines, because they are less affected by knowledge gain and learning as others may be. Moreover, Wang, Chan, and Deng (2006) found that many of the symptoms of the post-concussive syndrome population are also common in the "healthy" population. Issues with information processing, concentration, fatigue, and insomnia were prevalent in these healthy participants, suggesting that there are other emotional, social, or psychological issues that have an effect on athletes. This even further establishes that it is important to not compare cognitive tests of head injured participants to healthy populations, but instead to their own baseline scores to detect actual change in their cognitive state.

Sport-related head injury is underreported, possibly due to lack of education about head injury, fear of losing playing time, peer and coach pressure to stay in the game, and fear of career consequences. Sports that tend to have higher rates of concussion are football, rugby, soccer, boxing, wrestling, basketball, hockey, and lacrosse. Khurana and Kaye (2012) suggested the actual incidence of concussion in sport is probably higher than reported data. Additionally, the Center for Disease Control reported at least 1.6 million sport-related head injuries per year (Langlois, Rutland-Brown, & Wald, 2006). In the United States, football tends to have the highest incidence rate; 15% of football players reported symptoms related to head injury (McCrea, Hammeke, Olsen, Leo, & Guskiewicz, 2004) and it has been suggested that higher incidence could be found when players reported symptoms confidentially (Khurana & Kaye, 2012). Concussions occur more often in contact sports, in games, and at the high school level. For males, the sport with the highest incidence was football, and for females it was soccer (Lincoln et al, 2011).

Sport and Mood

Athletes that employ strong coping skills can harness their competitive anxiety to work in their favor. Indeed, anxiety can help the athlete obtain and maintain arousal levels necessary for sport, and it can affect their performance (Humara, 1999). Arousal level is the amount of physiological intensity in heart rate, blood pressure, sweating, and other somatic symptoms that can have an effect on the athlete. Anxiety is the buildup of stress as a result of low self-efficacy in the sport situation (Humara, 1999). Two kinds of anxiety exist: state anxiety, which is relative to the stress of the situation, and trait anxiety which is relative to the individual’s personal tendency to be anxious (Spielberger, 1966). In sport, high trait anxiety and high state anxiety for the individual may be detrimental for performance, but low trait anxiety and high state anxiety may actually be facilitative for performance (Humara, 1999). The highly trait anxious athlete will react sensitively to threatening triggers in the sport environment and even attend to distracting stimuli to the point of very heightened anxiety. An athlete with low trait anxiety will not react sensitively to every negative trigger in the environment, but instead react to the situational factors in the environment that cue their arousal to prepare to perform. For each athlete, these factors can be different. For example, distracting crowd noise, expectations of a parent or coach, opponent intimidation, presence of cameras or scouts, failure to perform pre-performance routines, unfamiliarity of the environment, scoreboards, watching others become injured, perform badly, or fear of personal injury/re-injury can have distracting, debilitating effects on the athlete, but not necessarily for all athletes. Low trait anxious, experienced, self-regulating athletes who can focus their attention on only important stimuli may be able to control how much anxiety builds up their arousal level.

Several models of anxiety have been developed to explain this phenomenon, the most recent of which are the multidimensional anxiety theory (Burton, 1988) and the catastrophe model of anxiety (Fazey & Hardy, 1988). The multidimensional model suggests that anxiety is made of three constructs: cognitive anxiety (based on worry and negative beliefs), self-confidence (belief in self), and somatic anxiety (based on physiological symptoms). Specifically, the model suggests that as cognitive anxiety increases, performance decreases, as self-confidence increases, performance increases and as somatic anxiety increases, performance will increase up until a certain point, until somatic anxiety it becomes detrimental and performance begins to decrease. In the catastrophe model, both the physiological arousal of the athlete and the cognitive interpretation of that arousal matters to performance (Fazey & Hardy, 1988). In this case, higher cognitive anxiety paired with lower physiological arousal will be better for performance. High cognitive anxiety with higher physiological arousal will be bad for performance. Lower cognitive anxiety is not as causal regardless of arousal level. The impact on performance of an increase in cognitive anxiety state is dependent on the physiological arousal, and once the athlete's physiological arousal becomes too high the only way to get performance back on track is to decrease that arousal level (citation).

Athletes can control their anxiety to maximize performance. Humara (1999) suggested strategies athletes can use are cognitive techniques like goal setting, positive thinking, cognitive restructuring, and focus, or relaxation techniques like diaphragmatic breathing, imagery, and progressive muscle relaxation. The athletes with the best coping and psychological skills will use these skills with minimal cognitive effort; the strategies will be used automatically and efficiently (Humara, 1999).

Anxiety in sport is generally measured by one of two scales: the Competitive State Anxiety Inventory-2 (CSAI-2; Martens, Burton, Vealey, Bump, & Smith, 1990), and/or the Sport Anxiety Scale-2 (Smith, Smoll, & Ptacek, 1990). The CSAI-2 consists of three subscales, measuring state cognitive anxiety, somatic anxiety, and self-confidence. The SAS-2 consists of three subscales as well, measuring trait cognitive anxiety, somatic anxiety, and concentration disruption. Past research has found many predictors of cognitive anxiety, such as years of experience, past performances, perception of preparedness, and goal setting. Self-confidence has been related to perception of preparedness, external conditions, and belief in amount of ability (Humara, 1999). A large amount of variance in performance is generally attributed to self-confidence. Factors that have influenced these measures in relation to performance are individual instead of team sports, female gender, location of performance away from home, and adolescence. For males, the ability of the opponent has also affected levels of cognitive and somatic anxiety. For females, changes in cognitive anxiety and self-confidence are largely due to the importance of the performance or how ready they are to perform (Jones, Swain, & Cale, 1991).

Lavallée and Flint (1996) found that competitive anxiety and tension were related to the frequency of injury in collegiate-aged football and rugby athletes. In addition they saw that anxiety, anger, and negative mood were related to injury severity. For rugby, injury frequency was also related to depression, and the athletes tended to downplay severity compared to football so that they could perhaps remain in play. Though Lavalee and Flint (1996) hesitated to conclude that high anxiety and negative mood state would make athletes more prone to injury, they did suggest that it may be a risk factor and may warrant intervention to teach better psychological skills and coping.

Sport-Related Head Injury and Mood

Sport-related head injuries cause psychological impairment based on a physiological cause, the actual trauma of the injury. The cognitive deficits, mood changes, and other symptoms are not necessarily the athlete's psychological response to the injury, but instead directly caused by the neuronal damage occurring to the brain (Giza & Hovda, 2001) However, in the incidence of post-concussive syndrome, anxiety and stress related to having the injury or being removed from sport may amplify symptom severity and complicate these direct physiological issues (Bay & Covassin, 2012; Macleod, 2010). For example, the head injury symptom of a headache could be worsened by frustration, insomnia, and worry related to lack of resolution of the symptom after weeks and months have passed. In this case, it is not the brain injury itself that is causing worsening of symptoms, but the fact that the symptom is persisting out of the athlete's control, and the lack of apparent progress may cause anxiety or fear for the athlete (Macleod, 2010).

Athletes tend to believe there will be financial, career, or social consequences to being removed from play. Removal from play and the stress that goes along with it has been connected to elevated levels of depression and anxiety in injured athletes (Hutchinson et al., 2009). An assessment of retired football players by Guskiewicz et al. (2007) demonstrated a relationship between recurring concussions and diagnosis of depression. Players with one or two concussions were 1.5 times more likely to be diagnosed with depression, and those with three or more concussions were three times more likely to be diagnosed with depression. In addition, Schoenhuber and Gentilini (1988) showed that patients with mild head injury had a greater risk of developing depression when compared to a "healthy" control group. They emphasized the importance of screening for depression and monitoring patients' mood post injury. The Zung Self-Rating Depression Scale (Zung, 1965) has been used in previous studies to show that head injury and depression are related post injury, and is easy to administer because it allows the participant to rate themselves rather than be evaluated by a psychologist (Schoenhuber & Gentilini, 1988).

