Emotional Sequelae of Sports-Related Injuries:

Concussive and Orthopedic Injuries

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ABSTRACT

Emotional Sequelae of Sports-Related Injuries:
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Jillian Claire Schneider
Eric A. Zillmer, Psy.D.
Stephen T. Moelter, Ph.D.

Sustaining and recovering from injury can be emotionally difficult for athletes and can disrupt the athletes' sense of well-being. Given the emotional impact of injury on athletes, it is surprising that little attention has been given to the emotional effects of sports-related concussion on athletes. The present study adds to previous research by comparing pre- and post- injury mood disturbances between athletes with concussion to that of athletes with orthopedic injuries. Injured athletes were predicted to experience heightened levels of mood disturbance post-injury compared to pre-injury mood levels. Additionally, athletes with concussive injuries were predicted to experience greater post-injury mood disturbance compared to athletes with orthopedic injuries. In contrast to expectations, injured athletes did not experience greater levels of mood disturbance immediately following injury, compared to pre-injury mood levels. Further, trend levels differences in the way athletes with different injury types react to athletic injury were detected, opposite to that predicted. Athletes with orthopedic injuries experienced heightened levels of mood disturbance post-injury and athletes with concussive injuries reported fewer negative mood symptoms post-injury. The present findings suggest the possibility that injury-specific factors may influence athletes' emotional reactions to athletic injury.

CHAPTER 1: BACKGROUND AND LITERATURE REVIEW

Athletes' reactions to sports-related injuries extend far beyond physical responses (Mainwaring et al., 2004). Although sports medicine has made great advances in the physical rehabilitation of injured athletes, less attention has been given to the emotional responses and psychological rehabilitation of athletic injuries (Quinn & Fallon, 2000). Emotional reactions to injury, including depression, anxiety, anger, frustration, fatigue, confusion and declines in self-esteem, have been shown to play a significant role in the recovery process (McDonald & Hardy, 1990). Investigations of emotional responses to and recovery from injury have been limited to orthopedic injuries with little emphasis on the emotional sequelae of concussion. Despite evidence that athletic injury is associated with post-injury elevations in emotional disturbance, it is unclear whether these changes are exhibited differently in athletes who have sustained concussive or orthopedic injuries.

1.1 Study Overview and Purpose

Most athletic injuries can be divided into orthopedic injuries (e.g., bruises, strains, sprains, fractures, muscle ligaments and tears) and concussive injuries. Although both types of injuries can be devastating, each is associated with a unique set of complications. Orthopedic injuries may involve visible signs of physical impairments (i.e. caste, crutches, and sutures), physical limitations (e.g., loss of mobility, limited range of motion, and decreased speed and agility), pain, surgery, and potentially lengthy rehabilitation periods. In comparison, the symptoms of concussion are often short-lived (Gunstad and Suhr, 2002) and "invisible" (Gordon et al., 1998).

When athletes incur injuries, attention is generally focused on the site of injury and thoughts, emotions, and behaviors associated with injury are sometimes ignored (Tracey, 2003). Athletic injuries, regardless of injury type, are traumatic events that may result in emotional disturbances including heightened depression, anxiety, anger, frustration, confusion, and declines in self-esteem (Green & Weinberg, 2001; Leddy, Lambert, and Ogles, 1994). Additionally, athletes have reported increases in fatigue concurrently with declines in vigor following injury (Leddy et al., 1994).

All athletes do not respond to injury in similar ways and for similar reasons. Therefore, the type of injury is an important variable to consider when examining emotional responses to and recovery from injury. It is clear that athletes often exhibit significant emotional disturbances following injury. What remains unclear is whether these changes are exhibited differently in athletes who have sustained concussive or orthopedic injuries. The emotional sequelae of concussion are often explained as being due to temporary brain function compromise and secondarily as "typical" reactions to injury (Mainwaring et al., 2004). In contrast, orthopedic injuries, which show a similar symptom profile, are explained as primarily reactive or related to preinjury characteristics (Brewer, 1994; Wiese-Bjornstal, Smith, Shaffer & Morrey, 1998). To date, few studies have investigated the emotional sequelae of concussion in sport and no study has compared emotional responses to and recovery from injury between athletes with orthopedic injuries and athletes with concussion.

The premise of the current investigation is that athletic injuries are often sudden and unexpected traumatic events resulting in emotional disturbances (Heil, 1993). Athletes who incur orthopedic or concussive injuries often display immediate post-injury emotional disturbances. The present study compared pre- and post- injury emotional functioning of collegiate athletes with concussion to that of athletes with orthopedic injuries and to their uninjured teammates. Additionally, this study examined the relationship between preexisting personality characteristics, athletic identity, cognitive appraisals and post-injury emotional disturbances. Comparisons of post-injury emotional functioning between athletes with concussion and athletes with orthopedic injuries were conducted to determine if emotional reactions were exhibited differently in athletes who sustained different injuries.

1.2 Epidemiology of Athletic Injury

An estimated 50 million sports-related injuries occur annually in the United States (Arnheim & Prentice, 2000). Of the estimated 50 million injuries each year, approximately 50 percent require significant medical attention (i.e. imaging, surgery, physical rehabilitation) and cessation of physical activity (Vinger & Hoerner, 1986). Orthopedic injuries account for approximately 90 percent of all athletic injuries. The most common orthopedic injuries involve the knee, ankle and upper limbs (Arnheim & Prentice, 2000) and the most frequently treated orthopedic injuries include strains, fractures, dislocations and contusions (DeHaven & Lintner, 1986). Concussive injuries make up the remaining 10 percent of athletic injuries and account for approximately twenty percent of the 1.54 million head injuries that occur annually in the United States (Erlanger, Kutner, Barth and Barnes, 1999). At the collegiate level, 1.6 percent to 6.4 percent of all sports-related injuries involve concussion, although the incidence may be underestimated (Echemendia, Putukuian, Mackin, Julian, & Shoss, 2001).

While no athlete is immune to injury, those participating in high contact or collision sports are at greater risk for incurring injury. High contact athletic activities including football, basketball, gymnastics, hockey, lacrosse, rodeo, rugby, volleyball and wrestling (Hillman, 2000) have a higher risk for potential fatalities, catastrophic head and neck injuries and severe orthopedic injuries compared to non contact sports (e.g., crew, swimming, tennis, golf) (Arnheim & Prentice, 2000). More specifically with regards to concussive injuries, equestrian sports have the highest incidence of injury followed by boxing, rugby, soccer and American football (Broshek and Barth, 2001).

With sport participation rising worldwide, sports-related injuries represent a significant potential health concern for all those who participate. More people than ever are participating in recreational and competitive sports necessitating a greater understanding of the emotional aspects of sports-related injury (Deutsch, 1985). With athletic injuries increasing in frequency, the potential negative emotional effects of athletic injury have become of greater concern (Leddy et al., 1994). Consequently, a number of empirical studies have been conducted to identify emotional changes that correlate with athletic injury. Although a number of studies have been conducted, they have been mostly limited to orthopedic injuries with little emphasis on concussive injuries.

1.3 Definition and Classification

One of the most important challenges facing sports medicine personnel is the identification and management of sports injuries. Injury occurs when a force, either external or internal, is applied to any part of the body, resulting in a harmful disturbance of function or structure. Tension, stretching, compression, shearing and bending of tissue all result in physical injury (Arnheim & Prentice, 2000). To date, no universally agreed-upon definition of what constitutes an athletic injury has been established, although most agree on three classification criteria: (a) time loss from sport participation, (b) anatomical tissue diagnosis and (c) medical consultation (Pargman, 1999).

In 1974 athletic trainers and other sports medicine professionals developed the National Athletic Injury Reporting System (NAIRS) in response to a need for a uniform system of recognizing and reporting injuries and illnesses affecting athletes (Hillman, 2000). Injuries and/or illnesses meeting the criteria established by NAIRS are deemed reportable, meaning a case report must be filed. According to NAIRS, athletic injuries include any injury or illness that requires substantive professional attention and cessation of participation from athletic activity. The purpose of their definition is to separate insignificant injuries that warrant little attention and do not substantially influence performance from health problems that have potential or demonstrated significance (Clarke & Miller, 1977).

1.3.1 Orthopedic Injuries

Orthopedic injuries typically involve visible signs of physiological damage (e.g., inflammation, bruising, bony protrusions) and may be associated with pain. Reliable and valid measures of the extent and nature of injury including palpation, movement assessment, manual muscle testing, assessment of joint stability, accessory motions, functional performance, postural examination, and anthropometric measures and volumetric measures are used to identify orthopedic injuries (Arnheim & Prentice, 2000). Imaging techniques (eg., X rays, arthography, arthroscopy, computed tomography [CT], bone scanning, magnetic resonance imaging [MRI], ultrasound, and echocariography) and other diagnostic tests (i.e. electrocardiography, electroencephalohraphy, electromyography, nerve conduction velocity, synovial fluid analysis, blood testing, and urine analysis) can also be used to clarify injury diagnosis and assist with treatment planning (Arnheim & Prentice, 2000).

Orthopedic injuries are generally assigned a grade (grade 1, 2, or 3) corresponding to an injury that is mild, moderate, or severe (Arnheim & Prentice, 2000). Grade 1 injuries typically involve minimal pain and tissue disruption with no loss of function. Grade 2 injuries are associated with moderate or partial tissue disruption with variable signs, symptoms and functional impairment depending on the extent of tissue disruption. The most severe injures, grade 3 injuries, involve complete tissue disruption and severe functional impairment (Shultz, Houglum, & Perrin, 2000).

Injuries may also be classified as either acute or chronic. Acute injuries often occur suddenly, typically resulting from a one-time traumatic event, and are of short duration. In contrast, chronic injuries have a gradual onset, are of longer duration and usually result from an accumulation of minor insults or repetitive stress. Chronic injuries are more difficult to treat since the longer the pathological or diseased state continues, the longer it takes for healing to occur and symptoms to subside (Shultz et al., 2000).

1.3.2 Concussive Injuries

In comparison to orthopedic injuries, concussive injuries are less well understood and their associated emotional sequelae remain largely unexplored. Broadly defined, concussion is a trauma-induced alteration of mental status that may or may not involve the loss of consciousness and is often accompanied by confusion and amnesia (Kelly & Rosenberg, 1997). More specifically, concussion is defined as "…a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces" (Aubry et al., 2001, p. 7) (see Appendix A). Concussion may result in neuropathological changes that may be undetected on neuroimaging studies. Additionally, the acute clinical symptoms largely reflect a functional disturbance rather than a structural injury. In comparison to orthopedic injuries, impairments associated with concussion are typically short-lived and spontaneously resolve (Aubry et al., 2001).

In comparison to orthopedic injuries, the physiological effects of concussion are “invisible” and there are no definitive measures which test for the presence of a concussion (Guskiewics, 2001). Unlike orthopedic injuries, which are associated with visible tissue disruption, the tissue disruption associated with concussive injuries are not overly physical and can only be visualized through neuroimaging measures, if they can be detected at all. Additionally, because the signs and symptoms of concussion are “invisible” the injured athlete is typically unaware of the significant changes in his or her functioning (Gordon et al., 1998). Hence, there is little way to objectively evaluate concussive injuries resulting in the evaluation of concussion based on clinical means (Echemendia and Cantu, 2003).

Comparable to orthopedic injuries, concussions are assigned a grade corresponding to a concussion that is mild (grade 1), moderate (grade 2) or severe (grade 3). According to the American Academy of Neurology (AAN) Quality Standards Committee, a grade 1 concussion involves transient confusion, no loss of consciousness and resolution of mental status abnormalities or symptoms within 15 minutes. Grade 2 concussions are characterized by transient confusion, no loss of consciousness and mental status abnormalities or symptoms that do not resolve within 15 minutes. Finally, grade 3 concussions are marked by any loss of consciousness from seconds to minutes (Quality Standards Committee of the American Academy of Neurology [AAN]) (see Appendix C). It is important to note that there has been limited published evidence to suggest that the severity of concussive injuries are correlated with the number and duration of acute signs and symptoms of concussion and/or the degree of impairment on neuropsychological evaluations (McCrory et al., 2005). Further, it has been noted that concussion severity can only be determined in retrospect after all concussive symptoms have resolved, the neurologic examination is deemed to be normal, and cognitive functioning has returned to baseline (McCrory et al., 2005).

1.4 Emotional Reactions to Orthopedic Injuries

Athletic injury is a negative experience, one in which athletes typically and strongly try to avoid (Pargman, 1999). For athletes, injury threatens the foundation upon which many self-concepts are built (Kelley, 1990). Regardless of physical complications, injuries can be a significant form of emotional distress for athletes (Deutsch, 1985; Daly, Brewer, Van Raalte, Petitpas & Sklar, 1995; Morrey, Stuart, Smith, & Wiese-Bjornstal, 1999; Tracey, 2003). Such distress includes frustration, depression, tension, confusion, and anger (Leddy et al., 1994; Smith, Scott, O'Fallon & Young, 1990). Athletes have also reported increases in fatigue and general mood disturbance concurrent with decreases in vigor following injury (Leddy et al., 1994; Smith et al., 1990).

In addition to post-injury emotional disturbances, athletes often experience a loss of self-definition following injury. Self-esteem, or an individual's feelings or moral value, virtue or worth, is a central component of one's overall sense of well-being and is therefore related to cognitive and affective states including depression (Rosenberg, 1979). Beck (1973) indicated that three types of events involve self-esteem: (1) negative experience that directly impinge on a person's self-worth, (2) experiences that impede important goals, and (3) physical disorders or injury that stimulate thoughts about physical decline. Athletic injury encompasses all three events.

Perceptions of the physical self have emerged as particularly important in self-esteem make-up. As individuals mature, stature, appearance and physical ability become the most public attributes and become increasingly used as a reference point in identity (Harter, 1989). Physical self-esteem appears to be a significant contributor to an individual's self-esteem and is associated with the decision to pursue physical activity (Fox, 1990). Anyone who derives significant amounts of self-esteem or personal competence from their ability to perform athletically is likely to experience an emotional loss as a result of injury (Lavalle, Grove, Gordon, & Ford, 1998). Self-esteem and in particular physical self-esteem are likely to be affected by injury since injury leads to changes in how individuals perceive themselves (Chan & Grossman, 1988). Following injury, athletes may experience disturbances in their feelings about themselves, their self-worth, their attractiveness, and their special qualities and/or capacities (Astle, 1986).

Weiss & Troxel (1986) were among the first to attempt to identify the emotional responses of athletes to injury. Weiss and Troxel (1986) interviewed 10 injured athletes either of elite or collegiate status participating in volleyball, basketball, running, throwing, and wrestling. Following injury, the most frequently reported emotional responses were disbelief, fear, anger, depression, tension and fatigue. Commonly reported physical symptoms included upset stomach, insomnia and loss of appetite. Additionally, athletes revealed a tendency to dwell on irrational thoughts (i.e. "what if I don't recover quickly") and indicated an inability to cope with injury, activity restriction, long rehabilitation, and the feeling of being externally controlled by the injury. Despite the lack of experimental controls and objective measures, Weiss and Troxel's work provided impetus for subsequent research in this area.

1.4.1 Stage Models

In the absence of empirical data, initial attempts to understand emotional responses to athletic injury were based upon stage models of grief and loss (Kubler-Ross, 1969). According to Kubler-Ross (1969), individuals coping with terminal illness move through a predictable series of stages: denial, anger, bargaining, depression and acceptance. Based on the premise that the disability associated with injury constitutes a loss of some aspect of the self (Peretz, 1970), injured athletes will alternate between these stages until acceptance is achieved (Heil, 1993).

Although popular, stage models have failed to gain empirical support (Brewer, 1994). There may be significant interpersonal differences in reactions to serious injury or illness. For instance, the experiences of terminally ill patients and injured athletes are likely to be quite different (Evans & Hardy, 1999; Udry & Anderson, 2002). Additionally, some researchers have failed to demonstrate that injured athletes' progress through set stages (McDonald & Hardy, 1990; Silver & Wotman, 1989; Smith, et al., 1990). Silver and Wortman (1989) completed a review of the literature on coping and undesirable events, including physical injury, and found no support for the assumption that there is a predictable, stage-like pattern of responses to negative life events. Additionally, other researchers have found post-injury mood disturbances to be more global in nature rather than comprised of discrete stages (McDonald & Hardy, 1990; Smith et al., 1990). A model that accounts for individual differences in post-injury emotional reactions, including personal and situation factors, will allow for a more comprehensive understanding of athletes' reactions to and recovery from injury.

1.4.2 Temporal Patterns of Post-injury Emotional Disturbance

Empirical studies have generally demonstrated linear patterns of emotional disturbance that proceed from negative to positive affect across time (McDonald & Hardy, 1990; Smith, et al., 1990). McDonald and Hardy (1990) examined emotional response patterns of five severely injured collegiate athletes (i.e. injuries resulting in cessation of sport activity for at least 3 weeks). Emotional reactions were measured using the Profile of Mood States (POMS) immediately following injury and again twice a week for 4 weeks. Athletes reported immediate increases in negative mood (depression, anger, tension, confusion, fatigue concurrent with declines in vigor) followed by gradual increases in positive mood during rehabilitation.

In a similar study, Smith et al. (1990) attempted to determine the presence, type, magnitude, and time course of emotional responses from injury onset until return to competition in recreational athletes. Emotional responses were measured using the Emotional Responses of Athletes to Injury Questionnaire

(ERAIQ) and POMS at 2-week intervals from injury onset until return to full participation in sports or 4 months, whichever came first. Immediately following injury, athletes experienced elevated levels of depression, anger, tension and confusion concurrent with declines in vigor with the most frequently reported symptoms being frustration, depression, and anger. At two weeks post-injury, depression, anger, tension and confusion had subsided with concurrent increases in vigor. Athletes continued to demonstrate improvements in post-injury mood disturbances 6 weeks following injury.

The previous studies demonstrate a linear pattern of emotional disturbance following injury in recreational (Smith et al., 1990) and severely injured collegiate athletes (McDonald & Hardy, 1990). Athletes exhibited immediate increases in negative emotion followed by gradual linear increases in positive mood during rehabilitation. Despite consistent findings, neither study used control groups (i.e. healthy controls, other injury types) or obtained preinjury mood profiles. Thus, post-injury mood disturbances could not be directly attributed to the effects of injury.

More recent studies have reported curvilinear, rather than linear patterns of post-injury mood disturbance (Morrey et al., 1999). Morrey and colleagues (1999) measured emotional responses in injured recreational and competitive athletes who required anterior cruciate ligament (ACL) reconstruction surgery. Participants completed the POMS and ERAIQ at 2 weeks, 2 months, 3 months, and 6 months following surgery. Results suggest that athletes’ emotional patterns fluctuate throughout rehabilitation. Specifically, athletes demonstrated an emotional “U” pattern experiencing greatest levels of emotional distress (i.e. anger, fear, anxiety) immediately post-surgery and at 6 months following surgery.

Immediate increases in negative mood followed by gradual declines in negative affect post-surgery are consistent with previous studies (McDonald & Hardy, 1990; Smith et al., 1990). Immediate increases in negative mood may be attributed to the consequences of injury including surgical experience, pain, cessation of activity, and concerns about rehabilitation. Additionally, as rehabilitation progresses and goals and visible progress are realized, negative emotions decrease. However, in comparison to previous studies, Morrey et al. (1999) reported that athletes demonstrated an increase in emotional disturbance towards the conclusion of rehabilitation. Severity of injury, length of rehabilitation and fears and anxiety of not being able to perform at preinjury levels and of reinjury may contribute to later increases in emotional disturbances.

Overall, these studies suggest that immediately following injury athletes demonstrate heightened emotional disturbances (i.e. increased depression, anxiety, tension, anger, fatigue concurrent with decreased vigor) followed by gradual increases in positive mood (McDonald & Hardy, 1990; Smith et al., 1990) and in some athletes, a second elevation in negative mood just before the conclusion of rehabilitation (Morrey et al., 1999). Despite similar findings, none of the aforementioned studies used control groups (i.e. healthy controls, other injury types) or obtained preinjury mood profiles. As a result, no definitive statements about the causal relationship between injury and mood disturbance can be made. One possibility is that prior to injury, regardless of injury type (i.e.

orthopedic, concussion), injured athletes had different mood profiles in comparison to uninjured athletes. Preexisting mood disturbances may predispose athletes to injury, rather than the occurrence of injury causing a mood disturbance. Another possibility is that all athletes, regardless of injury status, experience mood changes throughout the course of a season (Leddy et al., 1994; Smith, Stuart, Wiese-Bjornstal, Millner, O'Fallon, & Crowson, 1993).

1.4.3 Preinjury v. Post-injury Mood Disturbance

In an effort to transcend the limitations of previous studies, Smith et al. (1993) determined whether or not post-injury mood disturbances could be directly attributed to the effects of injury in competitive athletes. Preinjury and post-injury differences in global self-esteem were also measured. Participants completed measures of mood (ERAIQ and POMS) and global self-esteem (Rosenberg Self-Esteem Inventory) preseason and several times post-injury until he or she resumed full sport participation. In comparison to preinjury mood states, athletes reported significantly greater post-injury levels of depression and anger and decreased levels of vigor. No significant differences were found between preinjury and post-injury self-esteem. The differences between preinjury and post-injury mood states suggest that post-injury mood disturbances are likely attributed to the occurrence of injury rather than to preexisting mood disturbances.

1.4.4 Differences in Mood Disturbance between Injured and Uninjured Athletes

One limitation of the aforementioned studies is the lack of control groups. None of the studies compared injured athletes to uninjured athletes or to athletes with different types of injuries. To further understand emotional disturbance following athletic injury, Chan and Grossman (1988) examined the psychological effects of running loss upon consistent runners. Uninjured runners were compared to injured runners on measures of mood states (POMS), global self-esteem (Rosenberg Self-Esteem), and depression (Zung Depression Scale). Chan and Grossman (1988) found that injured runners exhibited significantly greater psychological distress including depression, anxiety, confusion, overall mood disturbance, and lowered self-esteem compared to uninjured runners. Consistent with previous studies involving other sport activities, these results suggest that the cessation of a valued sport activity results in negative affectivity (McDonald & Hardy, 1990; Morrey et al., 1999; Smith et al., 1990; Weiss & Troxel, 1986).

In a similar study, Pearson and Jones (1992) compared emotional profiles of injured athletes to that of matched healthy athletic controls. Participants completed measures of emotional functioning (Sportsmen's Feelings After Injury Questionnaire [SFAIQ] and Bi-polar Profile of Mood States [POMS-BI]) either before or after injured athletes' first physiotherapy appointment. In comparison to healthy athletic controls, injured athletes were significantly more tense, hostile, depressed, unsure, tired and confused.

In yet another related study, Leddy, et al. (1994) compared post-injury emotional reactions of injured collegiate athletes to uninjured collegiate athletic controls. Athletes completed measures of emotional functioning (Beck Depression Inventory [BDI], State-Trait Anxiety Inventory [STAI] and Tennessee Self-Concept Scale [TSC]) preseason and if injured, at 1 week and 2 months post-injury. In comparison to uninjured athletes, athletes who incurred injuries experienced increased depression and anxiety and lowered self-esteem. In some instances, athletes' emotional responses reached intensity levels equivalent to individuals receiving outpatient psychotherapy.

Studies comparing preinjury and post-injury emotional mood states (Smith et al., 1993) and injured and uninjured athletes (Chan & Grossman, 1988; Leddy et al., 1994; Pearson & Jones, 1992) report significant emotional mood disturbances following injury. Factors such as pain, cessation of activity and concerns of rehabilitation may explain athletes' post-injury emotional disturbances. Additionally, post-injury declines in self-esteem have been reported in some studies (Chan & Grossman, 1998; Leddy et al,. 1994), but not in other studies (Smith et al., 1993) necessitating a further understanding of the relationship between injury and self-esteem.

1.5 Emotional Reactions to Concussive Injuries

Most investigations of athletes' emotional reactions to injury have been limited to athletes with orthopedic injuries. Additionally, research typically focuses on two injury types: one with a range of injuries and severity levels and one with anterior cruciate ligament (ACL) injuries only. Empirical investigations of emotional reactions following sport-related concussion remain largely unexplored. To date, only one study has examined emotional functioning of athletes following concussion (Mainwaring et al., 2004).

1.5.1 Mechanism of Concussion

Concussion results from rapid acceleration/deceleration forces exerted on the brain (Bailes, 1998). The mechanism of acceleration/deceleration injuries can include an impact of a compressive blow to the head, an acceleration or tensile hit, or a shearing or rotational force (Cantu, 1992). Acceleration/deceleration injuries occur when the subjects' body and head are traveling at a particular speed and strike a solid object or when a moving object strikes a stationary cranium. The resultant injury produces linear, tensile, and compressive strains disrupting the cerebral cytoarchitecture (Bailes, 1998). Although protected by cerebral spinal fluid (CSF), the brain has freedom of movement before it abuts against the skull. As the head accelerates before impact with a stationary object, the brain lags towards the trailing surface squeezing away CSF allowing it to accumulate on the opposite surface creating maximal shearing forces opposite the site of impact where CSF is thinnest. On the other hand, when the brain is stationary prior to impact, there is neither lag nor disproportionate distribution of CSF allowing shearing forces to be greatest at the site of cranial impact (Cantu, 1992).

