THE IMPACT OF EXECUTIVE FUNCTION: EXTENDING THE THEORY OF PLANNED BEHAVIOUR TO UNDERSTAND CONCUSSION REPORTING AMONG UNIVERSITY ATHLETES

by

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ABSTRACT

Research addressing athlete concussion symptom reporting has primarily emphasized symptom recognition and knowledge of return to play (RTP) protocol as outcome variables. However, there is evidence knowledgeable athletes conceal symptoms to continue playing, especially in important games (Kroshus et al., 2020). A health behaviour model, the Theory of Planned Behaviour (TPB), has recently been used to explain concussion reporting based on associated beliefs and attitudes. Only one study (Register-Mihalik, Linnan, et al., 2013), however, has followed the original methodology designed to elicit a comprehensive account of concussion reporting using the TPB and found the TPB accounted for 58% of the variability in reporting behaviour. In the present study, the addition of executive function (EF; the ability to plan, organize, and execute goal-directed behaviour; Lezak et al., 2012) to the model was examined to determine the extent to which EF improved the model's predictive validity for intentions to report concussion symptoms. Methodological limitations of previous research were addressed by developing and validating a TPB questionnaire (Theory of Planned Behaviour Concussion Reporting Questionnaire [TPB-CRQ]) with university-level athletes (N = 55) prior to testing the extended model. Subsequently, university-level athletes (N = 264) completed an online questionnaire package including measures of concussion reporting (the TPB-CRQ), executive functioning, athletic identity, and symptoms of Attention-Deficit/Hyperactivity Disorder. Hierarchical multiple regression was used to evaluate the extended TPB model and found TPB variables accounted for 35.1% variance in intention to report. While EF did not improve the model, the findings highlighted the importance of context, inaccurate perceived social norms, and a lack of perceived control over reporting as key determinants of intention to report. Based on the findings, suggested modifications to current educational and intervention approaches include integrating the role of context, emphasizing positive consequences for reporting, building reporting self-efficacy, incorporating facilitated team conversations into pre-season education, and re-establishing commitment to safety procedures throughout the season to increase attitudes and belief transparency among athletes, coaches, and staff.

DEDICATION

This dissertation is dedicated with gratitude to JSPFC.

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LIST OF ABBREVIATIONS

Abbreviation	Meaning
TPB	Theory of Planned Behaviour
EF	Executive Function
TPB-CRQ	Theory of Planned Behaviour – Concussion Reporting Questionnaire
mTBI	Mild Traumatic Brain Injury
mNCD	Mild Neurocognitive Disorder
CDC	Center for Disease Control and Illness Prevention
RTP	Return to Play
TRA	Theory of Reasoned Action
ADHD	Attention Deficit/Hyperactivity Disorder
EFI	Executive Function Index
UNB	University of New Brunswick
STU	St. Thomas University
SCAT-5	Sport Concussion Assessment Tool – 5th Edition
TPB-CRQ-p	Preliminary Theory of Planned Behaviour – Concussion Reporting Questionnaire
TPB-CRQ-f	Final version of the Theory of Planned Behaviour – Concussion Reporting Questionnaire
ASRS	World Health Organization Adult Attention-Deficit/ Hyperactivity Disorder Self-Report Screening Scale for DSM-5
AIMS	Athletic Identity Measurement Scale
TPB-CRQ-f-revised	Final Revised version of the Theory of Planned Behaviour – Concussion Reporting Questionnaire
EM	Empathy subscale of EFI
MD	Motivational Drive subscale of EFI

CHAPTER 1: INTRODUCTION

Overview

With over one quarter of Canadians participating in sports (Canadian Fitness and Lifestyle Research Institute, 2018), sport-related concussion has become a growing public health issue (Center for Disease Control and Injury Prevention, 2007, 2011, 2019). Between 2016 and 2017, more than 17,000 sport-related brain injuries were recorded in Ontario and Alberta combined (Canadian Institute for Health Information, 2018). In the same time period, the number of hospital visits for sport-related brain injuries increased by 28% in these provinces (Canadian Institute for Health Information, 2018). Concussion thus poses a financial burden to Canadian health care, with total costs accrued from being struck by or against sporting equipment estimated at $187 million in 2010 alone (Parachute, 2015).

Concussion can be associated with negative health consequences, especially when athletes do not follow recommended return to play protocol and continue participating in games or practices while experiencing symptoms (Guskiewicz et al., 2003; McCrory et al., 2017; Quintana, 2016; Saffary et al., 2012). Current approaches to concussion safety most often involve pre-season education about concussion symptoms and return to play protocol (McCrory et al., 2017). Although a growing number of student athletes appear to understand the signs, symptoms, and dangers of continuing to play with concussion symptoms, there is evidence many knowledgeable athletes underreport symptoms and continue to participate even when they suspect they have a concussion (Conway et al., 2018; Kroshus et al., 2017; Llewellyn et al., 2014; Meehan et al., 2013; Meier et al., 2015; J. K. Register-Mihalik et al., 2017).

The Theory of Planned Behaviour (TPB; Ajzen, 1991) is a health behaviour change model that has recently been used to help explain aspects of athletes' intention to report concussion symptoms (Kroshus, Baugh, et al., 2014; Lininger, Wayment, Craig, et al., 2019; Rawlins et al., 2020; J. K. Register-Mihalik, Linnan, et al., 2013; Warmath & Winterstein, 2019). According to the TPB, the best predictor of human behaviour is one's intention to perform that behaviour (Ajzen, 1991). The theory states people form intentions based on their Attitudes toward the behaviour, Subjective Norms influencing the behaviour (i.e., the pressure one perceives from important people in their life), and the Perceived Behavioural Control one feels over performing the behaviour (Ajzen, 1991). Attitudes, Subjective Norms, and Perceived Behavioural Control are themselves influenced by associated beliefs about the advantages and disadvantages of performing the behaviour, whether they are motivated to comply with influential individuals, and aspects that make the behaviour easier or more difficult to perform.

To date, limited variance in intention to report has been explained by the TPB, suggesting additional factors may need to be added to the model to improve our understanding of reporting intention. One construct that may show promise is Executive Function (EF). EF is an umbrella term for a set of cognitive abilities we use to execute effective behaviour. It determines how we engage in behaviour in purposeful, strategic, self-regulated, and self-serving ways and is associated with the formation, retention, initiation, and execution of intentions (Altgassen et al., 2019; Gawrilow et al., 2013; Hofmann et al., 2012; Kliegel et al., 2002; Lezak, 2012; Willcutt et al., 2005). Thus far, no research exists examining whether higher EF helps athletes form more robust intention to report symptoms, or if higher EF is associated with safer decision-making.

The overall goal of the current study was to examine the impact of extending the TPB with EF to better understanding concussion reporting intention among university athletes, and to determine which beliefs help inform more effective concussion intervention. A first step was developing a TPB questionnaire for university athlete concussion reporting (the Theory of Planned Behaviour Concussion Reporting Questionnaire; TPB-CRQ), as no measure following Ajzen's recommended methodology existed (Ajzen, 2006b; Francis et al., 2004). The second step was to examine how the TPB constructs and EF impacted intention to report. Research questions investigated 1) the role of athlete demographic factors in intention to report, 2) the unique role of EF in reporting concussion symptoms, 3) whether adding EF to the TPB model would improve its explanatory power for university athlete's intention to report, and 4) the specific beliefs discriminating between athletes with higher and lower intentions to report. Figure 1 outlines the study design.

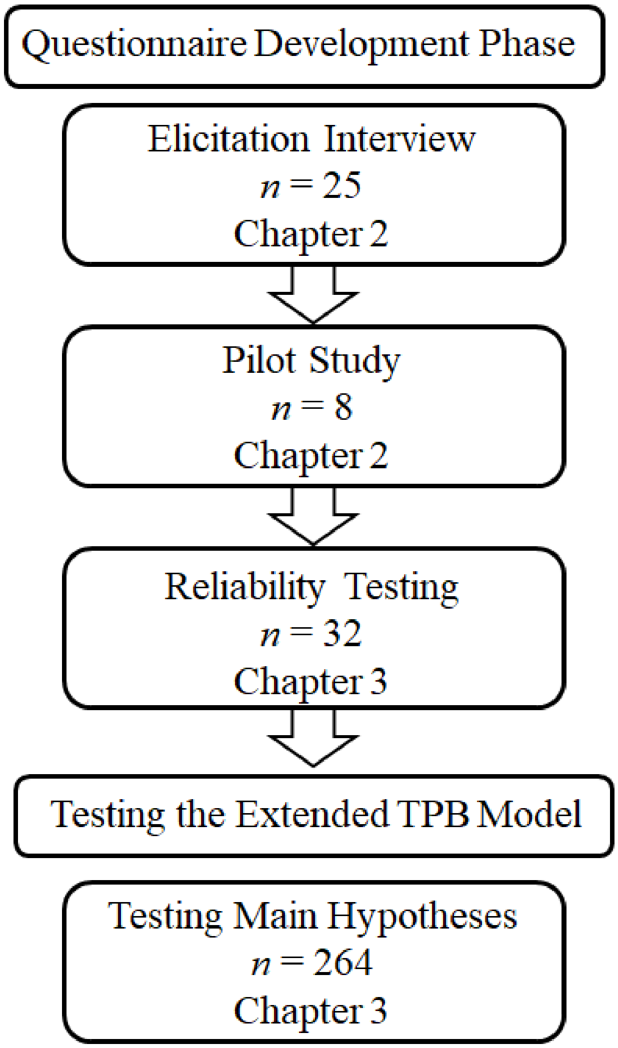
Literature Review

Concussion

Concussion is a mild traumatic brain injury (mTBI) caused by biomechanical forces such as a blow to the head or abrupt acceleration-deceleration forces following a fall or blow to the body (McCrory et al., 2017). Both blows and rapid changes in speed cause the brain to make contact with the inside of the skull or cause rotation of the brain within the skull. In moderate to severe cases the brain sustains axonal injury in the form of bruising, shearing, stretching, or tearing of neurons (Barth et al., 2001; Salerno et al., 2019; Stuss & Gow, 1992; Stuss & Levine, 2002). This damage can trigger a toxic neurometabolic cascade of events including abnormal neurotransmitter release and

Figure 1

Stages of the Current Study



movement of calcium, potassium, and glutamate in and out of cells (Bazarian et al., 2006; Giza & Hovda, 2001; Institute of Medicine and National Research Council, 2014; McCrory et al., 2017). Damage is most often located in the prefrontal cortex and its associated subcortical circuits throughout the brain (Barth et al., 2001; Stuss & Gow, 1992; Stuss & Levine, 2002). Brain changes due to concussion are milder than more traumatic injuries and typically result in temporary impairment of memory, attention, speech, processing speed, and balance, with variable symptom duration; most individuals recover between 10-17 days (McCrory et al., 2017). This type of functional damage is usually not visible by typical neurological imaging (McCrory et al., 2017).

