Predicting Symptom Recovery Post-Concussion: An Application of the Integrated Model of Response to Sport Injury

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Abstract

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Concussions are becoming a more prominent topic of discussion in sport. Following a concussion, most athletes experience only transitory symptoms that completely resolve within 10-14 days. However, approximately 10% of athletes experience prolonged symptoms that extend beyond this time period. There are few predictors of more severe or enduring self-reported concussion symptomatology, and those predictors that have been identified lack a theoretical underpinning. Using the Integrated Model of Response to Sport Injury (Wiese-Bjornstal, Smith, Shaffer, & Morrey, 1998) theoretically-grounded personal and situational psychosocial factors with the potential to influence changes in self-reported concussion symptoms over time are examined. Theoretically relevant personal factors include athletic identity, motivation for sport and performance anxiety. Theoretically relevant situational factors include goal-orientation, motivational climate and social support. Study participants were 70 youth athletes (*M*age = 14.60 years) who presented at a local hospital within two weeks following a concussion. Athletes self-reported concussion symptomatology at this hospital visit (Time 1), and one (Time 2) and two (Time 3) weeks following their initial visit. At Time 2, youth athletes completed self-report measures that assessed each personal and situational factor. Regression analyses revealed that higher athletic identity, amotivation, and performance anxiety predicted more self-reported symptoms, especially at Time 2 and Time 3. Regression analyses also demonstrated that higher athletic identity, amotivation and performance anxiety predicted significantly fewer reductions in symptoms from Time 1 to Time 2 and from Time 1 to Time 3, even when accounting for symptom presentation at Time 1, age, gender, concussion history, and time since their last concussion. When combined, personal factors accounted for significant variance in symptom changes, while situational factors did not. Personal factors accounted for 25% of the variance in symptom change from Time 1 to Time 2, and 19% of the variance in symptom change from Time 1 to Time 3, after accounting for symptom presentation at Time 1, age, gender, concussion history, and time since their last concussion. Implications of these findings are discussed. Results suggest that further examination of psychosocial predictors of post-concussion recovery in youth athletes is warranted.

Predicting Symptom Recovery Post-Concussion: An Application of the Integrated Model of Response to Sport Injury

A concussion, or mild traumatic brain injury, is a brain injury that results from forces transmitted to the head (McCrory et al., 2013). They are becoming a prominent topic of discussion in sport, with up to 3.8 million occurrences each year (Castile, Collins, McIlvain & Comstock, 2011). Following a concussion, athletes can experience somatic, cognitive, emotional and behavioral symptoms (McCrory et al., 2009). A large body of evidence suggests that these symptoms and deficits are a result of metabolic alterations, neurotransmission difficulties, and cellular functioning disruptions (Giza & Hovda, 2001; Henry et al., 2011; Maugans, Farley, Altaye, Leach & Cecil, 2012; Signoretti Lazzarino, Tavazzi & Vagnozzi, 2011).

The majority of athletes experience complete symptom resolution within 10 days post-concussion, although approximately 10% suffer prolonged symptoms up to and beyond three months (McCrory et al., 2009). Identifying factors that predict those at risk of continued difficulties has proven difficult. The research is most developed in demonstrating that age (Franklin & Weiss, 2012), gender (Frommer, Gurka, Cros, Ingersoll, Comstock & Saliba, 2011), previous concussion history (Guskiewicz et al., 2003), and symptom occurrence immediately post-concussion (Collins et al., 2003; Lau, Collins & Lovell, 2012; Lau, Lovell, Collins & Pardini, 2009) seem to have an effect. For example, younger athletes, those with a history of previous concussions, and those who experience greater severity of symptoms initially may be at risk for having prolonged post-concussion symptoms and a protracted recovery. Despite this understanding it is important to identify other predictors of post-concussion symptom severity and duration to maximize our ability to identify those at high risk for prolonged recoveries.

Psychological Factors Influence the Expression of Symptoms and Recovery

There is a strong research literature demonstrating the important role of psychological factors on general injury recovery. For example, motivation for treatment and recovery has long been linked to improved outcomes and rehabilitation adherence in physical injuries (e.g., Friedrich, Gittler, Halberstadt, Cermak & Heiller, 1998; MacLean & Pound, 2000). In injured athletes, high self-esteem and positive outlook predict faster recovery rates (Ford, Eklund & Gordon, 2000). For individuals with burn injuries, both pre-existing psychiatric diagnoses and post-injury psychological distress predict the rate of recovery (Tarrier, Gregg, Edwards & Dunn, 2005; Wisely, Wilson, Duncan & Tarrier, 2010). Following cardiac rehabilitation in patients with coronary heart disease, mortality is significantly greater when patients experience depressive symptoms (De Schutter, Lavie & Milani, 2011; Menezes, Lavie, Milani, O'Keefe & Lavie, 2011). Similarly, individuals on dialysis for renal failure have a two-fold increase in mortality rates when concurrently experiencing depression (Hedayati et al., 2008). Depression symptoms post-injury are highly related to rehabilitation adherence (DiMatteo, Lepper & Croghan, 2000), and the evidence linking depression and anxiety with outcome following physical illness is strong (Clarke & Currie, 2009). To this end, consensus statements (e.g., Wiese-Bjornstal, 2010) argue that greater anxiety is detrimental to mental and physical recovery post-injury. This may be related to more catastrophic interpretations of pain associated with anxiety (Campbell & Edwards, 2009). Importantly, evidence suggests that cognitive appraisals determine post-injury emotional reactions and can foster avoidance behaviors and hinder injury recovery (Riley, Dennis & Powell, 2010).

Current empirical understanding of psychological predictors for self-reported post-concussion symptom recovery is limited. Research has more recently been interested in the utility of using premorbid psychosocial factors to predict post-concussion recovery. McNally et al. (2013) found that premorbid symptoms of a concussion were especially predictive of symptom ratings post-concussion. Yeates et al. (2012) showed that premorbid behavioral adjustment problems and greater family functioning predicted more intense post-concussive symptomatology. Likewise, Babikian, McArthur and Asarnow (2013) found that premorbid behavioral adjustment difficulties six months prior to injury, a diagnosed learning disability, and lower achievement in school were all predictors of greater post-concussion symptoms at one and 12 months. Fay et al. (2010) demonstrated that children with lower cognitive ability pre-injury were particularly prone to post-concussion cognitive symptoms over time. In addition to these factors, research in the general population shows that pre-injury psychiatric or other health problems predict poor outcomes following a concussion (Carroll et al., 2004; Kashluba, Paniak & Casey, 2008; McLean et al., 2009). For example, Ponsford, Cameron, Fitzgerald, Grant, Mikocka-Walus, and Schonberger (2012) demonstrated that a premorbid psychiatric disorder was a predictor of concussion symptoms one week post-injury. These authors also found that premorbid psychiatric diagnoses predicted greater anxiety post-concussion that in turn predicted concussion symptoms up to three months post-injury. Other researchers also demonstrate that diagnosed anxiety and depressed mood are both important in predicting symptom intensity over time (McCauley et al., 2013; Wood, McCabe & Dawkins, 2011). Koponen et al. (2011) concluded that the occurrence of pre- and post-axis I and II mental disorders could hinder concussion recovery. In athletes, this topic has not been fully explored, but initial findings with athletes indicate that psychiatric diagnoses may be associated with a greater likelihood of incurring a concussion (Alosco, Fedor & Gunstad, 2014), and significantly longer recovery times (Hutchison, Comper, Csenge & Richards, 2014).

While this research is limited, especially with regards to sports concussions, it is further restricted by the lack of theoretical underpinning helping to elucidate *how* these predictors may affect self-reported recovery. Utilizing theory and measures that reflect psychological processes may allow us to expand on mechanisms underlying the effect of psychosocial factors on self-reported post-concussion recovery. In addition, theory will help identify potentially important predictors for self-reported recovery. The purpose of the present research is accordingly to study the role of psychological factors on self-reported post-concussion recovery in youth athletes, within an existing theoretical and empirically-supported framework. The theory I use to identify potential self-reported recovery predictors and mechanisms through which these may act is the integrated model of response to sport injury (Wiese-Bjornstal, Smith, Shaffer & Morrey, 1998).

The Integrated Model of Response to Sport Injury

The integrated model of response to sport injury is shown in Figure 1. According to Wiese-Bjornstal et al. (1998) both personal and situational factors influence the injury recovery through cognitive appraisals, and emotional responses. Personal factors include psychological, demographic, and physical differences, as well as the injury characteristics. Situational factors include sport characteristics and social and environmental influences. Following an injury, the interaction between personal and situational factors determines cognitive appraisals that include the athlete's perceived resources, ability to cope and the meaning that success, in this context recovery, has for the athlete. Cognitive appraisals affect emotional and behavioral responses that contribute to outcomes such as intensity and duration of post-concussion symptoms. As identified earlier, emotional responses such as distress, anxiety, and depressed mood appear to affect injury/illness recovery (De Schutter et al., 2011; Hedayati et al., 2008; Menezes et al., 2011; Tarrier et al., 2005; Wisely et al., 2010). Behavioral responses are also influential in the recovery process. For example, the use of coping skills such as imagery, relaxation, goal setting and positive self-talk has been linked to increased rehabilitation adherence, self-efficacy, and reductions in negative emotions (Cupal, 1998; Cupal & Brewer, 2001; Driediger, Hall & Callow, 2006; Hamson-Utley, Martin & Walters, 2008; Ievleva & Orlick, 1991; Murphy, 2005; Richardson & Latuda, 1995). Accordingly, this theory provides a model explaining how personal and situational factors may act through cognitive, affective and behavioral processes to ultimately affect recovery from an injury such as a concussion.

The present study aims to identify personal and situational factors within the integrated model of response to sport injury model that may predict post-concussion symptom intensity and duration. The following discussion will explore the possible role of identified personal and situational factors.

Influence of Personal and Situational Factors in Post-Concussion Recovery

The sport injury literature demonstrates that personal factors such as athletic identity, performance anxiety and sport motivation, and situational factors, such as motivational influences and social support, are important factors related to injury recovery (e.g. Brewer, Cornelius, Stephan & Van Raalte, 2010; Evans, Mitchell & Jones, 2006; Levy, Polman & Clough, 2008; Levy, Polman, Nicholls & Marchant, 2009; Podlog & Eklund, 2007; Rees, Mitchell, Evans & Hardy, 2010; Smith, Smoll & Passer, 2002). The following will discuss each factor and its possible relation to both post-concussion symptom intensity and duration.

1) Athletic Identity

Athletic identity is a self-concept variable related to investments of time and effort in sport, where athletes define themselves to varying degrees based on their involvement in the athletic role (Brewer, Van Raalte & Linder, 1993). There is research suggesting that injuries pose special adjustment difficulties to those with high athletic identity given that they directly threaten a central aspect of self-concept (Brewer et al., 1993; Manuel et al., 2002; Brewer, Cornelius, Stephan & Van Raalte, 2010). This is similar to self-complexity theory (Linville, 1985, 1987), in which individuals with few self-aspects, or low self-complexity, experience increased affective disturbances during challenging life events related to the self. Given that individuals with high athletic identity (low self-complexity) have greater adjustment difficulties post-injury, evidenced by stronger emotional responses and distancing behaviors from sport (e.g., Brewer et al., 2010), they should have greater symptom severity and duration than those with low athletic identity. Post-concussion, athletes with high athletic identity may experience more symptom intensity initially, and over time.