Hutchison, Mainwaring, Comper, Richards, and Bisschop (2009) explained that post-concussion athletes had heightened states of depression, confusion, and mood disturbance. They also compared a sport-related head injury group to a sport-related musculoskeletal injury group. They found that the head injury athletes experienced more fatigue and lack of energy, while the musculoskeletal injury athletes had an elevated sense of anger. This anger was attributed to the athlete's response to being removed from sport. Hutchinson et al. (2009) believed that the concussion group did not experience this anger because they were not as worried about losing playing time. Their lack of concern was attributed to having less education about the significant implications of head injury, so the athlete had less ability to understand and detect symptoms of their head injury, and could more easily return to play, either due to a lack of detection or lack of proper enforcement of post-concussion return to play procedures. In addition, Hutchinson et al. found that depression was elevated non-significantly for both groups post injury, and total mood disturbance was elevated for concussion athletes. The researchers believed that the large amount of variability in mood disturbance indicates that sport-related head injury and its emotional consequences should be considered and monitored on a highly individual basis. Ruddock-Hudson, O'Halloran, and Murphy (2011) studied Australian football players and found that their emotional reaction to the injury was due to a variety of factors, including severity of the injury, social isolation during injury, repetitive rehabilitation processes that frustrated the athlete, and social support surrounding the athlete. Many of these factors are related to social consequences of being removed from play, and many of these athletes experienced stress as a result of the possibility of being removed from play or lack of support from teammates and coaches when they were out of play. Therefore, it follows that if removal from sport was better enforced and detection of head injury in sport was more efficient, athletes with concussion might experience more similar symptoms to the musculoskeletal injury athletes in addition to the symptoms caused by the physiology of their brain energy. This implication warrants a need for better management and education especially as head injury treatment is better enforced and causes more athletes to be removed from play.

In addition to removal from play, there are many possibilities surrounding why an injured athlete might feel worried. Thompson, Eklund, Tenebaum, and Roehrig (2008) found a moderate relationship between expectation of pain and competitive state anxiety, especially with cognitive anxiety. Though they did not necessarily investigate injured athletes in their study, it is possible that the expectation of pain related to an athletic injury could heighten an athlete's cognitive anxiety in sport. If the athlete expects pain, they have consciously thought about or worried about pain, which is why cognitive anxiety may have been impacted more than somatic anxiety in this study. Anxiety related to pain expectation may decrease coping skills, range of motion, motivation, and cause avoidance behaviors. To this end, musculoskeletal injuries could cause more anxiety to the athlete than a concussion because the injured athlete expects and worries about future pain from movements related to the injured area, whereas the concussion experience differs individually and may not be necessarily associated with immediate or future pain. In addition, athletes may not realize the pain they experience is from a head injury, so the athlete is less worried about their head injury.

Chmielewski et al. (2011) showed that athletes with high pain experience tend to negatively and exaggeratedly focus on their pain, which results in a higher fear of becoming re-injured. Fear of re-injury, especially related to the athlete's pain experience, and therefore could explain why musculoskeletal-injured athletes may experience more cognitive anxiety than concussion athletes. Because the athlete with head injury may only experience a low level or absence of sensory pain, they may have less fear of re-injury, especially if they have little education or awareness about the significance of multiple head injuries. Therefore, they may have less anxiety related to their head injury. Lentz et al. (2015) found that after ACL reconstruction, athletes with more pain-related fear of movement or re-injury were unable to return to sport because of this fear of re-injury and lack of confidence, despite a similar amount of pain intensity to those with less fear of re-injury. This suggests that the athletes who experience fear of re-injury also have a lack of confidence in their ability to return to sport.

However, an athlete who has strong self-efficacy believes he/she is able to perform a task regardless of whether it is actually possible. This has been related to lower pain experience in injured athletes and a more positive rehabilitation process (Chmielewski et al. 2011). Those who experience more pain become more fearful of the movements that bring them pain, and this causes them to worry and lose their confidence in their abilities and their predicted recovery. For this reason, it is possible that increased self-efficacy is related to lower fear of re-injury (Arden, Taylor, Feller, and Webster, 2013).

Attention and other Neurocognitive Measures

Although many variables contribute to the efficiency of injury recovery, it appears that anxiety related to the injury can impact not only physical recovery but psychological recovery as well, which has implications for return to sport at normal performance levels. Athletes with head injury are likely not as affected by changes in self-efficacy unless they experience cognitive anxiety about their injury, especially related to the possibility of removal from play, expectation of pain, or re-injury (Ardern et al., 2013; Thompson et al., 2008); Hutchinson et al., 2009). If head injury athletes experience similar levels of cognitive anxiety as their musculoskeletal injured counterparts, a similar level of self-efficacy could be similarly expected. Assessment of self-efficacy can be accomplished with the Self-Regulation Scale. This scale measures attention control in goal pursuit and was positively correlated with proactive coping and general self-efficacy, while also negatively correlated with depressive symptoms (Diehl, Semegon, & Schwarzer, 2006). Measuring self-regulation is useful for understanding how well an individual can typically regulate his/her behavior and focus on the task at hand. It should follow that if an athlete has high self-regulation, he/she can cope well with situational factors, and believe in his/her performance ability. This trait would be useful in understanding how well the athlete is able to deal with fear of re-injury or high state anxiety sport situations. Anschel and Porter (1996) suggest that elite athletes have an advantage over their non-elite counterparts because they have better self-regulatory skills. Jonker, Elferink-Gemsera and Vissche (2010) showed that the athletes with the self-regulation skill of reflection were significantly better able to perform than athletes with less ability to self reflect.

The core concept of self-regulation, attention control in goal pursuit, could therefore reflect better performance outcomes and healthier psychological well-being. Deficits in attention control would lead to less desirable performance outcomes for the athlete. For an athlete with a head injury, this could be problematic; one of the common symptoms of head injury is difficulty with attention and subsequently, slow reaction time or accuracy (Khurana and Kaye, 2012; Whyte, Grieb-Neff, Gantz, & Polansky, 2006). These attention deficits have been measured in the past using the Sustained Attention to Response Task (SART) developed by Robertson, Manly, Andrade, Baddeley, and Yiend (1997). The SART has been used to show that people with traumatic brain injury tend to differ from healthy controls, especially in errors of commission, and that SART scores relate to everyday lapses of attention as measured by the Attention Related Cognitive Errors Scale (ARCES) (Cheyne, Carriere, & Smilek, 2006). Although the attention lapses referenced in this scale seem mundane, similar lapses of attention could have severe consequences for athletes; they may fail to respond to dangerous stimuli or inappropriately respond and endanger themselves on the field. Even without danger, cognitive error related to attention could be detrimental to performance, since focus is necessary for success in sport. It is even possible that attention failure may lead to inappropriate attention towards stimuli that may produce too much anxiety for the athlete, or the attention failure could lead them to focus on triggers that they would otherwise ignore. Regardless of what the actual consequence could be for the athlete, the fact that athletes may encounter attention deficits as a symptom of head injury that may even persist over a long period of time warrants use of attention scales as a neurocognitive measure for this population. These and other neurocognitive symptoms and deficits can persist well past the physical head injury (Guskiewicz et al. 2005). The athlete may not be able to efficiently maintain control over their attention, so they have a harder time focusing and self-regulating to achieve their goals..

Present Study

The present study examines athletes from University of Tennessee at Chattanooga who participate in organized clubs or teams in football, basketball, soccer, wrestling, and rugby, and who have a history of head injury. I examined the relationship between anxiety (CSAI-2 and SAS-2), depression (Zung Self-Rating Depression Scale), self-regulation (SRS), and attention (ARCES and SART) to determine if the scores of athletes with head injury would differ from that of a control group of athletes. Based on the literature I predict that athletes with head injury will have equal or higher cognitive anxiety, equal or lower self-confidence, and equal or higher somatic anxiety compared to the control group (CSAI-2). I also predict that athletes with head injury will have equal or higher somatic anxiety, equal or higher worry, and equal or higher concentration disruption compared to the control group (SAS-2). With respect to depression, I predict that head injured athletes will have a higher score on the Zung Self-Rating Depression Scale and I predict that these athletes will also have higher scores on both the SRS and ARCES. Finally, I predict the athletes with history of head injury will have lower accuracy and a higher rate of false alarms on the SART.

Method

Participants

The participants in this study were college students from the University of Tennessee at Chattanooga. They were recruited through emails from sports administrators and teachers with instructions about the study and how to sign up to participate. There were 20 participants total. Of these participants, 8 were male and 12 were female. The age of the participants ranged from 18-27. Seven of the participants were freshmen, 6 were sophomores, 3 were juniors, 2 were seniors, and 2 were graduate students. Eleven of the participants were full-time students only. Nine of the students had a part time job in addition to full-time status. Five of the participants played basketball, 1 played football, 3 wrestled, 6 played soccer, and 5 rugby. Two of the soccer participants and 1 of the football participants were on the school sponsored collegiate team, the rest participated on a club level. All of the athletes had experienced a past injury to their body. Nine of the participants had history of head injury, and 11 of the participants did not have history of head injury. This was how we determined the head injury group (n=9) and the control group (n=11).

Materials

Each participant session was conducted on the researcher's Macbook Pro. The demographic questionnaire, CSAI-2, SAS-2, Zung Self-Rating Depression Scale SRS, and ARCES were all presented as a single survey via Qualtrics (See Appendix A and Appendix B); the survey was presented in sections with specific instructions on each section. The SART was presented via a stimulus presentation program called Superlab (See Appendix C).