Identification of concussion is imperative for providing timely intervention; however, concussive injury is primarily a subjective experience and, barring loss of consciousness and obvious vestibular symptoms, it is not always behaviourally apparent to observers. Furthermore, symptoms such as headache or dizziness are non-specific to concussion, potentially leading athletes to disregard them as insignificant. As such, diagnosis can be challenging and underreporting is common (Conway et al., 2018; Kroshus et al., 2017; Llewellyn et al., 2014; Meehan et al., 2013; Meier et al., 2015; Register-Mihalik et al., 2017). The importance of accurate identification, however, is crucial. After suffering one concussion, the risk of subsequent brain injury from another blow increases four to six times, indicating a dose-response pattern (Fuller et al., 2007; Guskiewicz et al., 2003; Nordström et al., 2014). This is partly due to short- and long-term changes of brain function such as impaired obstacle avoidance and spatial orientation, and slower processing speed and reaction time (Catena et al., 2009; Guskiewicz et al., 2003; Institute of Medicine and National Research Council, 2014).

Notably, the consequences of returning to play prior to sufficient healing following a concussion can lead to serious neurological impairment or even death (Guskiewicz et al., 2003; Quintana, 2016; Saffary et al., 2012). Possible long-term consequences of early return to play and subsequent re-injury include the potential development of postconcussion syndrome/mild neurocognitive disorder (mNCD; protracted symptom recovery; American Psychiatric Association, 2013), second-impact syndrome (potentially fatal diffuse brain bleeding or swelling following a second blow prior to healing of the first concussion; Cantu, 1998; Guskiewicz et al., 2007), or chronic traumatic encephalopathy (a progressive neurological degenerative disorder affecting physical, mental, and cognitive health, believed to be caused by multiple concussions; McKee et al., 2009, 2015; Saffary et al., 2012). Controversy among healthcare specialists pertaining to these extreme outcomes translates to confusion amongst the public, athletes, and coaches. Although seemingly counterintuitive, this confusion may contribute to athletes and coaches feeling more comfortable not taking potential symptoms seriously after a hit or blow, leading to more instances of symptomatic play. Even if the diagnostic criteria and neuropathology are not universally agreed upon, evidence continues to point toward negative consequences of repeated traumatic brain injury to the degree that evidence-based intervention for athletes is critical for their long-term health. Therefore, recognizing and addressing possible concussion symptoms in university-level athletes is an important area of research.

Current Approach to Concussion Prevention and Management. The overwhelming evidence of significant short- and long-term consequences associated with mTBI have led researchers and policy makers to agree concussion should no longer be considered a low risk, transient phenomenon. Organizations such as the Center for

Disease Control and Illness Prevention (CDC) have made available open access pre-season concussion education initiatives under the reasoning that better educated individuals will engage in safer symptom reporting behaviour and not return to play while symptomatic. However, there is considerable evidence many athletes who understand and recognize the symptoms of concussion and the risks of premature Return to Play (RTP) still continue to play while symptomatic (Conway et al., 2018; Kerr et al., 2014; Kroshus, Garnett, Hawrilenko, et al., 2015; Kroshus et al., 2017; Llewellyn et al., 2014; Meehan et al., 2013; Meier et al., 2015; Register-Mihalik, Guskiewicz, et al., 2013; Register-Mihalik et al., 2017).

Return to Play. Strategies to ensure safer RTP have been formulated in response to increasing health concerns. As per the most recent *Consensus Statement on Concussion in Sports* (McCrory et al., 2017), and in accordance with the American Academy of Neurology and the Canadian Pediatric Society, a graduated, stepwise RTP protocol is recommended to limit physical and cognitive activity during recovery (see Table 1). RTP protocol was designed to facilitate healing and reduce the chances of a repeat brain injury within the first seven days of recovery (Cantu, 1998; Guskiewicz et al., 2003; McCrory et al., 2017), which is considered the window of vulnerability when the likelihood of sustaining a second concussion is increased (Institute of Medicine and National Research Council, 2014). Return to work and school protocols are also available, and involve gradually increasing symptom-free hours spent on cognitive tasks (CanChild, n.d.; Grady et al., 2012; Master et al., 2012; May et al., 2014; McCrory et al., 2017). According to recommended protocol, an athlete with a suspected concussion should be removed from play immediately and under no circumstances RTP the same day. The *Consensus Statement* recommends sideline evaluation completed by a licensed

Table 1

Graduated Return to Play Protocol (McCrory et al., 2017)

Stage	Aim	Activity	Goal
1	Symptom-limited activity	Daily activities that do not provoke symptoms	Gradual reintroduction of work/school activities
2	Light aerobic exercise	Walking or stationary cycling at slow to medium pace. No resistance training	Increase heart rate
3	Sport-specific exercise	Running or skating drills. No head impact activities	Add movement
4	Non-contact training drills	Harder training drills. Start progressive resistance training	Exercise, coordination and increased thinking
5	Full contact practice	Participate in normal training activities (following medical clearance)	Restore confidence, coach to assess functional skills
6	Return to sport	Normal game play	

health care professional at the time of injury and an initial rest period of 24-48 hours before beginning a stepwise RTP process (McCrory et al., 2017; Purcell et al., 2014). During this period, physical rest from exercise and sport participation, mental rest from electronics and screens, and initial restrictions on returning to work or school are recommended. Six stages of rehabilitation are highlighted in Table 1, with progression to the next step advisable only if the athlete is asymptomatic at the current level for at least 24 hours. Accordingly, it should take at least one full week to progress through all stages before an athlete is cleared to RTP.

An important caveat for *Consensus Statement* guidelines on RTP protocol is that they were derived by expert consensus, not from consistent empirical findings (Buckley et al., 2016; McCrory et al., 2017; Moor et al., 2015; Silverberg & Iverson, 2013). Some studies are beginning to suggest aspects of RTP protocol may not be best practice for recovery. For example, the reason for an initial rest period is based on the duration of time required for neurometabolic brain changes to normalize in animal concussion models (Crane et al., 2012; Giza & Hovda, 2001; Griesbach, 2011; Griesbach et al., 2004). Accordingly, it was initially suggested physical and cognitive activity interferes with resources allocated to recovery during this cerebral 'energy crisis'. This led to cocoon therapy recommendations (e.g., see Lee & Fine, 2010) – isolating individuals in quiet, dark rooms for days. Some now suggest this may cause more harm than benefit: there is evidence extended bedrest can lead to protracted symptom duration similar to postconcussion syndrome/mNCD even in healthy individuals (Silverberg & Iverson, 2013), and distress due to social isolation, missed school, and disengagement with regular activities has been linked with 'situational depression', anxiety, and other mNCD symptoms (Craton & Leslie, 2014; Thomas et al., 2015). In addition, resting more than two days has recently been found to be associated with delayed return to work or school among adults suffering non-sports related concussions (Silverberg & Otamendi, 2019). Other researchers claim the significant negative medicalization of concussion causes catastrophic misinterpretations, leading to symptom hypervigilance and higher endorsed mNCD symptoms (Craton & Leslie, 2014). Furthermore, there are findings that athletes who adhere to initial physical and cognitive rest periods experience recovery rates equivalent to athletes who do not (Buckley et al., 2016). Some researchers also point to evidence that athletes who return to their normal routine as soon as possible recover faster than those who adhere to strict RTP protocol (Moor et al., 2015; Silverberg & Iverson, 2013).

There is even less agreement on operationalizing the amount of appropriate activity at each level of recovery. Majerske and colleagues' (2008) findings suggest 'moderate' activity is ideal, but too much or too little can lead to negative outcomes. Further scientific evidence is necessary to quantify a safe and effective rest period, while prospective research is needed to ensure individuals who do not follow current recommended protocol and appear to recover at the same rate as RTP adherent athletes do not suffer unanticipated long-term consequences. The waters are muddied around exactly what "safe RTP" means and this likely contributes to confusion about, and non-adherence to, RTP protocol. Overall, although the details may not be clearly delineated, most agree upon the necessity of a gradual RTP, the importance of no same day RTP, and the necessity of preventing a second concussion during the initial healing period.

Concussion Education Initiatives. Several online concussion-education programs have been developed to increase awareness of symptoms, health consequences, and RTP protocol in athletes, coaches, and parents. Programs such as those developed by the Canadian injury prevention organization *Parachute* (formerly *ThinkFirst*) and the CDC's *Heads Up: Concussion in youth sports*, are generally considered effective in increasing recognition of concussion signs and symptoms (Covassin et al., 2012; Echlin et al., 2010; Feiss et al., 2020; Macartney et al., 2019; Sarmiento et al., 2010). Concussion education programs range from interactive oral presentations and educational video/computer-based programs to emails and written handouts, and most often include a symptom list, concussion management strategies, RTP protocol, and information about the long-term impact of concussion on the brain (Caron et al., 2015; Kroshus, Daneshvar, et al., 2014). Research on knowledge transfer suggesting target audiences benefit most from individualized learning strategies (e.g., online modules work better for coaches and trainers than for student-athletes; Provvidenza et al., 2013; Provvidenza & Johnston, 2009) indicates a one-size-fits-all dissemination approach may not effectively lead to higher reporting rates.

The result of concussion-education initiatives on symptom reporting appears to be mixed. For example, education initiatives seem to be relatively useful in terms of increasing knowledge and understanding about appropriate safety protocols over the short-term (Conaghan et al., 2020; Miyashita et al., 2013); however, some studies demonstrate athletes still do not fully understand the signs and seriousness of concussion (Kirk et al., 2018; Knollman-Porter Kelly et al., 2018; Kroshus, Daneshvar, et al., 2014; McAllister-Deitrick et al., 2014). For example, university-level athletes were less successful at identifying infrequent and more ambiguous symptoms of concussion such as memory impairment or nausea (Register-Mihalik, Guskiewicz, et al., 2013). This ambiguity of symptoms may lead athletes to disregard concussion signs and symptoms after an injury (Chrisman et al., 2013). In addition, colloquial terminology such as getting ‘dinged’ or having one’s ‘bell rung’ may further decrease the perceived severity of concussion, especially since athletes typically report more incidence of getting ‘dinged’ than of sustaining a concussion (Valovich McLeod et al., 2008). As a result, it is clear all athletes are not fully benefitting from educational initiatives.