2) Sport Performance Anxiety

Sport performance anxiety as a trait construct is a predisposition to experience cognitive, worry and/or somatic aspects of state anxiety in evaluative sporting environments (Smith, 1986). Evidence largely supports that high performance anxiety is associated with numerous negative consequences, including effects on performance, enjoyment, susceptibility to injury, motivation, and sport attrition (Smith & Smoll, 2004; Smith et al., 2002). To this end, sport performance anxiety can be considered a proxy for fear of failure (Conroy & Elliot, 2004). As might be expected, youth athletes experience reductions in anxiety when evaluative pressures are reduced, and this is associated with enhanced sporting experiences (e.g., Lewthwaite & Scanlan, 1989; Smith, Smoll, & Cumming, 2007). Athletes who report high performance anxiety may find sporting settings aversive given the evaluative pressures and associated anxiety they feel. Following a concussion, it is likely that high performance anxiety is a risk factor for ongoing adjustment difficulties. For example, the concussion may evoke worry in athletes about their performance levels or reinjury (Podlog & Eklund, 2007). They may experience concentration disruption as the associated anxiety interferes with cognitive processing (Sarason, 1988), and they may report somatic symptoms as a result of these factors and because of heightened sensitivity to physiological changes. Because the concussion elicits a fear of failure in athletes with high performance anxiety, they may be expected to report prolonged high symptom intensity for several reasons. First, it may help delay return to play until the athlete is fully confident of achieving pre-injury performance levels. Second, the athlete may possibly interpret some performance anxiety symptoms, such as somatic and concentration disruption as indicative of incomplete recovery. This could increase vigilance for other symptoms, which may exacerbate symptom reporting. Finally, it is possible that athletes with high performance anxiety will experience a self-handicapping phenomenon (e.g., Chen et al., 2008; Ommundsen, 2001) in which symptom expression in increased to provide an explanation or buffer for possible diminished performances upon returning to play.

3) Motivation

Motivation strongly affects injury recovery processes (e.g. Podlog & Eklund, 2007; Tracey, 2003), and it predicts psychological well-being and post-injury behaviors (Chan, Hagger & Spray, 2011; Deci & Ryan, 2000; Podlog & Eklund, 2007). There are two particularly relevant motivational theories (achievement goal theory (AGT) and self-determination theory (SDT)) for understanding how motivation might influence post-concussion physical and psychosocial outcomes. Exactly how each aspect of the theories might enhance prediction of self-reported post-concussion recovery is an empirical open to rival hypotheses.

i) Achievement Goal Theory

Achievement Goal Theory (AGT; Nicholls, 1984) posits that in achievement settings such as sport, individuals are motivated to display competence and/or to avoid displays of incompetence. They are motivated in this pursuit by both personal and situational factors. Personal factors include goal-orientation and situational factors include motivational climate.

a) Goal-Orientations

Individuals are disposed to adopt a conception of success called either mastery or ego achievement goal-orientation. In a mastery-orientation, success is self-referenced, defined in terms of personal improvement, enjoyment, effort, and learning from mistakes. In an ego-orientation, success is other-referenced, achieved through besting others or equaling their level of performance using minimal effort (Ames, 1992). Conceptually, goal orientations motivate approach behaviors during post-concussion recovery by contributing to the cognitive appraisal process. Revisions to AGT suggest that achievement goals can also be viewed from an avoidance perspective (Elliot & Harackiewicz, 1996; Harackiewicz, Barron, Pintrich, Elliot & Thrash, 2002), operationalizing as a fear of failure of their goals (Conroy & Elliot, 2004). During concussion recovery, a mastery-approach/avoidance orientation will result in athletes adopting personal progress appraisals, while an ego-orientation will create normative progress appraisals. For example, avoidance orientations, either mastery or ego, could result in deliberate exacerbation of symptom presentation to relieve the athlete from the aversive stimuli that has become sport (e.g., Elliot & Harackiewicz, 1996; Smith & Smoll, 2004). Conversely, approach orientations could motivate athletes to minimize symptom reporting so they can return to sport more quickly. There may also be differences between those with mastery- and ego-orientations as it pertains to motivation to recover quickly and reengage in sport. Furthermore, possible interactions between approach/avoidance and mastery/ego orientations may exist. How goal-orientations may affect self-reported post-concussion recovery is clearly a theoretically complicated matter and qualifies as an empirical question.

b) Motivational Climate

Under AGT, environmental conditions that reinforce mastery or ego success criteria are created by significant others (e.g. coaches/parents) and are termed the motivational climate (Ames, 1992). Motivational climate can be mastery or ego-oriented. A mastery climate reinforces enjoyment, effort, and self-referenced improvement, viewing mistakes as a valuable tool for learning. An ego climate emphasizes winning, success through positive social comparison involving equal or less effort, and views mistakes as a negative occurrence that necessitates punishment (Ames, 1992). As expected under AGT, outcomes such as enjoyment and self-esteem are enhanced within a mastery climate while anxiety and negative motivational consequences are reduced (e.g., O'Rourke, Smith, Smoll & Cumming, 2011; Reinboth & Duda, 2006; Smith et al., 2007; Vazou, Ntoumanis & Duda, 2006).

The effects of a mastery and ego climate on self-reported post-concussion recovery should be comparable to that of mastery- and ego-orientation. Directional hypotheses are difficult to generate because each could arguably increase or decrease self-reported recovery time. For example, under an ego climate some athletes may be relieved to be injured and parted from the normative environment whereas other athletes may be motivated to recover more quickly than average. However, it is reasonable that if goal-orientation and motivational climate differ (e.g., high mastery climate high ego-orientation) motivational climate is likely more influential given that the reinforcement contingencies are immediate and present in the environment.

ii) Self-Determination Theory

Self-Determination Theory (SDT; Deci & Ryan, 2000) is a motivational theory that focuses on the development of behavioral goals. SDT posits that there are three basic human needs contributing to behavioral goals, including connectedness to others, perceptions of competence, and feelings of personal autonomy. Meeting each of these needs, or need satisfaction, is a basic pre-requisite for intrinsically motivated behavior and positive facets of human nature and well-being (Deci & Ryan, 2000). SDT posits that behavioral goals are distributed on a continuum of self-determination. The most self-determined goals are associated with intrinsic motivation, where actions are performed only for enjoyment of the activity. The continuum includes three variants of extrinsic motivation that differ in their strength of self-determination. From higher to lower self-determination, these are identified regulation, where actions occur to achieve internal goals (e.g. lose weight), introjected regulation, where actions are to avoid a negative emotion or for ego enhancement, and external regulation, where actions occur for external reasons (e.g. tangible awards or the avoidance of punishment). According to Deci and Ryan (2000), as behavior becomes more self-determined, positive qualities of human nature flourish. A large body of evidence supports the contention that well-being is greatest under conditions of high intrinsic motivation (Baard, Deci & Ryan, 2004; Duda & Treasure, 2010; Gagne et al., 2003; Reinboth & Duda, 2006).

Given that a concussion removes an athlete from sporting settings in which they develop connectedness, feelings of competence, and autonomy (e.g. Podlog & Eklund, 2007) it is likely that well-being and need satisfaction will be temporarily disrupted. However, the effect on rate of self-reported concussion recovery may depend on the specific motivations for sport. For example, an intrinsically motivated athlete may recover quickly in order to re-achieve need satisfaction, and thus may report fewer symptoms over time. Conversely, an intrinsically motivated athlete may instead find that the concussion removes them from such a pleasurable activity that it is experienced more negatively and thus exacerbates their symptom expression. An extrinsically motivated athlete may recover more slowly as sport does not produce need satisfaction. Again, the reverse could be true and they may report fewer symptoms over time in order to return to sport and achieve extrinsic gains as quickly as possible. The exact nature of these relations is an empirical question.

Under SDT, there also exists the concept of amotivation in which an athlete loses all motivation to continue acting, as reflected by an absence of connectedness, feelings of competence, and autonomy (Deci & Ryan, 2000). The literature is convincing in linking amotivation with both ideation to drop out of sport and actually ceasing to participate (Sarrazin, Vallerand, Guillet, Pelletier & Cury, 2002; Vallerand, Fortier & Guay, 1997). Accordingly, for athletes who are amotivated in their sport, a concussion provides an ideal opportunity to drop out and is thus negatively reinforcing. In addition, these athletes are unlikely to desire a quick return to play and thus lack motivation to report fewer symptoms or engage in functional behaviors that may facilitate improved outcomes. As such, it is likely that athletes who report amotivation will experience a slower self-reported recovery than other athletes.

4) Social Support

Social support is an athlete's perception that there is help and emotional support available from other individuals who care. Social support has been identified as one of the most influential environmental resources that acts as a buffer against stress (Suls & Wallston, 2003). It has been linked to physical and psychological well-being in several studies (Baron, Cutrona, Hicklin, Russal & Lubaroff, 1990; Cohen, 1988; Rodin & Salovey, 1989). For example, there is evidence that suggests higher survival rates in cancer patients who receive greater social support (Spiegel, Bloom, Kraemer & Gottlieb, 1989). Research also suggests more generally that strong social improves immune system functioning (Baron et al., 1990) and helps people be more disease resistant when under stress (Hampson & Friedman, 2008). In the injury literature there is also support for beneficial physical and psychosocial outcomes with increased social support (Evans et al., 2006; Levy et al., 2009; Rees et al., 2010; Tracey, 2003), and some research supports this in the concussion literature (Potter et al., 2011; Yeates, Taylor, Walz, Stancin & Wade, 2010). It is likely that social support affects self-reported post-concussion recovery by influencing cognitive appraisals, particularly the perceptions of individual resources to cope and the motivation to return-to-play.

The strength of perceived social support, rather than the network size, may be a critical factor in self-reported post-concussion recovery. Under SDT, greater perceived social support could increase perceptions of the ability to cope, and maintain the need for connectedness (Deci & Ryan, 2000). In addition, high social support could protect against negative emotional responses (Rees et al., 2010), while promoting adherence rehabilitation behaviors (Levy et al., 2009). Accordingly, high social support may promote potentially adaptive psychological, emotional and behavioral responses and thereby reduce the symptom intensity and duration.

Purpose of the Present Study

Despite recent advances, to date there are several major gaps in the concussion literature. For example, there are few specific psychosocial predictors of post-concussion symptom intensity and duration, and this limits our ability to identify athletes at risk for continued difficulty. In addition, there is no theoretical framework underpinning responses to a concussive injury. Accordingly, the purpose of the present study is to examine whether the personal and situational factors reviewed above predict self-reported post-concussion symptom intensity and duration, using the integrated model of response to sport injury to understand how these variables may exert their influence. It is important to note that this study is only measuring self-reported symptoms and there is no objective assessment of post-concussion impairment over time.