Demographics Questionnaire. The demographics questionnaire was administered online in multiple choice or short answer format, depending on the question. It consisted of questions about age, sex, years of education, occupation, sport of participation, hand dominance, and use of assistive devices. In addition, it asked the participants to list medications, tobacco and alcohol behavior, basic medical history, and current medical conditions. This questionnaire also included questions about history of head injury (yes or no), including whether it was diagnosed, if there had been multiple head injuries, participation in sport during the injury, loss of consciousness, medical release to return to play, and an opportunity to describe symptoms during the acute injury phase and persistent effects. In addition, the questionnaire asked for information about other sport injuries, whether they were in current season of play, and if they had any future sport plans.

CSAI-2. The CSAI-2 is a multidimensional inventory with three subscales: cognitive anxiety, somatic anxiety, and self-confidence. The subscale for cognitive anxiety consists of nine items, the subscale for somatic anxiety consists of nine items, one of which is reverse scored, and the self-confidence subscale also consists of nine items.

The 27 items are presented in Likert format, with a four-point scale ranging from (1)“not at all”, (2)“somewhat” , (3)“moderately so” , and (4)“very much so” . It asks the participant to rate how they feel before a competition. Each subscale will add up to a score from nine (low) to 36 (high). The CSAI-2 has been found to have internal consistency, concurrent validity, and construct validity (Martens, Vealey, and Burton, 1995; Thompson et al. 2008).

SAS-2. The SAS-2 is a multidimensional inventory with three subscales: somatic anxiety, worry, and concentration disruption. The subscale for somatic anxiety consists of five items, the subscale for worry consists of five items, and the subscale for concentration disruption consists of five items. The 15 items are presented in Likert format, with a 4 point scale ranging from (1)“not at all” , (2)“a little bit” (3)“pretty much” , and (4)“very much” . It asks the participant to choose how they usually feel before or during sports. Each subscale score will add up to a score from 5 (low) to 20 (high). The SAS-2 has been found to have good internal consistency, test-retest reliability, and predictive validity (Smith, Smoll, Cumming, and Grossbard, 2006).

Zung Self-Rating Depression Scale. The Zung Self-Rating Depression Scale is a self-report inventory to assess frequency of depression symptoms without being assessed by a psychologist. It is quick to administer and covers a broad range of depression aspects. The individual is asked to rate how often they agree with the statement. There are 20 items rated through a Likert format on a 4 point scale ranging from “a little of the time”, “some of the time”, good part of the time”, and “most of the time”. There are 10 positively worded reversed scored items and 10 negatively worded and normally scored items. A total score is obtained by adding the value indicated for each item. Less depressed patients will have a lower total score, and more depressed patients will have a higher total score. Scores greater than 50 correlate with mild depression, scores greater than 60 correlate with moderate depression, and a score of greater than 70 correlates with severe depression. By no means does this scale actually indicate actual depression diagnosis, but it was designed to detect common symptoms of depression, though it is possible that with the recent DSM-V changes, these scores are somewhat questionable.

SRS. The Self Regulation Scale was developed to measure self-regulation of the individual toward his/her goals. This self-report assessment measures attention regulation and emotion regulation and is strongly correlated to general self-efficacy and proactive coping. The individual is asked to rate how well each statement describes him or herself. The scale consists of 10 items, rated in a Likert format with 4 points ranging from (1)“not at all true”, (2)“barely true”, (3)“moderately true”, and (4)“exactly true”. Three of the items are negatively worded and reverse scored. The items are then totaled. The SRS was found to have good internal consistency and retest stability (Diehl, Semegon, and Schwarzer, 2006).

ARCES. The Attention Related Cognitive Errors Scale is used to measure how often the individual commits absentminded mistakes and everyday task errors. The individual is asked to rate how often each statement happens to him or her self. The scale consists of 12 items, rated in a Likert formal with 5 points ranging from “never”(1), “rarely” (2), “sometimes”(3), “often”(4), and “very often”(5). The items are then totaled. The ARCES was found to have good convergent and construct validity. It has also been found to be moderately associated with SART errors and reaction times (Cheyne, Carriere, & Smilek, 2006).

SART. The Sustained Attention to Response Task is a computer-based task that measures inhibition failures based on responses errors and reaction time. In the task, the participant is presented with 225 single digits; each digit from 1 to 9 is presented 25 times each in a random order. The digit is presented for 250ms, followed by a mask of an X surrounded by a circle for 900ms. The participant is instructed to press the space bar when they see a digit unless the digit is 3. They are instructed to withhold the response if the digit is 3, and resume when the next digit comes up. If the participant presses the space bar during the presentation of a 3, it is considered a commission error, reported in the form of accuracy rate. If the participant does not press the space bar when they are supposed to, it is considered an omission error, reported in the form of false alarm rate. The SART also measures reaction time in milliseconds and error reaction time in milliseconds.

Procedure

The participants received information about the study from a sports administrator or psychology teacher. I shared all necessary information with these distributors to share with the basketball, wrestling, soccer, football, and rugby players. This information was then emailed to the related players or shared verbally. The instructions directed the athletes to sign up via the University of Tennessee at Chattanooga's scheduling system for psychology studies, the "SONA" website. Due to some difficulties the athletes found with the SONA website, the athletes were also informed they could directly contact the researcher with any questions or issues. The participants signed up for an individual, hour-long time slot to take the study. Participants were run through the study one at a time. At their appointed time slot, I met them in Dr. Amanda Clark's Assessing

Cognition Lab in Holt Hall 349E. They were greeted and sat down before they began. The researcher read over an informed consent page on the computer informing them about the procedure of the study, about their voluntary consent, the right to withdraw from the study at any time, and the confidentiality of their information. They were also informed that the Institutional Review Board at the University of Tennessee at Chattanooga had approved the study. In order to continue with the study, the participants clicked “yes” that they understood and agreed to continue, or they could click “no” to exit the study. The participants were told they could continue with the Qualtrics portion of the study at this time and should ask questions if they need help. Once the Qualtrics portion was complete, the researcher closed the webpage and immediately switched to the Superlab window to conduct the SART. The participants were given instructions for the SART, as well as a practice session before the actual SART began. After the participants had completed the SART, they were thanked for their time and were allowed to leave the lab.

Statistical Analysis

To compare the scores between the head injury group and control group, I conducted independent samples t-tests for the three subscales of the CSAI-2, the three subscales of the SAS-2, the sum score of Zung Depression scale, the sum score of SRS, the sum score of ARCES, and the scores for the four measures found in the SART. In addition, correlational analyses were conducted to determine the level of association between the SART, ARCES and SRS and the self-reported measures of mood.

Results

Participant Details

All participants in this study reported a musculoskeletal injury and nine of those also reported a head injury. Head injuries ranged in severity from mild to moderate and six participants reported multiple head injuries. No other patterns emerged in the injuries with respect to loss of consciousness, experience of memory disturbance, time since head injury, time until return to play, future plans with respect to sport or whether the athlete had been medically cleared to return to play.

Common symptoms reported by the head injury group were: headaches, light headedness, nausea, dizziness, disorientation, inability to balance, memory issues, irritability, negative mood, sensitivity to light, sensitivity to noise, tiredness, disturbed sleep, restlessness, personality changes, and emotional changes. In addition, some participants had persisting symptoms. One participant mentioned constant memory loss and was confused about its cause. Another mentioned headaches that persisted for a year, random headaches ever since, and a tendency since of being forgetful to the point of needing to make lists. Another mentioned that after the last head injury he felt “cognitively strained, like it was difficult to "begin" concentrating”, in addition to what the participant described as noticeable “personality shifts” that lasted for about four months post concussion. Another participant felt headaches and dizziness for hours after injury, and another said that his symptoms of dizziness, disorientation, memory issues, and headaches lasted up to two months after his injury.

Although seven of the head injury athletes were medically diagnosed, only three were officially released to return to play. Most athletes referenced the fact that they were diagnosed too long after the injury, returned to play soon after receiving the injury, resumed play whenever they wished, or simply were never given a return to play time. Some athletes mentioned lack of medical professionals around to even discuss the injury with, or a desire not to approach any medical professionals until after the game. This suggests that many of the athlete's head injuries were not properly monitored, treated, or even detected.

Mood Results

CSAI-2. Cognitive anxiety was hypothesized to be equal or higher for the head injury group and indeed the means between groups were not significantly different. Therefore history of head injury did not significantly effect on athletes' self-reported cognitive anxiety on the CSAI-2, $t(18) = .112$, $p = .912$. Similarly, self-confidence was hypothesized to be equal or lower for head injury group and again the means between groups were similar, $t(18) = -.648$, $p = .525$. Finally, somatic anxiety was hypothesized to be equal or higher for head injury group and the results indicated that there were no significant differences in the group means. Thus history of head injury did not have an significant effect on self-reported somatic anxiety in the athletes, $t(18) = -.378$, $p = .710$. Therefore, as shown in Figure 3, head injured athletes scored the same as bodily injured athletes, so head injury history did not likely have an effect on how cognitively anxious, self-confident, or somatically anxious the athletes were before competition.