Symptom Reporting and RTP Protocol Adherence. Straightforward guidelines indicating when it is safe to resume play are useful only to the extent that athletes adhere to them and being relatively knowledgeable about symptoms and RTP protocol does not necessarily translate to safe behaviour. Barring obvious signs such as loss of consciousness, confusion, or vestibular dysfunction, coaches and athletic trainers may be unaware an athlete is experiencing subtle symptoms of concussion, which means it is the responsibility of the athlete to report subjective symptoms. Unfortunately, studies investigating symptom reporting and RTP protocol adherence in knowledgeable athletes have mixed outcomes. Although some studies have found education leads to better adherence and volitional symptom reporting (Baker et al., 2013; Bloodgood et al., 2013; Bramley et al., 2012; Cook et al., 2003; Kroshus et al., 2016; Miyashita et al., 2013; Register-Mihalik, Guskiewicz, et al., 2013), there is evidence the incidence rate of concussion may be significantly underreported, and knowledgeable high school and collegiate athletes continue to participate in practices and games while symptomatic (Broglio et al., 2010; Conway et al., 2018; Kerr et al., 2014; Kroshus et al., 2020; Kroshus, Garnett, et al., 2015; Lininger et al., 2017; Wayment et al., 2019; Williamson & Goodman, 2006). Of further concern, some athletes report they would knowingly conceal symptoms to avoid removal from play (Kroshus, Baugh, et al., 2014; Kroshus et al., 2020; Kurowski et al., 2014; McAllister-Deitrick et al., 2014). In a review of 16 studies on concussion disclosure, Kerr et al. (2014) found up to 86% of athletes did not report symptoms in pre-game screening, and 25-43% of athletes admitted to continued play while knowingly concussed.

Motivation Associated with Non-Disclosure. Serious short- and long-term consequences are not the most important considerations for many athletes when faced with symptom reporting decisions. Reasons for non-reporting and RTP non-adherence include not wanting to miss a game or lose playing time, not considering symptoms serious, not thinking symptoms were due to concussion, and not wanting to let teammates or coaches down (Beidler et al., 2018; Conway et al., 2018; Kroshus et al., 2020; McAllister-Deitrick et al., 2020). Other reporting barriers include athletes thinking they can 'tough it out', worry about not being able to RTP whey they feel ready, the nonspecific nature of some symptoms (e.g., distinguishing between flu symptoms and concussion), perceived consequences such as having to sit out indefinitely, and coach approachability (Chrisman et al., 2013; Conway et al., 2018; Kroshus, Baugh, et al., 2014). Certain aspects of the 'culture of sport' have also been identified as contributing to non-reporting, such as the mentality of pushing through the injury and playing regardless of consequences, feeling they are expected to play through symptoms, respecting other athletes who receive hard hits and keep playing, and the threat that reporting in general will lead to increased safety measures lowering the excitement of the game (Kneavel et al., 2019). Furthermore, there is some evidence that a greater degree of 'Athletic Identity' (i.e., the extent to which a person identifies with the goals, values, and beliefs of prototypical athletes; Brewer et al., 1993), may also contribute to non-reporting when players believe concealing symptoms is congruent with the 'athlete role' (Kroshus, Kubzansky, et al., 2015; Wayment et al., 2019).

Health Behaviour Change Theories

It has been established that knowledge alone does not necessarily lead to change across many health-related behaviours (Ajzen et al., 2011; Griffin et al., 2015; McCaul et al., 1987; Thanavanh et al., 2013). One reason for this may be that items on knowledge questionnaires do not typically target behaviour or behaviour change (Ajzen et al., 2011). In addition, some health behaviour change models posit intention and behaviour are determined less by what one knows and more by the beliefs one holds about the information they know, regardless of its accuracy (Ajzen, 2001; Ajzen et al., 2011; Armitage & Conner, 2001; Baban & Craciun, 2007). For this reason, a focus on disseminating educational information as the only method of concussion management is an inefficient strategy, and it is time to consider how behavioural change models may better inform safe concussion management.

There is evidence that intervention based on an extensive theoretical approach to behaviour change tends to produce increased effect sizes for health behaviours in general (Webb et al., 2010; Webb & Sheeran, 2006). Despite this, much sports injury and prevention research does not utilize a theoretical model or framework to explain unsafe behaviours or when developing injury prevention programs (Gielen & Sleet, 2003; McGlashan & Finch, 2010). This is problematic on many levels and may partially explain the mixed findings in the RTP education literature. Without basing a program or intervention on theory, the chances of success and, more specifically, elucidating which variables are responsible for meaningful change, are significantly decreased (Gielen & Sleet, 2003; McGlashan & Finch, 2010; Michie & Abraham, 2004).

Health behaviour change theories identify proximal determinants of behaviour and are most commonly used for intervention design and program evaluation (Trifiletti et al., 2005). Accordingly, useful theories must be systematic, explain as well as predict behaviour, and provide some understanding of how and why people make health-based decisions (Glanz et al., 2008; National Cancer Institute, 1995). In doing so, behavioural change theories lead to effective intervention by providing a framework in which theoretical constructs or mechanisms determining risky behaviours and underlying change processes can be identified (Fishbein & Cappella, 2006; Gielen & Sleet, 2003; Webb et al., 2010). In the context of concussion symptom reporting, health behaviour change models are generally categorized as multi-stage models, behavioural enactment models, and motivational models (Armitage & Conner, 2000; Baban & Craciun, 2007).

Multi-stage models assume behaviour change occurs in steps across several distinct cognitive and decisional stages in a pre-determined order. (Armitage & Conner, 2001; Baban & Craciun, 2007; Noar & Zimmerman, 2005). An example is Prochaska and DiClemente's (1983) Transtheoretical Model (or Stages of Change Model), in which behaviour change occurs by progressing through five stages of change: precontemplation, contemplation, preparation, action, and maintenance. Multi-stage models are thus most relevant to continuous behaviours such as dieting or exercise rather than intermittent behaviours such as concussion reporting (Prochaska & Velicer, 1997). *Behavioural enactment models,* on the other hand, serve to augment other models by explaining the link between intention and behaviour (Armitage & Conner, 2001; Baban & Craciun, 2007). That is, they focus on identifying factors that increase the likelihood of the target behaviour by translating motivation into actual performance of the behaviour. For example, forming Implementation Intentions, or 'if/then' plans, strengthen one's commitment to and ease of following through on previously made intentions (Gollwitzer & Sheeran, 2006). *Motivational models* represent a more focused approach in that intention is examined as the most proximal predictor of behaviour. As such, motivational models are useful in predicting individual behaviours at specific points in time. That is, they are designed to identify the determinants of health-related intentions in order to predict the likelihood of specific future behaviours (Armitage & Conner, 2001), such as symptom reporting.

While both multi-stage and behavioural enactment models are likely valuable avenues of research in relation to better understanding aspects of concussion reporting, the focus of the present study was on extending our knowledge of predictors of intention to report. More specifically, this research focused on the Theory of Planned Behaviour (TPB; Ajzen, 1991; Ajzen et al., 1980; Fishbein & Ajzen, 1977), a motivational model that is among the most commonly used theoretical frameworks for designing health behaviour change interventions (Webb & Sheeran, 2006). The TPB has also recently been increasingly used to explain concussion symptom reporting (Beakey et al., 2016; Carpenter et al., 2020; Chrisman et al., 2013; Kroshus, Baugh, et al., 2014; Kroshus, Baugh, Daneshvar, Nowinski, et al., 2015; Lininger, Wayment, Craig, et al., 2019; Milroy et al., 2020; Rawlins et al., 2020; Register-Mihalik, Guskiewicz, et al., 2013; Register-Mihalik et al., 2020; Warmath & Winterstein, 2019).