Acceleration/deceleration forces may produce widespread damage within the brain. Shearing and rotational forces, particularly within the brainstem and cerebral hemispheres, cause tearing of axons resulting in axonal lesions. Compressive and tearing caused by dural edges and hard body prominences damage gray matter, especially within the frontal and temporal lobes. Hemodynamic changes including intracerebral hemorrhage, edema and impaired cerebral perfusion may produce further damage (McClelland, 1988). These microscopic brain lesions may have implications for behavioral sequelae including physical, cognitive, and emotional components.

1.5.2 Postconcussion Symptoms

Concussion is likely under-diagnosed and under-appreciated in the sports community (Mainwaring et al., 2004). Frequently described as a “silent epidemic,” concussion often goes undiagnosed due to its “invisible” symptoms (Almquist, Broshek & Erlanger, 2001). Individuals who have sustained a concussion commonly report persistent physical, cognitive, and emotional symptoms alone or in combination (Barth, Broshek, & Freeman, 2006; Kay et al., 1993). These symptoms, many of which are subtle, may go unrecognized by untrained professionals or even the athletes themselves. Additionally, concussive symptoms are difficult to document without standardized, sensitive diagnostic tests (Lovell, 2002) and rarely detected with magnetic resonance imaging (MRI) or computed tomography (CT) (Gordon et al., 1998). While the physical, cognitive and emotional symptoms may contribute significantly to disabilities observed in everyday activities including resuming school/work, sport activities, leisure activities, and general physical functions (Dikmen, McLean, & Temkin, 1986), they are typically transient (Barth et al., 2006).

Physical symptoms of concussion include nausea, vomiting, dizziness, sleep disturbance, fatigue, headache, blurred or double vision, photophobia, and hyperacoutism, pain, altered sense of taste and smell, decreased libido, and intolerance to alcohol (Anderson, 1996; Bailes, 1998; Bohnen & Jolles, 1992; Brunker, 1996; Kay et al., 1993; Mittenberg, DiGiulio, Perrin, & Bass, 1992; Wright & Telford, 1996). Cognitive problems can include disturbances in attention, concentration, perception, memory, speech and language, speed of information processing and executive functions (Bailes, 1998; Barth et al., 2006; Gasquoine, 1997; Kay et al., 1993) and emotional symptoms can include irritability, anger, anxiety, depression, disinhibition, emotional liability, feelings of loss, anger and feelings of helplessness (Anderson, 1996; Bailes, 1998; Barth et al., 2006; Bennett & Raymond, 1997; Kay et al., 1993).

Postconcussive symptoms are generally short-lived with the resolution of most symptoms occurring in less than 3 months (Barth et al., 1989; Levin et al., 1987) and with the most rapid recovery occurring during the first four weeks (Barth et al., 1989; Macciocchi, Barth, Alves, Rimel, & Jane, 1996). However, studies have reported recovery rates to range from 10 days (Macciocchi, Barth, Alves, Rimel, & Jane, 1996) to more than 1 year post injury (Alves, Macciocchi, & Barth, 1993).

Symptoms of concussion are nonspecific to brain injury further complicating the identification and management of concussion. Gouvier, Uddo-Crane and Brown (1988) established base rates of the occurrence of cognitive, physical, and psychological symptoms of concussion in healthy individuals.

Participants consisted of students enrolled in an undergraduate psychology class and the close relatives of those students (i.e. parents, siblings, spouse, offspring). Participants completed a 37-item symptom checklist indicating whether or not he/she and an identified relative had experienced that symptom within the past two months. According to the study, several subjective symptoms reported as problematic in brain injured individuals (Oddy, Hymphrey, & Uttley, 1978; Weddell, Oddy, & Jenkins, 1980) were also found at a similar rate to that of non-brain injured individuals supporting the notion that symptoms of concussion are nonspecific to brain injury.

Postconcussive symptoms have been reported in individuals with chronic fatigue syndrome, gastrointestinal disorders, Grave's disease, and the common cold. Additionally, postconcussion symptoms including depression, anxiety, tension, anger, confusion, fatigue, and decreased energy have been reported in healthy athletes (Gunstad & Suhr, 2001) and in athletes with orthopedic injuries (Leddy et al., 1994; McDonald & Hardy, 1990; Smith et al., 1990; Smith et al., 1993). The nonspecificity of postconcussive symptoms suggest that nonneurologic factors such as sex, chronic pain, presence of medical condition, cessation of activity, treatment seeking, depression, and negative affectivity may be more closely related to the self-report of postconcussive symptoms than head injury status (Gunstad & Suhr, 2002).

1.5.3 Emotional Reactions to Concussion

Most research has focused on the emotional sequelae of severe, rather than mild brain injury (MTBI). The few researchers that have examined MTBI have looked at acute and/or short-term (within 1 year) emotional responses to MTBI finding evidence of emotional disturbance following injury (Dikmen et al., 1986; Levin et al., 1987; Mainwaring et al., 2004; Mathias & Coats, 1999). Dikmen et al. (1986) compared neuropsychological and psychosocial symptoms between individuals with minor head injuries and healthy controls at 1 month and 1 year post-injury. With regards to psychosocial symptoms, individuals with minor head injuries experienced significantly greater disturbances in sleep, emotional behavior, body care, home management, mobility, social interaction, ambulation, alertness behavior, communication, and pastimes and recreation in comparison to healthy controls. These symptoms significantly declined from 1 month to 1 year and there were no significant differences in psychosocial symptoms between head injured individuals and healthy controls at 1 year post-injury.

In a related study, the neurobehavioral functioning of five patients with MTBI were compared to healthy matched controls at 1 week, 1 month and 3 months following injury to determine if symptoms resolved within 1 to 3 months post-injury (Levin et al., 1987). In addition to completing various neuropsychological tests, participants participated in a structured interview designed to assess the presence and severity of postconcussive symptoms. With regards to postconcussive symptoms and more specifically affective complaints (i.e. anxiety, depression, sleep disturbance), head injured patients reported an intensification of symptoms when interviewed at one month compared to when interviewed at 1 week. These symptoms greatly diminished in head injured patents at 3 months.

Similarly, Mathias and Coats (1999) compared the emotional functioning and cognitive abilities of patients who sustained MTBI in motor-related vehicle accidents to that of healthy controls. Participants completed a series of cognitive tests (i.e. verbal fluency, executive functioning, memory and attention) and measures of emotional functioning assessed through the Neuropsychological Behavior and Affect Profile (NBAP), a modified version of the a Neurobehavioral Rating Scale (NRS-R) and the Headley Court Psychosocial Rating Scale between 1 and 4 months post-injury. With regards to emotional functioning, patients with MTBI experienced significantly higher levels of depression compared to healthy controls.

These studies suggest that individuals with MTBI experience short-lived post-traumatic emotional disturbances in comparison to healthy controls. While these studies support the idea that significant emotional disturbances can occur following mild brain injury, several problems limit the strength and generalizability of their findings: (a) all of the studies used post-injury designs so the effects of selection bias could not be ruled out, (b) none of the studies investigated the effects of psychosocial factors such as malingering, (c) most of the studies measured emotional distress 1 month following injury after the period of most rapid recovery (Barth et al., 1989), and (d) Maithas and Coats (1999) used a retrospective design.

Empirical investigations of emotional reactions following sport-related concussion remain largely unexplored. To date, only one study has directly investigated post-traumatic emotional functioning of collegiate athletes with concussion (Mainwaring, et al., 2004). Mainwaring and his colleagues (2004) compared emotional reactions of concussed collegiate athletes to uninjured teammates and healthy undergraduates. Using the short version of the POMS, emotional responses were assessed pre-season in all groups and in concussed athletes and healthy athletic undergraduates post-injury. Healthy teammates were not assessed post-injury. In an effort to transcend the limitations of previous studies, Mainwaring et al. (2004) evaluated preinjury measures of emotional status in order to assess injury-induced emotional disturbances. Additionally, concussed athletes were compared to healthy athletic undergraduates to control for non-injury related factors that may contribute to emotional disturbances.

In contrast to other studies, Mainwaring and colleagues (2004) measured emotional states over a short-term period (i.e. < 1 month) immediately following injury, a time-period in which most researchers suggest the symptoms of concussion resolve. Additionally, emotional states of concussed athletes were measured serially post-injury (3 days post injury, 7 days post injury, and 14 days post injury) to evaluate trends in emotional disturbances. Emotional states of healthy athletic undergraduate controls were also serially evaluated (25 days post baseline, 28 days post baseline, and 32 days post baseline).

Results revealed a significant, acute postconcussion spike for depression, confusion and total mood disturbance compared to healthy athletic undergraduates suggesting that concussion precipitates increases in emotional disturbances. Additionally, emotional disturbances were generally brief, lasting on average less than 14 days. Specifically, levels of depression decreased by the third session (7 days post-injury) and levels of confusion and total mood disturbance resolved by session four (14 days post-injury). These results are consistent with previous studies which found the resolution of most postconcussion symptoms to occur within the first four weeks post-injury (Barth et al., 1989; Macciocchi et al., 1996).

Although the aforementioned study contributes significantly to the literature facilitating a clearer understanding of emotional recovery from sports-related concussion, several limitations reduced the strength and generalizability of the study. Mainwaring and colleagues (2004) assessed emotional disturbances in sixteen concussed athletes. Of these sixteen athletes, twelve were male and four were female. Additionally, the small sample size may contribute to the lack of significant changes in other measured emotional states (i.e. anger, tension, fatigue, and vigor). Time of assessment was another important limitation to the study. Athletes were evaluated between the months of August and March, with the majority of concussed athletes assessed in the fall (August – December) and the majority of healthy controls tested in the winter (January – March). The different times in which the athletes were measured leave open the possibility that mood ratings were influenced by seasonal affects. An additional caveat of the study was the reliance on a single instrument. Although the POMS has demonstrated adequate validity and reliability, using multiple instruments would enhance the study's validity.

The most significant limitation is the lack of control groups. Mainwaring and colleagues (2004) deliberately avoided using a matched cohort control group (i.e. athletes with orthopedic injuries) since exposing a subset of cohort athletes to serial assessment would have jeopardized the ability to provide meaningful clinical assessments and would have forced the exclusion of the these athletes from the concussion research group if they sustained subsequent concussions. However, without a matched cohort control group, important questions were left unanswered; namely, were emotional reactions due to injury type or to other factors such as the impact of injury, removal from play, or both?

Emotional disturbances following injury have been reported in athletes with orthopedic injuries (Leddy et al., 1994; McDonald & Hardy, 1990; Smith et al., 1990; Smith et al., 1993) and in athletes with concussive injuries (Mainwaring et al., 2004). Several factors have been proposed to explain emotional disturbances following athletic injury including cessation of activity, loss, removal from play, uncertainty, insufficient information and organic factors (Lavalle et al., 1998; Mainwaring et al., 2004; Quackenbush & Crossman, 1994). While several of these factors have been empirically supported in athletes with orthopedic injuries, few have been validated in athletes with concussion and to date, no study has directly compared the two populations to assess injury specific emotional reactions.

1.6 Mechanisms of Postconcussive Emotional Reactions

Clinicians suggest that emotional disturbances following brain injury reflect psychological interpretations of trauma effects (Gasquoine, 1997), physiological changes (Hovda, Prins, Becker, Lee, Bergsneider, & Martin, 1998), and cognitive impairments (Bohnen & Jolles, 1992; Ponsford et al., 2000). Psychological interpretations, or the way in which athletes perceive their injury, have been suggested to influence post-injury emotional disturbances in that athletes who perceive their injuries as more severe are more likely to experience greater emotional disturbances (Udry & Anderson, 2002). The physiological effects within the brain, inherent in brain injuries, have also been suggested to significantly influence the development of post-injury negative affect (Hovda et al., 1998). Finally, cognitive impairments, including inherent confusion and the compromise of cognitive functioning, are considered to be a potential influence in the development of emotional disturbances following brain injury (Bohnen & Jolles, 1992).

1.6.1 Psychological Interpretation

The fact that an injury occurred is less important than the way in which the injury is perceived. Research suggests that the way in which athletes interpret their injury influences their emotional responses (Brewer, 1994; McDonald & Hardy, 1990). Cognitive appraisal models have been developed as a means of explaining this mechanism and to account for individual differences in affective reactions to injury (Brewer, 1994; Evans & Hardy, 1999; Udry & Anderson, 2002).

According to cognitive appraisal-based models, cognition affects emotions, which in turn influences behavior. Additionally, these models assert that injuries are a stressor and the way in which athletes interpret injury determines their emotional response (Daly et al., 1995; Heil, 1993). Specifically, when athletes confront potentially stressful situations (i.e. injury), they will make cognitive appraisals of the situational demands, their abilities to meet the demands, and the consequences of not meeting the demands. If athletes perceive the demand to be greater than their resources and the consequences of failing to meet the demand dire, then the stress response and accompanying physiological and attentional disruptions may be significant (Udry & Anderson, 2002; Anderson & Williams, 1988). Additionally, if athletes perceive the consequences of not meeting the demands to be significant either to their career or self-esteem, the stress response and emotional reactions will be extreme (Anderson & Williams, 1988).

Daly et al. (1995) investigated the influence of cognitive appraisals of injury on emotional disturbances following injury. Recreational and competitive athletes who incurred injuries requiring either arthroscopic or open knee surgery completed a single item scale (i.e. my injury will be difficult to deal with) to assess cognitive appraisal and the POMS to measure emotional disturbances. Results indicated that emotional disturbances were correlated with cognitive appraisals of injury supporting the use of cognitive appraisal models to understand how athletes adjust to injury. However, the severity of injury, length of rehabilitation, timing of measurement, and injury type may also contribute to the cognitive appraisal of injury and in turn influence emotional reactions.

1.6.2 Physiological Changes

Relationships between postconcussion symptoms and changes within the brain have been shown. Although damage is less extensive compared to severe brain injuries, there is evidence of neuropathological changes and neurophysiological alterations after concussive injuries including neuronal damage, reduced cerebral blood flow, disturbances in water metabolism, altered brainstem-evoked potentials, neurotransmitters and brainstem dysfunction (Bohnen & Jolles, 1992). Hovda et al. (1998) suggests that brain damage disrupts normal neuronal metabolism. Neurons damaged by trauma are rendered dysfunctional through a metabolic cascade of neurotransmitters that are then unable to respond to normal physiological and pathophysiological challenges. The net result could be neurological deficits, which lead to the disruption of normal emotional and cognitive functioning (Mainwaring et al., 2004).

Localized disturbances of neural tissue can result in immediate and permanent changes in the control or expression of emotion. Closed head injuries (i.e. concussion) often result in injury to the frontal and temporal lobes, areas of the brain involved in emotional behavior. For example, damage to the frontal lobes may produce flattened affect, indifference, apathy, and difficulty with initiation and completing activities. Additionally, individuals may also exhibit socially inappropriate behaviors including acting impulsively and being less aware of the impact of their actions and behaviors on others. Temporal lobe damage may result in heightened emotionality, flattened affect, and hypersexuality (Bennett & Raymond, 1997).

1.6.3 Cognitive Impairments

Concussed individuals are typically described as the “walking wounded” (Bennett & Raymond, 1997) since they “look good” due to no obvious fractures, scars, or cuts serving as visible reminders of their injury but experience significant difficulty functioning at preinjury levels. Without noticeable signs of injury, concussed individuals may expect to be able to return to daily activities without problems. However, concussion results in disturbances in cognitive functioning, that although minor, may compromise one’s ability to function as well as he or she did before injury. Difficulties performing at preinjury levels and the compromise of adaptive skills may contribute to emotional disturbances and loss of self-esteem following injury (Bennett & Raymond, 1997; Prigatano, 1992). Bennett (1989) suggests that emotional disturbances may be more prevalent in individuals with minor head injury compared to individuals with moderate or severe injuries since individuals with minor head injury generally have less cognitive disturbances and are therefore more aware of their deficits and their long-term consequences.

Cognitive deficits related to concussion include decreased speed and efficiency of information processing, increased distractibility and decreased ability to sustain one's attention. These impairments may result in frustration, anger, confusion, depression, and overwhelming feelings of failure. Additionally, individuals with concussion no longer think as efficiently or as logically as they once did which may result in loss of self-esteem (Ruff, Camenzuli & Mueller, 1996). These reactions are especially prevalent in individuals who were always over-achievers, had high self-expectations, and whose feelings of self-worth were tied to their achievements (Bennett, 1989).

1.7 Injury Specific Factors

Although post-injury emotional disturbances in athletes with orthopedic injuries may result from removal from play, cessation of activity (Chan & Grossman, 1988) or from appraising the injury and situation as negative (Daly et al., 1995), the mechanism is less clear in athletes with concussive injuries. In comparison to reports of post-injury depression by athletes with orthopedic injuries (Leddy et al., 1994; Morrey et al., 1999), Paniak, Reynolds, Phillips, Toller-Lobe, Melynk, & Nagy, (2002) found no significant differences in depression between individuals with mild brain injury and matched healthy controls suggesting that it is not the injury per se that precipitates heightened depression, but rather the removal from play or the cessation of athletic activity (Chan & Grossman, 1988). In a related study, Mainwaring et al. (2004) found that athletes' post-injury emotional disturbances returned to preseason levels ten days before athletes returned to play suggesting that additional factors may contribute to depression following concussion. In comparison to athletes with orthopedic injuries, post-injury depression may be the result of transient biochemical disturbances following brain insult (Hovda et al., 1998). Similarly, organic causes may contribute to other psychological and emotional reactions post-injury (e.g. anger, anxiety, frustration).

Confusion following concussion has been frequently cited in literature (Mainwaring et al., 2004; Paniak et al., 2002) and in some sports injury research (Chan & Grossman, 1988; McDonald & Hardy, 1990). Some researchers attribute confusion following orthopedic injuries to a lack of understanding about injury during rehabilitation (Quinn & Fallon, 1999) and/or uncertainty about injury diagnosis (Mainwaring et al., 2004). In comparison, postconcussion confusion has been attributed to impaired cognitive functioning. Paniak et al. (2002) reported that cognitive disturbances including “doing things slowly,” “difficulty thinking clearly,” “poor concentration,” “difficulty planning,” and “forgetfulness” best differentiated individuals with mild brain injuries and healthy normal controls. Other evidence suggests that neurocognitive deficits may compound confusion as concussed athletes become aware of their cognitive deficits (Mainwaring et al., 2004). A direct comparison of post-injury confusion between athletes with orthopedic injuries and athletes with concussion may clarify the mechanism of post-injury confusions in concussed athletes.

Comparable to athletes with orthopedic injuries, athletes with concussion experience anger and irritability following injury (McDonald & Hardy, 1990). The frustration of having to cope with injury and disability, removal from play and cessation of activity may contribute to elevated levels of anger and irritability following injury. Additionally, athletes may become angry with anyone in their "ring of influence" or at themselves for allowing the injury to have happened (Briggs, 2001; Tracey, 2003). In comparison to athletes with orthopedic injuries, these factors are compounded by cognitive disturbances in athletes with concussion. Cognitive problems may make it more difficult to cope with environmental demands and irritability may emerge in response to repeated failures. Similarly, brain injured individuals may experience anger in response to frustration due to disruptions in cognitive, perceptual and memory abilities (Prigatano, 1992).

Although studies assessing emotional reactions in athletes with concussion (Paniak et al., 2002) and athletes with orthopedic injuries (McDonald & Hardy, 1990) found post-injury elevations in anger, a more recent study by Mainwaring et al. (2004) failed to find post-injury increases in anger in athletes with concussion. However, the lack of sensitivity in the measure used to detect heightened anger may have contributed to these results. Additionally, significant within-group variability for anger ratings among concussed athletes was more than double the variability in the control group. The significant within-group variability suggests the existence of subgroups of anger responders: those with marked anger and those with diminished responses (Mainwaring et al., 2004).

Inconsistent with sport injury research (McDonald & Hardy, 1990) and mild brain injury research (Paniak et al., 2002), Mainwaring et al. (2004) failed to find significant differences in postconcussion levels of fatigue and vigor between injured athletes and healthy controls. These results suggest that life events other than brain injury may contribute to levels of fatigue and vigor.

1.8 Mediating Variables

Athletes' emotional reaction to injury depend on at least three factors: (1) the meaning of the injury to the athlete, (2) the nature of the injury including severity of injury and duration of rehabilitation and (3) the athlete's premorbid psychological level of functioning including personality characteristics and athletic identity (Asken, 1991; Quackenbush & Crossman, 1994).

1.8.1 Perceptions of Injury

As previously discussed, the relationship between post-injury emotional disturbance and cognitive appraisal of injury has been shown (Daly et al., 1995). Perceptions of injury, including cause of injury, recovery status, consequences of injury and coping abilities influence post-injury emotional reactions and behaviors (Wiese-Bjornstal et al., 1998). Individuals who perceive their injuries as more problematic have greater emotional disturbances compared to individuals who have more positive perceptions of their injury (Moss-Morris, Weinman, Petrie, Horne, Cameron, & Buick, 2002).

1.8.2 Injury Severity

The relationship between injury severity/length of rehabilitation and post-injury emotional responses has been demonstrated (Smith et al., 1990; Smith et al., 1993). Athletes with severe and/or long lasting injuries report greater levels of emotional disturbance compared to athletes with less severe injuries (Smith et al., 1990; Smith et al., 1993) and injuries of a shorter duration (Smith et al., 1990). In one study, athletes with severe injuries experienced greater mood disturbances in comparison to athletes with minor or moderate injuries and these mood disturbances remained elevated for a longer period of time (Smith et al., 1990). All athletes, regardless of injury severity, experienced elevated levels of depression, anger, tension, and confusion concurrent with declines in vigor immediately following injury. However, these changes remained unchanged for about one month following injury for the most severely injured athletes. In comparison, athletes with minor or moderate injuries, reported declines in depression, anger, tension and confusion and increases in vigor at two weeks post-injury. These results suggest that injury severity and/or length of rehabilitation may positively correlate with the intensity and length of mood disturbance (Smith et al., 1990).

In a related study, Smith et al. (1993) determined whether injury severity contributed to post-injury emotional disturbances in competitive athletes with orthopedic injuries. This study concluded that severity of injury, determined by the duration of nonparticipation in sport activities, significantly predicted post-injury levels of depression. That is, in comparison to athletes with minor (i.e. not participating in sport for one week) and moderate injuries (i.e. cessation of activity for two weeks), athletes who incurred severe injuries (i.e. not participating in sport for three weeks or more) experienced significantly greater levels of post-injury depression. Since injury severity was defined by the amount of time restricted from play, these results suggest that athletes who incur severe injuries may experience heightened levels of depression compared to athletes with minor or moderate injuries due to the restriction and deprivation from sport participation for an extended period of time (3 weeks in this study).

Cessation of sport activity resulting in missed training opportunities, fun, competition, goal achievement, opportunities for scholarship, and replacement on the team may contribute to post-injury mood disturbances (Smith et al., 1993). In this regard, severely injured athletes may experience heightened levels of negative mood in comparison to athletes with minor or moderate injuries. As length of rehabilitation increases, athletes may experience heightened levels of negative mood caused by continued cessation of activity, lack of perceived progress, thwarted goals, sense of falling behind others, fears of reinjury and disappointment of not being able to perform at preinjury levels (Crossman, 1997).

1.8.3 Personality Characteristics

Premorbid personality characteristics have been suggested to be correlated with emotional disturbances following injury (Bornstein, Miller and Van Schoor, 1989; Costa & McCrae, 1992; McDonald & Hardy, 1990; Smith et al., 1990). Additionally, preexisting personality characteristics may be accentuated by injury and may contribute to persisting symptoms, especially in individuals with concussion (Bennett & Raymond, 1997). While preinjury personality characteristics have been hypothesized to play a role in post-injury symptom presentation (Kay et al., 1993; Lidvall, Linderoth, & Norlin, 1974; Lishman, 1988), the specific characteristics have yet to be specifically identified (Gasquoine, 1997).

Neuroticism, explanatory style, hardiness and extraversion have been shown to be associated with thought processes, emotional reactions, and/or coping behaviors that they are likely to influence athletes' emotional reactions to and from injury (Grove & Bianco, 1999). Neuroticism reflects a general tendency toward emotional lability and negative affect (Eysenck & Eysenck, 1985). Given that neuroticism reflects a general tendency to exaggerate negative emotions, it is likely that athletes with high levels of neuroticism will exhibit maladaptive emotional reactions to and from injury (Costa & McCrae, 1992).

Neuroticism may indirectly influence emotional reactions to and from injury through its influence on coping behaviors. Research has found neuroticism to be positively correlated with avoidance-oriented and emotion-oriented coping strategies and negatively correlated with problem-focused coping strategies (Endler & Parker, 1990). Such coping strategies may be maladaptive during injury rehabilitation contributing to heightened levels of negative affectivity.