Hypotheses

1. High athletic identity will predict high self-reported symptom intensity over time.
2. Goal-orientations will be related to self-reported symptom recovery.
3. Coach-initiated motivational climate will be related to self-reported symptom recovery.
4. Parent-initiated motivational climate will be related to self-reported symptom recovery.

5. Intrinsic and extrinsic motivation for sport will be related to self-reported symptom recovery.
6. High amotivation will predict higher self-reported symptom intensity over time.
7. High performance anxiety will predict higher self-reported symptom intensity over time.
8. Strong social support, or a large social network, will predict lower self-reported symptom intensity over time.

Method

Participants

Participants were 70 athletes (n male = 32, n female = 38, mean age = 14.60, SD = 1.90) who presented to a local hospital after suffering a concussion within the last 14 days. Athletes presented to the hospital on average 7.56 ± 3.25 days post-concussion, at Time 1. Athletes were recruited during this initial 14 day period with the assumption that presenting symptomatology can reasonably be explained by metabolic and neuronal changes (e.g. Giza & Hovda, 2001). Of those recruited, 51 participants completed measures seven days after their initial hospital visit, and at Time 2, approximately 14-21 days post-concussion. Seven days after Time 2, 46 of these participants completed follow up questionnaires, at Time 3, approximately 21-28 days post-concussion. The procedure is outlined in Figure 2.

Measures

Sport Concussion Assessment Tool-2 (SCAT-2): The SCAT-2 is a widely used clinical tool for post-concussion assessment. The self-report symptom inventory in the SCAT-2 is a 22-item measure developed by consensus at the Third International conference to assess post-concussion symptomatology (McCrory et al., 2009). Every item (e.g. dizziness, “don’t feel right,” more emotional) lists a different symptom and athletes endorse the extent to which they are affected by each in the past week on a 0 (*none*) to 6 (*severe*) scale. Summing all the items yields a symptom intensity score. The psychometric properties of the SCAT-2 are not published. However, few measures of post-concussion symptomatology have followed typical scale development processes or published psychometric data (McLeod & Leach, 2012). In the present study, internal consistency was high at each point, with $\alpha = .94$, $\alpha = .95$ and $\alpha = .96$ at Time 1, Time 2, and Time 3 respectively.

Athletic Identity Measurement Scale (AIMS): The AIMS is a 7-item measure that assesses the construct of self-identity within the athletic role. Athletes respond to each statement (e.g. “sport is the most important part of my life”; “I would be very depressed if I were injured and could not compete in sport”) on a 1 (*strongly disagree*) to 7 (*strongly agree*) scale. The AIMS demonstrates acceptable internal consistency and test-retest reliability, with coefficients exceeding .80, and construct validity is good (Brewer & Cornelius, 2001; Brewer et al., 1993; Good, Brewer, Petitpas, Van Raalte & Mahar, 1993). In the present study, internal consistency was acceptable, with an alpha coefficient of .71.

Achievement Goal Scale for Youth Sports (AGSYS): The AGSYS is a 12-item measure that assesses trait conceptions of success criteria in achievement situations. Each item pertains to a goal during sports participation, and athletes respond to each statement on a 1 (*not at all true*) to 5 (*very true*) scale. Six items assess a mastery orientation (e.g. "My goal is to learn new skills and get as good as possible") and six items assess ego orientation (e.g. "The most important thing is to be the best athlete"). Internal consistency is acceptable, with Cronbach alpha values above .75, and test-retest reliability is also good, with coefficients exceeding .92 (Cumming, Smith, Smoll, Standage & Grossbard, 2008). Research also supports the factorial, construct, and concurrent validity of this scale (Cumming et al., 2008). This measure also has a readability level below age 9, making this a suitable measure for younger as well as older athletes. In this study, internal consistency for mastery and ego orientation subscales was excellent, with $\alpha = .86$ and $\alpha = .91$ respectively.

Motivational Climate Scale for Youth Sports (MCSYS): The MCSYS is a 12-item scale that assesses a youth athlete's perceptions of the coach-initiated motivational climate. Each item is a statement regarding a coach's motivational goals for a team, and athletes respond on a 1 (*not at all true*) to 5 (*very true*) scale. Six items assess a mastery climate (e.g. "the coach made players feel good when they improved a skill") and six items assess an ego climate (e.g. "winning games was the most important thing for the coach"). Research demonstrates good reliability, with internal consistency coefficients exceeding .74 for both mastery and ego climate scales, in addition to good factorial and construct validity for this measure (Smith, Cumming & Smoll, 2008). In this study, reliability was acceptable for mastery and ego climate subscales, with α = .88 and α = .79 respectively.

Parent-Initiated Motivational Climate Questionnaire-2 (PIMCQ-2): The PIMCQ-2 is an 18-item measure that assesses the parent-initiated motivational climate on three subscales. Athletes respond to the stem "I feel that my mother/father/guardian…" on a 4-point scale ranging from 1 (*strongly disagree*) to 4 (*strongly agree*) for each item. The learning and enjoyment subscale reflects a mastery orientation (e.g. "makes sure I learn one thing before teaching me another"). Ego orientation is reflected by two subscales, the first assessing success-without-effort (e.g. "thinks I should achieve a lot without much effort"), and the second assessing worry-conducive behaviors (e.g. "makes me feel badly when I can't do as well as others"). Internal consistency coefficients for each of the three subscales ranges from .81 to .94, and research also supports adequate predictive and construct validity for youth sport samples (Duda & Whitehead, 1998; White, Duda & Hart, 1992; White, 1998, 2007). In this study, internal consistency for both subscales was excellent, with the mastery climate subscale demonstrating α = .87 and the combined ego climate items α = .88.

Sport Motivation Scale (SMS): The SMS is a 28-item measure that assesses the self-determination continuum, including intrinsic motivation, extrinsic motivation, and amotivation (Pelletier et al., 1995). Athletes respond to the stem question "why do you play sport?" Responses are rated on a scale that extends from 1 (*not true at all*) to 7 (*very true*). Twelve items assess each of intrinsic motivation (e.g., "For the pleasure of discovering new training techniques") and extrinsic motivation (e.g., "Because it allows me to be well regarded by people that I know"), and four items assess amotivation (e.g., "It is not clear to me anymore; I don't really think my place is in sport"). This scale has previously demonstrated acceptable internal consistency and good construct validity (Pelletier et al., 1995). In the present study, reliability for intrinsic motivation, extrinsic motivation and amotivation scales was $\alpha = .92$, $\alpha = .89$ and $\alpha = .74$ respectively.

Sport-Anxiety Scale-2 (SAS-2): The SAS-2 is a 15-item scale that assesses three dimensions of anxiety (Smith, Smoll, Cumming & Grossbard, 2006). Athletes respond to the stem "Before or while I perform…" on a 1 (*not at all*) to 4 (*very much*) scale. Five items assess each of somatic anxiety (e.g. "my body feels tense"), worry (e.g. "I worry that I will play badly"), and concentration disruption (e.g. "I lose focus on the game"), and the combined total score provides an index of performance trait anxiety. The SAS-2 demonstrates strong internal consistency with alpha coefficients exceeding .80, as well as good factorial and construct validity for youth athletes (Smith et al., 2006). In addition, a Flesch-Kincaid reading level score of 2.3 is appropriate for younger and older youth athletes. Internal consistency in the present study was excellent ($\alpha = .94$).

Social Network Scale: The SNS is a 40-item scale designed to assess the amount and quality of social support that athletes receive from a variety of different individuals. It is derived from a measure by Cauce, Felner, and Primavera, (1982) used to assess adolescents' appraisals of the social support network, and adapted to also include individuals specific to the sport setting (Smith et al., 1990). Athletes report the extent to which different individuals provide i) emotional support and caring, and ii) help and guidance, on a scale ranging from 1 (*not at all helpful*) to 5 (*very helpful*). One-week test-retest reliability (r=.87) is good and the two different components of social support correlate strongly with one another (r=.88; Smith et al., 1990). Because of this high correlation between the two components, and the theoretical importance of emotional support, I will administer only the 20 items pertaining to emotional support and caring. Internal consistency for this scale was acceptable ($\alpha = .72$).

Procedure

The research was approved by the institutional review board of Seattle Children's Hospital. Participants were given a complete written explanation of the study during their visit to the hospital. Hospital visits were to the Outpatient Orthopedics Department. Athlete assent and parental consent was given verbally over the phone after participants were given at least 24 hours to consider participation. SCAT-2 symptom scales were administered to the athlete in the hospital as part of routine care. This data were included retrospectively if participants agreed to participate in the study. All psychosocial questionnaires were administered one week following an athlete's visit to the hospital, at Time 2. The SCAT-2 was also administered at Time 2, and again two weeks following their visit to the hospital, at Time 3 (see Figure 2). At Time 2 and Time 3, arrangements were made with the family to access an online link to the study for the child participant to complete at home. Athletes completed measures individually and we emphasized that all responses were private and deidentified. We informed parents and athletes that the research purpose was to examine factors predicting post-concussion self-reported recovery. Athletes were given a $10 Amazon.com voucher upon completion of all three parts of the study.

Results

My analyses addressed several empirical questions. First, I considered the relation between each proposed personal and situational factor, assessed at Time 2, and concussion symptom intensity at each of the three measurement points, allowing me to determine the replicability and progression of relations across a two-week period following their hospital visit. Second, I assessed the relations between personal/situational factors and changes in symptom intensity over time, controlling for post-concussion symptom intensity during their initial hospital appointment (Time 1). For all regression analyses, I controlled for age, gender, self-reported number of concussions in the last 12 months, and the number of days since the last concussion, given that these variables have previously been identified as important predictors of symptom intensity.

At Time 1 I recruited 70 athletes. Of these, 51 took part at Time 2, and 46 took part at Time 3. Those who completed Time 2 and Time 3 measures did not differ on outcome variables at Time 1 compared with those who completed only Time 1 measures. Only subjects who completed both Time 1 and 2 data were included in the main analyses. Analysis of missing data revealed that .03% of values were missing. Missingness of data were assessed using Little's MCAR test and all data were missing completely at random ($p > .05$). I used mean value imputation to estimate missing values due to the negligible amount of missing data.

For statistical analysis, the Statistical Package for Social Sciences version 21.0 was used. Prior to the main analyses, all variables were examined to determine their relative distributions, the normality of the data, and the accuracy of data entry. All outcome variables except symptom intensity at Time 3 demonstrated univariate normality with skewness and kurtosis within +/- 2. Time 3 symptom intensity was transformed using a Log10 transformation in order to satisfy parametric regression parameters.

Certain analyses involved examination of interactions between personal and situational factors. To reduce multicolinearity between individual measures and the interaction product scores, scores for all variables involved in the product scores used to assess interaction effects were centered by subtracting the raw score from the group mean (Aiken & West, 1991). Means, standard deviations and alpha coefficients for the original (non-centered) variables are reported in Table 1. Table 1 also presents bivariate correlations among the variables and the Chronbach alpha values.