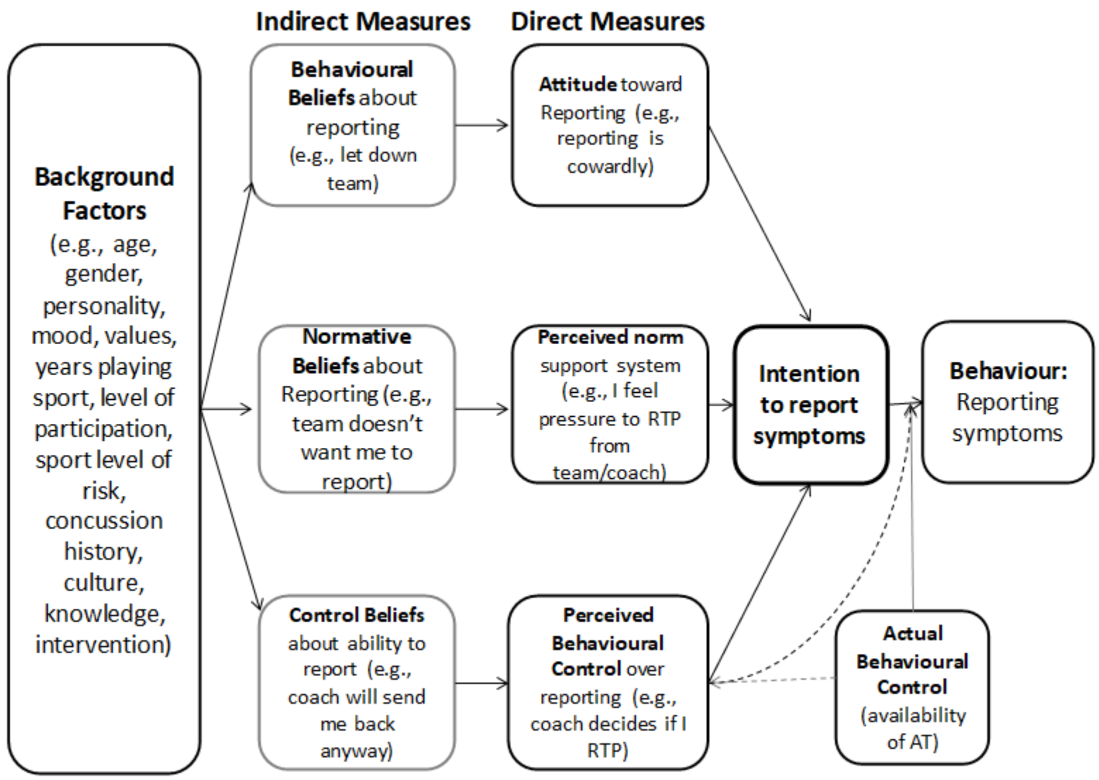
The Theory of Planned Behaviour

Compared to other health behaviour models, the TPB fits most closely with concussion symptom reporting intention and shows promise as a more comprehensive and representative theoretical framework for explaining reporting as an unpredictable and discrete behaviour that may occur sometime in the future. Several aspects of the TPB lend themselves well to predicting and explaining concussion symptom reporting intention. As noted, motivational models based on the premise that intention is a proximal measure of behaviour are relatively good at predicting behaviour at a single point in time (Armitage & Conner, 2001). Unlike habitual behaviours such as cigarette smoking or continuous behaviours such as healthy eating, concussion occurs infrequently, and although the sequence of events required for reporting should assuredly be considered ahead of time (e.g., pre-season), adhering to reporting policies is very much an ‘in the moment’ decision. As such, it is likely influenced by the heightened emotionality inherent in competitive sports (Kroshus & Chrisman, 2019; Martinent et al., 2012), and by ‘culture of sport’ factors such as not wanting to let the team down or desire to continue playing in an important game (Broglio et al., 2010; Chrisman et al., 2013; Corman et al., 2019; McCrea et al., 2004). At this critical time point, the intention to report (and actually reporting) is influenced by multiple constructs that can be accounted for within the TPB, such as the athlete’s attitude toward reporting, whether they believe other athletes would report, and how much personal control they feel over reporting. Furthermore, the TPB accounts for social pressures in forming and executing intentions, which is an important consideration when the target behaviour (i.e., reporting) impacts multiple people (i.e., teammates). Moving forward, the TPB is used in the current study as the guiding theoretical framework to explain symptom reporting intention among university athletes.

The TPB is an extension of the Theory of Reasoned Action (TRA; Ajzen et al., 1980; Fishbein & Ajzen, 1977), and posits the best predictor of human behaviour is one’s intention to perform that behaviour (Ajzen, 1985; Kroshus, Baugh, Daneshvar, Nowinski, et al., 2015; Webb & Sheeran, 2006). Therefore, the model describes predictors of intention rather than predictors of the actual behaviour (see Figure 2 for a diagram of the model and its application to concussion reporting). Each measure of the

Figure 2

The Theory of Planned Behaviour for Concussion Reporting



Note. Modification of the original TPB model for the context of concussion reporting (©Icek Ajzen 2019 reproduced with permission; Ajzen, n.d.).

model will be further described below. The TRA and TPB are models based on Expectancy Value Theory, which is used to explain many health-related behaviours by examining psychological antecedents of the behaviour (Ajzen, 1985, 1991; Fishbein & Ajzen, 1977). According to Fishbein and Ajzen's conceptualization of Expectancy Value Theory, people form attitudes based on beliefs and values. More specifically, attitudes are a function of weighted beliefs, or how much one holds a belief based on positive and negative evaluations of a behaviour. The evaluation is 'weighted' much like a cost-benefit analysis, in that disadvantages are subtracted from advantages, resulting in an overall belief people use to make decisions about engaging in the behaviour.

Efficacy of the TPB with Health Behaviour. There is evidence for the TPB's utility in predicting and explaining a wide range of health behaviour (Armitage & Conner, 2001; Godin et al., 1992; Madden et al., 1992; McEachan et al., 2011; Sheeran et al., 2016; Steinmetz et al., 2016). The TPB has previously been validated with exercise (Courneya, 1995), healthy eating (Armitage & Conner, 1999), and medical self-exam behaviours (Norman & Hoyle, 2004). More recently it has been used to predict diverse health behaviours such as exercising during pregnancy (Zhu et al., 2020), alcohol consumption (Cooke et al., 2016), oral hygiene (Patel et al., 2019), smartphone use while driving (Murphy et al., 2020), longitudinal physical activity in adolescents (Raudsepp et al., 2010), and even self-care practices in psychologists (Wong & White, 2021). As noted, there has been a growing interest in using the TPB framework to explain why athletes do not report concussion symptoms (Beakey et al., 2016; Carpenter et al., 2020; Chrisman et al., 2013; Kroshus, Baugh, et al., 2014; Kroshus, Baugh, Daneshvar, Nowinski, et al., 2015; Lininger, Wayment, Craig, et al., 2019; Milroy et al., 2020; Rawlins et al., 2020; Register-Mihalik, Guskiewicz, et al., 2013; Register-Mihalik et al., 2020; Warmath & Winterstein, 2019).

Behaviour change interventions based on the TPB are also useful in providing meaningful information about process and outcome variables, which are important considerations for effective intervention development (Webb & Sheeran, 2006). Furthermore, the TPB is supported in explaining and predicting behaviours similar to concussion (i.e., those with smaller short-term gains but potentially significant long-term consequences), such as sun safety and sunscreen use (Hillhouse et al., 2000; Jones et al., 2001; White et al., 2008, 2019). Much like concussion, people have a good understanding of the dangers associated with sunburn and the importance of using sunscreen, yet many still engage in tanning without using sun protection (Basch et al., 2017; Yilmaz et al., 2015).

Intention. Although correlational studies have traditionally found a large effect size in the ability of intention to predict behaviour (Sheeran, 2002), more recent experimental investigations find medium to large changes in intention lead to small to medium changes in the enactment of target behaviour (Rhodes & Dickau, 2012; Sheeran & Webb, 2016; Webb & Sheeran, 2006).Variability in the association between intention and behaviour may partly depend on the behaviour in question and the population in which it is measured (Ajzen & Kruglanski, 2019). This is because the beliefs relevant to one behaviour (e.g., recycling) are likely different from the beliefs relevant to other behaviours (e.g., concussion reporting). Similarly, there are differences between health behaviours (e.g., sun protection) found among adults and adolescents (Dobbinson et al., 2008). The association between intention and behaviour will also vary based on the time frame between intention formation and behavioural enactment. This is largely because interim events may change one's behavioural, normative, or control beliefs, and an element of self-regulation may be needed for this relationship to remain strong (Ajzen, 2011). Even so, several meta-analyses demonstrate interventions aimed at increasing intention lead to increases in behavioural enactment; therefore, regardless of effect size, intention is an important predictor of behaviour (Baban & Craciun, 2007; Godin & Kok, 1996; McEachan et al., 2016; Topa & Moriano, 2010; Webb & Sheeran, 2006).

As noted above, the TPB is an extension of the TRA (Ajzen et al., 1980; Fishbein & Ajzen, 1977), which bases intention to perform a target behaviour on one's beliefs about and attitude toward the behaviour in combination with the degree to which one believes significant others expect them to perform the behaviour. The TRA is a predictive model of behavioural intent when the behaviour is under volitional control. Thus, when an individual has complete control over a behaviour, intention is very good at predicting actual enactment of the behaviour. On the other hand, when behaviour is not under complete volitional control and failure is a possibility, intention does not predict the actual enactment of the behaviour as reliably. As is often the case, however, many behaviours may be only partly volitional. Ajzen (1985) uses the example of losing weight, noting intention alone may not be enough to predict behaviours partly influenced by other factors such as genetics and physiology. For these reasons, Ajzen (1985) proposed the addition of Perceived Behavioural Control as an extension of the TRA (and thus the formation of the TPB) to increase the predictive ability of the model in accounting for behaviours not completely under volitional control. In essence, Perceived Behavioural Control represents the degree of control one *feels* they have over actually performing the behaviour (Ajzen, 1991). Going forward, the focus of the current study will be primarily on the TPB.

Direct and Indirect Factors Influencing Intention. In the TPB model, intention is directly influenced by three factors: Attitudes, Subjective Norms, and Perceived Behavioural Control. Each of these factors, which are called "Direct Measures" in this model, is influenced by associated beliefs, which are called "Indirect Measures". As illustrated in Figure 2, Attitudes about concussion symptom reporting are influenced by behavioural beliefs about the consequences of reporting, Subjective Norms are influenced by normative beliefs about what important others would do or would want the athlete to do, and Perceived Behavioural Control is influenced by control beliefs about factors or circumstances that make it easy or difficult to report a concussion.

It is important to note that the Indirect Measures do not 'make up' the Direct Measures as the figure may suggest. Rather, Ajzen (n.d., 2020) describes the Indirect Measures as representing the beliefs that lead to the overall attitudes, pressures, and perceived control individuals have in relation to a behaviour, and the Direct Measures as the 'reflective indicators' of these beliefs. He further states that the correlations between the belief composite (Indirect Measures) and its corresponding Direct Measure indicate whether the Direct Measure adequately represents the identified beliefs (Ajzen, n.d., 2020). Although only the Direct Measures are included in the statistical analysis of the model, the Indirect Measures are important considerations in improving the efficacy of interventions by determining important athlete beliefs about reporting and identifying the beliefs that discriminate athletes with higher intention to report from athletes with lower intention to report. These discriminating beliefs can then be targeted to strengthen education and intervention initiatives (Ajzen, n.d., 2020). Overall, the more favorable the Attitude and Subjective Norms regarding the behaviour, and the greater the

Perceived Behavioural Control, the stronger the behavioural intention will be. Personality, demographic characteristics, or environmental context have typically been difficult to reliably link with health behaviours (Ajzen & Manstead, 2007) and have been conceptualized as background factors in the model. Background factors influence behaviour only indirectly *if* they affect the behavioural, normative, and/or control beliefs.

According to Ajzen (1985, 1991), understanding people's beliefs allows us to better explain their behaviour and develop more effective strategies to implement behavioural change. That is, by identifying the beliefs upon which certain attitudes are based, we better understand why the individual ascribes to those attitudes, and this can be used to more effectively change them. For example, if we understand an athlete's negative attitude toward reporting is based on the belief that it would be best for the team if they stay in the game, then we are better equipped to target that belief and change the attitude as appropriate. Ajzen (1991) states beliefs are the level at which people differ in the intention to engage in a behaviour, and it is at the belief level that unique individual factors can be teased apart to better understand behavioural intention.

Attitude toward the Behaviour. Within the TPB, attitude toward a behaviour is conceptualized as the overall favorable or unfavorable assessment of the behaviour, and is further understood in terms of evaluative opposites, such as good and bad (Ajzen, 1991). One has a more favorable attitude if the behaviour leads to a positive outcome. Attitude toward a behaviour is differentiated from attitude toward an object (Ajzen, 1991). For example, a better predictor of adherence to safe RTP protocol would be to assess attitude toward reporting symptoms (the behaviour) rather than attitude toward concussion in general (the object). Accordingly, athletes might engage in dangerous

RTP behaviour despite having a positive attitude toward concussion safety, if negative attitudes toward reporting outweigh positive safety attitudes. Focusing on convincing athletes of the dangers of concussion without addressing attitudes about symptom reporting may partly explain why current educational initiatives are not always successful at preventing premature RTP.