Explanatory style refers to the way individuals account for the significant events in their lives. Individuals with a pessimistic explanatory style are more likely to explain negative events as personally caused, stable over time, and global in nature while explaining positive events as externally caused, unstable over time, and specific in nature (Grove & Bianco, 1999). In this regard, injured athletes with a pessimistic explanatory style are more likely to experience heightened levels of post-injury negative mood compared to injured athletes with more positive explanatory styles.

Research examining explanatory styles in health related venues has shown pessimistic explanatory styles to be associated with negative health consequences. Peterson (1995) reported that individuals who attributed negative events to internal, stable, or global causes experienced poorer health compared to individuals who were more optimistic and explained negative events with external, unstable, and specific causes. In a related study, pessimistic explanatory styles were found to be associated with increased social isolation, loneliness, and/or depression (Grove & Bianco, 1990), factors shown to be associated with poor emotional adjustment following injury among athletes (Gordon, Milos, & Grove, 1991).

Grove, Stewart, & Gordon (1990) (in Grove & Bianco, 1990) investigated the relationship between preinjury explanatory style and post-injury emotional disturbance in athletes with knee injuries. This study found a significant relationship between post-injury mood disturbance and pessimistic explanatory style. During the first month of knee rehabilitation, pessimistic explanatory styles were positively correlated with tension, depression and anger and negatively correlated with vigor and self-esteem.

Hardiness is a constellation of personality characteristics including curiosity, willingness to commit, seeing change as challenging, and having control over one's life (Anderson & Williams, 1988). Hardiness has been suggested to be correlated with post-injury emotional disturbances. In one study, hardiness was positively correlated with depression, anger, and tension, and negatively associated with vigor and self-esteem (Grove et al., 1990).

Extraversion, a trait frequently observed in athletes, refers to a constellation of traits including sociable, outgoing, carefree, changeable, assertive, physically active and optimistic. In contrast, introversion includes traits such as hesitant, cautious, reflective and pessimistic. Sanderson (1981) asserts that individuals high on measures of extraversion are likely to under-react to injuries and have difficulty accepting the discipline of routines during rehabilitation. Additionally, because extraverted athletes typically have high levels of self-esteem, they are more likely to perceive injures as threatening in comparison to athletes low on measures of extraversion. On the other hand, injuries have a greater psychological impact for athletes who are high on measures of introversion since introverted athletes tend to over-react to injuries appraising the injury as more serious than it actually is. These assertions suggest that individuals high on measures of extraversion are likely to experience post-injury declines in self-esteem in comparison to individuals low on measures of extraversion. Additionally, individuals high on levels of introversion are more likely to experience post-injury mood disturbances in comparison to athletes low on measures of introversion.

1.8.4 Athletic Identity

Athletic identity refers to the degree to which an individual defines himself or herself in terms of an athletic role (Brewer, 1993). Additionally, individuals who are intensely involved with athletics and receive encouragement for their participation may focus their self identity on the role of an athlete (Rotella & Heyman, 1993 in Green & Weinberg, 2001). Athletic identity is considered to be a cognitive orientation that guides and organizes the processing of self-related information (Brewer, Van Raalte, & Linder, 1993). According to Brewer et al. (1993), individuals with strong athletic identities are more likely to interpret a given event in terms of its implications for their athletic functioning compared to individuals who only weakly identify with the athletic role. Individuals who derive their self-identity exclusively from their role as an athlete are more prone to experience a symbolic loss following a sports-related injury.

The influence of injury on athletic identity and the psychological reactions to injury has not been widely explored. Research suggests that individuals whose self-worth is derived exclusively or predominantly through athletic performance are more likely to appraise their injury in terms of a threat or loss which in turn may result in post-injury emotional disturbances and lowered self-esteem (Brewer et al., 1993). Brewer (1993) found that a strong and exclusive identification with the athletic role was associated with depression following injury, with participants higher in athletic identity reacting more negatively to injury, imagined or real, than participants lower in athletic identity. In another study, Manuel, et al. (2002) found athletic identity to be predictive of post-injury depressive symptoms after injury severity and gender were accounted for. Green and Weinberg (2001) however, failed to find a significant relationship between athletic identity and negative affect following injury.

With regards to self-esteem, Keliber and Brock (1992) found that among college student-athletes who had experienced career-ending athletic injuries, individuals who were invested in playing professional sport experienced lower post-collegiate self-esteem and life satisfaction compared to individuals without such investment. Additionally, Green and Weinberg (2001) found athletic identity to be significantly related to perceived physical conditioning as measured by the Physical Self-Perception Profile (PSPP) suggesting that individuals who value their role as an athlete also value their own physical conditioning and level of participation in exercise.

1.9 Aims of the Investigation

Evidence suggests that injured athletes experience intense emotional disturbances immediately following injury followed by a gradual return to preinjury emotional states (Leddy et al., 1994; McDonald & Hardy, 1990; Smith et al., 1990; Smith et al., 1993). Only a handful of studies have gathered preinjury data (Chan & Grossman, 1988; Leddy et al., 1994; McDonald & Hardy, 19900; Morrey et al., 1994; Pearson & Jones, 1992; Smith et al., 1990) and only a few have investigated longitudinal post-injury adjustment (Chan & Grossman, 1988; Pearson & Jones, 1992; Smith et al., 1993) resulting in a limited understanding of the full affective impact of athletic injury. To date, previous studies have been limited to one of two types of injuries: athletes with orthopedic injuries or athletes with concussive injuries. No studies have directly compared post-injury emotional disturbances between athletes with different types of injuries.

The aim of the present investigation was to evaluate the influence of athletic injury on emotional functioning. An overarching goal was to compare post-injury emotional reactions in athletes with concussion and athletes with orthopedic injuries. Comparing emotional responses following injury between athletes with concussion to that of athletes with orthopedic injuries yielded injury specific information as well as extended previous research in the field of emotion and traumatic brain injury (Mainwaring et al., 2004).

1.10 Hypotheses

1.10.1 Total Mood Disturbance Hypotheses

Hypothesis 1a. Incurring an athletic injury was expected to influence emotional functioning such that injured athletes would exhibit greater levels of total mood disturbance (TMD) immediately following injury (time 2) compared to preinjury levels of TMD (time 1).

Hypothesis 1b. The three groups of participants (concussion, orthopedic, healthy) were hypothesized to show different degrees of emotional disturbance immediately following injury (time 2). Specifically, athletes with concussive injuries were predicted to show significant elevations on the total mood disturbance (TMD) scale compared to athletes with orthopedic injuries. Athletes with orthopedic injuries were hypothesized to show elevations on the TMD scale relative to healthy athletic controls.

Hypothesis 1c. Total mood disturbance (TMD) was predicted to vary between groups according to time of measurement (**group by time interaction**). TMD was expected to decline from time 2 in athletes with concussion at a different rate compared to athletes with orthopedic injuries. TMD was hypothesized to vary according to injury type (**main effect for group**). Specifically, athletes with concussive injuries were predicted to show significant elevations on the TMD scale compared to athletes with orthopedic injuries. Athletes with orthopedic injuries were hypothesized to show elevations on the TMD scale relative to healthy athletic controls. TMD was hypothesized to vary according to time (**main effect of time**). TMD was expected to be significantly elevated at time 2 in comparison to TMD at time 1, time 3 and time 4. TMD was predicted to decline from time 2 to time 3 and to time 4.

1.10.2 Physical Self-Esteem Hypotheses

Hypothesis 2a. Injured athletes were predicted to experience lower levels of physical self-esteem, demonstrated by declines in physical self-worth (PSW) scores from the PSPP, immediately following injury (time 2) compared to preinjury levels of PSW.

Hypothesis 2b. The three groups (concussion, orthopedic, healthy) were hypothesized to show different degrees of emotional disturbance following injury (time 2). Specifically, athletes with orthopedic injuries were predicted to show significant declines on the physical self-worth(PSW) scale compared to athletes with concussive injuries. Athletes with concussive injuries were hypothesized to show declines on the PSW scale relative to healthy athletic controls.

Hypothesis 2c. Physical self-worth (PSW) was predicted to vary between groups according to time of measurement (**group by time interaction**). PSW was expected to increase from time 2 in athletes with concussion at a different rate compared to athletes with orthopedic injuries. PSW was hypothesized to vary according to injury type (**main effect for group**). Specifically, athletes with orthopedic injuries were predicted to show significantly greater declines on the PSW scale compared to athletes with concussive injuries. Athletes with concussive injuries were hypothesized to show declines on the PSW scale relative to healthy athletic controls. PSW was hypothesized to vary according to time (**main effect of time**). PSW was expected to be significantly lower at time 2 in comparison to PSW at time 1, time 3 and time 4. PSW was predicted to increase from time 2 to time 3 and to time 4.

1.10.3 Post-injury Mood Disturbance Correlation Hypotheses

Hypothesis 3a. Athletic identity and post-injury mood disturbances were hypothesized to be positively related. Individuals who identify more strongly with the athletic role were predicted to experience greater levels of emotional disturbance following injury such that athletes with higher preinjury athletic identity scores would report higher levels of post-injury total mood disturbance (TMD) in comparison to athletes with lower preinjury athletic identity scores.

Hypothesis 3b. Neuroticism and post-injury mood disturbance were predicted to be positively correlated. Athletes scoring high on a baseline measure of neuroticism, from the NEO-FFI, were predicted to report greater levels of post-injury total mood disturbance in comparison to athletes with lower preinjury neuroticism scores.

Hypothesis 3c. Perceived negative consequences and post-injury emotional disturbances were hypothesized to be positively related. It was hypothesized that athletes who appraise their injury as having negative consequences, as demonstrated by elevated IPQ-R consequences scores, would report greater levels of TMD scores, in comparison to athletes with lower IPQ-R consequences scores.

CHAPTER 2: METHODS

2.1 Participants

2.1.1 Demographic Characteristics of the Baseline Sample

Demographic characteristics of the baseline sample are listed in Table 1 (see below). A total of 232 varsity athletes completed initial baseline measures. Of those athletes, 173 (75%) attended Drexel University. The average age of the participants was 19.86 years (SD = 1.2, range = 18-23) and the majority of participants were in their first year of college (59.1%). Approximately 51% of the participants were men. Additionally, race/ethnicity varied among participants within the study, with the majority of participants Caucasian (88.8%). Athletes who completed baseline measures participated on one of nine varsity sports teams including basketball (12%), cheerleading/dance (7%), field hockey (9%), football (8%), ice hockey (3%), lacrosse (22%), soccer (21%), softball (6%), and wrestling (12%). The majority of participating athletes (64%) reported experiencing previous athletic injuries. Most (37%) athletes reported previously sustaining orthopedic injuries, and, of those injuries, 19% required surgical intervention to treat the injury.

Table 1. Descriptive Statistics of Baseline Sample (n = 232)

Variable	Frequency	Percentage
University		
Drexel University	n = 173	(74.6%)
Pennsylvania State University	n = 59	(25.4%)
Gender		
Male	n = 119	(51.3%)
Female	n = 113	(48.7%)

Table 1. (*continued*)

Race		
White	n = 206	(88.8%)
African American	n = 15	(6.50%)
Hispanic	n = 4	(1.70%)
Asian	n = 3	(1.30%)
Other	n = 4	(1.70%)
Education		
First Year	n = 137	(59.1 %)
Second Year	n = 42	(18.1 %)
Third Year	n = 31	(13.4 %)
Fourth Year	n = 18	(7.80 %)
Fifth Year	n = 4	(1.70 %)
Age		
Eighteen	n = 21	(9.10 %)
Nineteen	n = 82	(35.3 %)
Twenty	n = 70	(30.2 %)
Twenty-One	n = 33	(14.2 %)
Twenty-Two	n = 19	(8.20 %)
Twenty-Three	n = 7	(3.00 %)
Sport		
Men’s Soccer	n = 29	(12.5 %)
Wrestling	n = 28	(12.1 %)
Women’s Lacrosse	n = 26	(11.2 %)
Men’s Lacrosse	n = 25	(10.8 %)
Field Hockey	n = 21	(9.10 %)
Women’s Soccer	n = 20	(8.60 %)
Football	n = 18	(7.80 %)
Cheerleading	n = 16	(6.90 %)
Women’s Basketball	n = 16	(6.90 %)
Softball	n = 14	(6.00 %)
Men’s Basketball	n = 11	(4.70 %)
Men’s Ice Hockey	n = 8	(3.40 %)
Prior Injury		
None	n = 83	(35.8 %)
Orthopedic Injury	n = 85	(36.6 %)
Concussion	n = 27	(11.6 %)
Both	n = 37	(15.9 %)
Prior Surgical Intervention		
Yes	n = 189	(81.5 %)
No	n = 43	(18.5 %)

There were an additional 19 athletes who completed baseline study measures, but who were not included in the study because they were identified as being injured at the time of baseline. There was no significant change in demographics when the gender, grade, race/ethnicity, and sport information for these 19 athletes was added to that of the 232 athletes described above.

Athletes participating in the current study completed four measures, in addition to a demographic questionnaire, prior to sport participation. Of note, athletes attending Drexel University (DU) (n = 173) completed all four measures at baseline and athletes attending Pennsylvania University (PSU) (n = 59) completed only the POMS. Descriptive statistics for athletes who completed baseline measures and who were included in the study are listed in Table 2.

Table 2. Means and Standard Deviations for Athletes who Completed Study Measures at Baseline (n = 232)

Study Measure	Sample Size	Mean	Standard Deviation
POMS: TMD (Total)	n = 232	23.53	29.235
POMS: TMD (DU)	n = 173	24.68	29.858
POMS: TMD (PSU)	n = 59	20.19	27.293
PSPP: PSW	n = 173	17.81	3.307
NEO-FFI: Neuroticism	n = 173	19.62	8.154
AIMS	n = 173	44.66	7.565

An independent samples t-test was used to compare total mood disturbance scores at baseline between athletes attending Drexel University and athletes attending Pennsylvania State University athletes. Athletes enrolled in Drexel University exhibited comparable levels of mood disturbance (M = 24.68, SD = 29.858) compared to athletes attending Pennsylvania State University (M =

20.19, SD = 27.293). Independent samples t-test revealed no significant difference in levels of mood disturbance, t (231) = 1.019, p = 0.309, (two-tailed).

Athletes included in the current study were especially healthy at baseline in regards to their level of mood disturbance, physical self-esteem, and neuroticism, in comparison to college normative samples. Specifically, athletes who completed baseline measures and who were included in the current study reported significantly lower levels of total mood disturbance, higher levels of physical self-worth, and lower levels of neuroticism in comparison to the college normative sample. Table 3. (below) lists the results from one-sample t-tests conducted to evaluate the difference in baseline mood disturbance, physical self-worth, and neuroticism between athletes in the current study and the college normative sample.

Table 3. Comparisons between the Current Study Sample and the College Normative Sample on Baseline Study Measures.

Study Measure	Mean Difference (Current Sample – College Normative Sample)	T-Score	Significance
POMS: TMD (Total)	-19.47	-10.142	$p < 0.001$
POMS: TMD (DU)	-18.32	-8.072	$p < 0.001$
POMS: TMD (PSU)	-22.84	-6.420	$p < 0.001$
PSPP: PSW	2.07	8.231	$p < 0.001$
NEO-FFI: Neuroticism	-4.94	-7.971	$p < 0.001$

Independent-sample t-tests were initially performed to ensure the absence of difference between injury groups (concussion, orthopedic) on baseline total mood disturbance, physical self-worth, athletic identity, and neuroticism scores. In order to decrease the likelihood of capitalizing on chance, a Bonferonni procedure was used; therefore, findings were considered significant if $p < 0.01$ (0.05/4). As indicated in Table 4 (below), there was no significant difference between athletes who sustained orthopedic injuries and athletes who incurred concussive injuries during their sport season on baseline total mood disturbance, physical self-worth, athletic identity, and neuroticism.

Table 4. Comparisons between Athletes who Incurred Orthopedic Injuries and Athletes who Sustained Concussive Injuries on Baseline Study Measures.

Study Measure	Concussion Group	Orthopedic Group	T-Score	Significance
POMS: TMD (Total)	M = 15.33 SD = 31.99	M = 29.13 SD = 16.88	1.049	$p = 0.315$
PSPP: PSW	M = 18.00 SD = 1.41	M = 16.63 SD = 4.63	-0.399	$p = 0.700$
NEO-FFI: Neuroticism	M = 23.50 SD = 6.74	M = 21.50 SD = 6.74	-0.333	$p = 0.748$
Athletic Identity: AIMS	M = 51.50 SD = 0.71	M = 53.38 SD = 6.88	-1.594	$p = 0.194$

2.1.2 Demographic Characteristics of the Injury Sample

The demographic characteristics of athletes who became injured during the course of their sport season are listed in Table 5 (see below). Approximately 6% of the athletes (n = 15) who completed initial baseline measures sustained a sports-related injury during their regular sports season. Of those athletes, 10 (66.6%) attended Drexel University.

The mean age of athletes who completed baseline measures and who incurred an athletic injury was 20.20 years (SD = 1.082, range = 19-22) and approximately 66.7% of participants were in their first year of college. The majority of injured athletes were women (67%) and Caucasian (67%). Athletes who completed baseline measures and who sustained a sports-related injury incurred their injury while participating on one of seven varsity sports teams including basketball (40%), field hockey (6.7%), football (6.7%), ice hockey (13.3%), lacrosse (20%), soccer (6.7%), and wrestling (6.7%).

Approximately 53% of injured athletes sustained an orthopedic injury during their regular sport season. No athlete sustained both a concussion and an orthopedic injury. The majority of athletes (62.5%) who sustained an orthopedic injury incurred grade 3 injuries. Approximately half (50%) of the athletes with orthopedic injuries sustained their injury during practice and the majority of orthopedically injured athletes (76%) incurred their injury either during the beginning of the sport season or during midseason. The majority of athletes who sustained a concussion incurred a grade 2 injury (71.4%), sustained their injury during practice (57.1%), and towards the end of the sport season (42.9%).

Table 5. Descriptive Statistics of Injured Athletes (n = 15)

Variable	Total Injury n = 15	Orthopedic n = 8	Concussion n = 7
University			
Drexel University	n = 10 (66.7%)	n = 8 (100%)	n = 2 (28.6%)
Pennsylvania State University	n = 5 (33.3%)	N/A	n = 5 (71.4%)
Gender			
Female	n = 10 (66.7%)	n = 7 (87.5%)	n = 3 (42.9%)
Male	n = 3 (33.3%)	n = 1 (12.5%)	n = 4 (57.1%)
Race			
African American	n = 4 (26.7%)	n = 2 (25.0%)	n = 2 (28.6%)
Asian	n = 0 (00.0%)	n = 0 (0.00%)	n = 0 (0.00%)
Hispanic	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
White	n = 10 (66.7%)	n = 6 (75.0%)	n = 4 (57.1%)
Other	n = 1 (6.70%)	n = 0 (0.00%)	n = 1 (14.3%)

Table 5. (*continued*)

Education			
First Year	n = 10 (66.7%)	n = 5 (62.5%)	n = 5 (71.4%)
Second Year	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Third Year	n = 4 (26.7%)	n = 2 (25.0%)	n = 2 (28.6%)
Fourth Year	n = 1 (6.70%)	n = 1 (12.5%)	n = 0 (0.00%)
Fifth Year	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Age			
Eighteen	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Nineteen	n = 5 (33.3%)	n = 2 (25.5%)	n = 3 (42.9%)
Twenty	n = 4 (26.7%)	n = 4 (50.0%)	n = 0 (0.00%)
Twenty-One	n = 4 (26.7%)	n = 1 (12.5%)	n = 3 (42.9%)
Twenty-Two	n = 2 (13.3%)	n = 1 (12.5%)	n = 1 (14.3%)
Twenty-Three	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (7.70%)
Sport			
Field Hockey	n = 1 (6.70%)	n = 1 (12.5%)	n = 0 (0.00%)
Football	n = 1 (6.70%)	n = 0 (0.00%)	n = 1 (14.3%)
Men’s Basketball	n = 1 (6.70%)	n = 0 (0.00%)	n = 1 (14.3%)
Men’s Ice Hockey	n = 2 (13.3%)	n = 0 (0.00%)	n = 2 (28.6%)
Men’s Lacrosse	n = 3 (20.0%)	n = 2 (25.0%)	n = 1 (14.3%)
Women’s Basketball	n = 5 (33.3%)	n = 3 (37.5%)	n = 2 (28.6%)
Women’s Soccer	n = 1 (6.70%)	n = 1 (12.5%)	n = 0 (0.00%)
Wrestling	n = 1 (6.70%)	n = 1 (12.5%)	n = 0 (0.00%)
Current Injury Grade			
Grade 1	n = 2 (13.3%)	n = 1 (12.5%)	n = 1 (14.3%)
Grade 2	n = 7 (46.7%)	n = 2 (25.0%)	n = 5 (71.4%)
Grade 3	n = 6 (40.0%)	n = 5 (62.5%)	n = 1 (14.3%)
Place if Injury			
Practice	n = 8 (53.3%)	n = 4 (50.0%)	n = 4 (57.1%)
Game	n = 7 (46.7%)	n = 4 (50.0%)	n = 3 (42.9%)
Time of Injury			
Pre Season	n = 3 (20.0%)	n = 1 (12.5%)	n = 2 (28.5%)
Beginning of Season	n = 3 (20.0%)	n = 3 (37.5%)	n = 0 (0.00%)
Mid Season	n = 5 (33.3%)	n = 3 (37.5%)	n = 2 (28.6%)
End of Season	n = 4 (26.7%)	n = 1 (12.5%)	n = 3 (42.9%)
Current Surgical Intervention			
No Surgical Intervention	n = 11 (73.3%)	n = 4 (50.0%)	n = 7 (100%)
Surgical Intervention Required	n = 4 (26.7%)	n = 4 (50.0%)	n = 0 (0.00%)

Table 5. (*continued*)

Prior Injury			
None	n = 7 (46.7%)	n = 2 (25.0%)	n = 5 (71.4%)
Orthopedic Injury	n = 3 (20.0%)	n = 2 (25.0%)	n = 1 (14.3%)
Concussion	n = 1 (6.67%)	n = 1 (12.5%)	n = 0 (0.00%)
Both	n = 4 (26.7%)	n = 3 (37.5%)	n = 1 (14.3%)
Prior Surgical Intervention			
Yes	n = 3 (20.0%)	n = 2 (25.0%)	n = 1 (14.3%)
No	n = 12 (80.0%)	n = 6 (75.0%)	n = 6 (85.7%)

The number of athletes included in analyses used to test total mood disturbance hypotheses varied according to the amount of time athletes were removed from sport participation post-injury. For example, 15 athletes completed the Profile of Mood States (POMS) at baseline and again immediately following injury. These athletes were therefore included in analyses assessing Hypotheses 1a and 1b. A total of 9 athletes completed the POMS at baseline and serially post-injury at time 2 (0-48 hours post-injury), time 3 (3-5 days post-injury) and time 4 (6-10 days post-injury) and were therefore included in the analysis used to assess Hypothesis 1c. The demographic characteristics of athletes included in analyses investigating the impact of athletic injury on mood are listed in Table 6.

Table 6. Descriptive Statistics of Athletes Included in Analyses used to test Mood Disturbance Hypotheses.