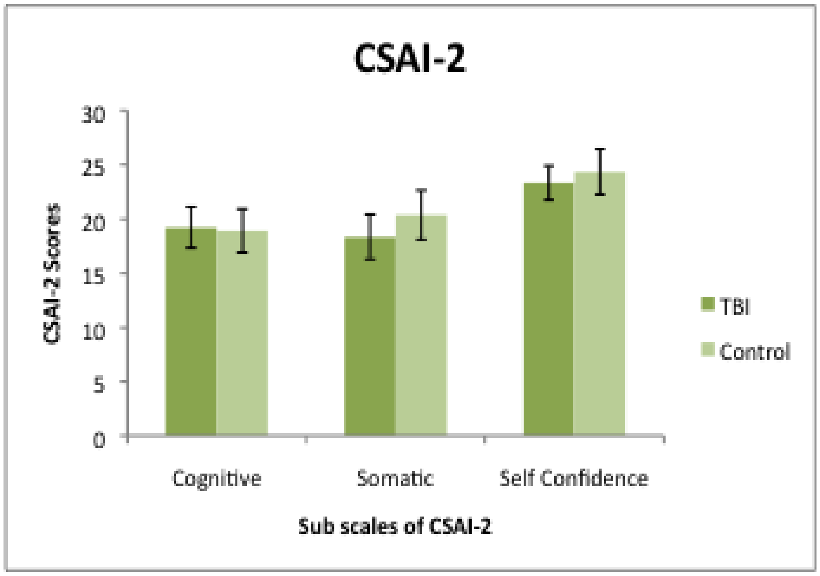

Figure 3: CSAI-2 scores.

SAS-2. The SAS-2 was also analyzed by subscales. Somatic anxiety was hypothesized to be equal or higher for head injury group and this hypothesis was supported in that the means between groups were not significantly different, $t(18)= -.309$, $p = .761$. Worry and concentration disruption were also hypothesized to be equal or higher for the head injury group. Again, no significant differences between groups were found, $t(18)= -.307$, $p = 0.762$ or concentration disruption, $t(18)= -.212$, $p = .835$. As such, as demonstrated in Figure 4, head injured athletes scored the same as bodily injured athletes, so head injury history did not likely have an effect on how much somatic anxiety, worry, or concentration disruption the athletes experienced before or during competition.

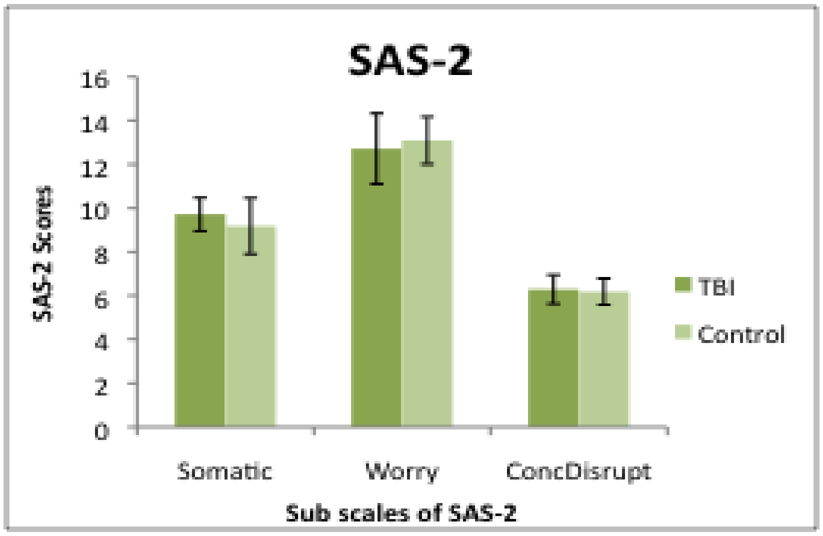

Figure 4: SAS-2 scores.

Zung Self-Rating Depression Scale. Depression score was predicted to be higher for the head injury group. The means between groups were very similar (see Figure 5), but the difference was approaching significance, $t(18) = 1.704$, $p = 0.10$.,

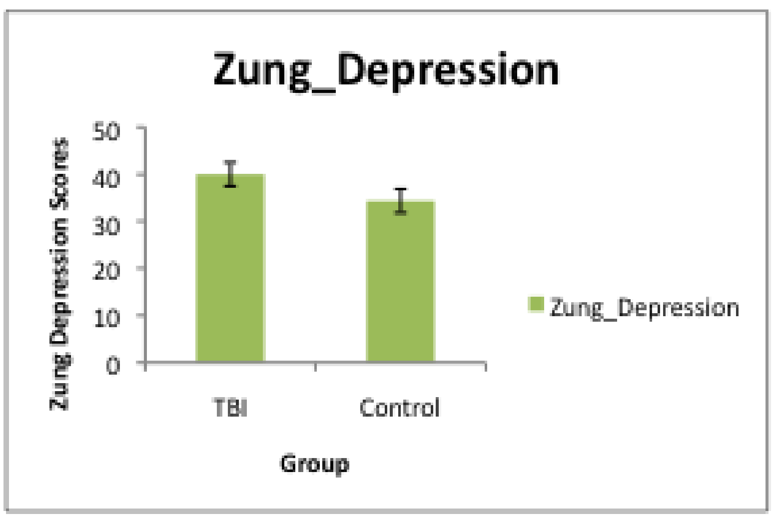

Figure 5: Zung Self-Rating Depression Scale scores.

Self Regulation Scale.

Self-regulation ability was predicted to be lower for head injury group in comparison to the control group however this hypothesis was not supported, $t(18) = .830$, $p = .418$. As demonstrated in Figure 6, head injured athletes self-reported similarly self-regulation ability as the bodily injured athletes.

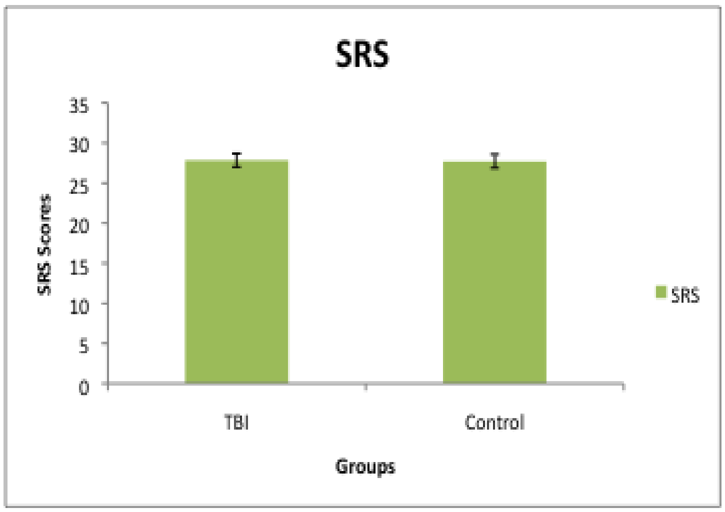

Figure 6: SRS scores.

Attention.

Cognitive errors, as measured by the ARCES, were predicted to be higher for the head injury group. However, the difference between the two groups' means was not significant, $t(18) = -.097$, $p = .924$, Figure 7.

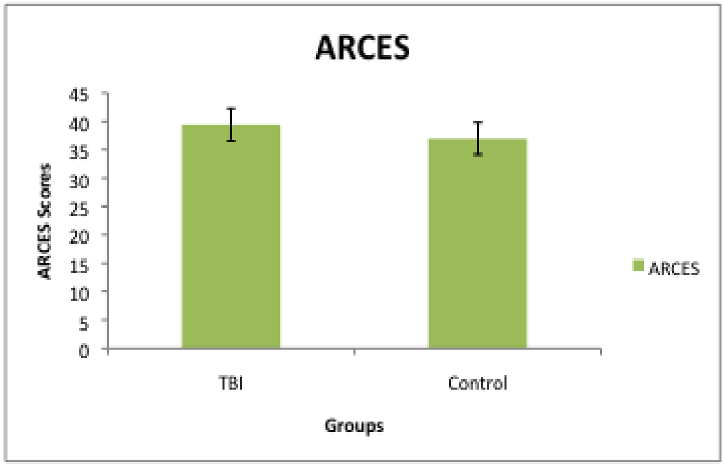

Figure 7: ARCES scores.