The Indirect Attitude Measure is comprised of *behavioural beliefs*. These beliefs about positive or negative consequences of the behaviour influence, or weight, the attitude toward that behaviour as either favorable or unfavorable (Ajzen, 1991; Francis et al., 2004). Specifically, attitudes are determined by underlying *salient* beliefs. One can possess many general beliefs about a behaviour, but only some of these will be significantly relevant at any one time. For this reason, when using the TPB for research purposes it is imperative to conduct elicitation interviews with a sample of the population of interest to determine which beliefs are most salient for this particular group regarding the specific behavior (Ajzen, 1991; Francis et al., 2004). Salient beliefs associated with concussion might include losing play, letting teammates down, or missing out on games and activities (Register-Mihalik, Linnan, et al., 2013).

Subjective Norms Influencing the Behaviour. Simply put, Subjective Norms are the pressures an individual perceives from social referents (i.e., significant others in their life) to perform or not perform a behaviour (Ajzen, 1991). The Direct Subjective Norms are assessed generally in items such as "People who are important to me approve of me reporting". Subjective Norms are influenced by *normative beliefs* comprising the Indirect Subjective Norm Measure. These beliefs include perceptions about whether specific social referents such as coaches, teammates, parents, etc., would want the athlete to perform the behaviour (i.e., report symptoms). These are further weighted by the degree to which the individual is motivated to comply with the wishes of each social referent. For example, if an athlete does not value someone's opinion, whether that person wants them to report would not significantly contribute to the athlete's reporting decision. Also taken into account is whether relevant social referents (in this case, other athletes) would perform the behaviour themselves. Together, the perceptions of pressure, desire to comply, and degree to which they think others would behave similarly, influence the overall decision about engaging in the target behaviour.

In much of the TPB literature, Direct and Indirect Subjective Norms tend to play a smaller role influencing and predicting health behaviours (Armitage & Conner, 2001). However, due to the culture of competitive team sports, some athletes make assumptions about what is expected of them based on implicit impressions of their coach's attitude toward reporting (Baugh et al., 2014; Chrisman et al., 2013; Kroshus, Baugh, et al., 2014). Similarly, some athletes hold positive beliefs about playing through pain and injury based on what they believe is expected of them by coaches and other athletes (Broglio et al., 2010; Chrisman et al., 2013; Kroshus, Kubzansky, et al., 2015; McCrea et al., 2004; Sye et al., 2006). Social pressure also manifests in terms of athletes not wanting to let the team down, especially in case their symptoms are not actually due to concussion (e.g., Chrisman et al., 2013). Because of the increased social pressure inherent in the culture of sport, Subjective Norms may play an important part in forming and executing intentions to report symptoms.

Perceived Behavioral Control. As noted, the addition of Perceived Behavioural Control extends the TRA and defines the TPB (Ajzen, 1985). The concept of Perceived Behavioural Control takes into account internal self-efficacy (Bandura, 1982) and external (actual) control. Degree of perceived control over a behaviour is based on *control beliefs* comprising the Indirect Perceived Behavioural Control measure. These determine how easy or difficult the behaviour is for the individual to perform, as well as whether they are confident they can actually do it (i.e., whether factors beyond their control determine their behaviour). The more resources or opportunities an individual believes they possess, the greater their perceived control over a behaviour (Ajzen, 1991). For example, having an athletic trainer or health care professional on the sidelines may increase an athlete's perception of control over reporting symptoms. Alternatively, it may decrease their sense of control if the athletic trainer or health care professional pulls the player out of the game against their will.

Ajzen differentiates Perceived Behavioural Control from Rotter's (1966) conceptualization of locus of control, which is a stable, more general belief that individuals have control over events in their lives. Direct and Indirect Perceived Behavioural Control varies across situations and relates to one's perception of the ease or difficulty of performing a *specific* behaviour (Ajzen, 1991). The Indirect control beliefs include consideration of both internal and external resources, opportunities, obstacles, and/or barriers faced by the individual, and reflect past experiences. For example, athletes may find it easier or more difficult to report depending on the coach's reaction to past reporting. Ajzen (1991) notes one's perception of control also includes consideration of vicarious experiences of close others. If another athlete reported symptoms and the coach did not take them seriously, teammates may not feel they have much control over reporting to that coach. Alternatively, athletes may feel pressure from social referents such as coaches or parents *to* report, making the decision easier and increasing one's sense of general (Direct) Perceived Behavioural Control. Confidence to report in challenging situations, such as when they wish to continue playing or when they are not entirely certain symptoms are indicative of concussion, is another consideration with which athletes are faced (Kroshus, Baugh, et al., 2014).

In the TPB model (see Figure 2; Madden et al., 1992), Perceived Behavioural Control can predict behaviour via both a direct and indirect pathway[1]. Indirectly, Perceived Behavioural Control acts as a predictor of intention like Attitude and Subjective Norms and is associated with motivational factors. For instance, if an individual believes they have few resources to carry out a behaviour, their intention to act may be low even if they have favorable Attitudes and Subjective Norms. Perceived Behavioural Control may also act directly, over and above intention, as an estimate of actual control. The direct path is a significant contributor when the individual perceives they have less control over the behaviour and when their perceptions of control are accurate and realistic. That is, the direct link from Perceived Behavioural Control to behaviour is less important when the individual has a great deal of control over the behaviour because when actual control is relatively high, the addition of Perceived Behavioural Control is expected to have less predictive validity. In this case, intention alone should be enough to predict the behaviour. Furthermore, for the joint function of Perceived Behavioural Control and intention to act as predictors of behaviour, three conditions must be met: 1) Perceived Behavioural Control and intention must correspond to and be compatible with the behaviour of interest (i.e., the specific context of when/where the behaviour will occur), 2) Perceived Behavioural Control and intention must be unchanged between the time they are assessed and when the behaviour is actually performed (i.e., nothing occurs in this interval to change the intention or

[1] This is different from the Direct and Indirect Measure terminology used to describe TPB variables and refers to a direct or indirect influence on Intention.

feelings of control), and 3) Perceived Behavioural Control must be accurate and realistically reflect actual control. Whether the direct or indirect pathway in the TPB model is more or less significant will be dependent on the situation and the target behaviour (Ajzen, 1991). Research supports the predictive validity of the Perceived Behavioural Control constructs over and above Attitude and Subjective Norm alone (i.e., the TRA; Armitage & Conner, 2001; Madden et al., 1992), giving credence to the TPB model.

Efficacy of the TPB in Concussion Literature

To accurately determine the efficacy of the TPB in predicting behaviour, best practice is to use the questionnaire format and development method outlined by Ajzen (2006), Francis and colleagues (2004), and Godin and Kok (1996). Ajzen's method involves first conducting an elicitation interview to accurately capture the target population's salient beliefs. Without this step, the Indirect Measures are a function of researcher assumptions rather than representative of athlete's actual beliefs underlying intention to report. From these responses a questionnaire is developed. Next, a small number of individuals from the target population completes the questionnaire and provides feedback on item clarity, etc. Finally, the questionnaire is administered to a separate group of individuals and the entire measure undergoes reliability testing. To utilize the full potential of the TPB to understand and intervene in unsafe RTP behaviour, it is imperative research methodology follow the guidelines set forth by Ajzen (2006). These are further described in the methods section of this document.

In general, few sports injury studies apply the systematic development of measures when using theoretical frameworks to describe behaviour (McGlashan & Finch, 2010). Even the vast majority of TPB concussion reporting studies do not use

Ajzen's questionnaire development process to accurately capture the Direct and Indirect variables of the theory (McGlashan & Finch, 2010). For example, some studies use Rosenbaum and Arnett's Concussion Attitude Index (2010) to represent various Attitude and Intention constructs, or examine Perceived Behavioural Control using researcher-generated questions or a general measure of self-efficacy (e.g., Carpenter et al., 2020; Kroshus, Baugh, et al., 2014; Kroshus, Garnett, et al., 2015; Rawlins et al., 2020). More recent studies on university-level athletes utilized a questionnaire developed by Kroshus and colleagues' (2014) which did not follow standardized TPB survey development, one developed by Register-Mihalik and colleagues' (2013) in which standardized survey protocol was followed, but the content of which came from a high school cohort, or a combination of the two questionnaires (Beakey et al., 2016; Kneavel et al., 2020; Kneavel et al., 2020; Rawlins et al., 2020; Register-Mihalik et al., 2020). While these methodologies are useful in general, the findings are either not based on the comprehensive TPB model or use measures designed for a separate target population. Thus, accurate statements about the value of the theory for predicting reporting intention and behaviour among university-level athletes cannot be appropriately made. Furthermore, researchers and policy makers risk making misinformed intervention decisions based on attitudes and beliefs identified in these studies if athlete elicitation has not been sought. One of the reasons targeted elicitation is key is because the Indirect Measure beliefs are used to discriminate intenders from non-intenders, providing rich content for development of more effective interventions.

Within the context of these methodological limitations, existing research provides some initial empirical support for the utility of TPB constructs in helping explain aspects of intention and reporting behaviours among university-level athletes.

Kroshus and colleagues (2014), for example, found Attitudes, Subjective Norms, and Perceived Behavioural Control were significantly associated with intention to report in university level athletes. Their model explained only 22.2% of the variance in intention, however, indicating TPB-based constructs may not be comprehensive enough to fully account for reporting behaviour on their own. More recent research highlights the importance of perceived control in reporting, suggesting that building reporting mastery (i.e., knowing when and how to do it) may be an important consideration in strengthening one's intention to report. Specifically, an investigation by Warmath and Winterstein (2019) using a newly developed Reporting Skill Scale found that understanding which actions to take when reporting was more important than concussion knowledge in intention formation. Further support for the role of self-efficacy (i.e., perceived control), was found by Lininger and colleagues (2019) using mixed modeling to evaluate components of the TPB. These researchers found a lack of self-efficacy as well as negative reporting attitudes were the most important considerations in concussion reporting intention. Notably, Rawlins and colleagues (2020) observed an increase of 140% in symptom reporting behaviour as self-efficacy increased.