Variable	Hypothesis 1a n = 15	Hypothesis 1b n = 15	Hypothesis 1c n = 9
University			
Drexel University	n = 10 (66.7%)	n = 10 (66.7%)	n = 9 (100%)
Pennsylvania State University	n = 5 (33.3%)	n = 5 (33.3%)	n = 0 (0.00%)
Gender			
Female	n = 10 (67.7%)	n = 10 (67.7%)	n = 8 (88.9%)
Male	n = 5 (33.3%)	n = 5 (33.3%)	n = 1 (11.1%)

Table 6. (*continued*)

Race			
African American	n = 4 (26.7%)	n = 4 (26.7%)	n = 2 (22.2%)
Asian	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Hispanic	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
White	n = 10 (66.7%)	n = 10 (66.7%)	n = 7 (77.8%)
Other	n = 1 (6.70%)	n = 1 (6.70%)	n = 0 (0.00%)
Education			
First Year	n = 10 (66.7%)	n = 10 (66.7%)	n = 6 (66.7%)
Second Year	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Third Year	n = 4 (26.7%)	n = 4 (26.7%)	n = 2 (22.2%)
Fourth Year	n = 1 (6.70%)	n = 1 (6.70%)	n = 1 (11.1%)
Fifth Year	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Age			
Eighteen	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Nineteen	n = 5 (33.3%)	n = 5 (33.3%)	n = 3 (33.3%)
Twenty	n = 4 (26.7%)	n = 4 (26.7%)	n = 4 (44.4%)
Twenty-One	n = 4 (26.7%)	n = 4 (26.7%)	n = 0 (0.00%)
Twenty-Two	n = 2 (13.3%)	n = 2 (13.3%)	n = 2 (22.2%)
Twenty-Three	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Sport			
Field Hockey	n = 1 (6.70%)	n = 1 (6.70%)	n = 1 (11.1%)
Football	n = 1 (6.70%)	n = 1 (6.70%)	n = 0 (0.00%)
Men’s Basketball	n = 1 (6.70%)	n = 1 (6.70%)	n = 0 (0.00%)
Men’s Ice Hockey	n = 2 (13.3%)	n = 2 (13.3%)	n = 0 (0.00%)
Women’s Basketball	n = 5 (33.3%)	n = 5 (33.3%)	n = 4 (44.4%)
Women’s Lacrosse	n = 3 (20.0%)	n = 3 (20.0%)	n = 3 (33.3%)
Women’s Soccer	n = 1 (6.70%)	n = 1 (6.70%)	n = 0 (0.00%)
Wrestling	n = 1 (6.70%)	n = 1 (6.70%)	n = 1 (11.1%)
Current Injury			
Orthopedic Injury	n = 8 (53.3%)	n = 8 (53.3%)	n = 7 (77.8%)
Concussion	n = 7 (46.7%)	n = 7 (46.7%)	n = 2 (22.2%)
Healthy Control	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Current Injury Grade			
Grade 1	n = 2 (13.3%)	n = 2 (13.3%)	n = 2 (22.2%)
Grade 2	n = 7 (46.7%)	n = 7 (46.7%)	n = 3 (33.3%)
Grade 3	n = 6 (43.0%)	n = 6 (43.0%)	n = 4 (44.4%)
Place if Injury			
Practice	n = 8 (53.3%)	n = 8 (53.3%)	n = 6 (66.7%)
Game	n = 7 (46.7%)	n = 7 (46.7%)	n = 3 (33.3%)

Table 6. (*continued*)

Time of Injury			
Pre Season	n = 3 (20.0%)	n = 3 (20.0%)	n = 3 (33.3%)
Beginning of Season	n = 3 (20.0%)	n = 3 (20.0%)	n = 3 (33.3%)
Mid Season	n = 5 (33.3%)	n = 5 (33.3%)	n = 3 (33.3%)
End of Season	n = 4 (26.7%)	n = 4 (26.7%)	n = 0 (0.00%)
Current Surgical Intervention			
No Surgical Intervention	n = 11 (73.3%)	n = 11 (73.3%)	n = 6 (66.7%)
Surgical Intervention Required	n = 4 (26.7%)	n = 4 (26.7%)	n = 3 (33.3%)
Prior Injury			
None	n = 7 (46.7%)	n = 7 (46.7%)	n = 1 (11.1%)
Orthopedic Injury	n = 3 (20.0%)	n = 3 (20.0%)	n = 3 (33.3%)
Concussion	n = 1 (6.67%)	n = 1 (6.67%)	n = 1 (11.1%)
Both	n = 4 (26.7%)	n = 4 (26.7%)	n = 4 (44.4%)
Prior Surgical Intervention			
Yes	n = 3 (20.0%)	n = 3 (20.0%)	n = 3 (33.3%)
No	n = 12 (80.0%)	n = 12 (80.0%)	n = 6 (66.6%)

A total of 10 athletes completed the Physical Self-Perception Profile (PSPP) at baseline and again at time 2 (0-48 hours post-injury) and time 3 (3-5 days post-injury). Of those 10 athletes, one returned to sport participation prior to completing the PSPP at time 4 (6-10 days post-injury). Given the number of days athletes were removed from sport participation, the number of athletes included in analyses used to evaluate physical self-esteem hypotheses varied. The demographic characteristics of athletes included in analyses investigating the impact of athletic injury on physical self-esteem are listed in Table 7.

Table 7. Descriptive Statistics of Athletes Included in Analyses used to test Physical Self-Esteem Hypotheses.

Variable	Hypothesis 2a n = 10	Hypothesis 2b n = 10	Hypothesis 2c n = 9
University			
Drexel University	n = 10 (100%)	n = 10 (100%)	n = 9 (100%)
Pennsylvania State University	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Gender			
Female	n = 9 (90.0%)	n = 9 (90.0%)	n = 8 (88.9%)
Male	n = 1 (10.0%)	n = 1 (10.0%)	n = 1 (11.1%)
Race			
African American	n = 3 (30.0%)	n = 3 (30.0%)	n = 2 (22.2%)
Asian	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Hispanic	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
White	n = 7 (70.0%)	n = 7 (70.0%)	n = 7 (77.8%)
Other	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Education			
First Year	n = 6 (60.0%)	n = 6 (60.0%)	n = 6 (66.7%)
Second Year	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Third Year	n = 3 (30.0%)	n = 3 (30.0%)	n = 2 (22.2%)
Fourth Year	n = 1 (10.0%)	n = 1 (10.0%)	n = 1 (11.1%)
Fifth Year	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Age			
Eighteen	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Nineteen	n = 3 (30.0%)	n = 3 (30.0%)	n = 3 (33.3%)
Twenty	n = 4 (40.0%)	n = 4 (40.0%)	n = 4 (44.4%)
Twenty-One	n = 1 (10.0%)	n = 1 (10.0%)	n = 0 (0.00%)
Twenty-Two	n = 2 (20.0%)	n = 2 (20.0%)	n = 2 (22.2%)
Twenty-Three	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Sport			
Field Hockey	n = 1 (10.0%)	n = 1 (10.0%)	n = 1 (11.1%)
Football	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Men’s Basketball	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Men’s Ice Hockey	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)
Women’s Basketball	n = 4 (40.0%)	n = 4 (40.0%)	n = 4 (44.4%)
Women’s Lacrosse	n = 3 (30.0%)	n = 3 (30.0%)	n = 3 (33.3%)
Women’s Soccer	n = 1 (10.0%)	n = 1 (10.0%)	n = 0 (0.00%)
Wrestling	n = 1 (10.0%)	n = 1 (10.0%)	n = 1 (11.1%)
Current Injury			
Orthopedic Injury	n = 8 (80.0%)	n = 8 (80.0%)	n = 7 (77.8%)
Concussion	n = 2 (20.0%)	n = 2 (20.0%)	n = 2 (22.2%)
Healthy Control	n = 0 (0.00%)	n = 0 (0.00%)	n = 0 (0.00%)

Table 7. (*continued*)

Current Injury Grade			
Grade 1	n = 2 (20.0%)	n = 2 (20.0%)	n = 2 (22.2%)
Grade 2	n = 3 (30.0%)	n = 3 (30.0%)	n = 3 (33.3%)
Grade 3	n = 5 (50.0%)	n = 5 (50.0%)	n = 4 (44.4%)
Place if Injury			
Practice	n = 6 (60.0%)	n = 6 (60.0%)	n = 6 (66.7%)
Game	n = 4 (40.0%)	n = 4 (40.0%)	n = 3 (33.3%)
Time of Injury			
Pre Season	n = 3 (30.0%)	n = 3 (30.0%)	n = 3 (33.3%)
Beginning of Season	n = 3 (30.0%)	n = 3 (30.0%)	n = 3 (33.3%)
Mid Season	n = 3 (30.0%)	n = 3 (30.0%)	n = 3 (33.3%)
End of Season	n = 1 (10.0%)	n = 1 (10.0%)	n = 0 (0.00%)
Current Surgical Intervention			
No Surgical Intervention	n = 6 (60.0%)	n = 6 (60.0%)	n = 6 (66.7%)
Surgical Intervention	n = 4 (40.0%)	n = 4 (40.0%)	n = 3 (33.3%)
Prior Injury			
None	n = 2 (20.0%)	n = 2 (20.0%)	n = 1 (11.1%)
Orthopedic Injury	n = 3 (30.0%)	n = 3 (30.0%)	n = 3 (33.3%)
Concussion	n = 1 (10.0%)	n = 1 (10.0%)	n = 1 (11.1%)
Both	n = 4 (40.0%)	n = 4 (40.0%)	n = 4 (44.4%)
Prior Surgical Intervention			
Yes	n = 4 (40.0%)	n = 4 (40.0%)	n = 3 (33.3%)
No	n = 6 (60.0%)	n = 6 (60.0%)	n = 6 (66.6%)

An additional 7 athletes sustained an athletic injury over the course of their sports season, but did not complete baseline study measures. When gender, grade, and race information for these 7 athletes was added to that of the 15 athletes described above, 12 of the total population were female (55%), 11 were in their first year of college (50%), and 14 were Caucasian (63.6%). Additionally, the average age for the total population was 20.73 years of age (SD = 1.279, range = 19-23). Sport participation varied, with athletes participating on one of nine sports teams including basketball (31.8%), cheerleading/dance (4.5%), field hockey (4.5%), football (13.6%), ice hockey (9.1%), lacrosse (13.6%), soccer (4.5%), softball (4.5%), and wrestling (13.6%).

2.2 Evaluation Measures

Following injury, team physicians and certified athletic trainers determined the athlete's eligibility for the study. The presence of an athletic injury was determined by the guidelines established by the National Athletic Injury/Illness Reporting System (NAIRS) (Clarke & Miller, 1977) (see Appendix B). Athletes who incurred injuries that required substantive professional attention resulting in the cessation of athletic participation were considered to be injured. Guidelines established by the Quality of Standards Subcommittee of the American Academy of Neurology (AAN) (1997) (see Appendix A) were used to determine the presence of concussion. Athletes were assigned a grade (grade 1, 2, or 3) based on the severity of their concussion following the AAN Grade Scale criteria (Quality of Standards Subcommittee of the American Academy of Neurology (AAN) 1997) (see Appendix C). Athletes who incurred orthopedic injuries were assigned a grade of either mild, moderate or major based on the amount of time the athlete was anticipated to be prevented from athletic participation as determined by the NAIRS Grading Scale criteria (1977) (see Appendix D).

2.3 Instruments

2.3.1 Demographics

The self-report preinjury questionnaire contained information regarding the athlete's gender, race, date of birth, education, sport, and level of sport participation. Athletes were also asked to indicate whether or not they were currently injured, whether they had previously sustained an injury and whether or not that prior injury required surgery. Finally, athletes were asked to indicate whether events, other than athletic injury, may have influenced their current mood state. See Appendix E for a copy of the questionnaire. The athlete face sheet included information regarding the athlete's current injury status. This questionnaire, which was completed by the athlete's athletic trainer, contained information regarding the severity of the athlete's injury, where and how the injury occurred, and the injury's prognosis. See Appendix F for a copy of the questionnaire.

2.3.2 Profile of Mood States (POMS)

The Profile of Mood States (POMS) is a measure of immediate mood reactions that is widely used in the research domains of sport and exercise psychology (LeUnes & Burger, 2000). It has been found to be highly reliable with all six mood scales having near or above 0.90 internal consistency ratings. Results of validation studies suggest good construct validity and cross validation between the POMS and other measures of mood (McNair, Lorr & Dropplemann, 1971).

The POMS measures current levels of depression, anger, vigor, fatigue, confusion and total mood disturbance. The one page front-and-back protocol includes 65 adjectives, which are rated on a five-point likert scale. Participants are asked to indicate how they are feeling at the present moment for each adjective by providing a rating of 0 for not at all, 1 for a little, 2 for moderately, 3 for quite a bit, and 4 for extremely. The POMS is not timed and generally takes approximately 3 to 5 minutes to complete (McNair et al., 1971). The following scores are calculated: tension-anxiety (T), depression-dejection (D), anger-hostility (A), vigor-activity (V), fatigue-inertia (F), confusion-bewilderment (C), and total mood disturbance (TMD). The total mood disturbance score (TMD) is considered to be a highly reliable score and is calculated by summing together the scores from the six factors (weighing vigor-activity negatively). The total mood disturbance score (TMD) is considered to be a highly reliable score which provides a global estimate of affective state.

The tension-anxiety (T) score is considered to be a reliable ($r = 0.90$) score and measures heightened orthopedic tension including observable anxiety (shaky, restless) and somatic tension that may not be observable (tension, on edge). The depression-dejection score (D) is a highly reliable ($r = 0.95$) measure of depression accompanied by a sense of personal inadequacy (unworthy, hopeless). The anger-hostility score (A) is a reliable ($r = 0.92$) variable measuring a mood of anger and antipathy towards others (angry, furious, ready to fight). Adjectives suggesting a mood of vigorousness, ebullience and high energy comprise the vigor-activity (V) score ($r = 0.87$). The fatigue-inertia (F) score is considered to be a reliable (r = 0.93) score which measures weariness, inertia and low energy levels (listless, weary). The confusion-bewilderment (C) score is a highly reliable (r = 0.84) measure of bewilderment and muddleheadedness.

2.3.3 Physical Self-Perception Profile (PSPP)

The Physical Self-Perception Profile (PSPP) is a measure of self-perceptions in the physical domain. The PSPP has demonstrated adequate reliability (r's between 0.81 and 0.92) and validity (Fox & Corbin, 1989). The one page front-and-back protocol consists of 30 two-part statements. For each item, respondents are asked to decide which of two sentences is more representative of how they are currently feeling, and are then asked to choose how true that statement is for them by marking either sort of true or for really true. The PSPP typically takes approximately 10 minutes to complete.

The PSPP measures individual's perceptions of the physical self from a multidimensional perspective. The PSPP consists of five 6-item subscales that represent various aspects of the physical self: perceived sport competence (sport), perceived bodily attractiveness (body), perceived physical strength and muscular development (strength), perceived level of physical conditioning and exercise (condition), and physical self-worth (PSW). The sport score is considered to be a reliable (r = 0.87 - 0.92) score which measures perceptions of sport and athletic ability. The body score is a reliable (r = 0.83 - 0.90) measure of perceived attractiveness of figure or physique. The strength score is a reliable (r = 0.82 – 0.89) variable measuring perceived strength, muscle development and confidence in situations requiring strength. Perceptions of physical condition, stamina and fitness make up the condition score (r = 0.85 - 0.90). The physical self-worth (PSW) score is reliable measure (r = 0.80 – 0.87) of general happiness, satisfaction, pride, respect, and confidence of the physical self.

2.3.4 Illness Perception Questionnaire-Revised (IPQ-R)

The Illness Perception Questionnaire-Revised (IPQ-R) is a measure of illness representation. It has been found to be a reliable (r's between 0.79 and 0.89) measure and results from validation studies suggest good construct and predictive validity (Moss-Morris, Weinman, Petrie, Horne, Cameron & Buick, 2002).

The IPQ-R provides a quantitative assessment of five components of illness representation: identity, consequences, timeline, control/cure, and cause. The three-page protocol is divided into three sections: identity, consequences/timeline and causes. The first section, identity, consists of 12 commonly experienced symptoms (e.g. nausea, fatigue, sleep difficulties). Participants are asked to indicate whether they have experienced each symptom since their injury using a yes/no format, and then indicate whether or not they believe the symptom to be related to their injury by marking yes or no. The consequences/timeline section is comprised of 38 statements measuring seven constructs (consequences, timeline acute/chronic, timeline cyclical, personal control, treatment control, coherence, and emotional dimensions) which are rated on a 5-point likert scale. Participants are asked to indicate how much they agree or disagree with each statement providing a rating of 1 for strongly disagree, 2 for disagree, 3 for neither agree nor disagree, 4 for agree, and 5 for strongly agree. The final section, causes, is comprised of eighteen possible causes of injury/illness (e.g. stress, chance or bad luck, accident). Participants are asked to rate on the same 5-point likert scale how much they agree or disagree with each cause.

The identity score is considered to be a reliable (r = 0.75) score which measures symptoms the participant views to be associated with his or her illness/injury. The consequences score is a highly reliable (r = 0.84) measure of the expected effects and outcome of the illness/injury. The timeline (acute/chronic and cyclical) score is a reliable (r = 0.89 and 0.79 respectively) variable measuring how long the participant believes the illness/injury will last. Control (personal and treatment) scores are considered reliable (r = 0.81 and 0.80 respectively) and measure the amount of control the participant believes he or she has over the injury. The coherence score is considered to be a reliable (r = 0.87) score which measures how one recovers from or controls the illness/injury. The emotional dimensions score, which measures ones feelings about the injury (e.g. depression, anxiety, anger), has been found to be highly reliable (r = 0.88). Factor analysis of the causes score revealed four separate constructs: psychological attributions, risk factors, immunity, and accident or chance. Cronbach alpha scores for these factors ranged from 0.23 for accident or chance to 0.86 for psychological attributions.

2.3.5 Athletic Identity Measurement Scale (AIMS)

The Athletic Identity Measurement Scale (AIMS) is a measure of the degree to which an individual identifies with the athletic role (Brewer et al., 1993). It has been found to be a highly reliable measure (r = 0.93). Results of validation studies suggest good construct validity and cross validation between the AIMS and other measures of athletic involvement (Brewer et al., 1993).

The AIMS measures the extent to which an individual relates to the role of an athlete. The one page protocol includes 10 statements, which are rated on a 5-point likert scale. Participants are asked to indicate how much they agree or disagree with each statement providing a ranking of 1 for strongly disagree, 2 for disagree, 3 for neither agree nor disagree, 4 for agree, and 5 for strongly disagree. The AIMS is not timed and typically takes about 3 to 5 minutes to complete.

Recent studies suggest that the AIMS can be broken down into 4 distinct sections: self-identity, social identity, exclusivity, and negative affectivity (Martin & Adams-Mushett, 1995; Martin, Ekland, & Muscheltt, 1997). The self-identity subscale (r = 0.66 - 0.72) measures how the individual views himself or herself as an athlete and the social-identity subscale (r = 0.51 - 0.65) measures ones perceptions of others viewing him or her as an athlete. The exclusivity subscale (r = 0.72 - 0.77) measures how strongly an individual relies on their athletic identity and how weakly they can define themselves with other important life roles. Negative affectivity (r = 0.62 - 0.64) is a measure of the degree to which an individual negatively responds as a result of being unable to participate in sport.

2.3.6 NEO-Five Factor Inventory (NEO-FFI)

The NEO-Five Factor Inventory (NEO-FFI) is a self-report inventory designed to measure the five factors of personality. The NEO-FFI is a shortened version of the NEO-Personality Inventory (NEO-PI-R: Costa & McCrae, 1992) and was designed to allow for a more rapid completion by large numbers of participants. The NEO-FFI measures five domains of personality including extraversion, agreeableness, conscientiousness, neuroticism, and openness. This protocol includes 60 items which are rated on a five-point likert scale. Participants are asked to indicate how much they agree or disagree with each item providing a rating of 0 for strongly disagree, 1 for disagree, 2 for neither agree nor disagree, 3 for agree, and 4 for strongly disagree. Each scale is composed of 12 items. The NEO-FFI is not timed and generally takes approximately 10 to 15 minutes to complete. The following scores are calculated: extraversion, agreeableness, conscientiousness, neuroticism, and openness.

The NEO-FFI has been found to be a highly reliable instrument (r = 0.68-0.86). Results from validation studies in both normal and clinical populations suggest good construct validity and cross validation between the NEO-FFI and other measures of personality (Costa & McCrae, 1992). Each of the five domains measured via the NEO-FFI is highly correlated with the domains measured by the longer NEO-PI-R for which extensive validity and reliability data also have been reported (Costa & McCrae, 1992). Correlations between the NEO-FFI domains and the NEO-PI-R domains were 0.92, 0.90, 0.91, 0.77, and 0.87 for N, E, O, A, and C respectively. Internal consistency scores of each domain measured by the

NEO-FFI have also been demonstrated to be acceptable. The extraversion score (r = 0.77) measures the tendency to experience positive emotions such as joy and pleasure. The agreeableness score (r = 0.75) is a measure of interpersonal behavior. The conscientiousness score (r = 0.83) measure is designed to contrast scrupulous, well-organized and diligent people with lax, disorganized and lackadaisical individuals. The neuroticism score (r = 0.79) measures ones tendency to experience psychological distress and the openness score (r= 0.80) is a measure of curiosity, flexibility and openness to experience (Costa & McCrae, 1992).

2.4 Procedure

Data collection began following approval from the Institutional Review Boards (IRB) of Drexel University and Pennsylvania State University. Informed consent was obtained from all participants prior to the beginning of the study. Measures were completed preseason and serially following injury (within 48 hours, within 3-5 days, within 6-10 days) during the sport season. All participants completed measures in a quiet room in the athletic office in the Drexel University Athletic Center or in the Pennsylvania State University Athletic Center. Description of study purposes, close observation and assurance of confidentiality encouraged honest responding. Athletes enclosed completed study measures into sealed envelopes that were returned to the primary investigator of the study. Information gathered was kept confidential and no feedback was given to athletic trainers, team physicians or team coaches.

The primary investigator, research assistant, or coach administered baseline measures to the athletes preseason. Either a research assistant or the athlete's respective athletic trainer administered post-injury evaluation measures to injured athletes. The primary investigator trained the research assistants, athletic trainers, and coaches on each of the study instruments.

2.4.1 Preseason Baseline Evaluation

All athletes participated in a pre-season physical examination and were considered to be in good health and able to participate in their respective sport. Participants were excluded from the study if they were not student-athletes participating on varsity sports teams at either Drexel University or Pennsylvania State University. Athletes injured at the time of recruitment and/or baseline assessment were excluded from the study.

The purpose and procedures of the study were explained to all potential varsity athletes either during mandatory preseason neuropsychological evaluations or during preseason team meetings. Voluntary informed consent was obtained during that time. Athletes who did not give consent were not required to complete the study measures. Participants completed a battery of measures including the POMS (test time = 5 minutes), PSPP (test time = 10 minutes), AIMS (test time = 3 minutes), and NEO-FFI (test time = 15 minutes) and Preinjury Athletic Questionnaire (time = 3 minutes) before official practice or competition began (time 1).

2.4.2 Post-injury Evaluation

Athletes who incurred orthopedic or concussive injuries completed the IPQ-R, POMS and PSPP within 48 hours post-injury (time 2). Additionally, athletes who sustained orthopedic or concussive injuries completed the POMS and PSPP again within 3-5 days post-injury (time 3) and again 6-10 days post-injury (time 4). If the concussed athlete continued to experience post-concussive symptoms and did not return to baseline neuropsychological functioning, he or she completed the POMS and PSPP again at 14, 21 and 28 days post-injury. The timing of these measures corresponded to the athletes' postconcussion neuropsychological assessments. Athletes with orthopedic injuries also completed the POMS and PSPP at 14 days, 21 days, 28 days or until he or she returned to full sport participation. The injured athlete's athletic trainer completed the Athlete Face Sheet each time he or she completed the study measures. Injured participants were excluded from the post-injury phase of the investigation if they did not meet the criteria for athletic injury set forth by the National Athletic Injury/Illness Reporting System (NAIRS) (Clarke & Miller, 1977) (see Appendix B).

Uninjured, healthy athletes completed the POMS and PSPP on approximately the same day in which the injured athlete completed the first set of measures (e.g., within 48 hours post-injury). Only three athletes agreed to participate in the current study as a healthy control. Problems contacting potential healthy controls as well as time constraints, cited by contacted athletes, made recruiting healthy matched controls for the current study difficult. Given the limited number of uninjured athletes who completed post-injury measures in the current study, the healthy athletic control group was excluded from all study analyses.

CHAPTER 3: RESULTS

Parametric tests (i.e., paired sample-test, analysis of covariance) were used to evaluate the proposed hypotheses in the current study. However, the applicability of parametric tests was limited given the size of the sample of data available for each analysis. As such, nonparametric tests (i.e. Wilcoxon Signed Rank Test, Mann-Whitney U-Test, Friedman Test) were also used to evaluate the proposed hypotheses in the present investigation.

An alpha level of 0.05 was selected for all a-priori hypotheses, so that, if a null hypothesis is rejected and an alternative hypothesis is supported, the likelihood of making a type I error (falsely rejecting the null hypothesis) is equal to or less than five percent. An alpha level of 0.10 was selected to interpret trend level effects.

3.1 Total Mood Disturbance

The means and standard deviations of TMD scores at baseline and immediately following injury are presented in Table 8. Additionally, descriptive statistics of TMD scores at baseline, time 2 (0-48 hours post-injury), time 3 (3-5 days post-injury) and time 4 (6-10 days post-injury) are presented in Table 9. Healthy athletic controls were not included in analyses due to the limited number of healthy athletes who participated in the current investigation (n = 3).

Table Eight. Total Mood Disturbance (TMD) Scores. Means ($\pm$ standard deviation) of POMS TMD raw scores, at baseline and immediately following athletic injury (0-48 hours) for athletes included in analyses evaluating the immediate impact of athletic injury on mood (hypothesis 1a) and the differences in post-injury mood disturbance between athletes with different injury types (orthopedic and concussion) (hypothesis 1b).