Relations between Personal/Situational Variables and Symptom Intensity

Symptom intensity at each time point was calculated by summing the severity of each of the 22 symptoms listed in the SCAT-2. As demonstrated in Table 1, bivariate correlations between personal and situational factors, measured at Time 2, and symptom intensity at Time 1, Time 2, and Time 3 were variable, with few consistent relations emerging. Parent ego climate was positively and significantly correlated with Time 1 symptom intensity, while social network satisfaction was negatively and significantly correlated. For Time 2 symptom intensity, age, athletic identity, amotivation, performance anxiety, and Time 1 symptom intensity were positively and significantly correlated. Age, athletic identity, performance anxiety and Time 2 symptoms were positively and significantly correlated with Time 3 symptom intensity.

To assess the effects of each proposed predictor variable on symptom intensity, I conducted 10 separate hierarchical multiple regression analyses for each of the three time points, with the outcome variable being symptom intensity at the respective time point. For each regression analysis, I entered age at Step 1, gender at Step 2, days since their last concussion at Step 3, self-reported concussion history in the last 12 months at Step 4, the situational/personal variable (e.g., athletic identity) at Step 5, and an interaction product score (e.g., mastery orientation X ego orientation) where theoretically relevant at Step 6. Table 2 shows the results for each personal/situational variable in independent hierarchical regression analyses. Although all the variables are listed together in Step 5 in the table for the sake of succinct presentation, they were conducted in separate regression analyses. Because the beta values for variables in Step 1 through 4 change in each hierarchical regression analysis, they are presented in Table 2 as they would appear if the regression analysis included only these four variables. All beta values presented are standardized.

As shown in Table 2, age was a significant predictor of Time 2 symptom intensity and Time 3 symptom intensity, with older athletes reporting higher symptom intensity than younger athletes. Parent ego climate and the concentration anxiety subscale were significant predictors of Time 1 symptom intensity, $F(1, 44) = 8.15$, $\beta = .34$, $p = .039$ *and* $F(1, 45) = 4.23$, $\beta = .29$, $p = .046$ respectively, with higher reported parent ego climate and concentration disruption predicting more intense symptom expression. The interaction between mastery and ego orientation was also a significant predictor of Time 1 symptom intensity, $F(1, 43) = 4.60$, $\beta = -.36$, $p = .038$, with greater ego and lower mastery orientation interacting to predict less intense symptomatology. Age, concussion history, intrinsic motivation, amotivation, performance anxiety and the concentration and somatic anxiety subscales were significant predictors of Time 2 symptom intensity, *F*(1,

49) = 6.00, $\beta = .28$, $p = .018$; $F(1, 46) = 4.52$, $\beta = -.28$, $p = .039$; $F(1, 45) = 4.26$, $\beta = .27$, $p = .045$; $F(1, 45) = 7.16$, $\beta = .33$, $p = .01$; $F(1, 43) = 5.95$, $\beta = .33$, $p = .019$; $F(1, 45) = 5.92$, $\beta = .31$, $p = .019$; *and* $F(1, 45) = 5.12$, $\beta = .31$, $p = .029$ respectively. Older athletes, and those who reported more intrinsic motivation, amotivation, performance anxiety, concentration disruption and somatic anxiety experienced more self-reported post-concussion symptoms at Time 2. Athletes who reported a higher number of concussions in the previous 12 months described fewer symptoms at Time 2. Finally, age, athletic identity, amotivation, performance anxiety and the concentration and somatic anxiety subscales were significant predictors of Time 3 symptom intensity, $F(1, 44) = 7.10$, $\beta = .35$, $p = .011$; $F(1, 40) = 5.10$, $\beta = .32$, $p = .03$; $F(1, 40) = 4.94$, $\beta = .31$, $p = .032$; $F(1, 40) = 6.19$, $\beta = .38$, $p = .017$; $F(1, 40) = 7.81$, $\beta = .39$, $p = .008$; and $F(1, 40) = 6.89$, $\beta = .39$, $p = .012$ respectively. Older age, higher athletic identity and more amotivation, performance anxiety, concentration disruption and somatic anxiety predicted more intense symptomatology.

To assess the unique predictive qualities of personal/situational variables when entered together, rather than separately, I conducted a hierarchical multiple regression analysis for each of the three time points, with the outcome variable being symptom intensity. For each regression analysis, I entered age, gender, days since their last concussion, and self-reported concussion history in the previous 12 months together at Step 1 as control variables. At Step 2, all personal and situational psychosocial variables were entered, and at Step 3, any theoretically possible interaction effects included. Table 3 shows the results of each regression analysis for each time point.

As shown in Table 3, no variables significantly predicted Time 1 symptom intensity. For Time 2 symptom intensity, the control variables together reached significance $F(4, 46) = 3.22$, $r^2 = .22$, $p = .021$, but no one variable accounted for a significant independent amount of variance. The personal/situational factors together significantly predicted Time 3 symptom intensity $F(13, 28) = 2.25$, $r^2 = .43$, $p = .036$. Intrinsic motivation and amotivation each accounted for a significant independent amount of variance in Time 3 symptom intensity $\beta = .48$, $p = .042$ *and* $\beta = .48$, $p = .018$ respectively. Greater intrinsic motivation and amotivation predicted more symptoms. There was no evidence of multicolinearity in this analysis.

Predicting Symptom Intensity Change using Personal/Situational Variables

An important empirical question is whether situational and personal variables predict changes in symptom intensity and continued difficulties post-concussion. To address this question, I computed two symptom intensity change variables intended to reflect increases or decreases in symptoms relative to initial symptom ratings during their hospital visit. These two dependent variables include the change in symptom intensity from Time 1 to 2, and the change in symptom intensity from Time 1 to Time 3. I created each by subtracting Time 2 and Time 3 symptom intensity respectively from Time 1 symptom intensity, so that a positive score indicated a reduction in symptoms (i.e., symptom improvement). I conducted hierarchical regression analyses (see Table 4) in which symptom intensity change scores were regressed on the various personal and situational variables, controlling for initial symptom presentation at Time 1, age, gender, number of days since their concussion and their self-reported concussion history in the last 12 months. I conducted 10 independent hierarchical regression analyses, one for each individual personal/situational variable, for each of the two change score dependent variables. Time 1 symptoms was entered at Step one, age at Step two, gender at Step three, number of days since concussion at Step four, and self-reported concussion history in the last 12 months at Step 5. The personal/situational variable (e.g., athletic identity) was entered at Step 6, and their interaction product terms (e.g., mastery orientation X ego orientation) when theoretically relevant at Step 7.

As shown in Table 4, Time 1 symptoms were a significant predictor of change in symptom intensity both from Time 1 to Time 2, $F(1, 49) = 12.19$, $\beta = .38$, $p = .001$, and from Time 1 to Time 3, $F(1, 44) = 33.35$, $\beta = .58$, $p < .001$, with more symptoms at Time 1 predicting greater overall symptom intensity change. Age was a significant predictor of Time 1 to 2 change, $F(1, 48) = 6.84$, $\beta = -.26$, $p = .012$, and of Time 1 to 3 change, $F(1, 43) = 10.28$, $\beta = -.32$, $p = .003$, with older age predicting reduced symptom intensity change across time. The number of self-reported concussions in the past 12 months was only a significant positive predictor of symptom change from Time 1 to Time 2, $F(1, 45) = 8.81$, $\beta = .34$, $p = .005$. Of the personal and situational variables, only amotivation was a significant predictor of Time 1 to Time 2 symptom change, $F(1, 44) = 11.02$, $\beta = -.34$, $p = .002$. Amotivation was also significant independent predictor of Time 1 to 3 change, with more amotivation associated with decreased symptom change, $F(1, 39) = 8.18$, $\beta = -.28$, $p = .007$. Finally, performance anxiety and the concentration disruption and somatic anxiety subscales were significant predictors of Time 1 to 3 change, $F(1, 39) = 7.17$, $\beta = -.28$, $p = .011$; $F(1, 39) = 10.90$, $\beta = -.35$, $p = .002$; $F(1, 39) = 6.03$, $\beta = -.27$, $p = .019$. Greater anxiety predicted decreased symptom change and performance anxiety was a significant predictor of symptom intensity change *over and above* age, gender, number of days since the last concussion and self-reported concussion history.

To assess the unique predictive effects of personal/situational variables when entered together, rather than separately, I conducted a hierarchical multiple regression analysis for each of the two change score dependent variables. For each regression analysis, I entered Time 1 symptoms, age, gender, days since their last concussion, and self-reported concussion history in the previous 12 months at Step 1 as control variables. At Step 2, all personal and situational psychosocial variables were entered. At Step 3, any theoretically relevant interaction effects were included. Table 5 shows the results of the two regression analyses.

As shown in Table 5, the control variables at Step 1 were a significant predictor of symptom change from Time 1 to Time 2 $F(5, 45) = 7.13$, $r^2 = .44$, $p < .001$, and from Time 1 to Time 3 $F(5, 40) = 10.40$, $r^2 = .57$, $p < .001$. Symptom intensity at Time 1 accounted for a significant amount of independent variance in both regressions, $\beta = .33$, $p = .012$ *and* $\beta = .68$, $p < .001$ respectively. Greater symptom intensity at Time 1 predicted more change in symptoms across time. At Step 2, the combined personal/situational variables were also a significant predictor of symptom change from Time 1 to Time 2 $F(13, 32) = 2.31$, $r^2 = .27$, $p = .027$, and from Time 1 to Time 3 $F(13, 27) = 2.36$, $r^2 = .23$, $p = .029$ with athletic identity and amotivation each accounting for a significant amount of independent variance for Time 1 to Time 2 change, $\beta = .-.39$, $p = .025$ *and* $\beta = -.45$, $p = .004$ respectively, and for Time 1 to Time 3 change, $\beta = .-.35$, $p = .027$ *and* $\beta = -.32$, $p = .014$ respectively. This was *over and above* age, gender, concussion history and the number of days since their concussion. Greater athletic identity and amotivation predicted fewer changes in symptoms across time. At Step 3, interaction effects were not significant predictors of symptom intensity change. There was no evidence of multicolinearity in this analysis.

Finally, to examine the overall effect of personal and situational variables on symptom change, both from Time 1 to Time 2 and from Time 1 to Time 3, I computed regression analyses in which all personal variables were entered as a block in one analysis, and all situational variables entered as a block in another analysis. Personal variables included athletic identity, mastery orientation, ego orientation, intrinsic motivation, extrinsic motivation, amotivation, and performance anxiety. Situational variables included coach mastery climate, coach ego climate, parent mastery climate, parent ego climate, social network size and social network satisfaction. For each regression analysis, I entered Time 1 symptoms, age, gender, days since their last concussion, and self-reported concussion history in the previous 12 months at Step 1 as control variables. All personal variables or all situational variables were entered at Step 2, as shown in Table 6.

The control variables entered at Step 1 predicted change in symptoms from Time 1 to Time 2, $F(5,45) = 7.13$, $r^2 = .44$, $p < .001$ and from Time 1 to Time 3, $F(5,40) = 10.40$, $r^2 = .57$, $p < .001$ accounting for 44% and 57% of the variance respectively. Personal variables entered at Step 2 significantly predicted change in symptoms from Time 1 to Time 2, $F(7,38) = 4.31$, $r^2 = .25$, $p < .001$ and from Time 1 to Time 3, $F(7,33) = 3.60$, $r^2 = .19$, $p = .006$ accounting for 25% and 19% of the variance respectively. Situational factors did not predict changes in symptom intensity.