At this time, only one study has directly tested the validity of the TPB for predicting reporting intention using Ajzen's questionnaire development method, that is, conducting elicitation interviews, a pilot study, and reliability testing of the measure. In this research by Register-Mihalik and colleagues (2013), the TPB model significantly explained 58% of the variance in intention to report symptoms among high school athletes. All three Direct Measures were associated with intention to report. They found a positive association between intention to report and favourable behavioural beliefs and normative beliefs but no association between Perceived Behavioural Control and intention. The authors concluded the athletes in their sample felt they had a good deal of volitional control over reporting symptoms to their coach or athletic trainer. Although athletes who reported increased intention also reported being less likely to play while experiencing symptoms, the study did not find a significant association between intention to report and actual reporting based on recalled (i.e., past) concussion/bell ringer events. They note, "[this] lack of association… may indicate failure in the theory to fully encompass the complexities and environment concerning concussion reporting behaviours" (p. 884), suggesting other factors may be more salient in the 'heat of the moment'.

A criticism of the efficacy of the TPB is that many of the links between intention and behaviour are found using correlational data relying on cross-sectional samples (Webb & Sheeran, 2006). In the concussion literature, however, one study examined reporting behaviour prospectively. Although they did not assess the Direct and Indirect Measures influencing intention, Kroshus and colleagues (2015) conducted a longitudinal assessment of concussion education and preseason symptom reporting intention with actual reporting behaviour across the season. They found intention to report significantly predicted in-season reporting behaviour, whereas preseason concussion knowledge and education did not. This is in line with findings that education does not always lead to symptom reporting, and further bolsters the argument that the TPB is a relevant and significant framework to begin seriously addressing the gap between being knowledgeable and reporting symptoms.

Another criticism of the TPB is, as previously noted, that medium to large changes in intention have generally been found to result only in small to medium changes in enactment of health behaviours (Rhodes & Dickau, 2012; Sheeran & Webb, 2016; Webb & Sheeran, 2006). Furthermore, some concussion reporting research has found TPB variables are only able to explain lower variance in intention to report (Kroshus, Baugh, et al., 2014). While this may indicate a weakness of the TPB in relation to symptom reporting intention, the TPB constructs may be an important starting point from which to explore adding other relevant variables that could, in combination, be more robust in helping understand this complex behaviour.

Overall, the TPB appears to be a useful model to improve concussion management by helping identify the constructs most influencing intention to report. Measuring and addressing athletes' attitudes toward reporting rather than how they feel about concussion in general may lead to effective modification of current education programs and approaches to safer play. Determining the sources of social pressure and the perceived expectations that athletes play through injuries may help facilitate a more open dialogue wherein players receive clear and explicit expectations about reporting. Promoting awareness among salient social referents (e.g., parents, coaches) and encouraging them to reward reporting behaviour, for example, may also increase symptom reporting (Kroshus & Chrisman, 2019; Register-Mihalik, Linnan, et al., 2013). Addressing control barriers to reporting symptoms even when athletes want to continue playing (e.g., in an important game, to avoid losing their spot on the team) may increase athlete confidence in feeling able to report if they suspect they have sustained a concussion.

Changing the focus of concussion education and intervention to target the beliefs behind Attitude, Subjective Norm, and Perceived Behavioural Control constructs increases intention to report as well as reporting behaviour, and ultimately results in safer play (Kroshus, Baugh, Daneshvar, Nowinski, et al., 2015). Unfortunately, concussion research to this point has not examined which TPB beliefs are more impactful in differentiating higher from lower intention to report, a missing step that could help inform more efficacious intervention planning. Additionally, the TPB model alone has accounted for 58% of the variance in concussion reporting behaviour in a study on high school athletes (Register-Mihalik, Linnan, et al., 2013), suggesting examination of the model in university athletes is warranted. Further improvements in the explanatory power of the model might be obtained by looking beyond the Direct and Indirect Measures for other influencing variables. One avenue that has yet to be explored is executive function (EF).

Executive Function

According to executive functioning theories of behaviour, the cognitive abilities we use in the intention, selection, monitoring, and execution of behaviour work together to elicit appropriate responses at the appropriate time and place (Lezak, 2012). Commonly referred to as the 'air traffic control system of the brain' (Center on the Developing Child at Harvard University, 2011), EF regulates multiple incoming flights/sensory information and makes decisions about outgoing flights/behaviour based on numerous pieces of information. It can be conceptualized as *how* we engage in behaviour in purposeful, strategic, self-regulated, and self-serving ways. These functions are highly dependent on neural circuits involving the frontal lobes and any impairment to the prefrontal cortex and associated subcortical circuits of the brain (Barth et al., 2001; Stuss & Gow, 1992; Stuss & Levine, 2002) negatively impacts the EF networks associated with important aspects of concussion symptom reporting, such as planning, decision making, and regulating emotion (Lezak, 2012; Spinella, 2007; van der Horn et al., 2016). Of note, the neural networks of the frontal lobes are the areas most impacted by the biomechanical forces of mTBI/concussion and thus a concussion may itself, interfere with the EF needed to report. Furthermore, given EF is responsible for emotional reasoning, the heightened emotional arousal of experiencing symptoms when an athlete wants to keep playing likely also affects their decision making processes about reporting behaviours (Kroshus et al., 2016; Kroshus, Garnett, Hawrilenko, et al., 2015; Martinent et al., 2012). Lastly, because individual components of EF are associated with the various stages of carrying out planned actions (Kliegel et al., 2002), EFs associated with symptom reporting may play a role in both forming an intention to report and executing that behaviour (i.e., actually reporting).

The main components of EF have been described as *volition* (the capacity for intentional behaviour), *planning and decision making* (the behavioural organization required for goal achievement and the ability to weigh options), *self-regulation* (productivity, flexibility, and the capacity to shift thought, action, or emotion), *purposive action* (impulse control and the ability to initiate, maintain, switch, and stop sequences of complex behaviour), and *effective performance* (the ability to monitor, correct, and regulate behaviour; Lezak, 2012). EF also has cognitive load limitations (Baddeley, 2007), meaning the brain can only effectively engage in a certain degree of mental effort at one time. Adding concussive impairment further depletes decision making capabilities, leading to potentially dangerous behaviour (i.e., concealing symptoms). As reporting is an ‘in the moment’ decision an athlete makes while likely emotionally and potentially cognitively impaired, it is important to consider the impact of concussion on certain EFs and the protections against risky decision making that higher overall EF might provide athletes.

Planning and Decision Making. Part of the organizational capacity to plan, multitask, make decisions, and carry out complex goal-directed behaviour involves working memory and prospective memory components of EF. Working memory is generally conceptualized as the ability to hold and manipulate information in mind (Baddeley, 1992; Lezak, 2012), and prospective memory is understood as the ability to remember to perform a planned action or recall planned intent to act at a specific future point in time (i.e., 'remembering to remember'; Brandimonte et al., 2014; Lezak, 2012). Athletes with more sophisticated organizational and strategic planning skills are likely able to access and hold information in mind to more effectively carry out pre-planned symptom reporting intentions.

Prospective memory also appears to be closely linked with the formation, retention, initiation, and execution of intention, and intention *formation* has been positively correlated with action planning phases in particular (Kliegel et al., 2002). Planning and forming an intention also require several other skills, including the ability to think ahead, view situations objectively, and consider and weigh available options (Lezak, 2012). These aspects of EF impact all components of the TPB model, affecting the formation of and ability to access one's attitudes and beliefs about reporting, weighing social referent pressure to report, accurately determining one's behavioural control over reporting, and translating intention into actual reporting behaviour.

Self-Regulation. Self-regulation, the ability to purposefully manage attention and emotional arousal toward goal-directed behaviour (Blair & Ursache, 2011), plays a significant role in decision making both directly and through its influence on other EFs. Blair and Ursache (2011) propose a bidirectional relationship between self-regulation and other EFs. In this conceptualization overall EF regulates attention, emotion, and stress reactions in a top-down manner while also being controlled by these factors through bottom-up processes. Dysregulated emotional states (e.g., experiencing concussion symptoms during an important game) contribute to dysfunctional EFs such as impaired decision making abilities, leading to heightened attention to emotional rather than rational problem solving (e.g., deciding not to report; Baddeley, 2007). In this way, self-regulation and other EFs influence each other in an interactive feedback loop. Thus, during highly emotional states, such as playing in an important game, EF may be negatively impacted (Baddeley, 2007; Hofmann et al., 2012; Laborde & Raab, 2013; Martinent et al., 2012) and it is plausible athletes with lower self-regulatory abilities are more likely to make risky, emotional decisions, disregarding previously made intentions.

There is evidence working memory is also closely associated with self-regulatory functions related to RTP decision making, such as flexibility in emotional responding, cognitive framing or appraisal of emotional episodes, and inhibition of negative emotional responses incompatible with current goals (Gross, 1998; Hofmann et al., 2011; Schmeichel et al., 2008; Schmeichel & Demaree, 2010). Those with higher working memory capacity are better able to appraise emotional stimuli in an unemotional manner and respond more rationally (Schmeichel et al., 2008), essentially down-regulating negative emotions (Schmeichel & Demaree, 2010). They are also better able to inhibit automatic behaviours and use working memory to retrieve and manage self-regulatory goals (Hofmann et al., 2008).

Working memory dysregulation also disrupts one’s internal representation of goal-relevant information (Hofmann et al., 2011). Without clearly defined goals, intentions may be only partially formed, and controlling heightened emotions to make safe RTP decisions when experiencing possible concussion symptoms can be extremely difficult. In this role, working memory recruits the mental representation of the goal along with the strategy to attain it (Hofmann et al., 2012). Without a strong mental representation, intention to follow through is unlikely to be fully formed.

Of further complexity, athletes likely have competing goals – long term health *and* maximum playing opportunity. Conflict monitoring (i.e., the ability to flexibly adjust goal representations with new information), is also associated with working memory (Hofmann et al., 2012) and may be of vital importance when prioritizing goals and following through with intentions. It may be that goal adjustment must occur for an athlete to disengage from the 'RTP goal' and prioritize the 'report goal'. This is described as working memory's 'cool cognition' process controlling or inhibiting 'hot emotions' in a top-down manner (Hofmann et al., 2011; Metcalfe & Mischel, 1999). In effect, working memory is an important part of the self-regulatory process, keeping goal-relevant information about symptom reporting in mind and controlling associated 'hot' emotional reactions about returning to the game at any cost.