In addition, attention deficits as measured by the SART (Figure 8) were expected to be reflected in lower accuracy and more false alarms for head injury group. However, neither of these hypotheses were supported, $t(18) = -.559$, $p = .583$ and $t(18) = .572$, $p = 0.574$, respectively. Therefore the head injured athletes were not significantly less accurate at correctly inhibiting a response when necessary than the control group. Also, reaction time also did not differ between groups, $t(18) = .122$ and $p = .904$, so the head injured athletes were not reacting any faster or slower than the control group. Error reaction time was also similar, $t(18) = .118$ and $p = .907$. The head injured athletes were not making error responses significantly faster or slower than the control group.

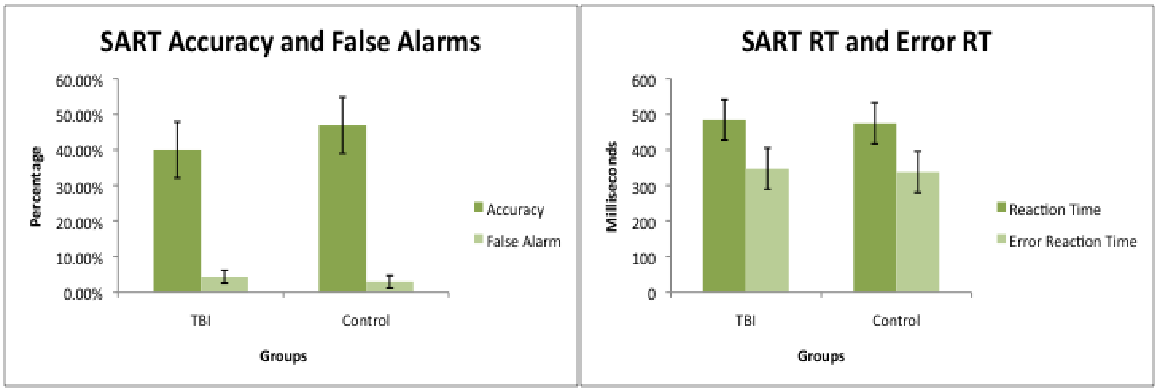

Figure 8: SART scores.

Importantly though, the SART also seems to be working properly because a paired samples *t* test indicates that as expected, the mean of reaction time when one made an error (482.43ms) was significantly faster than the mean reaction time to regular trials (350.33ms).

Correlations Between Measures.

Finally, correlation analyses examine if there were significant relationships between measures. Table 1, below, shows that the subscales within CSAI-2 and SAS-2 are related, as would be expected, but the only other relationship that is significant is the relationship between the self-confidence measure of CSAI-2 and the ARCES (r= -0.469, p= 0.037).

Table 1: Correlations Between Measures

		CSAI2_Cognitive	CSAI2_Somatic	CSAI_SelfConfidence	SAS2_Somatic	SAS2_Worry	SAS2_ConcDisrupt	Zung_Depression	SRS	ARCES
CSAI2_Cognitive	Pearson Correlation	1	.821**	-.591**	.457*	.781**	.144	.184	.084	.349
	Sig. (2-tailed)		.000	.006	.043	.000	.545	.437	.724	.132
	N	20	20	20	20	20	20	20	20	20
CSAI2_Somatic	Pearson Correlation	.821**	1	-.748**	.605**	.853**	.116	.093	-.028	.318
	Sig. (2-tailed)	.000		.000	.005	.000	.627	.696	.908	.171
	N	20	20	20	20	20	20	20	20	20
CSAI_SelfConfidence	Pearson Correlation	-.591**	-.748**	1	-.499*	-.721**	-.262	-.371	.103	-.469*
	Sig. (2-tailed)	.006	.000		.025	.000	.265	.107	.667	.037
	N	20	20	20	20	20	20	20	20	20
SAS2_Somatic	Pearson Correlation	.457*	.605**	-.499*	1	.625**	.313	.183	.309	-.073
	Sig. (2-tailed)	.043	.005	.025		.003	.179	.441	.185	.758
	N	20	20	20	20	20	20	20	20	20
SAS2_Worry	Pearson Correlation	.781**	.853**	-.721**	.625**	1	.181	.162	.148	.328
	Sig. (2-tailed)	.000	.000	.000	.003		.444	.496	.533	.158
	N	20	20	20	20	20	20	20	20	20
SAS2_ConcDisrupt	Pearson Correlation	.144	.116	-.262	.313	.181	1	.250	-.078	-.223
	Sig. (2-tailed)	.545	.627	.265	.179	.444		.288	.751	.345
	N	20	20	20	20	20	20	20	20	20
Zung_Depression	Pearson Correlation	.184	.093	-.371	.183	.162	.250	1	-.271	.022
	Sig. (2-tailed)	.437	.696	.107	.441	.496	.288		.248	.928
	N	20	20	20	20	20	20	20	20	20
SRS	Pearson Correlation	.084	-.028	.103	.309	.148	-.078	-.271	1	-.222
	Sig. (2-tailed)	.724	.908	.667	.185	.533	.751	.248		.348
	N	20	20	20	20	20	20	20	20	20
ARCES	Pearson Correlation	.349	.318	-.469*	-.073	.328	-.223	.022	-.222	1
	Sig. (2-tailed)	.132	.171	.037	.758	.158	.345	.928	.348	
	N	20	20	20	20	20	20	20	20	20

Discussion

The purpose of this study was to directly examine the impact of head injury on mood, attention, and anxiety about returning to play. This was completed by studying individuals with head injury and a control group who all reported other body injuries associated with sport. Some of these injuries were less specific than others and/or less severe, but the presence of these injuries effectually makes the study a little different than anticipated. Though it could have been possible to control for type of body injury, or find participants that had never been injured, that was not within the scope of this research. It would have been ideal to control for and match our individuals in the groups with the same types of body injuries, but it was not something foreseen, so it was unable to be accounted for in this research. In general, the results of this study indicate that the presence of head injury may not actually change self-reported perception of performance anxiety, depression, or attention.

Specifically, the results of this study indicate that there were no significant differences in any measures between the head injury group and control group. Mood was not affected by history of head injury. Performance anxiety, measured by the CSAI-2 and SAS-2 subscales was similar between groups. This could easily be attributed to the weak statistical power and the size of the sample, but also perhaps to how the tests were administered. Past research has employed these measures directly before the athletes have a competition, but this was not feasible for the study. The CSAI-2 has been found to be best administered 60 minutes before a competition for most accurate results (Martens et al,, 1990; Craft, Magyar, Becker, & Feltz, 2003). This timeline was not feasible for this study because of the variability of the athlete scheduling, and the retrospective nature of the study. Future studies should seek to employ this scheduling method if the use of the

CSAI-2 is necessary. Future studies should also look into creating better scales for measuring sport-related anxiety retrospectively.

This study’s lack of significant findings does not necessarily mean that there is no difference in emotional disturbance as a result of concussion or body injuries. Instead, it could mean that a measure that differentiates between the two types of injury was not selected. It is also possible that the study did not specify performance anxiety well enough. Although two highly validated measures of anxiety were given to the participants, these were not specific measures of re-injury anxiety. While that was not the aim of this study, it would still be pertinent to use an additional measure that relates more closely to fear of re-injury. Though a group difference would still not be expected necessarily, since Hutchinson et al. (2009) did show that emotional disturbance for musculoskeletal injuries was similar to concussions except in measures of anger and vigor, it would at least better support the results if the finding could be replicated.

Hutchinson et al.’s (2009) concussion group felt more fatigue and lack of energy, while the musculoskeletal group had more anger. These findings might be related to removal from play. Removal from play may be a more emotionally salient issue for athletes; those with a musculoskeletal injury are generally told a specific timeline by a physician or trainer of when they can return to sport, so they can reasonably be more emotionally disturbed following injury. Head injury athletes may never be told this, and in fact the majority of our head injury group was never given a timeline for return to play, and only three of our participants were medically released to return to play.

Future studies should look at how often concussed athletes are removed from play following head injury, then assess those who are removed against those who are not, to see if they also have increased mood states related to anger or anxiety. It is also possible that differences in mood or anxiety were not detected because the head injury athletes were not removed from play for an extended period of time.

It is also possible that even if removal of play was a factor, it was not as serious because many of the athletes competed on a club level, not in a professional capacity. It would be interesting to ask participants questions about how removal from play would affect them emotionally, socially, and financially. Only half of the head injury group reported that they have future plans in sport, and some mentioned competing only recreationally. This could affect how anxious one feels about receiving another head injury, as well as how depressed they might feel following injury. For this reason, it is not surprising that the groups reported similar means for anxiety and depression.