	Baseline TMD (raw score)	Time 2 TMD (raw score)
Total Injury Group (n = 15)	M = 24.73, SD = 24.770	M = 31.73, SD = 30.058
Concussion (n = 7)	M = 19.71, SD = 31.426	M = 16.70, SD = 10.173
Orthopedic (n = 8)	M = 29.13, SD = 16.881	M = 44.84, SD = 9.522

In contrast to the first prediction (**hypothesis 1a**), a paired samples t-test revealed that athletes did not report significantly greater levels of TMD, $\underline{t}$ (14) = 0.785, $\underline{p}$ = 0.445, one-tailed, immediately following athletic injury compared to baseline levels of TMD (see Table 8). As shown in Figure One (below), injured athletes reported increased levels of TMD immediately following injury compared to preinjury mood levels; however, the increase was not significant. Using a paired sample t-test to assess the primary hypothesis in a one-tailed investigation that includes 15 participants, with an alpha of 0.05, and a small effect size (d = 0.26), a power of 0.19 is produced. Therefore, if the anticipated effect exists in the current study, there is a 19% chance that it will be detected.

TMD scores were rank ordered by the magnitude of the change between preinjury and post-injury values and a Wilcoxon Signed Rank Test was used to supplement the original analysis (i.e., paired samples t-test) (**hypothesis 1a**). A slight majority of injured athletes (53%) reported increased TMD scores following injury, compared to preinjury TMD scores. One injured athlete did not report a change in TMD following injury and was excluded from the analysis. As with the paired samples t-test, the results, using a Wilcoxon Signed Rank Test, did not demonstrate a significant increase in TMD scores immediately following injury, T(13) = 41, p = 0.551.

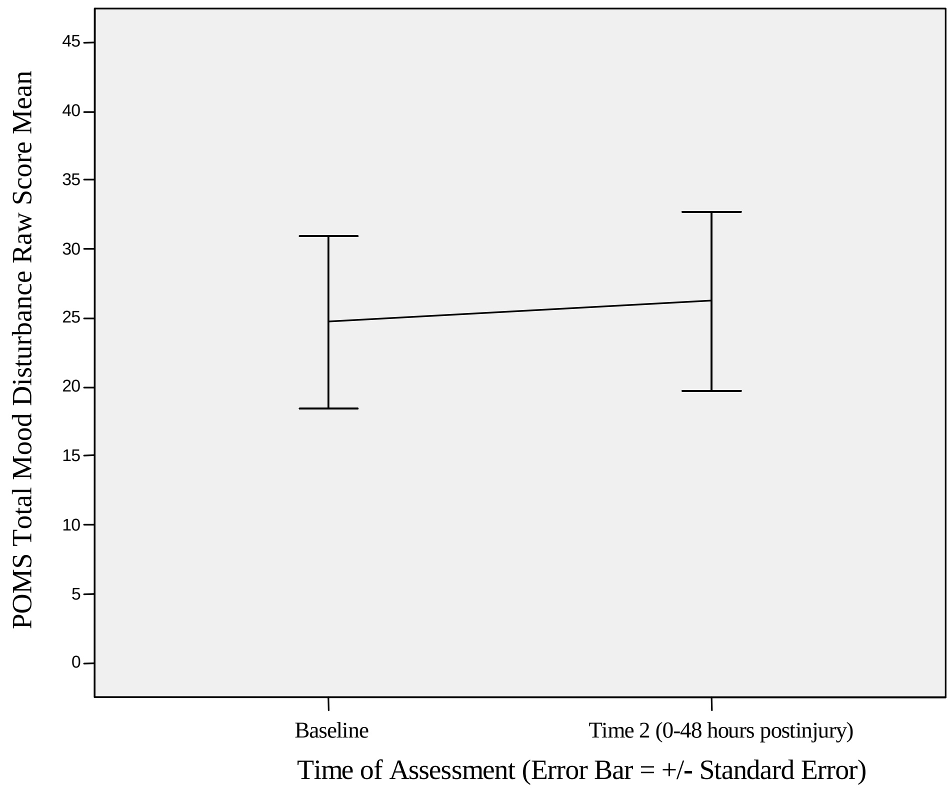

Figure One. Change in POMS: Total Mood Disturbance raw score means from baseline to time 2 (0-48 hours post-injury) for all injured athletes.

Contrary to expectations (**hypothesis 1b**), a one-way analysis of covariance found that, when controlling for baseline TMD, the difference in post-injury TMD between injury types (orthopedic and concussion) (see Table 8 above) revealed trend level effects, F (1, 14) = 3.607, p = 0.082, opposite to that predicted. Results from the current investigation revealed a small sample size (total n = 15), an alpha of 0.05, a large effect size ($\eta^2 = 0.231$), and a power of

0.416. As such, there is a 41.6% probability that the anticipated effect will be detected, if one truly exists.

A Mann-Whitney U-Test was also used to evaluate the difference in TMD between athletes with different injury types (orthopedic and concussion) (**hypothesis 1b**). Injured athletes post-injury TMD scores (time 2) were rank ordered and a Mann-Whitney U-Test was used to compare ranks between athletes with concussive injuries (n = 7) and athletes with orthopedic injuries (n = 8). Consistent with results obtained using an ANCOVA, the results, using a Mann-Whitney U-test revealed a trend level difference between injury group $U(15) = 12.50$, $p = 0.072$, with the sum of ranks equal to 40.50 for athletes with concussive injuries and 79.50 for athletes with orthopedic injuries. Although not statistically significant, trends were identified opposite to that predicted. Athletes who sustained orthopedic injuries demonstrated increased mood disturbance immediately following athletic injury while athletes who incurred concussive injuries reported fewer negative mood symptoms post-injury (see Figure Two below).

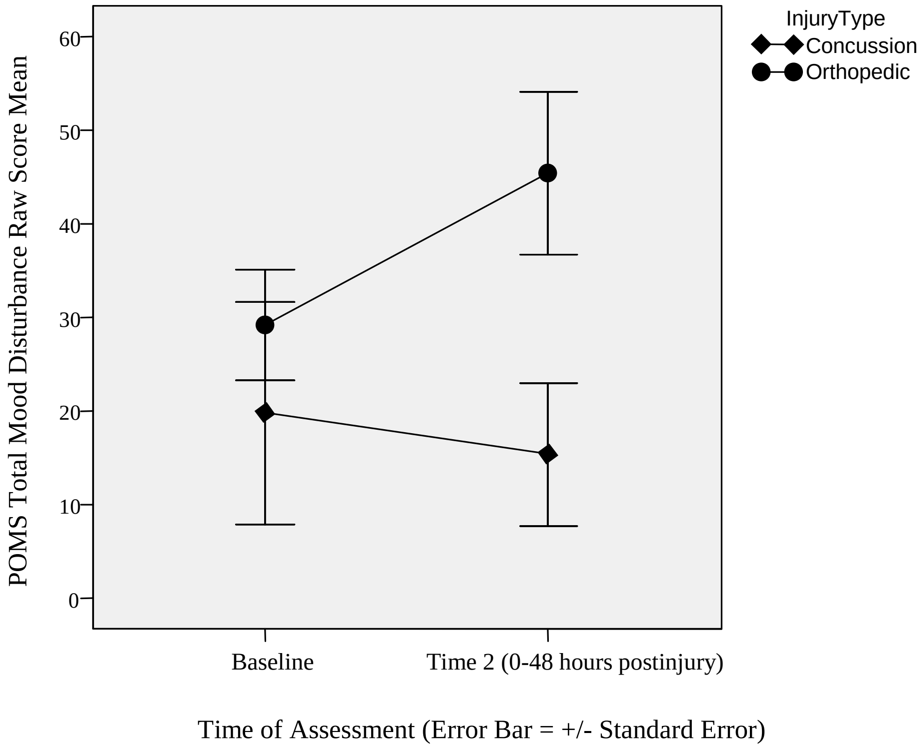

Figure Two. Change in POMS: Total Mood Disturbance raw score means from baseline to post-injury time 2 (0-48 hours post-injury) for athletes with concussive injuries and athletes with orthopedic injuries.

The number of participants available in each injury group (orthopedic and concussion) was limited. Therefore, the repeated-measures mixed-factorial analysis of covariance, originally proposed to evaluate the interaction between injury type (orthopedic and concussion) and time of assessment (time 2, time 3, time 4) on TMD scores, covarying baseline TMD scores (**hypothesis 1c**), could not be conducted. Instead, the change in TMD scores was assessed across time (time 2, time 3, time 4) (**main effect for time**) for all injured athlete types (orthopedic and concussion combined).

Table Nine. Total Mood Disturbance (TMD) Scores Across Time. Means ($\pm$ standard deviation) of the POMS: TMD raw scores across assessment intervals (baseline, 0-48 hours post-injury, 3-5 days post-injury, 6-10 days post-injury) for athletes included in analysis evaluating post-injury mood disturbance across time (hypothesis 1c).

	Baseline	Time 2 (0-48 hours post-injury)	Time 3 (3-5 days post-injury)	Time 4 (6-10 days post-injury)
Total Injury Group	M = 24.22	M = 43.78	M = 20.78	M = 7.11
(n = 9)	SD = 24.77	SD = 24.97	SD = 23.70	SD = 20.65
Concussion Group	M = 21.50	M = 45.00	M = 11.50	M = -12.00
(n = 2)	SD = 2.12	SD = 31.11	SD = 34.65	SD = 12.73
Orthopedic Group	M = 25.00	M = 43.43	M = 23.43	M = 12.57
(n = 7)	SD = 13.18	SD = 25.87	SD = 22.63	SD = 19.63

Predicted changes in TMD across post-injury assessment intervals (time 2, time 3, time 4) were not revealed [Wilks' $\lambda = 0.484$, $\underline{F}$ (1, 6) = 3.196, p = 0.114, $\eta^2 = 0.516$]. Results from a one-way repeated measures analysis of covariance indicate that when controlling for baseline TMD, the decline in TMD across time was not significant. As shown in Figure Three (below) athletes reported a decline in TMD scores across assessment intervals; however, this decline was not significant. Using a one-way repeated measures analysis of covariance to assess the primary hypothesis in an investigation that includes 9 participants, with an alpha of 0.05, and a large effect size ($\eta^2 = 0.516$), a power of 0.402 is produced. Consequently, if an anticipated effect exists, there is a 40.2% chance that it will be detected in the current study.

TMD scores were ranked and a Friedman Test was used to evaluate the difference in TMD scores across time 2 (n = 9), time 3 (n = 9), and time 4 (n = 9). In contrast to the results found using a one-way repeated measures ANCOVA, results, using a Friedman Test, revealed a significant decline in TMD scores from time 2 (mean rank = 2.67), to time 3 (mean rank = 2.00), and time 4 (mean rank = 1.33), χ^2 (24) = 8.00, p = 0.018.

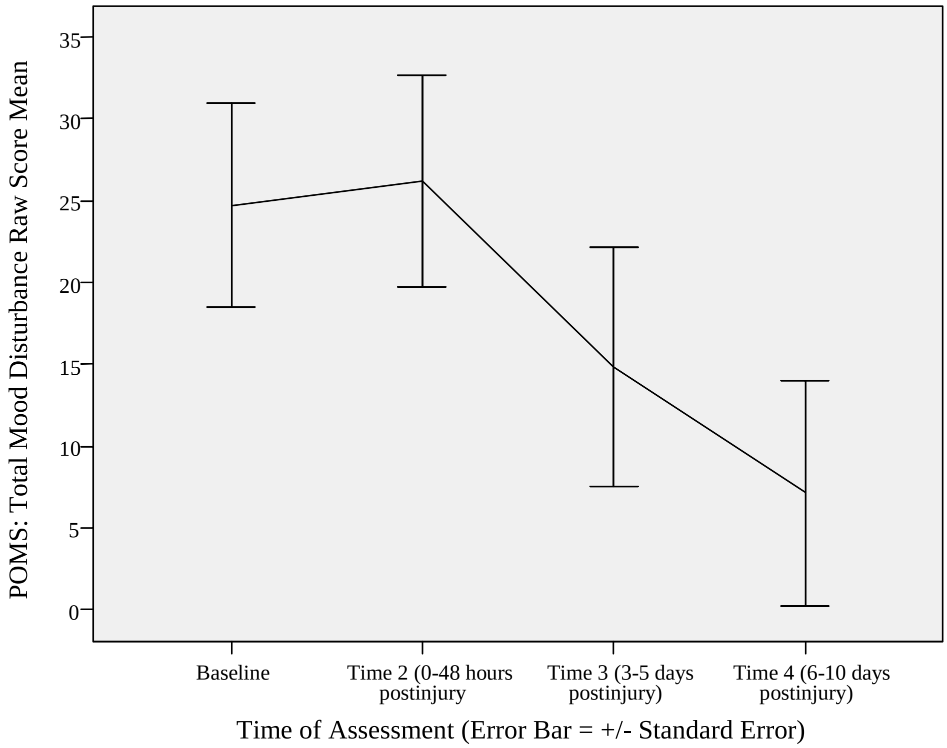

Figure Three. Changes in POMS: Total Mood Disturbance raw score means across assessment intervals (Baseline, 0-48 hours post-injury, 3-5 days post-injury, 6-10 days post-injury) for all injured athletes.

3.2 Physical Self-Esteem

The means and standard deviations for athletes included in analyses investigating the impact of athletic injury on physical self-esteem are shown in Table 10. Given the limited number of healthy athletes in the current study (n = 3), the control group was not included in analyses.

Table Ten. Physical Self-Worth (PSW) Scores. Means ($\pm$ standard deviations) of the PSPP: PSW raw scores across assessment intervals (baseline, 0-48 hours post-injury, 3-5 days post-injury, 6-10 days post-injury).

	Baseline	Time 2 (0-48 hours post-injury)	Time 3 (3-5 days post-injury)	Time 4 (6-10 days post-injury)
Total Injury Group (n = 10)	M = 17.20 SD = 4.264	M = 19.40, SD = 2.917	M = 20.78, SD = 7.716	M = 7.11 SD = 6.177
Concussion (n = 2)	M = 18.00 SD = 1.414	M = 21.50 SD = 3.536	M = 22.50 SD = 2.121	M = 21.50 SD = 3.536
Orthopedic (n = 8)	M = 17.00 SD = 4.781	M = 18.88 SD = 2.748	M = 17.38 SD = 2.560	M = 18.86 SD = 2.795

In contrast to the first prediction (**hypothesis 2a**), a paired samples t-test revealed that athletes did not report significantly lower levels of PSW, $\underline{t}$ (9) = -1.516, $\underline{p}$ = 0.164, immediately following athletic injury compared to preinjury levels of PSW (see Table 10). As shown in figure Four (below), injured athletes did not report significant changes in PSW immediately following athletic injury, compared to baseline PSW levels. However, for this study, which included 10 participants, an alpha level of 0.05 and a large effect size (d = 5.4), the power was small ($1-\beta = 0.27$). Therefore, if an effect did exist there would only be a 27% chance of detecting it.

Physical self-worth scores were also rank ordered by the magnitude of the change between preinjury and post-injury values, and a Wilcoxon Signed Rank Test was used to evaluate the data. Approximately 60% (n = 6) of injured athletes reported decreased PSW scores post-injury, compared to baseline. In contrast, 20% (n = 2) reported increased PSW scores immediately following injury, compared to baseline scores. Two athletes (20%) did not report changes in PSW scores immediately following injury, compared to preinjury PSW scores, and therefore, were discarded prior to analysis. Consistent with the paired samples t-test, the results, using a Wilcoxon Signed Rank Test, did not demonstrate a significant change in PSW scores immediately following injury, $\underline{T}$ (7) = 8.5, $\underline{p}$ = 0.551.

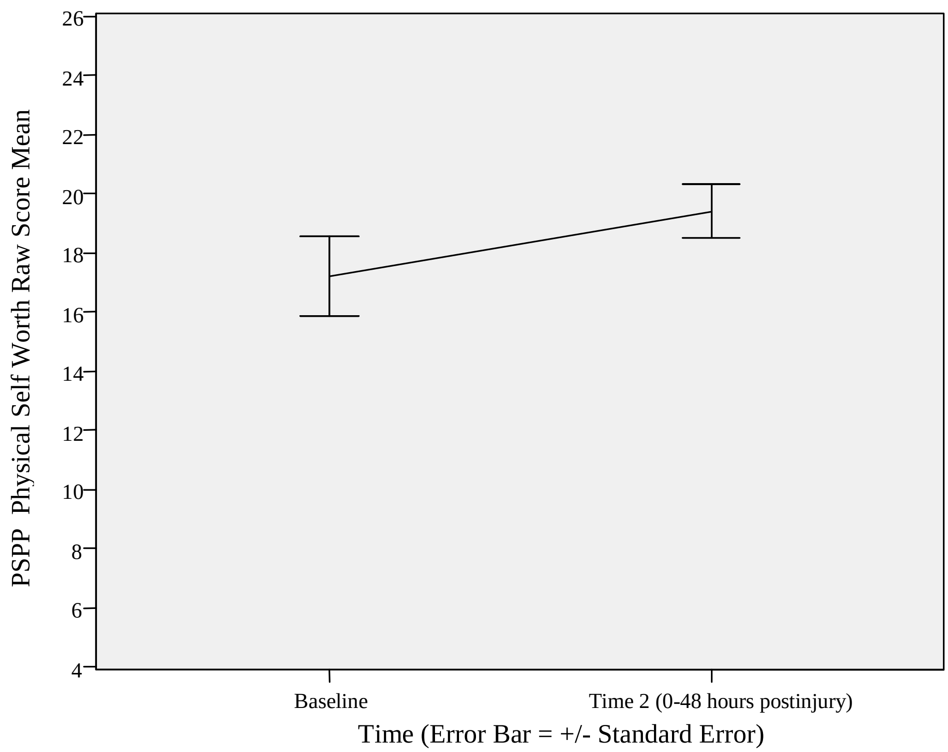

Figure Four. Changes in PSPP: Physical Self-Worth raw score means from baseline to time 2 (0-48 hours post-injury) for all injured athletes.

The current investigation aimed to investigate the difference in physical self-worth between athletes with different injury types (orthopedic and concussion) immediately following athletic injury (**hypothesis 2b**). Additionally, the current study intended to examine the interaction between injury type (orthopedic and concussion) and time of post-injury assessment (time 2, time 3, time 4) (**hypothesis 2c**). Given the limited sample size and different number of participants included in each athletic injury group (concussion = 2, orthopedic = 8), there was insufficient data to analyze the difference in PSW scores between athletes with different injury types immediately following athletic injury (**hypothesis 2b**). Additionally, the repeated measures mixed-factorial analysis of covariance, originally proposed to evaluate the interaction between injury type and time of post-injury assessment (**hypothesis 2c**) could not be conducted. Alternatively, the change in PSW scores was assessed across time post-injury (time 2, time 3, time 4) (**main effect for time**) for all injured athletes types (orthopedic and concussion combined).

Contrary to expectations (**hypothesis 2c**), a one-way repeated measures analysis of covariance revealed that, when controlling for baseline PSW, the difference in PSW across time (time 2, time 3, time 4) (see Table 10) was not significant [Wilks' $\lambda = 0794$, $\underline{F}(1, 6) = 0.778$, $\underline{p} = 0.501$, $\eta^2 = 0.206$]. As illustrated in Figure 5 (see below), athletes who sustained athletic injuries did not report significant changes in PSW across post-injury assessment. Results from the present investigation, using a one-way repeated measures analysis of covariance to test the primary hypothesis, revealed a small sample size (n = 10), an alpha of 0.05, a large effect size ($\eta^2 = 0.206$), and a power of 0.130. Therefore, there is a 13.0% chance that the anticipated effect will be detected, if one truly exists in the current study.

Physical self-worth scores were ranked and a Friedman Test was used to evaluate the difference in PSW scores across time (time 2, time 3, time 4). As with results from the one-way repeated measures ANCOVA, results using the Friedman Test, did not demonstrate a significant change in PSW scores across time 2 (mean rank = 2.28), time 3 (mean rank = 1.83), and time 4 (mean rank = 1.89), χ^2 (10) = 1.58, p = .453.

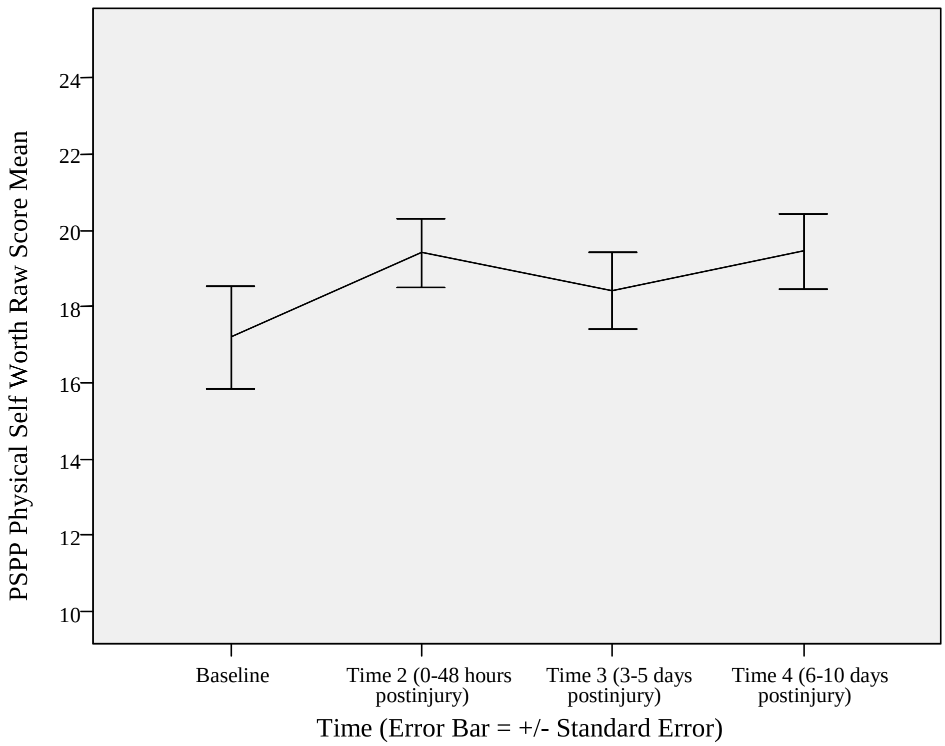

Figure Five. Changes in PSPP: Physical Self-Worth mean scores across assessment intervals (baseline, 0-48 hours post-injury, 3-5 days post-injury, 6-10 days post-injury).

3.3 Post-injury Total Mood Disturbance Correlations

The size of available data to evaluate the total mood disturbance correlations was small (n = 10). Therefore, correlations using the Spearman Rho were conducted to explore the relationships between post-injury mood disturbance and premorbid personality characteristics (athletic identity, neuroticism) and perceived consequences of injury. Correlations between post-injury total mood disturbance (TMD) and (a) athletic identity, (b) neuroticism, and (c) perceived negative consequences are listed in Table 11.

Table Eleven. Correlations between Post-Injury POMS: TMD Raw Scores, at Different Time Intervals, and Athletic Identity, Neuroticism, and Perceived Negative Consequences.

Post-injury Total Mood Disturbance	Athletic Identity	Neuroticism	Perceived Negative Consequences
Time 2 (0-48 hrs)	r_s = -0.123	r_s = -0.049	r_s = -0.425
Time 3 (3-5 days)	r_s = -0.351	r_s = -0.432	r_s = 0.199
Time 4 (6-10 days)	r_s = -0.220	r_s = -0.483	r_s = 0.469

In contrast to predictions (**hypothesis 3a**), there was no positive relationship between athletic identity and post-injury mood disturbance. In fact, contrary to expectations, athletes who reported identifying more strongly with the athletic role exhibited fewer negative mood symptoms immediately following injury (r_s = -0.123, p = 0.735) and 6-10 days post-injury (r_s = -0.220, p = 0.569), compared to athletes who did not identify strongly with the athletic role.

A predicted positive correlation between premorbid neuroticism and post-injury total mood disturbance (**hypothesis 3b**) was also not revealed immediately following injury (r_s = -0.049, p = 0.894) and between 6-10 days post-injury (r_s = -0.483, p = 0.187). Athletes who reported low levels of neuroticism preinjury reported high levels of total mood disturbance following athletic injury.

Contrary to expectations (**hypothesis 3c**), perceived negative consequences, as measured by the IPQ-R were not significantly correlated with TMD immediately following injury ($r_s = -0.425$, $p = 0.221$). Athletes who reported the greatest level of mood disturbance post-injury tended to perceive fewer negative consequences of their injury, compared to athletes who reported fewer negative mood symptoms immediately post-injury. However, 6-10 days post-injury, athletes who initially perceived more negative consequences of their injury also reported more negative mood symptoms ($r_s = 0.469$, $p = 0.203$).

CHAPTER 4: DISCUSSION

Previous research has demonstrated that injured athletes experience intense emotional disturbances immediately following injury, followed by a gradual return to preinjury emotional states (Leddy et al., 1994; McDonald & Hardy, 1990; Smith et al., 1990; Smith et al, 1993). Only a few studies have gathered preinjury data (Leddy et al., 1994; Smith et al., 1990) and just a handful have investigated longitudinal post-injury adjustment (Chan & Grossman, 1988; Pearson & Jones, 1992; Smith et al., 1993) resulting in a limited understanding of the full affective impact of athletic injury. The current investigation is the first study that has directly compared post-injury emotional disturbances between athletes with different types of athletic injuries (orthopedic and concussion).