Purposive Action and Effective Performance. Intention formation and follow-through also depend on one's ability to engage in purposive, complex, and controlled behaviour, including inhibiting or changing maladaptive thinking or behaviour to make safe RTP intentions and decisions. An aspect of EF associated with effectively carrying out planned actions, and particularly relevant to reporting behaviour, is impulse control and the inhibition of unsafe responses in the face of immediate, short-term rewards. Impulsive actions, such as concealing symptoms, bypass those pre-planning stages of action regulated by the prefrontal cortex, and rely more heavily on subcortical connections (Lezak, 2012; Munakata et al., 2011).

Attention Deficit/Hyperactivity Disorder (ADHD), a neurodevelopmental disorder characterized by inattention, hyperactivity, and difficulties with impulse control (American Psychiatric Association, 2013), is linked to EF impairment and has a significant impact on intention formation, planning, vigilance, working memory, and response inhibition (Gawrilow et al., 2013; Willcutt et al., 2005). ADHD is associated with poor prospective memory and difficulties forming intentions in both children (Gawrilow et al., 2013) and adults (Altgassen et al., 2019), and those with these types of EF difficulties recall and execute less of their own real-life intentions (Altgassen et al., 2019). This has the potential to affect impulsive, in-the-moment RTP decisions. ADHD is also a significant risk factor for sustaining concussion (Adeyemo et al., 2014; Alosco et al., 2014; Biederman et al., 2015). A recent study found athletes with ADHD were two to three times more likely to have experienced multiple concussions and prolonged recovery compared to neurotypical athletes (Horris et al., 2017; Nelson et al., 2016). It is unclear whether athletes with ADHD experience more concussions due to increased risk taking behaviours, accidents, and injuries associated with the disorder (Barkley, 1997; Barkley et al., 1993; Mash & Barkley, 2007), or whether the underlying neurophysiology associated with ADHD creates a lower threshold of injury (Nelson et al., 2016). Regardless, screening for and noting ADHD diagnoses or symptoms in athletes and recognizing potential impairment in intention formation as well as tendencies for impulsive action may be an important consideration for coaches and athletic trainers in terms of addressing the importance of forming a plan to report as well as monitoring these athletes' behaviour after a hit or blow. It is also essential to make athletes with ADHD aware they are more likely to sustain concussion and make risky RTP decisions when experiencing impaired EF due to concussion symptoms.

Concussion and EF. Concussions are associated with acute and sometimes prolonged executive dysfunction (Lezak et al., 2012). For example, prospective memory, associated with intention formation, retention, initiation, and execution, has been found to be negatively affected for up to three months following mTBI (Tay et al., 2010). While there is increasing evidence multiple concussions likely contribute to neurological consequences later in life (Cunningham et al., 2020; Montenigro et al., 2017; Seichepine et al., 2013; Stern et al., 2013), the literature is mixed regarding the impact of multiple concussions on prolonged EF dysfunction (i.e., symptoms persisting beyond the initial 10-14 days after concussion). Among athletes with multiple concussions, estimates of prolonged EF dysfunction range between 10-55% (Belanger et al., 2010; Belanger & Vanderploeg, 2005; McCrea et al., 2013; Voormolen et al., 2018). Among studies with athletes experiencing prolonged dysfunction, there is also evidence of enduring effects on specific EFs, including attention, task switching, and memory (Broglio et al., 2007; Catena et al., 2009; Cunningham et al., 2020; Halterman et al., 2006; Howell et al., 2013; Mayr et al., 2014; Tapper et al., 2017). However, some research finds differences between concussed and non-concussed athletes only with increased cognitive load, such as in dual-task conditions (Tapper et al., 2017). Consequently, much confusion exists among athletes, coaches, and health care professionals regarding expected recovery.

There is evidence that cognitive reserve (i.e., higher premorbid levels of cognitive functioning; Stern, 2002) has a protective effect on the degree of cognitive dysfunction experienced post-TBI (Barnett et al., 2006; Nunnari et al., 2014). For example, research has found that factors such as larger premorbid brain size, higher scores on intelligence testing, and higher educational attainment decrease the magnitude of cognitive deficits following TBI (Green et al., 2008; Kesler et al., 2003; Sumowski et al., 2013). However, it is unclear whether higher EF acts as a buffer for athletes leading to more robust intention formation and safer decision making, or whether certain EF domains are more influential than others in this regard.

EF as a Component in the TPB model. Ajzen notes the TPB is "open to the inclusion of additional predictors if it can be shown they capture a significant proportion of the variance in intention or behaviour after the theory's current variables have been taken into account" (1991, p. 199). Since EF is affected by concussion and impacts intention formation through to execution (i.e., the RTP decision making process), it is plausible EF may explain some of the unaccounted variance in the TPB model with respect to concussion reporting behaviour. Individuals with higher EF have demonstrated better success translating intention to behaviour (Allan et al., 2011; Hall et al., 2008), therefore EF may also be important in translating TPB components into stronger intention, such that athletes who report higher EF may be more likely to follow through with their stated Attitudes, Subjective Norms, and Perceived Behavioural Control, and report higher intention to disclose possible concussion symptoms. EFs such as working memory, strategic planning, organization, and impulsivity/risk-taking can be measured with self-report scales such as the Executive Function Index (EFI; Spinella, 2005), and may be particularly relevant to intention formation.

Furthermore, there are neurobehavioural factors supporting the addition of EF to the TPB model for concussion reporting. It is understood that the prefrontal cortex, the seat of EF, selects appropriate actions based on internal, external, and contextual cues (Kolb & Whishaw, 2021). TPB constructs may be associated with EF based on their association with these internal and external/context cues. *Internal cues* are primarily associated with dorsolateral areas of the prefrontal cortex, include planning and organization, are conceptualized as rules to guide thoughts and actions, and are reliant to a significant degree on memory function, (Cummings, 1993; Jiang et al., 2018; Kolb & Whishaw, 2021). Attitudes and Subjective Norms can be considered internally cued TPB constructs, as Attitudes develop through internally-cued value-based judgements and Subjective Norms involve internally-cued assumptions made regarding the expectations, approval, or behaviours of valued others.

External and *contextual cues* are both largely driven by the orbitofrontal cortex (Kolb & Whishaw, 2021). External cues can be understood as learning occurring by association or feedback regarding reward/punishment, and contextual cues impact information gained through social interactions or the specific environment in which the individual finds themselves poised to make decisions or execute behaviour (Jiang et al., 2018; Kolb & Whishaw, 2021). Impulse control is based on external/contextual cues, is associated with the orbitofrontal cortex (Cummings, 1993; Miley & Spinella, 2006; Spinella, 2005), and may also be associated with symptom non-reporting. Similarly, Perceived Behavioural Control is experienced through the lens of external/contextual cues (in this case, experiencing symptoms *during an important game*) based on the degree of control an athlete feels in the moment. By examining EF in accordance with Attitudes, Subjective Norms, and Perceived Behavioural Control, it may be possible to predict which athletes may be more likely to conceal symptoms and should be monitored closely after hits or blows, or which athletes/teams should be targeted for more intensive preseason intervention, such as by forming implementation intentions, defined as strategic *if/then* plans that demonstrate more substantial intention-behaviour follow-through (Gollwitzer, 1999).

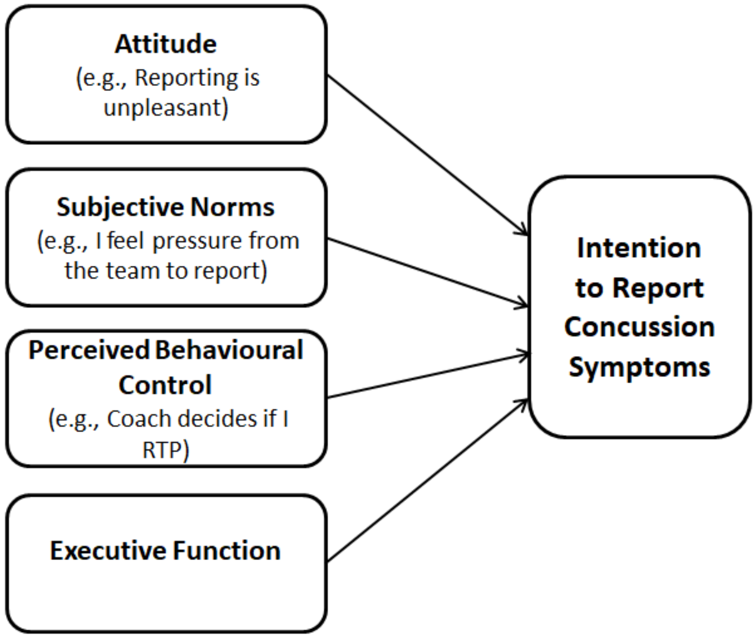
The Current Study

As research continues to uncover the deleterious effects of concussions in professional contact sports, there is a clear need to understand the psychological underpinnings associated with symptom reporting among university-level athletes. Using a health behaviour change model such as the TPB to uncover motivations underlying athlete reporting intention will provide a more rigorous approach to understanding symptom reporting than exists in current concussion education and management strategies. Although researchers have begun using conceptual elements from the TPB to help understand non-reporting, few studies follow the methodological procedures designed to comprehensively evaluate all constructs in the model. Furthermore, no study has examined the impact of specific beliefs in determining an athlete's intention to report, or how these beliefs can be used to improve symptom reporting intervention. Also missing from the research literature is information addressing the link between EF and symptom reporting. EF is an aspect of cognition related to performing goal-directed behaviours and may add to the explanatory power of the original TPB model in understanding athletes' intent to report concussion symptoms. To that end, a unique contribution of the current study is the additional investigation of beliefs, the influence of EF, and whether specific EF domains are more or less influential on intention to report.

To address gaps in the research, the current study used an extended model of the TPB to better explain intention formation (see Figure 3). The extended model assesses the role of Direct Attitudes, Subjective Norms, Perceived Behavioural Control, and the

Figure 3

The Extended Theory of Planned Behaviour Model



additional variable of EF[2] in the intention to report. The Indirect Measures (i.e., the specific behavioural, normative, and control beliefs) are not included in the model analyses. Instead, they will be evaluated in separate analyses to help identify the most important symptom reporting beliefs (i.e., those that discriminate athletes with higher from lower intention). The symptom reporting beliefs that discriminate higher from lower intenders are then used to inform more efficacious interventions. To better understand the relationship between TPB variables and reporting behaviour, as well as to investigate the role of EF within this relationship, the current study a) developed a TPB questionnaire for concussion symptom reporting with university-level athletes (including an elicitation interview, pilot study, and questionnaire reliability testing), b) determined the extent to which TPB constructs influence intention to report, c) investigated the role EF plays within an extended TPB model, and d) put forth a suggested intervention plan based on the salient beliefs emerging from the Indirect Measure analyses.