Scores on the Zung Self-Rating Depression Scale were also similar between groups, but the difference was at least approaching significance. A non-significant difference for depression is likely attributable to the sample size. Studies that found significant differences in depression, as attributed to head injury history (Schoenhuber & Gentilini, 1988; Guskiewicz et al., 2007) had larger sample sizes. In addition, future studies might consider alternate measures of depression. The shortened Profile of Mood States Scale (Shacham, 1983) has been used to assess athlete baselines. A study by Appaneal et al. (2009) assessed post injury depression using the Center for Epidemiologic Studies Depression (CES-D) Scale (Radloff, 1977) and a semi-structured interview guide for the Hamilton Rating Scale for Depression, or SIGH-D (Williams, 1988). In addition, they used a clinical interview and a self-rated symptom checklist, both of which would be interesting and possibly more accurate ways to identify depression presence. Clinical interviews could be costly and cumbersome to schedule, but they would likely produce stronger results in studies of this nature.

With the current state of athlete attitudes about receiving and reporting concussion, there is a need to find appropriate measures of sport-specific mood that can be used much later after the competition and concussion occurrence. The majority of the athletes in this study reported that they did not immediately tell a medical professional of their injury, or failed to even attempt to follow the necessary period of physical and cognitive rest. It is clear that athletes need more education and more strictly enforced monitoring for concussion incidence. Until that happens, evaluation of changes in mood and attitude towards competition in a more retrospective way is required so that the effect of head injury on future mood states for the individual and potentially for others can be predicted. The results of this study did not support any significant differences with these measures, but, as mentioned, it is possible that a larger sample size might have provided more significant results. Ideally, sport-specific measures of attitudes and moods could be included in neurocognitive baselines to better evaluate and understand possible differences in a way that retrospectives studies cannot.

Although we did find slightly lower means for false alarm and accuracy rates in participants with head injury history, it was not a significant difference. Whyte, Grieb-Neff, Gantz, and Polansky (2006) also could not find significant differences between TBI and control groups when they tried to replicate the original SART findings by Robertson et al. (1997). They were unsure to what cause they could attribute this lack of difference in their study.

The sample in the present study was likely too small to find any significant results, and it depended on athlete's recall of their own head injury history to determine if they belonged to the control group. It would be better to have a closer look at medical history or a symptom checklist that the athletes could fill out to see if they had a head injury without knowing. It is risky to study head injuries in the way this study did because athletes may not be properly educated on what constitutes head injury. This is clear simply from the variety of participant questions and concerns that were directed toward the researcher (e.g. what symptoms "count" and one of the participants mentioned that he/she did not lose consciousness but had other symptoms, so may not have considered it a concussion). Similarly, multiple participants asked if they should include any "maybe" head injuries that they were not sure about because they did not receive medical attention. The research procedure did not involve any interview process to try to find out this anecdotal information, so it was not included it in the present study.

However, these anecdotes and the fact that the study's hypotheses were only partially supported suggest that perhaps some of the control group also had head injury, but were unaware. It is entirely possible that the athletes were unable to detect their own head injury because the symptoms were not severe enough to be noticeable, or their trainers did not notice the symptoms because they did not have strong enough tools or measures. Since we cannot be absolutely sure that the control group did not consist of some athletes with questionable head injury status, it is very possible that different results would be observed with more rigorous checks for head injury. Therefore, future studies should consider employing head injury education before competing the study, using supplemental physician reports, or providing self-rating checklists for symptoms. In addition to these research purposes, providing head injury education to athletes in general could help improve detection and awareness so that better research can be conducted and better medical treatment for athletes with head injury can be provided. Future research should look at how well education on head injury improves self-report detection as well.

Athletes may always be difficult to study, as the variability between the athletes in the current study demonstrates. Athletes may be unwilling to disclose information for fear of removal from play. They may rely too much on their trainers, or believe what their coaches are telling them just to get back in the game. It is also possible that athletic trainers are not even able to properly detect head injuries, are not enforcing cognitive and physical rest well enough post-concussion, or are not providing enough information to the athletes about concussions. The lack of social support, misunderstandings by coaches or family, or plain fear of letting others down could be psychosocial factors affecting mood disturbance for these athletes (Baugh, Kroshus, Daneshvar, & Stern, 2014).

The myriad of reasons that concussions could be mismanaged or not detected is the basis psychologists' need to research sport-related concussions further. There needs to be a reason for athletes to pay attention to their head injuries, and to follow the correct rest guidelines for injuries. If we can provide reasons to care about head injury for the athletes, beyond the medical jargon, and make the information more accessible, we could provide better treatment and subsequently begin to understand sport-related head injury better. Athletes need a reason to pay attention to their head injury, and this study hoped to find a reason in performance anxiety. Even though there were no significant differences for performance anxiety in this study, it does not mean that it is not possible to find greater performance anxiety with a better-designed study.

Future Research

Future research should examine if more specific measures of performance anxiety exist for head injuries, and locate the true source of that performance anxiety, whether it is physiological, psychosocial, or emotional. Future research should also look into monitoring the state of attitudes and emotions towards head injury in an epidemiological way, to see if there are any changes after awareness and education changes. While it would not necessarily be positive to see increased anxiety in athletes with head injury due to this awareness, it would at least indicate they are taking head injury seriously and are beginning to understand how detrimental it could be for their future mental health.

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Appendix A: Demographic Questionnaire

This is a brief questionnaire developed by the current investigators to collect information related to education and vocational history, current health conditions and medications, and history of medical illness/event that could produce neurological changes, including changes to cognition.

General Demographic Questionnaire: Participant ID: ________________

Age: ____________________

Sex: ____________________

Race: ___________________

Years of Education: _______________________

Current / Past Occupation: _____________________________

Hand Dominance (circle): Right Left

Do you wear glasses? Yes No

Do you have hearing aids? Yes No

Do you use (circle): Cane Wheelchair Walker

Medical History:

Please list any medications that you currently take:

__________________________ __________________________

__________________________ __________________________

__________________________ __________________________

__________________________ __________________________

__________________________ __________________________

Do you current use:

__ Tobacco: If so, how often: ________________

How much: ________________

__ Alcohol: If so, how often: ________________

How much: ________________

Have you experienced any of the following medical conditions in the past? If so, please indicate.

__ Head injury or concussion If yes, please indicate when this injury occurred: ____________

__ Seizure

__ Stroke

__ Parkinson's disease / Lewy Body disease

__ Multiple Sclerosis

__ Alzheimer's disease

__ Mild Cognitive Impairment

__ Hypoxic event

__ Toxin overexposure / poisoning

__ Meningitis

__ Heart Attack

__ Attention Deficit Hyperactivity Disorder

__ Substance dependence If yes, please indicate type of dependence: ________________

__ Family history of dementia or "memory problems"

__ Depression / Anxiety

Do you currently experience any of the following medical conditions?
__ Heart disease / High blood pressure

__ Diabetes

__ High cholesterol

__ COPD/Emphysema:

__ Acute illness/infection:

__ Recent surgery with general anesthesia

__ Thyroid disease:

__ Recent UTI:

__ Sleep Apnea

__ Insomnia

If you have experienced head injury or concussion, please answer the following questions.

Were you diagnosed by a medical professional? YES NO
What was the diagnosis regarding the head injury? If you were not diagnosed, please explain.

Have you had multiple head injuries? If so, please state when you received each head injury and how you received them.

Were you participating in sport when you received the head injury? YES NO
If so, what sport?

How long did your head injury last?

Did you lose consciousness after your head injury, and for how long? If multiple head injuries, explain each incident.

What symptoms did you experience during the time you were injured? (For example: memory issues, disorientation, dizziness, nausea, emotional changes, headaches, sleep disturbances, etc.)

How long after the head injury did you return to play?

Were you medically released/ cleared to return to play? If not, please explain.

Did your symptoms persist past the recovery time? (For example, "Yes, I still had dizziness, forgot things, have headaches even when I was cleared and went back to playing sports", etc.)

Which symptoms persisted and for how long? (For example, "I had memory issues for the next 3 months, unexplained dizziness off and on for the next year" etc.)

Please report any other sport-related injuries (not head injury) that you may have had. Include the kind of injury and how long it persisted.

Are you in your current season of play?

Do you have future sport-related plans? Please explain.

Appendix B: Self-Report Scales

Zung Self-Rating Depression Scale (Zung, 1965)

This is a 20-item self-report questionnaire that assess the level of depression in the individual from affective, somatic, and psychological symptoms.

ZUNG SELF-RATING DEPRESSION SCALE

Patient's Initials

Date of Assessment

Please read each statement and decide how much of the time the statement describes how you have been feeling during the past several days.

Make check mark (✓) in appropriate column.	A little of the time	Some of the time	Good part of the time	Most of the time
1. I feel down-hearted and blue				
2. Morning is when I feel the best				
3. I have crying spells or feel like it				
4. I have trouble sleeping at night				
5. I eat as much as I used to				
6. I still enjoy sex				
7. I notice that I am losing weight				
8. I have trouble with constipation				
9. My heart beats faster than usual				
10. I get tired for no reason				
11. My mind is as clear as it used to be				
12. I find it easy to do the things I used to				
13. I am restless and can't keep still				
14. I feel hopeful about the future				
15. I am more irritable than usual				
16. I find it easy to make decisions				
17. I feel that I am useful and needed				
18. My life is pretty full				
19. I feel that others would be better off if I were dead				
20. I still enjoy the things I used to do				

Adapted from Zung, A self-rating depression scale, *Arch Gen Psychiatry*, 1965;12:63-70.