Discussion

The present study sought to examine the predictive utility of personal and situational variables upon post-concussion symptom intensity. The findings suggest that athletic identity, amotivation and performance anxiety may be important in predicting changes in concussion symptoms. Youth athletes who report high athletic identity, amotivation and performance anxiety, particularly concentration disruption and somatic anxiety, are more likely to experience fewer declines in symptom presentation and continued symptomatology up to 21-28 days post-concussion. To my knowledge, this is one of the first studies to quantitatively assess the impact of psychosocial variables upon self-reported post-concussion symptom expression in youth athletes. The following discussion will first explore relations between personal/situational factors and self-reported symptom intensity at each time point, before discussing in depth the role of athletic identity, amotivation and performance anxiety upon post-concussion symptom change. Finally, I will discuss the role of personal and situational factors upon symptom change and highlight practical considerations based on these findings.

Relations between Personal/Situational Variables and Symptom Intensity

The current study found that parent ego climate, the concentration disruption subscale of performance anxiety, and the interaction between mastery orientation and ego orientation predicted Time 1 symptom intensity. Age, concussion history, intrinsic motivation, amotivation, performance anxiety and the concentration disruption/somatic anxiety subscales were significant predictors of Time 2 concussion symptom intensity. Age, athletic identity, amotivation, performance anxiety and the concentration disruption/somatic anxiety subscales were significant predictors of Time 3 concussion symptom intensity. Although each of these variables were significant predictors when entered into independent regression analyses, only athletic identity and coach mastery climate accounted for a significant amount of independent variance, and only at Time 3, when all variables were entered into one regression. The following discusses each personal/situational variable that was a significant predictor of symptom intensity. Because athletic identity, amotivation and performance anxiety predict changes in post-concussion symptomatology, I will delay discussion of these concepts until the following section on changes in symptoms over time.

High parent ego climate was associated with more self-reported concussion symptoms seven days post-concussion. Considering the integrated model of response to sport injury, this makes theoretical sense given that a high ego climate affects cognitive appraisals of the injury by influencing how the injury interferes with demonstrating normative competence. Conceptually, this could affect self-reported symptom presentation in two ways. First the increased perception of pressure to perform at high normative standards may pose a burden on athletes that the injury provides relief from. Accordingly, athletes could report more symptoms in order to avoid returning to sport and the associated evaluative stress. Second, athletes may feel pressure from their parents to achieve normative success, and experience the concussion as a negative event that frustrates demonstration of success under an ego climate. To this end, there is a strong literature that a concussion results in negative emotional experiences (Hutchison et al., 2009; Mainwaring, Hutchison, Bisschop, Comper & Richards, 2010). Accordingly, a perception of high parent ego climate exacerbates the relative psychological trauma of a concussion and results in increased distress and associated symptoms.

The interaction between mastery and ego orientation, whereby high mastery and low ego orientation predict the most symptoms seven days post-concussion, is unexpected given that the Achievement Goal Theory literature supports more positive effects with a strong mastery orientation and involvement (Ames, 1992), and interventions have even worked toward fostering mastery orientation for the benefit of youth athletes (Smoll, Smith & Cumming, 2007). It is possible that athletes with high mastery orientation combined with low ego orientation are highly motivated to avoid returning to sport in order to protect their self-referenced perceptions of competence. Within seven days post-concussion, it is expected that athletes will experience a fear of re-injury or other self-referenced performance concerns (Podlog & Eklund, 2007) that could threaten an athlete's competence perceptions. With low ego orientation in the context of high mastery orientation, there is little pressure to return to sport quickly in order to prove normative ability. Accordingly, this combination results in more self-reported symptoms that delay the athlete's return to sport.

Older age was a predictor of greater concussion symptom intensity approximately 14 and 21 days post-concussion. Although this is contrary to previous research (Franklin & Weiss, 2012), there is some evidence that suggests little relation between age and symptom expression (Lee et al., 2013). It is generally unclear why older athletes reported more symptoms than younger athletes at Time 2 and Time 3 in the current study. However, it should be noted that age did not account for a significant amount of independent variance when entered in a block with gender, concussion history and the number of days since the last concussion (Table 3). In addition, in the longitudinal analyses, performance anxiety was a predictor over and above age (see Table 2). Accordingly, it could be that older athletes are more likely to experience performance anxiety and that this explains the greater symptom expression.

Also unexpected was the finding that a greater self-reported concussion history within the previous 12 months predicted fewer symptoms. Much of the literature reliably demonstrates that a greater concussion history predicts increased symptom expression (Colvin et al., 2009; Hollis et al., 2009). It is possible in this study that athletes who experienced a concussion within the last 12 months have more realistic expectations of recovery and understand the detrimental effects of a concussion, such as being ruled out from sport or even school. In this manner, a concussion history moderates cognitive appraisals of the situation and reduces the threat of the injury. Accordingly, it is conceivable that athletes with a concussion history report fewer symptoms to return to activities more quickly, or because they are less negatively affected by the experience. As with age, when entered with other control variables into one block, concussion history did not account for a significant amount of independent variance.

Finally, high intrinsic motivation predicted more symptom expression at Time 2, and accounted for a significant amount of independent variance in Time 3 symptom intensity. Intrinsic motivation is usually associated with more positive adaptations (Deci & Ryan, 2000). However, athletes who intrinsically value sport could be more strongly affected by removal from sport due to the concussion. For such athletes, removal from sport could exacerbate symptom expression because these athletes are more disturbed by removal from an intrinsically valuable activity.

Psychosocial Variables Predict Changes in Post-Concussion Symptomatology

The present research suggests that symptoms tend to increase up to 14 days post-concussion and that by 21 days post-concussion most youth athletes are recovered. This is similar to other research examining concussions in children and youth athletes (Moser, Fryer & Berardinelli, 2011). However, a number of athletes continue to experience prolonged symptom expression over time, and identifying factors that predict who these athletes might be is an important and worthy goal in the research. To this end, a relatively heavy emphasis has been placed on the importance of predicting post-concussion self-report symptom recovery. For example, following a concussion, initial symptom intensity has been identified as a strong predictor of post-concussion symptom change. Recent research by Chrisman, Rivara, Schiff, Zhou and Comstock (2013) indicates that certain post-concussion symptoms such as nausea, drowsiness, and concentration difficulties predict having elevated symptoms for more than one week. Other researchers also demonstrate that initial symptom presentation predicts self-reported recovery (Lau et al., 2009, 2012; Lau, Collins & Lovell, 2011; McCrory et al., 2009). To this end, the current findings suggest that overall symptom intensity, especially around 14 days post-concussion is a strong predictor of symptoms 21 days post-concussion.

The present research also identifies psychosocial factors that predict post-concussion self-reported recovery. This extends previous research in the area of psychosocial predictors. Currently, there is some evidence that behavioral adjustment difficulties in the six months prior to concussive injury, predicts symptoms up to one year post-concussion (Babikian et al., 2013; Yeates et al., 2012). Other research mostly outside of the sporting domain suggests that premorbid psychiatric diagnoses, especially anxiety and depression, predict more severe or lasting symptomatology post-concussion (Carroll et al., 2004; Kashluba et al., 2008; McCauley et al., 2013; McLean et al., 2009; Ponsford et al., 2012; Wood et al., 2011). In sport, premorbid psychiatric diagnoses have also been linked to an increased concussion incidence (Alosco et al., 2014), and significantly longer times (Hutchison et al., 2014).

The present research identifies new and novel factors that may be important premorbid psychosocial considerations. In particular, athletes reporting greater athletic identity, amotivation and performance anxiety appear to be at the highest risk of protracted recoveries.

Athletic Identity

Athletic identity was a significant predictor of changes in symptoms from both Time 1 to Time 2 and Time 1 to Time 3. Athletic identity accounted for a significant unique proportion of variance when entered with all other psychosocial variables, and after accounting for age, gender, concussion history and the number of days since their last concussion. Athletes who reported greater athletic identity reported fewer changes in symptoms across time, even after controlling for Time 1 symptoms, age, gender, concussion history, and the number of days since their last concussion. The finding that athletic identity predicts fewer symptom changes over time is consistent with the injury literature that suggests high athletic identity is a risk factor for greater adjustment difficulties post-injury (Brewer et al., 2010). Because these athletes have a high degree of psychological investment in sport, the injury threatens their self-identity and overall sense of competence. Evidence supports that for longer-duration injuries, athletes distance themselves from sport as a coping mechanism (Brewer, Selby, Linder & Petitpas, 1997; Brewer et al., 2010). Typically the research demonstrates this process over a six to twelve month period, and Brewer and colleagues find that during this time period athletic identity can actually reduce to reflect this distancing from sport. In the present study however, considering that a concussion is often a relatively temporary injury, athletes may not have had time to adapt to the injury by altering their self-identity. Accordingly, it is likely that athletes experienced threats to their self-identity and sense of competence as a result of the concussion and possibly also because of consequences such as temporary removal from sport. Those reporting more athletic identity may have experienced greater distress as a result of this process, potentially exacerbating symptom expression. Given the short injury duration, they will also have been unable to engage in protective mechanisms such as distancing from sport.

From the perspective of the integrated model of response to sport injury, athletes reporting high athletic identity interpret the injury more catastrophically and have difficulty adjusting given their low self-complexity. Because the injury is so threatening to self-identity, an athlete’s coping resources become strained, the athlete may be hypervigilant for ongoing symptomatology, and the emotional distress may exacerbate symptom expression. A crucial self-aspect of sporting identity has been removed because of the concussion. Accordingly, when asked to complete self-report symptom intensity, these athletes are more likely to describe a high intensity of symptoms as they are focused on these symptoms and have a strong negative interpretation of the injury that affects symptom expression.

Amotivation

Amotivation was a significant predictor of symptom change both from Time 1 to Time 2 and from Time 1 to Time 3. It was the only variable in the present study that significantly predicted symptom change both when entered independently in a regression and when entered in a block with all other psychosocial variables. In the present study, athletes reporting high amotivation endorsed items assessing hopelessness, lack of self-efficacy, and distancing from their sports. Research in the sport literature argues that amotivation occurs when athletes fail to perceive contingencies between their actions and consequences of their actions, and is experienced as low self-efficacy and control over target outcomes (Pelletier et al., 1995). Amotivation in sport reflects a lack of feelings of competence, connectedness, and autonomy (Deci & Ryan, 2000; Pelletier, Dion, Tuson & Green-Demers, 1999), and is epitomized by athletes being unable to identify good reasons to continue playing sport. Accordingly, athletes high in amotivation have been shown to think more about quitting sport and be at increased risk of sporting dropout (Sarrazin et al., 2002; Vallerand et al., 1997). A concussion provides an opportunity for brief or extended relief from an amotivating setting. Theoretically, athletes endorsing greater amotivation are given an “out” from an aversive sporting situation. In the integrated model of response to sport injury, athletes who are amotivated may have cognitive appraisals of the injury that are positive and result in interpreting the injury as a relief. The presence of symptoms offers an opportunity to stop playing sport, at least temporarily, and because the athlete is inherently amotivated to return to sport quickly, there is no incentive to minimize symptoms. Whether amotivated athletes report increased symptoms for longer duration or in fact more motivated athletes actually minimize their symptoms is unclear, but this appears to be a plausible explanation for the relation between amotivation and self-reported symptom recovery.