The goal of the present investigation was to evaluate the influence of athletic injury on emotional functioning and to delineate injury-specific emotional reactions to athletic injury. Results from the present study suggest that collegiate athletes experience mild emotional distress immediately following athletic injury followed by a gradual return to preinjury emotional states. Additionally, the current study suggests a trend towards different emotional reactions immediately following injury based on different injury types (orthopedic, concussion). Psychosocial factors, including personality and athletic identity, athletic involvement, and social support appear to be related to optimistic cognitive appraisals of injury and thus, positive mental health.

These findings, which will be discussed in detail below, highlight the impact of athletic injury on emotional functioning, the importance of preinjury psychosocial factors, the challenges associated with assessing collegiate athletes, and the need for further investigation of the differences in emotional reactions to and from athletic injury between athletes with different injury types. Most importantly, results from this study provide support for early and ongoing management of athletes at risk for sustaining sports-related injuries.

4.1 Review of Results

4.1.1 Total Mood Disturbance

The literature describing emotional reactions to athletic injury, which has mostly been studied with athletes who have sustained severe orthopedic injuries, suggests that injured athletes experience a period of emotional distress following athletic injury (Chan & Grossman, 1988; Leddy et al., 1994; McDonald & Hardy, 1990; Morrey et al., 1999; Pearson & Jones, 1992; Smith et al., 1990; Smith et al., 1993). Athletes with concussive injuries have also been shown to exhibit heightened levels of emotional distress following athletic injury, compared to preinjury levels (Mainwaring et. al., 2004). Based on the extant literature, it was predicted that, in comparison to preinjury mood states, injured athletes, regardless of injury type, would experience heightened levels of mood disturbance immediately following athletic injury (Hypothesis 1a) followed by a gradual return to baseline mood states (Hypothesis 1c). Additionally, athletes with concussive injuries were predicted to experience greater levels of mood disturbance immediately following athletic injury compared to athletes with orthopedic injuries (Hypothesis 1b).

Findings from the present study suggest a trend towards increased mood disturbance immediately following athletic injury. That is, compared to preinjury mood states, injured athletes, as a group, experienced increased mood disturbance immediately following athletic injury (Hypothesis 1a). Heightened mood disturbance immediately following athletic injury was followed by a gradual decline in negative mood symptoms across time (0-48 hours post-injury, 3-5 days post-injury, 6-10 days post-injury) for athletes in the current study (Hypothesis 1c). A closer look at the data suggests a trend towards different emotional reactions to athletic injury immediately following injury based on the type of athletic injury sustained; athletes who incurred orthopedic injuries in the current study experienced increased mood disturbance immediately following injury, compared to preinjury mood states while athletes with concussive injuries reported less negative mood symptoms immediately following injury, compared to baseline mood symptoms (Hypothesis 1b). These findings suggest that injury specific factors may explain athletes' emotional reactions to athletic injury.

Trends from the current investigation, in addition to results from previous studies suggest that orthopedic injury negatively impacts emotional functioning immediately following injury. Total mood disturbance, in addition to depression (Leddy et al., 1994; Pearson & Jones, 1992; Quackenbush & Crossman, 1994; Smith et al., 1990; Smith et. al., 1993), anger (Quackenbush & Crossman, 1994; Smith et. al., 1993), tension (Smith et al., 1990), anxiety (Leddy et al., 1994), and confusion (Smith et al., 1990) have all been found to be elevated immediately following athletic injury for athletes with orthopedic injuries. Additionally, Smith et al. (1993) found that athletes with orthopedic injuries experience declines in energy levels immediately following injury. Consistent with previous findings (Leddy et al., 1994; Pearson & Jones, 1992; Quackenbush & Crossman, 1994; Smith et al., 1990; Smith et. al., 1993), heightened mood disturbance immediately following injury was followed by a gradual return to preinjury mood states over time in the current study.

Factors such as cessation from sport activity for extended periods of time, loss, removal from play, uncertainty, insufficient information regarding injury and injury outcome, and organic factors may play a role in explaining why athletes with orthopedic injuries experience heightened levels of emotional distress immediately following injury compared to preinjury mood states (McDonald & Hardy, 1990, Pearson & Jones, 1992; Quackenbush & Crossman, 1994; Smith et al., 1990; Smith et al., 1993). Additionally, according to LewisGriffith (1982), athletes may feel as though they will no longer vitally contribute to their team and will be reliant on others through the potentially lengthy rehabilitation progress, contributing to heightened mood disturbance immediately following injury as compared to preinjury mood states. The majority of athletes in the current study who sustained orthopedic injuries, incurred severe injuries preventing their return to sport participation for an average of 147 days. The length of time athletes were prevented from sport participation, in addition to potential uncertainties associated with their injury, injury outcome, and rehabilitation may explain why athletes who incurred orthopedic injuries in the current study experienced a transient spike in mood disturbance immediately following athletic injury. While the aforementioned factors may offer explanations as to why athletes with orthopedic injuries experience heightened emotional distress following athletic injury, they may not fully explain the reasons for the observed emotional reactions experienced by athletes with concussive injuries in the current study.

In contrast to the observed increase in mood disturbance following injury for athletes who incurred orthopedic injuries in the current study, athletes who sustained concussive injuries reported fewer negative mood symptoms immediately following injury, compared to preinjury mood symptoms. These results contrast with findings from a similar study that found that athletes with concussion experienced post-injury spikes in total mood disturbance immediately following injury, compared to preinjury mood levels (Mainwaring et al., 2004). Differences in findings may be due to the length of time athletes were removed from sport participation, sample characteristics, the measure used, and sample size.

The mean number of days concussed athletes were prevented from sport participation (M = 15) in previous research (Mainwaring et al., 2004), was greater than the average number of days athletes with concussion were removed from sport participation (M = 7.7 days, SD = 5.1, range = 2 – 18 days) in the current study. The brief amount of time athletes with concussive injuries were removed from sport participation in the current study may contribute to the lack of significant change in mood symptoms post-injury and the difference in results between the current study and previous research (Mainwaring et al., 2004). In regards to sample characteristics, prior research included more male athletes compared to female athletes (Mainwaring et al., 2004). In contrast to previous research (Mainwaring et al., 2004), the current study included a more even gender distribution (4 males, 3 females). Differences in the ways males and females react to athletic injury may explain the difference in results between the current study and previous literature (Mainwaring et al., 2004). For example, Broshek and colleagues (2005) found that morphological, physiological, and hormonal differences may explain the differential outcomes of concussion in males and females. Mainwaring and colleagues (2004) evaluated mood disturbance using an abbreviated version of the POMS, which includes 40 items comprising 7 mood scales. In contrast, the current study used the original POMS, which includes 65 items comprising 6 mood scales, to assess emotional functioning and changes in emotional functioning. The inconsistencies between results in the current study and previous research (Mainwaring et al., 2004) may be due to the different assessment tools used to measure emotional functioning. Finally, a small sample size may explain the difference between results. In contrast to the current study which included 7 athletes with concussive injuries, Mainwaring and colleagues (2004) evaluated post-injury mood functioning on 16 athletes with concussive injuries.

Injury-specific factors including length of time removed from sport participation and visibility and awareness of injury are the most parsimonious explanations for the difference in emotional reactions to athletic injury between athletes with orthopedic injury and athletes with concussive injuries. In contrast to orthopedic injuries, which may take weeks to months to resolve, symptoms of concussive injuries typically revert to baseline within 4 weeks of injury onset (Barth et al., 1989; Macciocchi et al., 1996). Additionally, Mainwaring et al. (2004) found that the negative emotional symptoms, experienced by athletes with concussive injuries immediately following injury, returned to baseline levels within three weeks of injury. Consistent with findings from previous research, athletes in the current study who incurred concussive injuries were removed from sport participation (M = 7.7 days) for a shorter period of time compared to athletes who sustained orthopedic injuries (M = 147 days). Responses to questions regarding the number of days athletes anticipated being prevented from engaging in sport activity suggests that athletes in the current study, regardless of injury type, were aware of the length of time they would be removed from sport participation. Awareness of the length of time one would be prevented from engaging in sport activity may explain why, in the current study, athletes with orthopedic injuries experienced heightened levels of mood disturbance and athletes who incurred concussive injuries reported no change or fewer negative mood symptoms following injury, compared to preinjury symptoms.

While orthopedic injuries are readily apparent, the signs and symptoms of concussive injuries are frequently “invisible” (Gordon et al., 1998). In contrast to orthopedic injuries, which are associated with visible tissue disruption potentially resulting in the need for braces/casts, or crutches to ambulate, athletes with concussive injuries typically “look good” due to no obvious fractures, scars, or cuts serving as visual reminders of injury. Similar to these findings, unlike athletes who incurred concussive injuries, approximately half of the athletes who sustained orthopedic injuries in the current study required surgical intervention and most required orthotics to support their injury. Previous research suggests that emotional reactions to injury may be related to the visual aspect of the injury (Tracey, 2003). The visibility of injury may explain why athletes who incurred orthopedic injuries in the current study experienced greater levels of mood disturbance compared to athletes who incurred concussive injuries.

It is interesting to note that the levels of emotional distress both before and after injury, reported by athletes in the current study, were less than the levels of emotional distress reported by the normative college sample. Minimal increases in total mood disturbance scores immediately following athletic injury, compared to preinjury scores, may be related to the study participants involvement in athletic activity. Crossman (1985) proposed that athletes are usually emotionally healthy individuals who tend towards extraversion and who are characterized as tough-minded, assertive, and self-confident. Additionally, there is a strong consensus that mood enhancement is a primary benefit of physical activity (Berger & Motl, 2000). Thayer, Newman, & McClain (1994) found exercise to be the most successful method for changing bad mood, the fourth most successful strategy for raising energy levels, and the third or fourth most effective technique for reducing tension in the “normal” population. Compared to a mean raw score of 43, which was assumed to represent the average level of total mood disturbance in a group of typically developing college students, baseline total mood disturbance scores for participating athletes in the current study were significantly lower than the normative sample mean. Although not statistically significant, total mood disturbance scores reported by athletes in the current study immediately following injury were also lower than the normative sample mean. The levels of mood disturbance reported by athletes in the current study are comparable to the levels of mood disturbance endorsed by athletes in similar studies (Smith et al., 1990; Terry and Lane, 2000). Terry and Lane (2000) assessed the level of emotional functioning, using the POMS, among athletes competing at the international, recreational, and club levels prior to their participation in athletic activity. Results from that study found that, in comparison to the published college normative sample (McNair et al., 1971), uninjured athletes reported significantly lower levels of emotional distress, including lower levels of tension, depression, anger, fatigue, and confusion, and higher levels of vigor. Investigating the levels of emotional distress in injured athletes, Smith et al., (1990) found injured athletes to have significantly lower levels of tension, depression, and confusion immediately following injury compared to the college normative sample (McNair et al., 1971). Additionally, although not significant, injured athletes also experienced lower levels of anger and greater levels of vigor immediately following athletic injury in comparison to the college normative sample (Smith et al., 1990). Results from the present investigation and from previous research (Smith et al., 1990; Terry & Lane, 2000) suggest that participation in athletic activity is related to positive mental health.

In comparison to non-athletes, athletes may develop strategies that enable them to self-regulate performance-threatening moods (Thayer et al., 1994).

Prior experience with sport participation and perhaps athletic injury, in addition to current participation on team-oriented sports may also explain why athletes in the current study, as a group, experienced minimal increases in emotional distress following injury and why levels of post-injury emotional distress were less than that of the normative college sample. Lilliston (1985) suggested that athletes reactions to injury may be due to the interaction between personality characteristics (e.g., coping styles) and the environment (social support). In regards to personality characteristics, evidence suggests that emotional reactions to athletic injury may be contingent upon ones' coping skills and abilities (Ben-Sira, 1983). Although the exact coping styles of the injured athletes in the current study are unknown, it is possible that the athletes were optimistic and proactive in their approach to their injury and the rehabilitation process. Additionally, athletes in the current study reported low levels of neuroticsm which may limit their tendency to overreact to athletic injury. Given collegiate athletes' preinjury personality characteristics (i.e. low levels of neuroticism), in addition to experience with previous athletic activity and perhaps, athletic injury, injured athletes participating in the current study may have accepted the inherent risk of injury associated with athletic participation and taken their current injury in "stride" resulting in nonsignificant levels of emotional distress following injury.

Social support has been widely recognized as a potentially strong influencing factor to dealing emotionally with an injury (Udry, 1997) and during the rehabilitation process (Smith et al., 1990; Weis & Troxell, 1986). Research suggests that athletes with a strong social support network (athletic trainers, coaches, teammates, friends, family) may experience lower levels of distress following athletic injury compared to athletes with limited social supports (Pearson & Jones, 1992; Udry, 1997). Social support serves to meet one's need for venting feelings and reassurance. Additionally, social support may also serve to reduce uncertainty during times of stress, provide resources and companionships, and aids in mental and physical recovery (McDonald & Hardy, 1990). Most of the athletes in the current study participated on team-oriented sports (e.g., basketball, lacrosse, football), which may be related to low levels of post-injury emotional distress. Although the level of perceived social support for athletes in the current study is unknown, teammates, coaches and athletic trainers may have provided injured athletes with emotional support following their injury and throughout the rehabilitation process indirectly impacting injured athletes' emotional functioning following injury.

4.1.2 Physical Self-Esteem

Research suggests that incurring an injury impacts self-esteem in three ways: (1) injury is a negative experience that directly impinges on ones' sense of self-worth, (2) injury may impede important goals, and (3) physical disability due to injury may stimulate thoughts about declines in physical ability (Beck, 1973).

Despite Beck's (1973) theory, studies examining the impact of athletic injury on self-esteem are mixed. Post-injury declines in self-esteem have been reported in some studies (Chan & Grossman, 1988; Leddy et al., 1994) but not in others (Smith et al., 1993) necessitating further research into the relationship between athletic injury and self-esteem.

As with previous studies, the current study aimed to investigate the impact of athletic injury on self-esteem, and in particular physical self-worth. It was predicted that, compared to preinjury levels of physical self-worth, injured athletes would experience lower levels of physical self-worth immediately following injury (Hypothesis 2a) followed by a gradual return to baseline levels of physical self-worth over time (Hypothesis 2c). In contrast to these predictions, athletes did not experience a significant change in levels of physical self-worth immediately following injury (Hypothesis 2a). Additionally, levels of physical self-worth did not significantly fluctuate across time intervals post-injury (0-48 hours post-injury, 3-5 days post-injury, 6-10 days post-injury) (Hypothesis 2c).

The lack of significant change in levels of physical self-worth following injury, compared to preinjury levels of physical self-worth, is consistent with findings from one study that investigated the impact of orthopedic injury on physical self-worth in athletes (Smith et al., 1993). In contrast, results from the current study are inconsistent with findings from a similar study that showed reductions in athletes' physical self-worth following orthopedic injury (Leddy et al., 1994). Differences in the measure used to assess physical self-esteem may best explain the inconsistencies in results between the current study and previous literature (Leddy et al., 1994).

In contrast to previous literature (Leddy et al., 1994), which evaluated physical self-esteem using the Tennessee Self-Concept Scale, the current study assessed physical self-esteem using the Physical Self Perception Profile. The Tennesee Self-Concept Scale provides an overall physical self score by totaling several items associated with various aspects of the physical self (i.e., state of appearance, skills, appearance, and sexuality), all potentially eliciting different responses. In contrast, the Physical Self-Perception Profile employs a multidimensional or hierarchical perspective to evaluating physical self-worth based on more related facets of the physical-self (i.e., sport competence, attractive body, physical strength, physical condition). The Physical Self-Perception Profile may therefore be a more robust measure of physical self-worth compared to the Tennessee Self-Concept Scale.

Differences in findings between the current study and the study completed by Leddy and colleagues (1994) may also be due to sample characteristics and limited sample size. In contrast to previous research, which included only male athletes (Leddy et al., 1994), the current study was comprised of mostly (90%) female athletic participants. To date, there is a dearth of literature exploring the difference between the way males and females react to athletic injury and how their reaction impacts physical self-esteem. The difference, if any exists, in the way athletic injury impacts physical self-esteem between males and females may explain the inconsistencies in results between the current investigation and a related study (Leddy et al., 1994). Finally, the difference in sample size between the current study (n = 10) and previous literature (Leddy et al., 1994) (n = 343) may illustrate the difference in findings. Limitations due to small sample size will be discussed in further detail below.

Emotional distress may intensify perceptions of somatic symptoms (Brewer et al., 1995), which may indirectly impact feelings of physical self-worth. Additionally, experiencing perceived or real loss of fitness, independence, and place on ones' team, in addition to emotional distress, could challenge ones' perception of invulnerability and their identity as an athlete (Tracey, 2003). As a result, predictions for the current study included heightened levels of emotional distress, intense somatic symptoms, and perceived negative consequences of the injury post-injury. Contrary to these predictions, however, athletes in the current study did not exhibit a significant increase in mood disturbance following athletic injury (see Hypothesis 1a), nor did they perceive the consequences of their athletic injury to be threatening to their physical self-worth (see Hypothesis 3c).

Athletes' self-esteem, and in particular physical self-esteem, has been argued to be susceptible to declines post-injury since injury can lead to changes in how individuals perceive themselves (Chan & Grossman, 1988). In contrast, conflicting research has shown self-esteem and perceptions of the physical self to be relatively stable constructs (Fox, 1990; Wasley & Lox, 1998). Although findings from the current study would suggest that physical self-esteem is a relatively stable construct, flaws in the current study's methodology (e.g., sample size and sample representativeness) may provide an alternative explanation for why changes in self-esteem were not found. Further studies are needed to better understand the stability/vulnerability of self-esteem and in particular physical self-esteem following athletic injury.

The lack of support for hypotheses involving the impact of athletic injury on physical self-worth (Hypotheses 2a and 2c) may be related to the participants' involvement in athletic activity. As described above, participation in athletic activity may be related to positive mental health (Berger & Motl, 2000). Similarly, involvement in athletic activity may be related to high self-esteem. Compared to college students who do not participate in athletic activity, college athletes endorse higher levels of self-esteem (Taylor, 1995) and report higher self-images, compared to less competitive or recreational athletes (Young & Cohen, 1979; Young & Cohen, 1981). Athletes in the current study also reported higher levels of physical self-esteem compared to the "normal" college population both at baseline and post-injury. Compared to physical self-worth scores in a group of typically developing college students, baseline and post-injury levels of physical self-worth for athletes participating in the current study were significantly higher than the normative sample mean. These results suggest that participation in athletic activity may be related to high levels of physical self-worth. Additionally, athletes with high levels of physical self-worth may be more resilient to declines in physical self-esteem post-injury compared to athletes with lower levels of physical self-worth.

4.1.3 Post-injury Total Mood Disturbance Correlation

A number of mediating variables may partially explain athletes' emotional reactions to injury. These include (a) the meaning of the injury to the athlete and (b) the athletes' premorbid psychological level of functioning including personality characteristics and athletic identity (Quackenbush & Crossman, 1994; Asken, 1991). Based on these proposed mediating variables, the current study aimed to assess the relationship between athletes' emotional reactions to injury and (a) athletes' perceived negative consequences of injury, (b) athletes' preinjury ratings of athletic identity, and (c) athletes' preinjury levels of neuroticism. Correlation analysis indicated that post-injury mood disturbance was not significantly related to athletes' perceived negative consequences of injury, athletic identity, or level of neuroticism.

Previous research has shown that emotional reactions to injury are related to the perceived consequences of that injury (Quackensbush & Crossman, 1994). Applying stress models (Daly et al., 1995) to the experience of athletic injury, athletes are expected to interpret injury as threatening or non-threatening, pleasant or unpleasant, and evaluate the consequences of the injury on their lives. In turn, subsequent cognitive appraisal of injury also influences emotional reactions to that injury (Brewer, 1994; Weiss & Troxel, 1986). In contrast to study predictions, post-injury mood disturbance was, although not statistically significant, negatively correlated with perceived negative consequences of athletic injury immediately following athletic injury. In contrast, although not significant, post-injury mood disturbance 6-10 days following injury was positively related to the perceived negative consequences of athletic injury. One explanation for the lack of significant findings may be due to the restricted range of perceived negative consequence scores from the IPQ-R. In contrast to the total possible range of IPQ-R Consequence scores (0-30), IPQ-R Consequence scores in the current study ranged from 7 to 21 ($M = 13.5$, $SD = 6.96$). The majority (60%) of athletes in the current study did not endorse negative consequences associated with their athletic injury, which may explain the limited increase in mood disturbance immediately following injury.

It is interesting to note that perceived negative consequences of injury was negatively correlated with post-injury mood disturbance immediately following athletic injury and positively correlated with post-injury mood disturbance 6-10 days post-injury. These results may suggest that the potential negative impact of athletic injury may not be fully realized immediately following athletic injury, as demonstrated by the negative relationship between immediate post-injury mood disturbance and perceive negative consequences. However, with time, the perceived negative consequences of athletic injury impacts athletes' emotional functioning.

Participation on team-oriented sports, may have been a protective factor against predicted negative cognitive appraisals of injury. While teammates, coaches, and even sports fans may exert pressure on injured athletes to quickly return to sport, they may also serve as a source of support. As described above, social support, from teammates and significant others (friends, family, coaches, athletic trainers) can offer injured athletes the opportunity to vent feelings and receive reassurance regarding their injury and injury outcome (McDonald & Hardy, 1990). Additionally, social support from teammates and other sports medicine personnel may help injured athletes accurately appraise the consequences of their injury (Johnston & Carroll, 1998).

Interpersonal factors, including self-esteem and personality traits, have also been suggested to influence athletes' cognitive appraisal of injury (Brewer, 1994; Weiss & Troxel, 1986). Athletic injury may lead to decreased self-esteem, which can consequently lead to irrational thinking (Beck, 1970) and result in athletes exaggerating the meaning of their injury, disregarding important aspects of their injury, oversimplifying their injury as good or bad, right or wrong, over-generalizing from this single event, or drawing unwarranted conclusions when evidence is lacking or contradictory (Rotella & Heyman, 1986). Athletes participating in the current study did not report low levels of physical self-esteem at baseline, nor did they report low levels of physical self-esteem immediately following injury (see Hypothesis 2a). Therefore, high self-esteem may have acted as a buffer against a negative cognitive appraisal of injury for athletes in the current study.

Premorbid personality characteristics may also be related to emotional disturbances following injury (Bornstein, et al., 1989; Costa & McCrae, 1992; McDonald & Hardy, 1990; Smith et al., 1990). Neuroticism, specifically, has been shown to influence emotional reactions to injury through its influence on coping behaviors (Endler & Parker, 1990). In contrast to predictions, the current study did not find a significant correlation between preinjury neuroticism and post-injury mood disturbance. These results are consistent with findings from one study that found preinjury personality characteristics have little effect on early adjustment to injury (Rush, Malec, Moessner, & Brown, 2004).

Another explanation for the lack of findings in the current study may be related to the range of neuroticism scores in the current study. Compared to the mean standard score of 24.68, which represents average levels of neuroticism in typically developing college students, athletes in the current study endorsed significantly lower levels of neuroticism compared to the normative college sample mean. Given this, athletes in the current study may be less likely, given low levels of neuroticism, to exhibit maladaptive emotional reactions (exaggeration of negative emotions) to athletic injury.

Other personality characteristics not explored in the current study may be more useful in predicting post-injury emotional reactions. Explanatory style has been one of the most studied personality characteristics in sports psychology (Gordon, Milos, & Grove, 1991; Grove & Bianco, 1999). Individuals with pessimistic explanatory styles are more likely to explain negative events, such as athletic injury, as personally caused, stable over time, and specific in nature. In this regard, injured athletes with a pessimistic explanatory style are more likely to experience heightened levels of post-injury negative mood disturbance compared to injured athletes with more positive explanatory styles. While athletes' explanatory styles were not assessed in the current study, it is possible that the athletes in the current study adopted positive coping strategies and demonstrated a more positive outlook on their injury. The relationship between explanatory style and other personality characteristics, such as extraversion and hardiness, and post-injury emotional reactions should be explored further in future studies.

Athletic identity was also not related to post-injury mood disturbance. Similar to results from the current study, Green and Weinberg (2001) did not find a significant correlation between total scores on the Athletic Identity Measurement Scale and Total Mood Disturbance scores from the POMS. In contrast, results from the current study are inconsistent with other similar studies that found that students who related more strongly to the role of an athlete demonstrated higher levels of depression following real and imagined athletic injury (Brewer, 1993; Brewer et al., 1993).