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 Printed in USA. WEL056R0 February 1997

Competitive State Anxiety Inventory-2 (CSAI-2)(Martens, Vealey, and Burton, 1995*)*

This is a 27-item self-report questionnaire that assesses cognitive anxiety, somatic anxiety, and self-confident, specifically written to be administered to athletes before competition.

The following are several statements that athletes use to describe their feelings before competition. Read each statement and circle the appropriate number to indicate how you feel right now, at this moment. There are no right or wrong answers. Do not spend too much time on any one statement.

	Not at all	Somewhat	Moderately so	Very much so
1. I am concerned about this competition.	1	2	3	4
2. I feel nervous.	1	2	3	4
3. I feel at ease.	1	2	3	4
4. I have self-doubts.	1	2	3	4
5. I feel jittery.	1	2	3	4
6. I feel comfortable.	1	2	3	4
7. I am concerned I may not do as well in this competition as I could.	1	2	3	4
8. My body feels tense.	1	2	3	4
9. I feel self-confident.	1	2	3	4
10. I am concerned about losing.	1	2	3	4
11. I feel tense in my stomach.	1	2	3	4
12. I feel secure.	1	2	3	4
13. I am concerned about losing.	1	2	3	4
14. My body feels relaxed.	1	2	3	4
15. I'm confident I can meet the challenge.	1	2	3	4
16. I'm concerned about performing poorly.	1	2	3	4
17. My heart is racing.	1	2	3	4
18. I'm confident about performing well.	1	2	3	4
19. I'm worried about reaching my goal.	1	2	3	4
20. I feel my stomach sinking.	1	2	3	4
21. I feel mentally relaxed.	1	2	3	4
22. I'm concerned that others will be disappointed with my performance.	1	2	3	4
23. My hands are clammy.	1	2	3	4
24. I'm confident because I mentally picture myself reaching my goal.	1	2	3	4
25. I'm concerned I won't be able to concentrate.	1	2	3	4
26. My body feels tight.	1	2	3	4
27. I'm confident of coming through under pressure.	1	2	3	4

Sport Anxiety Scale-2 (SAS-2)(Smith, Smoll, & Ptacek, 1990)

This is a 10-item self-report questionnaire designed to assess sport-specific trait anxiety in the individual.

Appendix: Sport Anxiety Scale-2

REACTIONS TO PLAYING SPORTS

Many athletes get tense or nervous before or during games, meets or matches. This happens even to pro athletes. Please read each question. Then, circle the number that says how you USUALLY feel before or while you compete in sports. There are no right or wrong answers. Please be as truthful as you can.

	Before or while I compete in sports:	Not At All	A Little Bit	Pretty Much	Very Much
1.	It is hard to concentrate on the game.	1	2	3	4
2.	My body feels tense.	1	2	3	4
3.	I worry that I will not play well.	1	2	3	4
4.	It is hard for me to focus on what I am supposed to do.	1	2	3	4
5.	I worry that I will let others down.	1	2	3	4
	Before or while I compete in sports:	Not At All	A Little Bit	Pretty Much	Very Much
6.	I feel tense in my stomach.	1	2	3	4
7.	I lose focus on the game.	1	2	3	4
8.	I worry that I will not play my best.	1	2	3	4
9.	I worry that I will play badly.	1	2	3	4
10.	My muscles feel shaky.	1	2	3	4
	Before or while I compete in sports:	Not At All	A Little Bit	Pretty Much	Very Much
11.	I worry that I will mess up during the game.	1	2	3	4
12.	My stomach feels upset.	1	2	3	4
13.	I cannot think clearly during the game.	1	2	3	4
14.	My muscles feel tight because I am nervous.	1	2	3	4
15.	I have a hard time focusing on what my coach tells me to do.	1	2	3	4

Scoring Key. Somatic: Items 2, 6, 10, 12, 14; Worry: Items 3, 5, 8, 9, 11; Concentration Disruption: Items 1, 4, 7, 13, 15.

Self-Regulation Scale (SRS) (Schwarzer, Diehl, & Schmitz, 1999)

This is a 10-item self-report questionnaire that is designed to assess post-intentional self-regulation when individuals are in goal-pursuit and faced with a maintenance situation.

Self-Regulation

Ralf Schwarzer, Manfred Diehl, & Gerdamarie S. Schmitz, 1999

This scale refers to post-intentional self-regulation when individuals are in the phase of goal-pursuit and face difficulties in maintaining their action. In such a **maintenance situation** it is required to focus attention on the task at hand and to keep a favorable emotional balance. Thus, **attention-regulation** and **emotion-regulation** are reflected in these scale items.

In a sample of N = 442 persons the scale has obtained an internal consistency of **Cronbach's alpha** = .76. In a sample of N = 239 persons the scale yielded a **retest stability** of .62 after six weeks.

There were **associations** found with general self-efficacy beliefs (r = .57), and with proactive coping (r = .55).

1. I can concentrate on one activity for a long time, if necessary.
2. If I am distracted from an activity, I don't have any problem coming back to the topic quickly.
3. If an activity arouses my feelings too much, I can calm myself down so that I can continue with the activity soon.
4. If an activity requires a problem oriented attitude, I can control my feelings.
5. It is difficult for me to suppress thoughts that interfere with what I need to do. (–)
6. I can control my thoughts from distracting me from the task at hand.
7. When I worry about something, I cannot concentrate on an activity. (–)
8. After an interruption, I don't have any problem resuming my concentrated style of working.
9. I have a whole bunch of thoughts and feelings that interfere with my ability to work in a focused way. (–)
10. I stay focused on my goal and don't allow anything to distract me from my plan of action.

Note: (–) indicates the item has to be reversed.
Response format:
(1) not at all true, (2) barely true, (3) moderately true, (4) exactly true

Attention Related Cognitive Errors Scale (ARCES) (Cheyne, Carriere, & Smilek, 2006)
This is a brief 12-item self-report questionnaire that is designed to determine how often a participant experiences attention-related errors in everyday life

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ARCES

The following statements are about minor mistakes and absent-mindedness everyone notices from time to time, but we have very little information about just how common they are. The great majority of time these little foibles are harmless, though they do have serious safety implications in industry and everyday life. We want to know how frequently these sorts of things have happened to you.

There are 12 Questions. Please answer by circling a number on the scale provided below each question.

---

1. I have gone to the fridge to get one thing (e.g., milk) and taken something else (e.g., juice).

never	rarely	sometimes	often	very often
1	2	3	4	5

2. I go into a room to do one thing (e.g., brush my teeth) and end up doing something else (e.g., brush my hair).

never	rarely	sometimes	often	very often
1	2	3	4	5

3. I have lost track of a conversation because I zoned out when someone else was talking.

never	rarely	sometimes	often	very often
1	2	3	4	5

4. I have absent-mindedly placed things in unintended locations (e.g., putting milk in the pantry or sugar in the fridge).

never	rarely	sometimes	often	very often
1	2	3	4	5

5. I have gone into a room to get something, got distracted, and wondered what I went there for.

never	rarely	sometimes	often	very often
1	2	3	4	5

6. I begin one task and get distracted into doing something else.

never	rarely	sometimes	often	very often
1	2	3	4	5

7. When reading I find that I have read several paragraphs without being able to recall what I read.

never	rarely	sometimes	often	very often
1	2	3	4	5

8. I make mistakes because I am doing one thing and thinking about another.

never	rarely	sometimes	often	very often
1	2	3	4	5

9. I have absent-mindedly mixed up targets of my action (e.g., pouring or putting something into the wrong container).

never	rarely	sometimes	often	very often
1	2	3	4	5

10. I have to go back to check whether I have done something or not (e.g., turning out lights, locking doors).

never	rarely	sometimes	often	very often
1	2	3	4	5

11. I have absent-mindedly misplaced frequently used objects, such as keys, pens, glasses, etc.

never	rarely	sometimes	often	very often
1	2	3	4	5

12. I fail to see what I am looking for even though I am looking right at it.

never	rarely	sometimes	often	very often
1	2	3	4	5

Appendix C: Description of SART

Sustained Attention to Response Task (SART) (Robertson, Manly, Andrade, Baddeley, and Yiend, 1997)

The SART is a computer administered task that requires participants to respond to on-screen digits by pressing a key on the keyboard. In the task a series of 200 digits are randomly shown (digits range from 0-9). The participant is required to respond as quickly as possible to each cue with the exception of the digit 3, in which they are instructed to withhold any response. Each digit is presented for 250 ms, followed by a 900 ms lapse before the next digit is presented.