What is also unclear in the present study is whether amotivation is a pre-morbid or post-morbid variable; that is, whether athletes were amotivated towards sport prior to their concussion, or became amotivated because of their concussion. If athletes were amotivated prior to their concussion, the concussion provides welcome relief from sport. If athletes become amotivated towards sport following their concussion, likely because the concussion affects their cognitive appraisals toward sport and they fear further head trauma (e.g., Podlog & Eklund, 2007; Podlog et al., 2011) or find the state of injury reinforcing, the concussion is again a relief from aversive and less reinforcing settings. Examination of the Sport Motivation Scale suggests that amotivation in the current study may assess the state of motivation when athletes completed the scale, rather than a more general sense of motivation independent of the concussion injury. For example, in response to the stem “why do you play sport?” items such as “it is not clear to me anymore; I don’t really think my place is in sport” could reflect a state of motivation heavily influenced by recent events. However, whether feelings of amotivation change following a concussion is an empirical question for future research.

Regardless of whether amotivation is a pre-morbid or post-morbid variable, it is clear that if an athlete endorses high amotivation approximately 14 days post-concussion they are more likely to continue experiencing symptoms significantly longer than other athletes. While it is possible that those athletes who have more severe concussion experiences are increasingly likely to become amotivated toward sport, the present analyses control for symptom expression at Time 1 and time since the concussion occurred to account for this possibility. Instead, another interpretation is that amotivated athletes have no motivation to report fewer symptoms in order to return to activity as soon as possible. This may be because sport is amotivating in the pleasure/mastery sense, and/or because the negative aspects of sport such as head injury outweigh and subsume any positive aspects. Amotivated athletes may also be more sensitive to post-concussive symptoms because these symptoms are reinforcing of removal from amotivating settings. From the integrated model of response to sport injury perspective, amotivated athletes interpret post-concussion consequences, such as removal from sport, positively and that helps maintain self-reported symptom expression.

Performance Anxiety

Performance anxiety was a significant predictor of symptom intensity change *over and above* age, gender, and concussion history in independent regression analyses. Its overall influence was suppressed by other psychosocial factors when all variables were entered together. However, given its strong relation with symptom changes in independent regression analyses, performance anxiety appears to be an important consideration in self-reported post-concussion recovery. A trait construct, sport performance anxiety is a predisposition to respond with cognitive and/or somatic state anxiety to competitive sport situations in which the adequacy of the athlete's performance can be evaluated. This state anxiety response involves components of worry, cognitive interference, and physiological arousal that are often correlated with the intensity of evaluative pressures (Smith, 1986). Greater levels of performance anxiety are generally associated with maladaptive consequences, including effects on performance, enjoyment, injury susceptibility, motivation, and sport attrition (Smith & Smoll, 2004; Smith et al., 2002), while lower levels are associated with enhanced sporting experiences (Lewthwaite & Scanlan, 1989; Smith et al., 2007). In the concussion literature, heightened general anxiety has been identified as both an important premorbid and post-concussion emotional response in predicting longer recoveries after a concussion (Hutchison et al., 2014; Ponsford et al., 2012).

Conceptually, performance anxiety may be an important factor in self-reported concussion recovery because evaluative fears are evoked both during the recovery process itself (e.g., speed of recovery compared to others), and as the prospect of returning to play nears. It is an indicator of fear of failure that increases avoidance of evaluative situations. The concussion provides an opportunity to temporarily relieve this anxiety until the athlete is confident of achieving more competent performances and thus cognitive appraisals of the injury function to prolong symptom expression. In addition, the athlete may interpret certain anxiety symptoms (e.g., somatic and concentration disruption) as indicating an incomplete recovery. This may heighten symptom vigilance as the athlete believes he/she is not fully recovered, which likely results in greater symptom self-reports. It is also possible that athletes with high performance anxiety use symptom self-reports as an opportunity for self-handicapping (Chen et al., 2008; Ommundsen, 2001). In this situation, high symptom reports provide an explanation for any suboptimal performance, and thus function to lessen anxiety.

In the present study, analysis of the important components of performance anxiety suggests that somatic anxiety and concentration difficulty most strongly predict symptom changes.

Somatic Symptoms

Somatic anxiety was a strong predictor of changes in post-concussion symptomatology, with greater somatic symptoms in performance situations associated with more prolonged duration of post-concussion symptoms. Athletes reporting high somatic symptoms of performance anxiety are more inclined to experience physiological sensations and/or be sensitive to those sensations in evaluative situations such as sport. Given their high level of performance anxiety, sport is conceivably an aversive environment in which fear of failure is pervasive. The concussion provides a haven in which to avoid associated somatic symptoms of the performance anxiety. Accordingly, it might be expected that such athletes take longer to recover as they avoid somatic symptoms that are elicited by returning to sport quickly.

During post-concussion recovery, an athlete with high premorbid somatic anxiety may be more likely to experience and hyperfocus on post-concussion symptoms, particularly somatic symptoms, while also viewing them as a poor indicator of recovery. In this regard, somatic aspects of performance anxiety may be similar to a personality trait concept called *anxiety sensitivity* in which high levels of somatic anxiety symptoms are related to negative beliefs about what those symptoms represent (e.g., Wood et al., 2011). *Anxiety sensitivity* has been linked to post-concussion recovery through its association with negative beliefs about recovery (Whittaker, Kemp & House, 2007). In addition, *anxiety sensitivity* is predictive of sensitivity to pain in several studies (Asmundson, 2001; Asmundson & Norton, 1995; Jenewein, Moergeli, Wittmann, Buchi, Kreamer & Schnyder, 2009; Keogh & Mansoor, 2001). Accordingly, athletes reporting greater somatic aspects of performance anxiety may have a comparably increased sensitivity to concussion symptoms, while also viewing these symptoms as a negative indicator of recovery. This provides a good explanation for why high somatic performance anxiety predicts prolonged post-concussion symptomatology. Athletes with high somatic anxiety are more prone to experience and focus on their symptomatology, thereby likely reporting increased and prolonged symptom intensity. In addition, because these athletes may also interpret symptoms of somatic anxiety as a negative indicator of recovery, the meaning of these symptoms may foster negative affect and deter fast self-reported recovery.

In addition to these processes, the prospect of recovery and returning to play may evoke more feelings of somatic anxiety as the athlete nears re-exposure to evaluative environments during their self-reported recovery. For example, athletes may worry about their level of performance or about re-injury (Podlog, Dimmock & Miller, 2011). Given the already heightened sensitivity to these sensations, and the negative meaning associated with them, one possibility is that their occurrence is misinterpreted as a sign that the athlete is not fully recovered or will be easily re-injured, further increasing their vigilance for other symptoms. Accordingly, they may report symptoms for a longer period of time to delay their return to sport until they are assured recovery is complete or they can compete at pre-injury performance levels.

Concentration Disruption

Greater premorbid concentration difficulties also appear to be important and predict a more intense and prolonged post-concussion symptom experience. Concentration disruption has been specifically identified as a symptom associated with protracted recoveries (Asplund, McKeag & Olsen, 2004; Chrisman et al., 2013), and the present findings suggest that a trait disposition to concentration difficulties is an important recovery factor for self-reported symptoms. Conceptually, concentration disruption in the context of performance anxiety occurs because a fear of failure in evaluative situations impairs cognitive processing. Performance anxiety results in a self-preoccupation in which athletes are vulnerable to thoughts that interfere with the processing of information (Sarason, 1988). It is likely that situations occurring naturally during post-concussion recovery, such as the return to evaluative settings (including sport), provoke anxiety and ultimately disrupt concentration. Indeed, research demonstrates that during injury recovery, athletes returning to sport experience concerns related to competence, connectedness, and autonomy (Podlog et al., 2011). Podlog and colleagues found that these concerns include fear of re-injury, worries about the ability to perform at pre-injury levels, self-presentational concerns, fears of social isolation, and feeling pressured to return to sport. During concussion recovery, disruptions in concentration may occur as these fears and anxieties manifest. This is potentially detrimental to self-reported symptom recovery because self-preoccupation results in a focus on environmental cues, such as post-concussion symptoms, to which the athlete is sensitive (e.g., Strack, Blaney & Ganellen, 1985). In addition, self-preoccupation can exacerbate negative affect and further increase anxiety (Mor & Winquist, 2002). Accordingly, as information processing is disrupted, athletes become hyperaware of the impairment and may interpret this as a negative prognostic sign of recovery. As a result, an athlete with high performance anxiety who experiences concentration disruption may report prolonged symptomatology because they are more aware of their symptoms.

Aside from self-preoccupation, one additional explanation for the role of concentration disruption is the possibility that sport is an aversive environment because it is inherently anxiety provoking. The concussion may be an opportunity to avoid sport temporarily as it provides relief from evaluative environments and the associated impairments to cognitive processing.

The Relative Influence of Personal and Situational Factors in Predicting Symptom Change

The research to date rarely considers the role of psychosocial factors in sport concussion self-reported symptom recovery. The current data strongly suggests that psychosocial factors may be far more influential than previously thought. For example, the combined influence of the psychosocial factors in the present study account for 43% of the variance in symptom expression at Time 3, even after accounting for variables such as age, gender and concussion history. Psychosocial factors also accounted for 27% of the variance in symptom change from Time 1 to Time 2, and 23% of the variance in symptom change from Time 1 to Time 3. These findings speak to the need for more research examining psychological predictors of self-reported recovery.

The present study found that when grouped together, personal and situational factors are clearly important for self-reported recovery. However, the current research also found that personal factors accounted for far more variance in symptom change than do situational factors. This is unsurprising given that all three major predictors of symptom change in the current study, athletic identity, amotivation, and performance anxiety, were personal factors. The lack of relation between situational factors and symptom change may reflect the fact that this study failed to assess some important situational variable affecting an athlete post-concussion. However, given that situational variables consisted of motivational climate and social support, two of the most prominent environmental influences on youth athlete well-being, the absence of any significant relation to symptom change is noteworthy.

Practical Considerations

The present findings suggest that individuals working with concussions be aware of an athlete's level of athletic identity, especially given the injury literature demonstrates that high athletic identity predicts greater adjustment difficulties following a trauma (Brewer et al., 2010). Athletes with high athletic identity generate a sense of self and perceptions of competence from sport. A concussion threatens this self-concept by removing athletes from the domain in which they in part define themselves. For athletes who report high athletic identity, it may be important that practitioners find meaningful ways to engage the athlete in their sporting community without jeopardizing the recovery process itself. This might include continuing to visit practices and being involved in social aspects of their sport. For some athletes it might also be helpful to facilitate greater self-complexity by engaging in activities outside of the sporting domain.