Individuals with strong athletic identities are more likely to interpret injury in terms of its implications for their athletic functioning compared to individual who only weakly identify with the athletic role. Additionally, athletes who derive their self-identity exclusively from their role as an athlete are more likely to appraise their injury in terms of threat or loss (Brewer et al., 1993). Given this, injured athletes who identify strongly with the athletic role would be expected to experience heightened post-injury mood disturbance as long as their attention was focused on the consequences of injury (Brewer et al., 1993). The majority (60%) of athletes in the current study did not perceive their injury to be associated with negative consequences, as described above. As such, athletes may not have perceived their injury as a threat to their identity as an athlete. Additionally, athletes in the current study may have identified with multiple social roles (athlete, student, occupational role, friend, family member, etc.) and once injured, refocused their thoughts and energies on roles other than as an athlete. In contrast to athletes who lack other sources of self-worth and self-identification, athletes who identify with multiple roles are at a lower risk for experiencing emotional disturbance following athletic injury (Brewer et al., 1993). The lack of focus on the consequences of injury, either through neutral appraisals of injury or by refocusing energies into other social roles may explain why athletic identity may not have been related to post-injury mood disturbance in the current study.

4.2 Limitations

There were several limitations to the current study that warrant attention and should be addressed in future studies. By addressing these limitations, more confidence may be placed on the conclusions drawn so that the information could be used to better manage recovery from injury in college athletes.

4.2.1 Sample Size

The study sample was small resulting in reduced power necessary to detect differences across time intervals or injury groups. Athletes were recruited to complete baseline measures for the study based on their injury status (i.e. non-injured) and participation on a high-contact varsity sports team at either Drexel University or Pennsylvania State University. Approximately 50 eligible athletes from Drexel University declined to participate in the current study at baseline due to lack of interest in the study, time constraints, or other unidentified reasons. Additionally, only first time college athletes (i.e., first year students, first year transfer students) completed baseline measures at Pennsylvania State University. Approximately 3 athletes from Drexel University and 7 athletes from Pennsylvania State University became injured during their regular sport season but were not eligible to participate in the post-injury portion of the study because they had not completed baseline measures.

Athletes recruited for the post-injury portion of the study were referred by athletic trainers and/or team physicians who diagnosed at least a grade 1 (concussion) or minor (orthopedic) athletic injury that required the athlete to refrain from sport participation for at least 48 hours. There is a possibility that a number of athletes who incurred athletic injuries (concussion or orthopedic) went undetected or were not referred for the study and, therefore, did not complete post-injury study measures. Additionally, it is possible that athletes who sustained athletic injuries may have declined to enroll in the post-injury portion of the study due to lack of interest in the study, time constraints, limited contact with athletic trainers, and a desire to focus on rehabilitation rather than on the current study. Finally, when an athlete became injured, his or her healthy matched control was recruited to participate in the current study. Only three athletes agreed to participate in the study as a healthy control in the current study. Problems contacting potential healthy controls as well as time constraints, cited by contacted athletes, made recruiting healthy matched controls for the current study difficult. These factors highlight the challenges of performing research with college athletes. Collegiate athletes have demanding schedules that include completion of coursework, weightlifting, practice, and games both away and on campus. Additionally, once injured, athletes may focus their time and energy into rehabilitation and return to sport participation. Providing athletes with incentives for participation in studies may increase their level of motivation to participate in research.

Although many results were not found to be significant, some effect sizes were relatively large (Hypothesis 1b, Hypothesis 1c, Hypothesis 2a, and Hypothesis 2c). A larger sample size ($n \geq 30$) would increase statistical power and allow for more definitive conclusions to be drawn. Absence of statistically significant findings in the current investigation have been interpreted cautiously and are viewed as preliminary, until more data can be collected.

4.2.2 Representativeness of Sample

The representativeness of the sample may have also influenced the results of this study. The study sample included varsity student-athletes attending two universities (Pennsylvania State University and Drexel University) that participate in NCAA Division I athletics. While these results may be generalized to other groups of collegiate varsity athletes, one cannot assume that education, socioeconomic status, and other unforeseen variables experienced by attending a Pennsylvania university did not influence the findings in this study. A more inclusive study, one that includes collegiate athletes participating in Division I athletic programs across the nation could allow study findings to be generalized with more reliability.

The study sample had a relatively higher female to male ratio when compared to the general athletic population participating on varsity sports teams from which these athletes were recruited. Many of the reviewed studies included more males than females in their study sample (Leddy et al., 1994; Mainwaring et al., 2004; Pearson & Jones, 1992; Smith et al., 1990; Smith et al., 1993). There is some evidence that men experience emotional reactions to athletic injury differently than women (Smith et al., 1993). Smith et al. (1993) found that female athletes experienced similar mood profiles as uninjured athletes immediately following athletic injury. In contrast, male athletes exhibited significant increases in depression, anger, fatigue, and confusion, with concurrent declines in vigor immediately following injury compared to uninjured athletes. Although the reviewed study did not investigate reasons for the difference in emotional reaction to athletic injury between male and female athletes, sociological variables, coping styles, personality factors, and type of sport in which the athlete competes may offer an explanation as to why male athletes may report greater levels of mood disturbance compared to female athletes following athletic injury. In regards to sociological variables, fewer patrons attend female sporting events compared to male sports, there is less media attention for female sports and female athletes compared to male sports and male athletes, and there are fewer professionally recognized female sports leagues which female collegiate athletes may aspire to join. Given the aforementioned factors, female athletes may perceive their injury as less threatening to their identity as an athlete. Finally, there may be less pressure associated with female sports compared to male sports. Studies including more female athletes compared to male athletes may explain some of the reasons why emotional reactions to and from athletic injury may differ between male and female athletes.

4.2.3 Lack of Appropriate Control Group

Only a handful of studies investigating the impact of athletic injury on emotional functioning compared injured athletes with uninjured athletes or against a comparison group (college students) (Chan & Grossman, 1988; Leddy et al., 1994; Mainwaring et al., 2004; Pearson & Jones, 1992). Although the current study employed a control group, consisting of healthy athletic teammates, the conclusions that can be drawn when examining the overall functioning of this group are limited. As described above, only three uninjured athletes agreed to participate in the study; therefore, the control group consisted of a self-selected group of athletes who found time and interest to participate in the study. Additionally, the healthy athletic controls were all female and came from either the Drexel University basketball team (n = 2) or field hockey team (n = 1). A more appropriate control group (larger sample size, more even distribution of gender and sport participation) would have allowed more definitive conclusions to be made regarding whether or not reactions to and from athletic injury were unique to injured athletes.

4.2.4 Test Administration

Athletes in the current study were given envelopes to seal their questionnaires and were told that their responses would remain confidential and would not impact their return to sport participation. Despite these warnings, it is possible that the athletes underreported negative mood symptoms. Minimizing symptoms is not uncommon in research with injured athletes (Kontos, Collins, & Russo, 2004). The tendency to underreport symptoms may be due to a hesitation to admit injury, fears of being removed from sport participation, a cavalier attitude towards mild head injury, or a lack of awareness about changes in mental status or personality (Pardini & Collins, 2006). Additionally, injured athletes may feel pressure (self-imposed, situational, and from others) to resume sport participation (Kontos et al., 2004). Within this context, relying solely on the self-report of symptoms (emotional or physical) may be misleading, misrepresentative, and potentially problematic (Bailes & Cantu, 2001), especially for athletes with concussive injuries since their injuries are generally less physically apparent (Kontos et al., 2004). Future studies should include measures of social desirability (i.e., Marlow-Crowne Social Desirability Scale) to assess athletes' tendency to bias their responses towards the socially desirable norm. Additionally, information regarding changes in the injured athletes' mood/personality, lethargy, and confusion, should be gathered from athletic trainers or other sports personnel who work closely with injured athletes.

Athletes initially recruited to participate in the current study completed baseline measures during preseason meetings. Participating athletes therefore, completed study measures at different times during the year. All healthy athletic controls participated in the study at the same time (October of 2005). Given the different times in which athletes completed study measures, effects of timing can not be ruled out. For example, midterm examinations, stressful athletic competition, and other time-sensitive variables may have influenced mood.

4.3 Summary of Findings

The purpose of the current investigation was to evaluate the influence of athletic injury on emotional functioning. More specifically, the overarching goal was to compare post-injury mood disturbance between athletes with concussive injuries and athletes with orthopedic injuries. Although athletes as a group experienced heightened levels of mood disturbance immediately following athletic injury, compared to preinjury mood states, the change in emotional functioning was not statistically significant. Athletes, as a group did however, experience a significant decline in mood disturbance across assessment intervals post-injury (0-48 hours, 3-4 days post-injury. 6-10 days post-injury). Additionally, although not statistically significant, results from the current study suggest a trend towards different emotional responses to injury based on the type of athletic injury incurred. That is, athletes who sustained orthopedic injuries experienced heightened levels of mood disturbance post-injury whereas athletes who incurred concussive injuries experienced no change or minimal declines in mood disturbance following injury. Factors such as the length of time athletes are removed from sport participation in addition to the visibility of injury may explain the difference in emotional reactions to athletic injury. Results from this study provide evidence to suggest that the type of injury is an important factor to consider when evaluating emotional recovery from sports-related injury.

Injured athletes in the current study, regardless of injury type, did not exhibit changes in physical self-worth post-injury, compared to preinjury levels physical self-worth. Consistent with previous findings (Wasley & Lox, 1998), physical self-esteem appeared to act as a relatively stable construct in the current study. If this is true, then sports-medicine personnel may need to focus less on rebuilding self-esteem in injured athletes and more on reducing emotional distress during rehabilitation. Self-esteem should however, continue to be monitored during rehabilitation.

There were no meaningful relationships detected between post-injury emotional reactions and (a) negative perceptions of athletic injury, (b) baseline neuroticism, and (c) athletic identity in the current study. Athletes in the present investigation did not perceive their injury to have significant negative consequences. These results suggest that athletes in the current study may have employed adaptive coping styles and strategies that enabled them to self-regulate performance threatening moods (Thayer et al., 1994). Additionally, given the low levels of neuroticism and moderate to strong identification with the athletic role, athletes in the current study may have accepted the inherent risk of injury associated with athletic participation, and therefore, took their current injury in “stride” resulting in limited perceptions of negative consequences associated with their injury and limited post-injury emotional distress.

4.4 Implications/Future Directions

The acknowledgement of pain and injury is different in males and females (Brooks, 2006). Additionally, perceptions of concussive injuries differ based on gender such that compared to males, females tend to be less informed about concussive injuries and view their injury as less serious (Brooks, 2006). Despite these known differences, few studies exist that have investigated the difference in the way males and females react to athletic injury and, to date, no studies exist that have focused solely on the emotional reactions to athletic injury in female athletes. While a few studies include female athletes, the majority of studies are comprised of only male athletes. The lack of findings in the current study may be explained by the greater inclusion of female athletes compared to male athletes. Future studies should explore gender differences in psychological recovery from athletic injury. Factors, including awareness and understanding of injury, personality, coping styles, type of sport in which the athlete competes, and sociological variables are important to consider when interpreting differences in post-injury emotional reactions between male and female athletes.

Emotions may naturally vary over the course of the athletic season (Leddy et al., Smith et al,. 1993). Therefore, situational variables such as time during the year when the injury is sustained, setting in which the injury is sustained, and other contextual factors are important to consider when interpreting research findings on emotional recovery from injury (Mainwaring et al., 2004). Future studies should closely evaluate the impact of situational variables on athletes' cognitive appraisal of athletic injury and subsequently on athletes' emotional reactions to and from athletic injury.

Given the small sample size, the current study did not investigate the interaction between injury type and time of assessment during rehabilitation. Future studies should investigate the difference in emotional reactions across rehabilitation between athletes who sustain different types of athletic injuries (orthopedic, concussion). It is important for sports-medicine personnel to consider the different rehabilitation trajectories experienced by athletes with orthopedic injuries and athletes with concussive injuries as they may impact athletes' emotional functioning differently. While athletes with orthopedic injuries typically refrain from sport participation longer than athletes with concussive injuries, they are not prohibited from engaging in all sport activity. In this regard, injured athletes may experience different reactions to injury given the factors associated with their rehabilitation trajectory.

Athletes with orthopedic injuries initially refrain from participation in any athletic activity that would exacerbate their specific injury. As orthopedic injuries begin to heal, athletes progressively increase their activity level to include activities that may improve their range of motion, strength, proprioception, and flexibility. Finally, athletes gradually increase their involvement in sport-specific skills, ultimately leading to full sport participation (Kissick and Johnston, 2005). As suggested by the literature and the results of this study, injured athletes experience a gradual decline in mood disturbance across phases of rehabilitation (McDonald & Hardy, 1990; Smith et al., 1990; Smith et al., 1993). It is important to keep in mind, however, that athletes may experience transient increases in mood disturbance during rehabilitation and may experience negative mood patterns just before the conclusion of rehabilitation and return to sport participation (Morrey et al., 1999). Symptoms of mood and self-esteem should be carefully monitored throughout rehabilitation and support offered when necessary.

In contrast to athletes with orthopedic injuries, athletes who sustain a concussion during athletic activity must refrain from all athletic activity until they are asymptomatic (which includes physical, cognitive, and emotional manifestations of concussion) (Kissick & Johnston, 2005); postconcussive symptoms are aggravated by exertion, both physical and cognitive (McCrory, et al., 2005). This fact necessitates that athletes rehabilitation from concussion differ from the rehabilitation trajectory of athletes with orthopedic injuries. Athletes with concussive injuries must refrain from all athletic activity including fitness activity, aerobic activity, and exertion activity. Only when the athlete is asymptomatic can he or she progress to a step-wise return to play protocol.

Health-care professionals should be made aware that athletes may have profound emotional reactions to injury than can affect rehabilitation and return-to-play. Although athletes in the current study did not experience clinically statistically significant levels of mood disturbance immediately following injury, small increases in mood disturbance are nevertheless important in this population. Additionally, it is possible that even subclinical levels of mood disturbance can negatively impact the rehabilitation process. These findings are important because knowing that the period immediately following athletic injury is associated with heightened mood disturbance may allow sports medicine professionals to streamline intervention efforts by targeting this period of the rehabilitation progress.

Accurate identification of athletic injury is imperative in order to effectively treat not only the physical symptoms of injury, but the emotional symptoms as well. In comparison to orthopedic injuries, the physiological effects of concussion are “invisible” and there are no definitive measures which test for the presence of concussion (Guskiewics, 2001). As described above, because the signs and symptoms of concussion are not visibly apparent (Gordon et al., 1998), the injured athlete is typically unaware of the significant changes in his or her functioning. Hence, it is imperative that mood symptoms, in addition to other physical and cognitive symptoms, be consistently evaluated during the course of rehabilitation from concussion. Additionally, symptoms of emotional distress may persist even when physical symptoms are decreasing (Kissick & Johnston, 2005). Accurate assessment of emotional reactions to concussive injuries is important since the presence of emotional disturbance may indicate that a concussive injury has not resolved. Preinjury assessment of mood, as well as physical and cognitive factors should be conducted with athletes prior to their involvement in athletic activity. Additionally, post-injury serial assessment of mood and cognitive functioning should be routinely assessed until symptoms return to baseline functioning.

While it is common, and sometime often expected for athletes to play with minor athletic injuries, the dangers of participating in athletic activity with a concussion are potentially more serious and may have a wide range of implications for performance and future injuries (Kontos, Collins, and Russo, 2004) compared to participating in athletic activity with unresolved orthopedic injuries. Athletes, with any injury, who return to sport too early may play with less confidence, comfort, and intensity (Williams & Roepke, 1993). Tentative play or frustration over performance difficulties can create a mindset that places athletes at greater risk for a variety of other injuries and limits their ability to focus on their performance (Williams & Roepke, 1993). Given the inherent dangers associated with sustaining a second concussion when not fully recovered from the first concussion, sports medicine personnel should assess athletes' postconcussion state anxiety, self-efficacy, and perceptions of subsequence risk using a combination of self-report measures and observations of athletes in practice or competition (Kontos, Collins, & Russo, 2004).

4.5 Conclusions

The number of individuals participating in recreational and competitive sport activity is growing exponentially (Bauman, 2005). Increasing numbers of professional teams across sport, additions of new internationally competitive summer and winter sports, and an overall increase in everyday people participating in recreational sport push the number of people at risk for sports-related injuries to new levels. Athletes are becoming bigger, faster, quicker, stronger, and more athletic in order to meet with growing demands of sport. The intense media exposure of athletes in sports and the ever-increasing social pressures to set personal, school, national, professional, and Olympic records encourage athletes to push and find new physical and mental limits (Bauman, 2005). Due to the significant increase in individuals participating in sport activity, there is an increasing number of sport-related injuries. Therefore, there needs to be a more widespread understanding of athletic injuries and athletes' reactions to and from these injuries. Formal sports management program should be in place for every professional, semi-professional, college, high school, club team, little league, and youth sports programs. Such programs are needed to identify cognitive, physical, and emotional symptoms of athletic injury, to provide support and counsel during rehabilitation, to monitor symptoms and determine readiness to return to play, and to protect athletes against future athletic injury.

Sports medicine personnel should provide athletes, coaches, and sports medicine teams with the appropriate education, recognition, and preventative information regarding sports-related injuries. It is important to educate athletes about the causes, symptoms, and dangers of athletic injury, especially those related to concussive injuries (Pardini & Collins, 2006). Although emotional distress is common for athletes with athletic injury, researchers have found that education, normalizing symptoms, stress reduction, and the amelioration of emotional difficulties can reduce the incidence and length of post concussion reactions (Mittenberrg, Tremond, Zielinski, Fichera, & Rayls, 1996). Sports medicine personnel are encouraged to supply athletes with information about their symptoms and provide an outlet for their concerns (Kontos, Collins, and Russo, 1994). Athletes armed with basic information about their injury may be more inclined to follow the medical advice of their treatment providers and this new knowledge may circumvent the worry and apprehension that can accompany prolonged symptoms (Gasquione, 1997). Educational information at the outset of treatment may also serve to protect athletes from returning to sport participation too early, experiencing setbacks, and extending their recovery time (Kontos, Collins, & Russo, 2004).

This study was the first of its kind to make an attempt to assess differences in emotional reactions between athletes with orthopedic injuries and athletes with concussive injuries. Despite the many limitations, this study highlighted the possibility that injury-specific factors may influence athletes' emotional reactions to athletic injury. The potential influence of specific injuries on athletes must be understood in order to help athletes to overcome emotional disturbances and progress to an optimal rehabilitation progress (Smith et al., 1993). Therefore, future research is required to further delineate injury-specific factors that may impact athletes' emotional reactions to injury. With improved research designs and more refined research questions, future studies will facilitate a more clear understanding of psychological recovery from different athletic injuries.

LIST OF REFERENCES

Almquist, J., Broshek, D., & Erlanger, D. (2001). Assessment of mild head injuries. *Athletic Therapy Today*, *6*, 13-17.

Alves, W., Macciocchi, S.N., & Barth, J.T. (1993). Post-concussive symptoms after uncomplicated mild head injury. *Journal of Head Trauma Rehabilitation*, *8*, 48-59.

Anderson, S.D. (1996). Postconcussional disorder and loss of consciousness. *Bulletin of the American Academy of Psychiatry and Law, 24*, 493-504.

Anderson, M.B., & Williams, J.M. (1988). A model of stress and athletic injury: Prediction and prevention. *Journal of Applied Sport and Exercise Psychology*, *10*, 294-306.

Arnheim, D.D., & Prentice, W.E. (2000). *Principles of Athletic Training*. Boston: McGraw Hill.

Asken, M.J. (1991). Psychological aspects of sports injury: Part II. *American Fitness Quarterly, 27,* 36-37.

Astle, S.J. (1986). The experience of loss in athletes. *Journal of Sports Medicine, 26,* 279-284.

Aubry, M., Cantu, R., Dvorak, J,. Graf-Baumann, T., Johnston, K.M., Kelly, J., et al. (2002). Summary and agreement statement of the 1st international symposium on concussion and sport, Vienna 2001. *Clinical Journal of Sports Medicine*, *12*, 6-11.

Bailes, J.E. (1998). Head injuries in sports. In B.D. Jordan (Ed.), *Sports Neurology* (pp. 215-233). Philadelphia: Lippincott-Raven Publishers.

Barth, J.T., Alves, W.M., Ryan, T.V., Macciocchi, S.N., Rimel, R.W., Jane, J.A., et al. (1989). Head injury in sports: Neuropsychological sequelae and recovery of function. In H.S. Levin, H.M. Eisenberg, & A.L. Benton (Eds.), (pp. 257-275). *Mild Head Injury*. New York: Oxford Press.

Barth, J.T., Broshek, J.T., & Freeman, J.R. (2006). Sports: A new frontier for neuropsychology. In R.J. Echemendia (Ed.) (pp. 3-16). *Sports Neuropsychology*. New York: Guilford Press.

Bauman, J. (2005). Returning to play: The mind does matter. *Clinical Journal of Sports Medicine, 15*, 432-435.

Beck, A.T. (1973). *The diagnosis and management of depression.* Philadelphia: University of Pennsylvania Press.

Bennett, T.L. (1989). Individual psychotherapy and minor head injury. *Cognitive Rehabilitation, 7,* 20-25.

Bennett, T.L., & Raymond, M.J. (1997). Emotional consequences and psychotherapy for individuals with mild brain injury. *Applied Neuropsychology, 4,* 55-61.

Ben-Sira Z. (1983) Loss, stress and readjustment: the structure of coping with bereavement and disability. *Social Science & Medicine, 17*, 1619-1632.

Berger, M.G. & Motl, R.W. (2000). Exercise and mood: A selective review and synthesis of research employing the Profile of Mood States. *Journal of Applied Sport Psychology, 12,* 69-92.

Bohnen, N., & Jolles, J. (1992). Neurobehavioral aspects of postconcussive symptoms after mild head injury. *The Journal of Nervous and Mental Disease, 180*, 683-692.

Bornstein, R.A., Miller, H.B., & van Schoor, J.T. (1989). Neuropsychological deficit and emotional disturbance in head-injured patients. *Journal of Neurosurgery, 70*, 509-513.

Brewer, B.W. (1993). Self-identity and specific vulnerability to depressed mood. *Journal of Personality, 61*, 343-364.

Brewer, B.W. (1994). Review and critique of models of psychological adjustment to athletic injury. *Journal of Applied Sport Psychology, 6*, 87-100.

Brewer, B.W., Van Raalte, J.L., & Linder, D.E. (1993). Athletic identity: Hercules' muscles or achilles heel? *International Journal of Sports Psychology, 24*, 237-254.

Briggs, J. (2001). Sports injuries: Research/epidemiology, classification, causes and risk factors. In J. Briggs (Ed.), *Sports therapy: Theoretical and practical thoughts and considerations* (pp. 55-116). Chichester, England: Corpus Publishing Ltd.

Brooks, J. (2006). Concussion management programs for school-age children. In R.J. Echemendia (Ed.) (pp. 3-16). *Sports Neuropsychology*. New York: Guilford Press.

Broshek, D.K., & Barth, J.T. (2001). Neuropsychological assessment of the amateur athlete. In J.E. Bailes & A.L. Day (Eds.), *Neurological Sports Medicine: A Guide for Physicians and Athletic Trainers* (pp. 155-168). Rolling Meadows, IL: American Association of Neurological Surgeons Publications.

Broshek, D.K., Kaushik, T., Freeman, J.R., Erlanger., D., Webbe, F., & Barth, J.T. (2005). Gender differences in outcome from sports-related concussion. *Journal of Neurosurgery, 102,* 856-863.

Brunker, P. (1996). Sports medicine: Concussion. *Australian Family Physician, 25*, 1445-1448.

Cantu, R.C. (1992). Cerebral concussions in sport: Management and prevention. *Sports Medicine, 14*, 64-74.

Chan, C.S., & Grossman, H.Y. (1988). Psychological effects of running loss on consistent runners. *Perceptual and Motor Skills, 66*, 8*75-883.*

Clarke, K.S. & Miller, S.J. (1977). The national athletic injury/illness reporting system (NAIRS). *Proceedings of the Second National Sports Safety Congress*. (pp. 41-45). Washington, DC: American Alliance for Healthy, Physical Education, Recreation and Dance.

Costa, P.T., & McCrae, R.R. (1992). Normal personality assessment in clinical practice: The NEO Personality Inventory. *Psychological Assessment, 4*, 5-13.

Crossman, J. (1997). Psychological rehabilitation from sports injuries. *Sports Medicine, 23,* 333-339.

Daly, J.M., Brewer, B.W., van Raalte, J.L., Peitpas, A.J., & Sklar, J.H. (1995). Cognitive appraisal, emotional adjustment, and adherence to rehabilitation following knee surgery. *Journal of Sport Rehabilitation, 4,* 23-30.

DeHaven, K.E., & Lintner, D.M. (1986) Athletic injuries: comparison by age, sport, and gender. *American Journal of Sports Medicine, 14,* 218-224.

Deutsch, R.E. (1985). The psychological implications of sports related injuries. *International Journal of Sports Psychology, 16*, 232-237.

Dikmen, S., McLean, A., & Temkin, N. (1986). Neuropsychological and psychosocial consequences of minor head injury. *Journal of Neurology, Neurosurgery, and Psychiatry, 49,* 1227-1232.