TRIAL	DIGIT	CORRECT REPONSE
1	2	Press
2	3	Withhold Input
3	7	Press
4	4	Press
5	6	Press
6	3	Withhold Input
7	7	Press
8	5	Press
9	8	Press
10	1	Press
11	9	Press
12	5	Press
13	2	Press
14	6	Press
15	4	Press
16	3	Withhold Input
17	8	Press
18	6	Press
19	0	Press
20	1	Press

Appendix D: Informed Consent Letter

Sport Related Head Injury and Performance Anxiety

Principal Investigator: Haley Popp
Email: rvk146@mocs.utc.edu

Faculty Advisor: Dr. Amanda Clark, Assistant Professor
Department of Psychology, University of Tennessee at Chattanooga
Phone: 423-425-5851; Email: Amanda-Clark@utc.edu

You have been asked, to participate in a study that is designed to help us understand how head injury in sport affects athlete's mental state. Please know that you must be 18 years of age or older to participate. Although it is unlikely that there will be any immediate benefits to you or other participants, we hope that the knowledge gained will contribute to future care and treatment of those who have experienced head injury. Please read this information sheet carefully and take your time to decide whether you would like to participate.

What is the purpose of this study?

The purpose of this study is to gain a better understanding of the impact of head injury in sport on performance anxiety. We are doing this by testing assessments that measure people's levels of anxiety, depressive affect, self-regulation, and attention. We believe these assessments have great value for both research and clinical purposes. To determine the reliability and validity of these assessments we must assess both people who have had a sports related head injury as well as those who have not.

What will I be asked to do and how long will it take?

This study involves a testing session that will last approximately one hour. The testing session will take place at the University of Tennessee at Chattanooga within Dr. Amanda Clark's Assessing Cognition lab. During the testing session, you will be asked to complete questionnaires and complete a computer task.

Can I change my mind about participating in the study?

Your participation in this study is voluntary. You are free to withdraw from this study at any time, for any reason, without penalty and without affecting any aspects of your education or sport involvement.

Are there any risks or benefits involved in participating in this study?

There are no anticipated physical risks with this study. There is minor risk however that your involvement in this study could generate emotional, mental and psychology stress. Also, at times you may find an activity boring or frustrating. We will be taking regular breaks and if you become fatigued during the testing sessions, we will take additional breaks between tasks. Please know that you may take a break or withdraw from the study at any time, for any reason, with no resulting penalties. If you experience depressive feelings you should seek immediate consultation with a qualified psychiatrist or psychology. Such individuals are available on campus within the Counseling and Personal Development Center. Also, there are many private counseling services that you can reach for guidance. New Beginnings Counseling Center, located here in Chattanooga, offers a variety of therapeutic and counseling services through a diverse and qualified staff. They can be reached by phone at (423)-870-5647. It is unlikely that the study will benefit you directly but it is designed to improve our understanding of how people like you accomplish their daily tasks. It will also give us valuable information about how well these tests measure actual daily functioning.

Will my name be used in the study?

No, all information obtained during the study will be held in strict confidence. You will be assigned a code to replace your name. Names will not be used in any part of the data collection or data analysis or appear in any part of the experimental report. The data, with identifying information removed, will be securely stored on a password protected computer and will be accessible only to authorized researchers associated with this study.

What if I have questions or concerns about my participation?

Thank you for considering taking part in this study. Please do not hesitate to contact Haley Popp (423-290-1061) or the Faculty Advisor (Dr. Amanda Clark, 423-425-5851) if you have any questions or concerns about the study. If you wish to contact someone not connected with the project about your rights as a research participant, feel free to contact the Chair of the UTC Institutional Research Board, Dr. Bart Weathington at 423-425-4289.

I have read and received a copy of the Information Sheet, had the opportunity to discuss this study and my questions have been answered to my satisfaction. I voluntarily consent to take part in the study.

Participant's Name (Please Print)	Participant's Signature	Date
Witness's Name (Please Print)	Witness's Signature	Date

This research has been approved by the UTC Institutional Review Board (IRB). If you have any questions concerning the UTC IRB policies or procedures or your rights as a human subject, please contact Dr. Bart Weathington, IRB Committee Chair, at (423) 425-4289 or email instrb@utc.edu

Appendix E: Recruitment Email to Coaches

To Whom It May Concern:

My name is Haley Popp, I am a senior Psychology student here at UTC and I am conducting an undergraduate Departmental Honors thesis project, entitled "Sports-related Head Injury and Performance Anxiety" (IRC #14-###). My advisor for this project is Dr. Amanda Clark of the Psychology department.

The purpose of this study is to gain a better understanding of the impact of sport-related head injury on performance anxiety. I will do this by using assessments that measure athlete's levels of anxiety, depressive affect, self-regulation, and attention. I believe these assessments have value for both research and clinical purposes. To determine the reliability and validity of these assessments, I must assess athletes who have a history of sport-related head injury, as well as those who have not. It is my hope that I will contribute to a growing body of research on sports-related head injuries that will ultimately provide better information to athletic trainers and coaches who must help treat these injuries.

My research requires that I find willing volunteers in the collegiate level athletic teams at UTC. The format of the study is a series of brief questionnaires and one computer task. The entire assessment should last about one hour and will take place in classroom facilities on campus. Sign ups for the study will take place online. My goal is to accommodate the athletes to make scheduling as easy as possible for their busy schedules. I would love to have as close to full team participation as possible, from athletes that have and have not had head injuries in the past. There are no prerequisites for taking the assessments other than that all participants must be 18 years of age or over and must also be a member of their respective teams. My hope in writing to you today is that you will talk to your athletes about participating in my research and direct them towards me with any questions.

Please feel free to contact me with any concerns or questions you may have. My email address in addition to my advisor's can be found at the bottom of this letter. When signups for my study become available online, I will notify you by email with a link to the signup page. Feel free to forward this link to your athletes upon receiving it. Furthermore, feel free to share my email address with your athletes and/or collect their contact information so that I may send them the sign up information directly. In addition, I will post the sign up information in the Student-Athlete computer laboratory located in Arena 218, as well as other athletic facilities.

Thank you so much for your cooperation and assistance in making my research project possible. I will certainly do my best to make this project as accommodating and convenient for the athletes. GO MOCS!

Thank you,
Haley Popp, rvk146@mocs.utc.edu

Advisor: Amanda Clark, Amanda-Clark@utc.edu

Appendix F: Recruitment Email to the Assistant Athletic Director

To Laura Herron:

My name is Haley Popp, I am a senior Psychology student here at UTC and I am conducting an undergraduate Departmental Honors thesis project, entitled “Sports-related Head Injury and Performance Anxiety” (IRC #14-138). My advisor for this project is Dr. Amanda Clark of the Psychology department.

The purpose of this study is to gain a better understanding of the impact of sport-related head injury on performance anxiety. I will do this by using assessments that measure athlete’s levels of anxiety, depressive affect, self-regulation, and attention. I believe these assessments have value for both research and clinical purposes. To determine the reliability and validity of these assessments, I must assess athletes who have a history of sport-related head injury, as well as those who have not. It is my hope that I will contribute to a growing body of research on sports-related head injuries that will ultimately provide better information to athletic trainers and coaches who must help treat these injuries.

My research requires that I find willing volunteers in the collegiate level athletic teams at UTC. The format of the study is a series of brief questionnaires and one computer task. The entire assessment should last about one hour and will take place in classroom facilities on campus. Sign ups for the study will take place online. My goal is to accommodate the athletes to make scheduling as easy as possible for their busy schedules. I would love to have as close to full team participation as possible, from athletes that have and have not had head injuries in the past. There are no prerequisites for taking the assessments other than that all participants must be 18 years of age or over and must also be a member of their respective teams. My hope in writing to you today is that you will contact the **football, wrestling, basketball, and soccer athletes** about participating in my research and direct them towards me with any questions.

In January, I will send you a link to the signup page. Please forward this link to the **football, wrestling, basketball, and soccer athletes** upon receiving it. This email will also include a brief description of the study and my contact information so that athletes can contact me directly with any questions or concerns. In addition, I will post the sign up information in the Student-Athlete computer laboratory located in Arena 218, as well as other athletic facilities. Please feel free to contact me with any concerns or questions you may have. My email address in addition to my advisor’s can be found at the bottom of this letter.

Thank you so much for your cooperation and assistance in making my research project possible. I will certainly do my best to make this project as accommodating and convenient for the athletes. GO MOCS!

Thank you,
Haley Popp, rvk146@mocs.utc.edu

Advisor: Amanda Clark, Amanda-Clark@utc.edu