The present research also supports that practitioners working with athletes post-concussion be aware of their motivations for returning to sport. Identifying activities that are motivating for an athlete is important because activity appears to be an important factor in reducing time out post-concussion (De Kruijk, Leffers, Meerhoff, Rutten & Twijnstra, 2002; McCrory et al., 2013; Leddy, Kozlowski, Donnelly, Pendergast, Epstein

& Willer, 2010; Leddy, Sandhu, Sodhi, Baker & Willer, 2012). Having activities and roles athletes are motivated to assume may be beneficial by making the prospect of recovery more reinforcing than the current injured status. Given that motivation may affect self-reported recovery, medical professionals should also use other indicators than self-report of symptoms to assess recovery (e.g., McCrory et al., 2013).

With regard to anxiety, the present research suggests that interventions focused on reducing physiological anxiety and concentration disruption around sport-specific performance anxiety may have real benefit. For example, a brief Cognitive-Behavior Therapy protocol such as stress management training (Crocker, 1989) could increase athletes' resources to deal with issues related to performance anxiety, including the fear that a concussion affects performance upon return to play. Such interventions may not only reduce anxiety and increase coping appraisals but also limit the hyper-focus on anxiety symptoms as an indicator of incomplete concussion recovery or of meaning that return to play performance will be affected, as proposed in the present paper.

Limitations and Future Directions

The present study has several limitations that need addressing. First, there was no premorbid baseline measurement and all personal and situational variables were completed approximately 14 days post-concussion. While most of the measures were chosen to reflect stable constructs, it is possible that the concussion experience altered self-perceptions and perceptions of others' behavior that are relevant for the constructs being measured. For example, it is unclear whether amotivation in the present study reflects a more stable state of motivation, or whether it was influenced by the concussion.

In addition, given the time of measurement, relations between psychosocial variables and Time 1 symptom intensity may reflect postdiction rather than prediction. Future research should attempt to include premorbid baseline measurements of certain variables, and it would be an interesting experiment to determine how psychosocial constructs change following a concussion. It would also be clinically advantageous to compare the effect of premorbid versus post-concussion psychosocial changes in predicting self-reported symptom recovery.

Importantly, the indicator of recovery in this study was self-report of symptoms. However, researchers note that symptoms alone should not be used to diagnose recovery (Guskiewicz et al., 2013; McCrory et al., 2013) because recovery is a multifaceted construct also including factors such as balance disruption and other cognitive impairments. In the current study, many of the explanations of mechanisms for action consider that self-report of symptoms may be subject to reporting bias, where symptom reports are affected by motivations to return to sport or biases in the interpretation of symptoms. There is some evidence that self-report of symptoms can be affected by such biases, with researchers highlighting that male and female self-reports vary substantially (Dick, 2009). In addition, other evidence supports that athletes report fewer symptoms in order to return to play sooner (Chrisman, Quitiquit & Rivara, 2013). The present study is therefore limited in that predictors of recovery are based on self-report and do not include other components of recovery. Future research should incorporate physical, behavioral and neuropsychological measures to more accurately assess recovery (e.g., Craton & Leslie, 2014). For example, researchers could use the newly revised SCAT-3 at several time points to better account for different facets of recovery. In addition, it may be advantageous to consider other outcomes that better reflect functional recovery, such as the time to return to school and other activities. It should be noted that at Time 1 in the present study many athletes completed the entire SCAT-2, providing more data than simply self-report symptoms. This was not included in the main analyses because not all medical providers utilized the whole SCAT-2 assessment. When I added SCAT-2 score as a control in predicting symptom change over time, findings were similar to those presented and no changes in relations between variables were observed.

The current sample involved children who visited a hospital post-concussion for evaluation. It is possible that this group may be qualitatively and quantitatively different to children and families who do not visit a hospital post-concussion. The average age of the present group was 14.60 ± 1.90 years and it is unclear whether these findings generalize to other age groups. The number of athletes who participated also limits the present study. With a higher number of participants, more complex analyses such as structural equation modeling could be considered. In addition, given that some research identifies continued difficulties beyond 21 days post-concussion (Babikian et al., 2013; McCrea et al., 2013), future research should attempt to determine whether the currently studied variables, particularly athletic identity, autonomy and performance anxiety, are predictive of more long-term impairments.

Finally, the present study adds to recent findings that psychosocial factors, especially personal factors, are important for self-reported recovery post-concussion. Future research should continue to identify other influences that may be important for managing care and developing interventions to prevent protracted recoveries and assist youth athletes in making full recoveries.

Conclusion

In conclusion, the present study finds that athletic identity, amotivation and performance anxiety are important factors in predicting changes in self-report symptoms from approximately seven to 21-28 days post-concussion. From the perspective of the integrated model of response to sport injury, these factors influence cognitive appraisals of the concussive injury that determine self-reported symptom expression. The results suggest greater empirical attention toward psychosocial influences on self-reported concussion recovery is warranted.

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Table 1

Means, standard deviations, Cronbach alphas and bivariate correlations.

Variable	*1*	*2*	*3*	*4*	*5*	*6*	*7*	*8*	*9*	*10*	*11*	*12*	*13*
1. Age	-												
2. Days Since Concussion	-.02	-											
3. Concussion History	-.05	.04	-										
4. Athletic Identity	.17	-.16	-.08	-									
5. Mastery Orientation	-.21	-.03	-.08	.35*	-								
6. Ego Orientation	.00	-.12	.17	.43**	.08	-							
7. Coach Mastery Climate	-.12	.10	.08	.27	.45**	-.03	-						
8. Coach Ego Climate	.21	.00	-.03	.02	-.04	-.10	-.30*	-					
9. Parent Mastery Climate	-.10	-.12	.11	-.14	.39**	-.13	.43**	-.41**	-				
10. Parent Ego Climate	.02	-.06	.11	.31*	-.31*	.22	-.19	.22	-.67**	-			
11. Intrinsic Motivation	-.13	.06	-.00	.38**	.50**	.05	.55**	-.13	.29*	.04	-		
12. Extrinsic Motivation	.00	.05	.02	.36**	.12	.32*	.27	.17	-.05	.28*	.47**	-	
13. Amotivation	.12	-.03	.02	-.11	-.20	-.07	-.24	.53**	-.35*	.33*	-.12	.15	-
14. Performance Anxiety	.41**	-.04	-.10	.14	-.33*	-.06	-.26	.32*	-.32*	.37**	-.12	.20	.38**
15. - Somatic Anxiety	.36**	-.14	-.04	.13	-.32*	-.05	-.18	.19	-.28	.36**	-.10	.15	.33*
16. - Concentration Disruption	.26	-.01	-.06	.21	-.38*	.15	-.23	.27	-.51**	.40**	-.09	.17	.37**
17. - Worry	.39**	.04	-.13	.05	-.17	-.20	-.24	.33*	-.10	.22	-.10	.18	.28*
18. Social Network Size	-.07	-.27	.02	.32*	.35*	.02	.49**	-.06	.25	-.09	.31*	.13	.05
19. Social Network Satisfaction	-.10	.18	.01	-.13	.37*	.03	.37**	-.21	.49**	-.59**	.19	-.07	-.30*
20. Time 1 Symptoms	.01	-.24	.14	.11	-.15	.02	.03	-.00	-.06	.36**	.25	.23	-.02
21. Time 2 Symptoms	.33*	-.04	-.32*	.29*	-.07	-.22	-.03	.24	-.24	.22	.19	.10	.36*
22. Time 3 Symptoms	.37*	-.02	.10	.39**	-.09	.03	-.13	.15	-.19	.26	.18	.11	.35*

Variable	*14*	*15*	*16*	*17*	*18*	*19*	*20*	*21*	*22*	*M (SD)*	*Alpha*
1. Age										14.53 (1.85)	-
2. Days Since Concussion										7.67 (3.12)	-
3. Concussion History										1.71 (.99)	-
4. Athletic Identity										38.25 (6.23)	.71
5. Mastery Orientation										25.94 (4.43)	.86
6. Ego Orientation										18.46 (6.44)	.91
7. Coach Mastery Climate										23.80 (5.39)	.88
8. Coach Ego Climate										13.49 (5.44)	.79
9. Parent Mastery Climate										28.43 (4.86)	.87
10. Parent Ego Climate										16.57 (5.62)	.88
11. Intrinsic Motivation										64.09 (14.82)	.92
12. Extrinsic Motivation										50.92 (16.60)	.89
13. Amotivation										8.43 (.95)	.74
14. Performance Anxiety	-									29.44 (9.99)	.94
15. - Somatic Anxiety	.89**	-								9.32 (3.88)	-
16. - Concentration Disruption	.76**	.62**	-							7.60 (3.22)	-
17. - Worry	.86**	.64**	.40**	-						12.52 (4.79)	-
18. Social Network Size	-.04	.06	-.03	-.10	-					45.43 (10.86)	.72
19. Social Network Satisfaction	-.41**	-.27	.49**	-.32*	.18	-				5.76 (1.29)	-
20. Time 1 Symptoms	.19	.18	.27	.07	.04	-.30*	-			30.63 (23.53)	.94
21. Time 2 Symptoms	.44**	.40**	.40**	.32*	.11	-.21	.39**	-		39.41 (27.72)	.95
22. Time 3 Symptoms	.48**	.47**	.47**	.29	.08	-.14	.29	.79**	-	14.39 (19.40)	.96

Table 2

Hierarchical regression analyses at three time points, using personal and situational variables in independent analyses to account for variance in post-concussion symptom intensity at each time point

Step	Variable	Symptom Intensity								
		Time 1			Time 2			Time 3		
		ΔR^2	β	F	ΔR^2	β	F	ΔR^2	β	F
1	**Age**	.00	.01	.01	.11	.28	6.00*	.14	.35	7.10*
2	**Gender**	.00	.02	.06	.03	.15	1.83	.01	.07	.28
3	**Days post-concussion**	.05	-.24	2.71	.00	.00	.00	.00	.01	.00
4	**Concussion History**	.02	.15	1.09	.08	-.28	4.52*	.01	-.08	.27
5	**Athletic Identity**	.01	.08	.35	.05	.22	2.81	.10	.32	5.10*
	Mastery Orientation	.02	-.16	1.14	.00	-.01	.01	.00	-.02	.02
	Ego Orientation	.00	-.03	.05	.03	-.19	1.98	.00	.03	.03
	Coach Mastery Climate	.00	.05	.11	.00	.05	.13	.01	-.08	.33
	Coach Ego Climate	.00	-.00	.00	.03	.16	1.52	.00	.07	.23
	Parent Mastery Climate	.01	-.10	.50	.03	-.16	1.46	.02	.14	.84
	Parent Ego Climate	.11	.34	6.20*	.06	.25	3.99	.06	.25	3.23
	Intrinsic Motivation	.07	.28	3.89	.07	.27	4.26*	.05	.24	2.73
	Extrinsic Motivation	.06	.24	2.90	.01	.12	.84	.01	.10	.51
	Amotivation	.00	-.04	.06	.11	.33	7.16*	.09	.31	4.94*
	Performance Anxiety	.04	.23	2.16	.09	.33	5.94*	.11	.38	6.19*
	- Somatic Anxiety	.02	.17	1.21	.08	.31	5.12*	.13	.39	6.89*
	- Concentration Disruption	.08	.29	4.23*	.09	.31	5.92*	.14	.39	7.81**
	- Worry Anxiety	.01	.11	.49	.03	.20	1.97	.02	.15	.86
	Social Network Size	.00	-.03	.04	.02	.14	1.08	.01	.10	.46
	Social Network Satisfaction	.07	-.27	3.60	.03	-18	1.88	.01	-.11	.53
6	**Mastery Orientation X Ego Orientation**	.09	-.36	4.60*	.02	-.16	.97	.01	-.17	.63
	Coach MC X Coach EC	.00	-.07	.18	.00	-.04	.06	.00	-.07	.20
	Parent MC X Parent EC	.06	-.36	3.63	.00	-.08	.08	.00	-.07	.11

Note. Beta values for age, gender, days since concussion and concussion history are reported for a regression analysis incorporating only these variables.