Echemendia, R.J., & Cantu, R.C. (2003). Return to play following sports-related mild traumatic brain injury: The role for neuropsychology. *Applied Neuropsychology, 10*, 48-55.

Echemendia, R.J., Putukian, M., Mackin, R.S., Julian, L, & Shoss, N. (2001). Neuropsychological test performance prior to and following sports-related mild traumatic brain injury. *Clinical Journal of Sport Medicine, 11*, 23-31.

Endler, N.S., & Parker, J.D.A. (1990). Multidimensional assessment of coping: A critical evaluation. *Journal of Personality and Social Psychology, 58*, 844-854.

Erlanger, D.M., Kutner, K.C., Barth, J.T., & Barnes, R. (1999). Neuropsychology of sports-related head injury: Dementia Pugilistica and post concussion syndrome. *The Clinical Neuropsychologist, 13*, 193-209.

Evans, L., & Hardy, L. (1999). Psychological and emotional responses to athletic injury: Measurement issues. In D. Pargman (Ed.), *Psychological Bases of Sports Injuries.* (pp. 49-64). Morgantown, WV: Fitness Information Technology

Eysenck, H. J., & Eysenck, M. W. (1985). *Personality and individual differences: A natural science approach.* New York: Plenum.

Fox, K.R. (1990). *The physical self-perception profile manual*. Dekalb, IL: Office for Health Promotion, Northern Illinois University .

Fox, K.R., & Corbin, C.B. (1989). The physical self-perception profile: Development and preliminary validation. *Journal of Sport and Exercise Psychology, 11*, 408-430.

Gasquoine, P.G. (1997). Postconcussion symptoms. *Neuropsychology Review, 7*, 77-85.

Gordon, S., Milios, D., & Grove, R. (1991). Psychological aspects of the recovery process from sport injury: The perspective of sport physiotherapists. *The Australian Journal of Science and Medicine, 23*, 53-60.

Gordon, W.A., Brown, M., Sliwinsky, M., Hibbard, M.R., Patti, N., Weiss, M.J., et al., (1998). The enigma of “hidden,” traumatic brain injury. *Journal of Head Trauma Rehabilitation, 33*, 39-56.

Gouvier, W.D., Uddo-Crane, M., & Brown, L.M. (1988). Base rates of post-concussional symptoms. *Archives of Clinical Neuropsychology, 3,* 273-278.

Grove, J.R., & Bianco, T. (1999). Personality correlates of psychological responses during injury rehabilitation. In D. Pargman (Ed.), *Psychological Bases of Sports Injuries*. (pp. 89-110). Morgantown, WV: Fitness Information Technology

Grove, J.R. & Gordon, A.M.D. (1995). The psychological aspects of injury in sport. In J. Bloomfield (Ed.) *Science and Medicine in Sport (2nd ed)* (pp. 176-186). Oxford: Blackwell Scientific.

Green, S.L., & Weinberg, R.S. (2001). Relationship among athletic identity, coping skills, social support, and the psychological impact of injury in recreational participants. *Journal of Applied Sport Psychology, 13,* 40-59.

Gunstad, J., & Suhr, J.A. (2002). Perception of illness: Nonspecificity of postconcussion syndrome symptom expectation. *Journal of the International Neuropsychological Society, 8,* 37-47.

Guskiewicz, K.M. (2001). Concussion in sport: The grading-system dilemma. *Athletic Therapy Today, 6,* 18-27.

Harter, S. (1989). Causes, correlates, and the functional role of global self-worth: A lifespan perspective. In J. Kolligan and R. Sternberg (Eds.), *Perceptions of competence and incompetence across the lifespan.* (pp. 67-97). New Haven, CT: Yale University.

Heil, J. (1993). *Psychology of sport injury*. Champaign, IL: Human Kinetics.

Hillman, S.K. (2000). *Introduction to Athletic Training*. Champaign, IL: Human Kinetics.

Hovda, D.A., Prins, M., Becker, D.P., Lee, S., Bergsneider, M., & Martin, N.A. (1998) Neurobiology of concussion. In J.E. Bailes, M.R. Lovell, & J.C. Maroon (Eds.), *Sports related concussion* (vol. 2, pp. 12-51). St. Louis: Quality Medical Publishing

Johnson, L.H. & Carroll, D. (1998). The context of emotional responses to athletic injury: A qualitative analysis. *Journal of Sport Rehabilitation, 7,* 206-220.

Kay, T., Harrington, D.E., Adams, R., Anderson, T., Berrol, S., Cicerone, K., et al. (1993). Definition of mild traumatic brain injury. *Journal of Head Trauma Rehabilitation, 8,* 86-87.

Kelley, M.J. (1990). Psychological risk factors and sports injuries. *The Journal of Sports Medicine and Physical Fitness, 30*, 202-221.

Kelly, J.P. & Rosenberg, J.H. (1997). The development of guidelines for the management of concussion in sports. *Journal of Head Trauma Rehabilitation, 13*, 53-65.

Kissick J. & Johnston KM. (2005). Return to play after concussion: principles and practice. *Clinical Journal of Sport Medicine, 15*, 426-431.

Klieber, D.A., & Brock, S.C. (1992). The effects of career-ending injuries on the subsequent well-being of elite college athletes. Sociology of Sport Journal, 9, 70-75.

Kontos, A.P., Collins, M. & Russo, S. A. (2004). An introduction to sports concussion for the sport psychology consultant. *Journal of Applied Sport Psychology, 16*, 220-235.

Kubler-Ross, E. (1969). *On Death and Dying*. London, England: MacMillan Ltd.

Lavallee, D., Grove, J.R., Gordon, S., & Ford, I.W. (1998). The experience of loss in sport. In J.H. Harvey (Ed.), *Perspectives on loss: a sourcebook*. (pp. 241-252). Philadelphia: Brunner/Mazel.

Leddy, M.H., Lambert, M.J., & Ogles, B.M. (1994) Psychological consequences of athletic injury among high-level competitors. *Research Quarterly for Exercise and Sport, 65*, 347-354.

Leith, L.M. & Taylor, A.H. (1990). Psychological aspects of exercise: A decade of literature review. *Journal of Sport Behavior, 13*, 219-239.

LeUnes A., & Burger J. (2000). Profile of Mood States research in sport and exercise: Past, present, and future. *Journal of Applied Sport Psychology, 12*, 5-15.

Levin, H.S., Mattis, S., Ruff, R.M., Eisenberg, H.M., Marhsall, L.F., Tabador, K., et al. (1987). Neurobehavioral outcome following minor head injury: A three-center study. *Journal of Neurosurgery, 66*, 234-243.

Lewis-Griffith, L. (1982). Athletic injuries can be a pain in the head too. *Women's Sport, 4*, 44.

Lidvall , H.F., Linderoth, B., & Norlin, B. (1974). Causes of the post-concussional syndrome. *Acta Neurologica Scandinavica, 50 (Suppl 56)*, 1-144.

Lilliston , B.A. (1985). Psychosocial responses to traumatic physical disability. *Social Work in Healthcare, 10*, 1-13.

Lishman, W.A. (1988). Physiogenesis and psychogenesis in the post-concussional syndrome. *British Journal of Psychiatry, 153,* 460-469.

Lovell, M.R. (2002) The relevance of neuropsychologic testing for sport-related head injuries. *Current Sports Medicine Reports, 1*, 7-11.

Macciocchi, S.N., Barth, J.T., Alves, W., Rimel, R.W., & Jane, J.A. (1996). Neuropsychological functioning and recovery after mild head injury in collegiate athletes. *Neurosurgery, 39,* 510-514.

Mainwaring, L.M., Bisschop, S.M., Green, R.E.A., Antoniazzi, M., Comper, P., Kristman, V., et al. (2004). Emotional reactions of varsity athletes to sport-related concussion. *Journal of Sport and Exercise Psychology, 26*, 119-135.

Maithias, J.L., & Coats, J.L. (1999). Emotional and cognitive sequelae to mild traumatic brain injury. *Journal of Clinical and Experimental Neuropsychology, 21*, 200-215.

Manuel, J.C., Shilt, J.S., Curl, W.W., Smith, J.A., Durant, R.H., Lester, L., et al. (2002). Coping with sports injuries: an examination of the adolescent athlete. *Journal of Adolescent Health, 31,* 391-393.

Martin, J. J. & Adams-Mushett, C. (19995). Athletic identity and sport orientation of adolescent swimmers with disabilities. *Adapted Physical Activity Quarterly, 12,* 113-123.

Martin, J. J. Ekland, R. C. & Muscheltt, C. A. (1997). Factor structure of the athletic identity measurement scale with athletes with disabilities. *Adapted Physical Activity Quarterly, 14*, 74-82.

McClelland, R.J. (1988). Psychosocial sequelae of head injury- Anatomy of a relationship. *British Journal of Psychiatry, 153*, 141-146.

McCrory, P., Johnston, K., Meeuwisse, W., Aubry, M., Cantu, R., Dvorak, J., et al., (2005). Summary and agreement statement of the 2nd international conference on concussion in sport, Prague 2004. *Clinical Journal of Sports Medicine, 15*, 48-57.

McDonald, S.A., & Hardy, C.J. (1990). Affective response patterns of the injured athlete: An exploratory analysis. *The Sport Psychologist, 4,* 261-274.

McNair, D.M., Lorr, M., & Droppleman, L.F. (1971). *Profile of Mood States Manual*. San Diego: Educational and Industrial Testing Service.

Mittenberg, W., DiGiulio, D.V., Perrin, S., & Bass, A.E. (1992). Symptoms following mild head injury: expectation as aetiology. *Journal of Neurology, Neurosurgery, and Psychiatry, 55*, 200-204.

Mittenberg, W., Tremont, G., Zielinski, R.E., Fichera, S. & Rayls, K.R. (1996). Cognitive-behavioral prevention of postconcussion syndrome. *Archives of Clinical Neuropsychology, 11*, 139-145.

Morrey, M.A., Stuart, M.J., Smith, A.M., & Wiese-Bjornstal, D.M. (1999). A longitudinal examination of athletes' emotional cognitive responses to anterior cruciate ligament injury. *Clinical Journal of Sport Medicine, 9*, 63-69.

Moss-Morris, R., Weinman, J., Petrie, K.J., Horne, R., Cameron, L.D., & Buick, D. (2002). The revised illness perception questionnaire (IPQ-R). *Psychological and Health, 17,* 1-16.

Oddy, M., Humphrey, M., & Uttley, D. (1978). Subjective impairment and social recovery after closed head injury. *Journal of Neurology, Neurosurgery, and Psychiatry, 41*, 611-616.

Paniak, C., Reynolds, S., Phillips, K., Toller-Lobe, G., Melynk, A., & Nagy, J. (2002). Patient complaints within 1 month of mild traumatic brain injury: A controlled study. *Archives of Clinical Neuropsychology, 17,* 319-334

Pardini, J. & Collins, M. (2006). Creating a successful concussion management program at the high school level. In R.J. Echemendia (Ed.) (pp. 3-16). *Sports Neuropsychology*. New York: Guilford Press.

Pargman, D. (1999). *Psychological Bases of Sports Injuries*. Morgantown, WV: Fitness Information Technology.

Pearson, L., & Jones, G. (1992) Emotional effects of sports injuries: Implications for physiotherapists. *Physiotherapy, 78*, 762-770.

Peretz, D. (1970). Development, object-relationships, and loss. In B. Schoenberg, A.C. Carr, D. Peretz. & H. Jutscher (Eds.), *Loss and grief: Psychological practice in medical practice*. (pp. 3-19). New York: Columbia University Press.

Peterson, Christopher. Explanatory style and health. (1995) In. G. M. Buchanan & M. Seligman (Eds.) *Explanatory style.* Hillsdale, NJ, England: Lawrence Erlbaum Associates, Inc.

Ponsford, J., Willmott, C., Rothwekk, A., Cameron, P., Kelly, A., Nelms, R., et al. (2000). Factors influencing outcome following mild traumatic brain injury in adults. *Journal of the International Neuropsychological Society, 6*, 568-579.

Prigatano, G.P. (1992). Personality disturbances associated with traumatic brain injury. *Journal of Counseling and Clinical Psychology, 60*, 360-368.

Putukian, M. & Echemendia, R.J. (2003). Psychological aspects of serious head injury in the competitive athlete. *Clinics in Sports Medicine, 22*, 617-630. Quackenbush, N., & Crossman, J. (1994). Injured athletes: a study of emotional responses. *Journal of Sport Behavior, 17*, 178-187.

Quality Standard Subcommitee, American Academy of Neurology (1997). *Practice parameter. Neurology, 48*, 581-585.

Quinn, A.M., & Fallon, B.J. (1999). The changes in psychological characteristics and reactions of elite athletes from injury onset until full recovery. *Journal of Applied Sport Psychology, 11*, 210-229.

Quinn, A.M., & Fallon, B.J. (2000). Predictors of recovery time. *Journal of Sport Rehabilitation, 9,* 62-76.

Rosenberg, M. (1979). *Conceiving the self*. New York: Basic.

Rotella, R.J. & Heyman, S.R. (1986). Stress, injury and the psychological rehabilitation of athletes. In J.M. Williams (Ed.), *Applied Sport Psychology* (pp. 343-364). Palo Alto, California: Mayfield.

Ruff, R.M., Camenzuli, L. & Mueller, J. (1996) Miserable minority: Emotional risk factors that influence the outcome of mild traumatic brain injury. *Brain Injury, 10*, 551-565.

Rush, B.K., Malec, J.F., Moessner, A.M. & Brown, A.W. (2004). Preinjury personality traits and the prediction of early neurobehavioral symptoms following mild traumatic brain injury. *Rehabilitation Psychology, 4*9, 275-281.

Sanderson, F.H. (1981). The psychology of the injury-prone athlete. In T. Reilly (Ed.), Sports Fitness and Sports Injuries (pp. 31-41). London & Boston: Faber and Faber.

Shultz, S.J., Houglum, P.A., & Perrin, D.H. (2000). Assessment of athletic injuries. Champaign, IL: Human Kinetics.

Smith, A.M., Scott, S.G., O'Fallon, W.M., & Young, M.L. (1990). Emotional responses of athletes to injury. *Mayo Clinic Proceedings, 65,* 38-50.

Smith, A.M., Stuart, M.J., Wiese-Bjornstal, D.M., Millner, E.K., O'Fallon, M., & Crowson, C.S. (1993). Competitive athletes: preinjury and post-injury mood state and self-esteem. *Mayo Clinical Proceedings, 68*, 939-947.

Taylor, D.L. (1995). A comparison of college athletic participants and nonparticipants on self-esteem. *Journal of College Student Development, 36,* 444-451.

Terry, P.C. & Lane, A.M. (2000). Normative values for the Profile of Mood States for use with athletic samples. *Journal of Applied Sport Psychology, 12*, 93-109.

Thayer, R.E., Newman, J.R., & McClain, T.M. (1994). Self-regulation of mood: Strategies for changing a bad mood, raising energy, and reducing tension. *Journal of Personality and Social Psychology, 67,* 910-925.

Tracey, J (2003). The emotional response to the injury and rehabilitation process. *Journal of Applied Sport Psychology, 15*, 279-293.

Udry, E., & Anderson, M.B. (2002). Athletic injury and sport behavior. In T.S. Horne (Ed.), *Advances in sport psychology (2nd ed.)* (pp. 529-553). Champaign, IL: Human Kinetics.

Vinger PF & Hoerner E (Eds.) (1986). *Sports Injuries. The Unthwarted Epidemic*. (pp. 529-553). Littleton, MA: PSG Publishing Company, Inc

Wasley, D. & Lox, C.L. (1998). Self-esteem and coping responses of athletes with acute versus chronic injuries. *Perceptual and Motor Skills, 86*, 1402.

Weddell, R., Oddy, M., & Jenkins, D. (1980). Social adjustment after rehabilitation: A two-year follow-up of patients with severe head injury. *Psychological Medicine, 10*, 257-263.

Weiss, M.R., & Troxel, R.K. (1986). Psychology of the injured athlete. *Athletic Training, 21*, 104-111.

Weise-Bjornstal, D.M., Smith, A.M., Shaffer, S., & Morrey, M.A. (1998). An integrated model of response to sport injury: Psychological and sociological dynamics. *Journal of Applied Sport Psychology, 10*, 46-69.

Williams, J.M. & Roepke, N. (1993). In R. N. Singer, M. Murphey, & L. K. Tennant (Eds.), *Handbook of research on sport psychology*. NY: Macmillan.

Wortman, C.B., & Silver, R.C. (1989). The myths of coping with loss. *Journal of Consulting and Clinical Psychology, 57*, 349-357.

Wright, J.C., & Telford, R. (1996). Postconcussive symptoms and psychological distress. *Clinical Rehabilitation*, *10*, 334-336.

Young, M.L. & Cohen, D.A. (1979). Self-concept and injuries among female college tournament basketball players. *American Corrective Therapy Journal, 33*, 139-142.

Young, M.L. & Cohen, D.A. (1981). Self-concept and injuries among female high school basketball players. *Journal of Sports Medicine Physical Fitness, 21*, 55-61.

APPENDIX A: DEFINITION OF CONCUSSION

"Concussion is defined as a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces. Several common features that incorporate clinical, pathological, and biomechanical injury constructs may be used in defining the nature of a concussive head injury include:

- Concussion may be caused either by a direct blow to the head, face, neck, or elsewhere on the body with an "impulsive" force transmitted to the head.
- Concussion typically results in the rapid onset of short-lived impairment of neurological function that resolves spontaneously.
- Concussion may result in neuropathological changes, but the acute clinical symptoms largely reflect a functional disturbance rather than structural injury.
- Concussion results in a graded set of clinical syndromes that may or may not involve loss of consciousness. Resolution of the clinical and cognitive symptoms typically follow a sequential course.
- Concussion is typically associated with grossly normal structural neuroimaging studies" (Aubry et al., 2001, p. 7).

APPENDIX B: DEFINITION OF ATHLETIC INJURY

- Any brain concussion causing cessation of the athlete’s participation in order to allow medical observation prior to permitting return to play
- Any dental injury that should receive professional attention
- Any injury or illness that causes cessation of an athlete’s customary participation on the day following the day of onset of the problem
- Any injury or illness that requires substantive professional attention before the athlete’s return to participation is permitted (i.e. without such attention, the athlete would not have been permitted to return to participation on the next participation day.

APPENDIX C: AMERICAN ACADEMY OF NEUROLOGY (AAN) GRADING SCALE CRITERIA

Grade 1:

- Transient confusion
- No loss of consciousness
- Concussion symptoms resolve in less than 15 minutes

Grade 2:

- Transient confusion
- No loss of consciousness
- Concussion symptoms last more than 15 minutes

Grade 3:

- Any loss of consciousness, lasting anywhere from a few seconds to minutes

APPENDIX D: NATIONAL ATHLEITC INJURY/ILLNESS REPORTING SYSTEM (NAIRS) GRADING SCALE CRITERIA

Minor:

- An injury/illness which does not prevent the athlete from returning to effective participation within one week from the day of onset

Moderate:

- An injury/illness permitting the athlete to return to participation within 8 to 21 days from the day of onset

Major:

- An injury/illness which prevents the athlete from returning to participation within 21 days of onset

APPENDIX E: PREINJURY ATHLETE QUESTIONNAIRE

Athlete Name: ____________________________ Date: ___________________

Gender (circle one): Male Female Date of Birth: ____________

Year in School (circle one): 1st 2nd 3rd 4th 5th Race: _______________

Sport: ___________________________________ Circle: Varsity Club

Trainer: __ M. Westefer __ P. VandeBerg __ B. Traugott

__ C. Oguekwe __ C. Mishalko __ Other

Are you currently injured (circle one)? Yes No

Have you ever incurred a sports-related injury (circle one)? Yes No

If yes, please answer the following questions:

1. What type(s) of sports-related injuries have you had (circle):

   Concussion Orthopedic Both

2. How many times have you incurred the following injuries?

   - ❑ Concussion ____________________________
   - ❑ Orthopedic ____________________________

3. What was the date of your most recent injury?

   - ❑ Concussion ____________________________
   - ❑ Orthopedic ____________________________

4. Have you ever needed to have surgery as a result of a sports-related injury (circle one)?

   Yes No

5. In terms of academics, have the last two days been (circle):

Easier Normal More Difficult

6. Have any other events (other than injury) occurred that may influence your current mood sate (circle)?

Yes No

APPENDIX F: ATHLETE FACE SHEET

Athlete Name: ___________________________ Date of Injury: ___________

Gender (circle one): Male Female Date of Birth: ___________

Year in School (circle one): 1st 2nd 3rd 4th 5th Race: ______________

Sport: __________________________________ Circle: Varsity Club

Trainer: __ M. Westefer __ P. VandeBerg __ B. Traugott

__ C. Oguekwe __ C. Mishalko __ Other

Nature and Severity of Injury:

- ❑ Concussion Injury
  - ❑ Grade I (no loc, confusion, sx resolve in 15 min)
  - ❑ Grade II (no loc, confusion, sx resolve after 15min)
  - ❑ Grade III (loc from seconds to min)

  Physician Dx (circle one): Grade I Grade II Grade III

- ❑ Orthopedic Injury
  - ❑ Mild (up to 7 days removed from play)
  - ❑ Moderate (8-21 days removed from play)
  - ❑ Major (21 days or more removed from play)
  - ❑ Severe (permanent disability or death)

  Physician Dx (circle one): Mild Moderate Major Severe

- ❑ Healthy Athlete (no injury)

Injury: ____

1. Where did the injury occur (circle one)?

   Practice Game Other: ______________________

2. At what point in the season did the injury occur (circle one)?

   Before Season Mid Season End of Season

3. How did the injury occur? ____

4. Has the athlete incurred this injury before (circle one)? Yes No

   If yes, when?__________ how many times? ________________

5. Does this injury require surgery (circle one)? Yes No

   If yes, when?______

6. When is the athlete's estimated date of return to sport? __________________

   Actual Date: _____________

Injury Assessment (assessment should be conducted at least three times post-injury):

0-48 hours post-injury (IPQ-R, POMS, PSPP) Date of Assessment: _________

If 0% is no recovery, what percentage of recovery to the athlete's preinjury status has he/she made?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Comments: ____

2-5 days post-injury (POMS, PSPP) Date of Assessment: __________________

If 0% is no recovery, what percentage of recovery to the athlete's preinjury status has he/she made?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Comments: ____

6-10 days post-injury (POMS, PSPP) Date of Assessment: _________________

If 0% is no recovery, what percentage of recovery to the athlete's preinjury status has he/she made?

0% 10% 20% 30% 40% 50% 60% 70% 80% 90% 100%

Comments: ____

VITA

Jillian Claire Schneider
August 23, 1979

Education

Drexel University, Philadelphia, PA
Ph.D., Clinical Psychology (September, 2006)
M.S., Clinical Psychology (March, 2003)
University of Virginia, Charlottesville, VA
B.A. with Distinction, Psychology (June, 2001)

Professional Publications

Zillmer, E.A., **Schneider, J.**, Tinker, J., & Kaminaris, C.I. (2006, January). A History of Sports-Related Concussions. A Neuropsychological Perspective. In R. Echemendia (Ed.). *Sports Neuropsychology: Assessment and Management of Brain Injury*. Guilford Press: New York.

Tynan, W.D. & **Schneider, J.** (2003, Fall). Evidenced-based practice: Show me the money. *Clinical Child and Adolescent Psychology, 18*, 8-9.

Poster Presentations

Tinker J., Kaminaris C., **Schneider J.**, Zillmer E. (2005, October). *Effects of visual symptoms on computerized cognitive assessment of concussed athletes.* Poster presented at the 25th annual meeting of the National Academy of Neuropsychology, Tampa, FL.

Schneider, J., Schiehser, D., Myers, T., Irani, F., Panyavin, I., Glosser, G. & Platek, S. (2004, November). *The effects of anterior temporal lobectomy on self-face recognition.* Poster presented at the 24th annual meeting of the National Academy of Neuropsychology, Seattle, WA.

McKeever, C., Schatz, P., Covassin, T., Sachs, M., **Schneider, J.**, Heydt, J, & Zillmer, E. A. (2004, February). *Sports-related concussions in collegiate athletes: Gender differences across neuropsychological test performances.* Poster presented at the 32nd annual meeting of the International Neuropsychological Society, Baltimore, Maryland.

Schneider, J., McKeever, C., Covassin, T., Sachs, M., Wait, S., Clayborne, J., Schatz, P. & Zillmer, E. (2003, October). The evaluation of pre- and post- measures of emotional indices associated with sports-related concussion. Poster presented at the 23rd annual meeting of the National Academy of Neuropsychology, Dallas, TX.

Paper Presentations

Broshek, D.K., Freeman, J.R., Barth, J.T., & **Schneider, J**. (2000, June). *Urinary incontinence after traumatic brain injury*. Paper presented at the a Williamsburg Conference, Williamsburg, VA.