Table 3

Hierarchical regression analyses at three time points, using personal and situational variables combined together in one block to account for variance in post-concussion symptom intensity at each time point

Step	Variable	Symptom Intensity Time 1 β	Time 1 ΔR^2	Time 1 F	Time 2 β	Time 2 ΔR^2	Time 2 F	Time 3 β	Time 3 ΔR^2	Time 3 F
1	**Age**	.11	.08	.43	.18	.22	3.22*	.22	.15	1.81
	Gender	.08			.21			.08		
	Days post-concussion	-.20			-.05			-.04		
	Concussion History	.05			-.18			.07		
2	**Athletic Identity**	-.19	.29	1.18	.31	.34	1.96	.41*	.43	2.25*
	Mastery Orientation	-.09			-.10			.00		
	Ego Orientation	-.12			-.34			-.16		
	Coach Mastery Climate	.14			-.04			-.36		
	Coach Ego Climate	.01			-.10			-.31		
	Parent Mastery Climate	.28			-.04			-.03		
	Parent Ego Climate	.27			-.01			.08		
	Intrinsic Motivation	.23			.38			.48*		
	Extrinsic Motivation	.13			-.12			-.21		
	Amotivation	-.17			.38			.48*		
	Performance Anxiety	-.06			.18			.31		
	Social Network Size	.06			-.01			-.02		
	Social Network Satisfaction	-.17			.04			.18		
3	**Mastery Orientation X Ego Orientation**	.08	.05	.86	.32	.02	.35	.33	.02	.43
	Coach MC X Coach EC	-.13			.11			.19		
	Parent MC X Parent EC	-.49			-.30			-.21		

Table 4

Hierarchical regression analyses, using personal and situational variables in independent regressions to predict post-concussion symptom intensity change over time

Step		Time 1 to 2			Time 1 to 3		
		ΔR^2	β	F	ΔR^2	β	F
1	**Time 1 Symptoms**	.20	.38	12.19**	.43	.58	33.35**
2	**Age**	.10	-.26	6.84*	.11	-.32	10.28**
3	**Gender**	.03	-.14	1.85	.00	-.04	.08
4	**Time since concussion**	.01	-.11	.50	.01	-.13	1.18
5	**Concussion history**	.11	.34	8.81**	01	.11	.97
6	**Athletic Identity**	.03	-.18	2.46	.01	-.12	1.22
	Mastery Orientation	.00	-.07	.24	.03	.02	2.94
	Ego Orientation	.00	.17	2.31	.00	.02	.00
	Coach Mastery Climate	.05	-.07	.05	.02	.20	2.16
	Coach Ego Climate	.03	-.18	2.35	.04	-.11	3.76
	Parent Mastery Climate	.00	.18	.17	.01	.05	1.32
	Parent Ego Climate	.01	-.11	.87	.04	-.02	3.87
	Intrinsic Motivation	.02	-.15	1.57	.00	.01	.02
	Extrinsic Motivation	.00	-.01	.01	.00	.04	.10
	Amotivation	.11	-.34	11.02**	.08	-.28	8.18**
	Performance Anxiety	.04	-.23	3.68	.07	-.31	7.17*
	- Somatic Anxiety	.04	-.23	3.73	.06	-.27	6.03*
	- Concentration Disruption	.03	-.19	2.60	.10	-.35	10.90**
	- Worry Anxiety	.02	-.15	1.44	.01	-.13	1.12
	Social Network Size	.02	-.15	1.70	.00	.05	.22
	Social Network Satisfaction	.00	.06	.28	.02	.15	1.80
7	**Mastery Orientation X Ego Orientation**	.00	-.01	.00	.03	.27	2.70
	Coach MC X Coach EC	.00	.01	.00	.00	-.02	.02
	Parent MC X Parent EC	.02	-.22	1.62	.03	.25	2.84

Note. Beta values for age, gender, days since concussion and concussion history are reported for a regression analysis using only these variables.

Table 5

Hierarchical regression analyses, combining personal and situational variables together into one block to predict post-concussion symptom intensity change over time

Step		Time 1 to 2			Time 1 to 3		
		β	ΔR²	F	*β*	ΔR²	F
1	**Time 1 Symptoms**	.33**	.44	7.13**	.68**	.57	10.40**
	Age	-.12			-.12		
	Gender	-.17			.07		
	Time since concussion	-.06			-.10		
	Concussion history	.20			-.03		
2	**Athletic Identity**	-.39*	.27	2.31*	-.35*	.23	2.36*
	Mastery Orientation	.05			.08		
	Ego Orientation	.27			.10		
	Coach Mastery Climate	.11			.22		
	Coach Ego Climate	.11			.01		
	Parent Mastery Climate	.18			.08		
	Parent Ego Climate	.14			.07		
	Intrinsic Motivation	-.26			-.18		
	Extrinsic Motivation	.18			.17		
	Amotivation	-.45**			-.32*		
	Performance Anxiety	-.20			-.16		
	Social Network Size	.03			.00		
	Social Network Satisfaction	-.13			-.20		
3	**Mastery Orientation X Ego Orientation**	-.27	.03	.96	.21	.01	.54
	Coach MC X Coach EC	-.17			-.06		
	Parent MC X Parent EC	.05			.00		

Table 6

Regression analyses examining the influence of personal and situational factors upon symptom intensity change

Personal Factors

Step		Time 1 to 2		Time 1 to 3	
		ΔR^2	F	ΔR^2	F
1	**Control Variables**	.44	7.13**	.57	10.40**
2	**Personal Factors**	.25	4.31**	.19	3.60**

Situational Factors

Step		Time 1 to 2		Time 1 to 3	
		ΔR^2	F	ΔR^2	F
1	**Control Variables**	.44	7.13**	.57	10.40**
2	**Situational Factors**	.06	.73	.09	1.39

Note:

Control variables include time 1 symptom intensity, age, gender, number of days since previous concussion, number of concussions in last 12 months.

Personal Factors include athletic identity, mastery orientation, ego orientation, intrinsic motivation extrinsic motivation, amotivation, and performance anxiety.

Situational Factors include coach mastery climate, coach ego climate, parent mastery climate, parent ego climate, social network size and social network satisfaction.

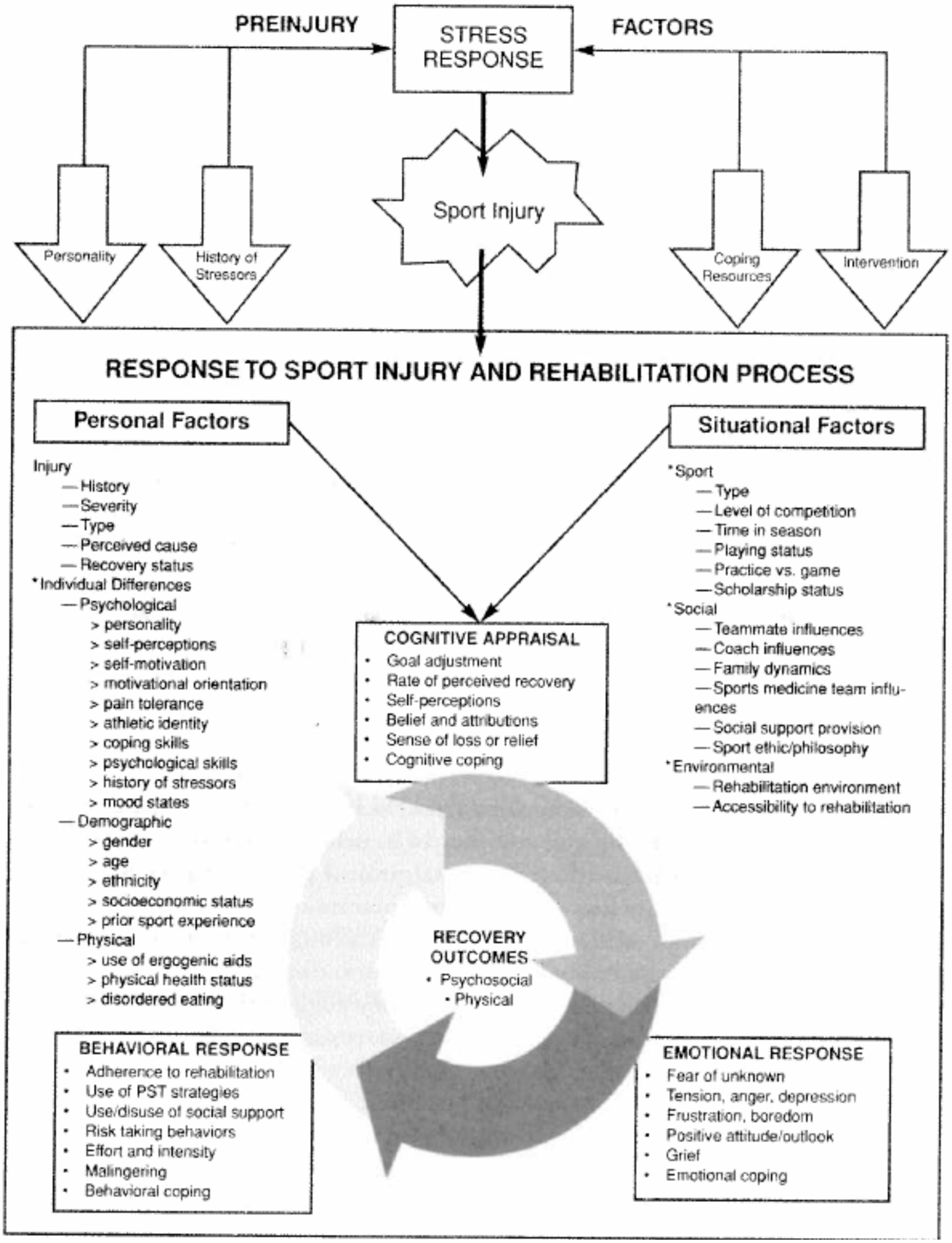

Figure 1. The Integrated Model of Response to Sport Injury (Wiese-Bjornstal et al., 1998).

Time	Location	Measures Administered
Time 1 (approximately 7 days post-concussion)	Hospital N = 70	SCAT-2
Time 2 (approximately 14 days post-concussion)	Home N = 51	SCAT-2 AIMS AGSYS MCSYS PIMCQ-2 SMS SAS-2 SNS
Time 3 (approximately 21 days post-concussion)	Home N = 46	SCAT-2

Figure 2. An outline of measures taken at each time point.