Using the **TACT** principle to operationally define the target behaviour (Ajzen, 2002), concussion symptom reporting is defined in this study as university-level athletes (**T**arget) intending to report (**A**ction) possible concussion symptoms to their coach or athletic trainer (**C**ontext) after a hit or blow (**T**ime). 'University-level athlete' denotes all post-secondary level athletes on clubs or teams, including college student athletes.

[2] It should be noted this study assessed a general, every-day level of EF, not state-specific EF as a result of concussion.

Research Questions and Hypotheses

Research Question 1: Do demographic factors (e.g., years of sport experience, concussion history, previous concussion symptom reporting, etc.) influence intention to report?

No specific hypotheses were made regarding demographic factors, due to the inconclusive findings in previous research.

Research Question 2: Does EF play a role in reporting possible concussion symptoms?

Hypothesis 2A: Athletes with higher scores on the EFI were expected to indicate stronger intention to report than athletes with lower EFI scores.

Hypothesis 2B: Athletes with higher total EFI scores were expected to indicate a history of reporting concussion symptoms more than athletes with lower total EFI scores.

Research Question 3: Does the extended TPB model better explain university-level athlete’s intention to report concussion symptoms compared to the original TPB model?

Hypothesis 3A: The extended TPB model was expected to account for significant additional variance in intention to report over and above the original TPB model.

Hypothesis 3B: Impulsivity, organization, and strategic planning were expected to account for a significant amount of variance in the relationship between TPB constructs, EF, and intention to report concussion symptoms.

Research Question 4: Which Indirect Measure beliefs discriminate between athletes with higher and lower Generalized Intention and can be used to inform better symptom reporting interventions?

Hypothesis 4A: All Indirect Beliefs will significantly discriminate intenders.

CHAPTER 2: CONTENT DEVELOPMENT FOR THE PRELIMINARY THEORY OF PLANNED BEHAVIOUR AND CONCUSSION REPORTING QUESTIONNAIRE (TPB-CRQ-p)

Introduction

Ajzen (2006) as well as Francis and colleagues (2004) recommend the development of a content-specific TPB questionnaire when studying the role intention plays in a particular behavioral outcome. The general process for developing a TPB questionnaire follows a three-step procedure. First, elicitation interviews are conducted to capture salient beliefs held by the target population to generate content for the Indirect Measures. Second, a pilot study is used to ensure items are clear and reflect salient content. Third, internal consistency and test-retest reliability are performed on the Direct and Indirect Measures, respectively, to analyse and develop a final version of the questionnaire. This chapter reports on the completion of the first two steps of this process: the elicitation interview and the pilot test. For practical purposes of collecting a sufficiently large sample for the statistical analysis, evaluation of the internal consistency and reliability of the measure was completed during the second part of the dissertation (the evaluation of the extended TPB model) and is discussed in the following chapter.

Elicitation Interview

Participants

Student athletes from University of New Brunswick (UNB) and St. Thomas University (STU) sports teams were recruited to participate in the elicitation interviews. Inclusion criteria included English speaking athletes at least 17 years of age or older, playing on a university varsity or club team. A history of sustaining a concussion was not necessary to participate in this study.

Consistent with the recommendations of Francis and colleagues (2004) and Godin and Kok (1996), a minimum of 25 participants was considered sufficient for developing the initial pool of questionnaire items. A total of 25 student athletes between the ages of 18 and 29 (M = 21.8, SD = 2.8) were recruited. Twenty-one athletes participated in telephone interviews, and four were interviewed in person. The majority played on a UNB (N = 23) team and had a history of concussion (N = 19). For additional details about the sample's demographic characteristics and experience with concussion education and injury, see Tables 2 and 3.

Procedure

Following approval by the UNB and STU research ethics boards, student athletes were recruited via email and electronic/paper advertisements. Specifically, an email (Appendix A) was sent to UNB and STU athletic directors and coaches asking them to forward information about the study to their student athletes, who were invited to participate in an interview about concussion reporting. Advertisements were also posted to social media (i.e., Facebook, Twitter), online UNB news posts, and placed on bulletin boards around the UNB and STU campuses (Appendix B). Participants signed a consent form (Appendix C) and subsequently answered questions regarding personal and sport-related demographic information (see Appendix D for complete elicitation interview guide).

The interview took approximately 30-50 minutes, depending on the athlete's concussion history, and all responses were recorded in writing by the interviewer. Upon

Table 2

Demographic Characteristics of the Elicitation Interview and Pilot Study Participants

Variable	**Elicitation Interview (*N* = 25)**	**Pilot study (*N* = 8)**
Age (years)		
M (*SD*)	21.8 (2.8)	20.75 (2.1)
Gender *n* (%)		
Female	17 (68.0)	5 (62.5)
Male	7 (28.0)	3 (37.5)
Transgender	1 (4.0)	-
Self-reported ADHD diagnosis *n* (%)[a]		
Yes	3 (12.0)	-
No	23 (88.5)	8 (100)
Year in university *n* (%)		
First year	1 (4.0)	1 (12.5)
Second year	3 (12.0)	-
Third year	9 (36.0)	4 (50.0)
Fourth year	6 (24.0)	2 (25.0)
Fifth year	5 (20.0)	1 (12.5)
Sixth year or higher	1 (4.0)	-
Sport played *n* (%)[b]		
Baseball	2 (7.7)	2 (25.0)
Basketball	2 (7.7)	-
Cheerleading	2 (7.7)	-
Hockey	4 (15.4)	-
Rugby	3 (11.5)	3 (37.5)
Soccer	3 (11.5)	-
Swim	1 (3.8)	-
Track and Field	4 (15.4)	-
Volleyball	3 (11.5)	1 (12.5)
Woodsmen	1 (3.8)	1 (12.5)
Wrestling	1 (3.8)	1 (12.5)
Length of time played sport *n* (%)		
Since elementary school	9 (36.0)	2 (25.0)
Since middle school	6 (24.0)	1 (25.0)
Since high school	7 (28.0)	3 (37.5)
Since university/college	3 (11.5)	2 (25.0)

Note. [a]Although ADHD diagnosis was not part of questionnaire development, this information was collected and included in Table 2 as a comparison to the sample used for evaluating the extended model in Chapter 3. [b]Some athletes played multiple sports.

Table 3

Elicitation Interview and Pilot Study Participant Concussion Experience

Variable	**Elicitation Interview (*N* = 25)**	**Pilot study (*N* = 8)**
Concussion education *n* (%)		
Yes	13 (52.0)	6 (75.0)
No	12 (48.0)	2 (25.0)
Have had concussion *n* (%)		
Yes	19 (76.0)	7 (87.5)
No	6 (24.0)	1 (25.0)
Number of diagnosed concussions in primary sport		
M (*SD*)	2.1 (3.4)	1.3 (1.3)
Reported symptoms *n* (%)	10 (40)	3 (37.5)
Did not report symptoms *n* (%)	2 (7.7)	1 (25.0)
Number suspected/undiagnosed concussions in primary sport		
M (*SD*)	1.7 (0.6)	2.5 (3.5)
Reported symptoms *n* (%)	2 (7.7)	1 (25.0)
Did not report symptoms *n* (%)	11 (44.0)	5 (62.5)
Would you always report symptoms *n* (%)		
Yes	18 (72.0)	7 (87.5)
No	1 (4.0)	1 (25.0)
Depends	6 (24.0)	-
Would teammates always report symptoms *n* (%)		
Yes	3 (12.0)	1 (12.5)
No	2 (8.0)	2 (25.0)
Depends	20 (80.0)	5 (62.5)

completion of the interview, participants were provided with the debriefing page (Appendix E) and the opportunity to be entered into a draw to win one of two $25 gift cards. At the end of the elicitation interview, athletes were asked if they would be willing to take part in the pilot study to review the subsequently developed questionnaire for content and clarity.

Measures

The complete elicitation interview can be found in Appendix D. All athletes answered demographic questions and were provided with a list of concussion symptoms from the Sport Concussion Assessment Tool – 5th Edition (SCAT-5; Concussion in Sport Group, 2017), a standardized sideline concussion evaluation tool. This ensured they had a basic understanding of concussion symptoms (Register-Mihalik, Linnan, et al., 2013). They were then asked if they had ever been diagnosed with a concussion or experienced any of the listed symptoms after a hit or blow. Athletes who endorsed at least one symptom were subsequently asked how many concussions they experienced in their primary sport, whether they reported these symptoms to their coach or athletic trainer, and whether they continued to play in the same game or practice. They were further asked about their decision-making process for reporting or not reporting their symptoms and whether they believed they or their teammates would always report symptoms in the future. The interview involved similar questions about experiences with non-sport-related concussions, if relevant.

All athletes, regardless of concussion history, completed the TPB elicitation interview questions. To elicit salient beliefs to form the content of the Indirect TPB Measures, athletes were asked to list the advantages and disadvantages of reporting or not reporting; individuals or groups who would approve or disapprove of reporting;

individuals or groups most and least likely to report; and factors that would make it easy or difficult to report. They were also asked if any other issues came to mind when thinking about reporting symptoms, or anything else they associate with reporting.

Analysis and Results

Two independent readers analysed the content of responses as outlined by Ajzen (2006) and Francis and colleagues (2004). Each response was individually reviewed and grouped by theme (e.g., under advantages of reporting, the responses "*you have a better chance of getting rest and taking time off right away to recover*" and "*if you're trying to self-recover, you may not do it correctly*" were coded under 'Decreased recovery time/better chance of recovery'). Common themes identified by each reader were compared and themes were listed in order of frequency for each of the behavioural beliefs, sources of social pressure, and control beliefs. Athletes identified a number of safety advantages to reporting, which informed the Indirect Attitude measures, *"You have a better chance of getting rest, taking time off right away, or getting what you need to recover", "You can take proper steps so you can come back when you're actually ready, versus when you think you're ready"*, and *"You can start the rehab process right away"*. Others noted longer-term benefits, such as *"You'll be able to play for longer… have a longer career", "You prevent damage or long-term symptoms".* Academic disadvantages of *not* reporting were noted. Specifically, participants indicated concern about potential accommodations, for example, *"If it's serious [and you do not report], you don't have documentation of when or what happened".* Being removed for the benefit of the team was identified as an advantage *("It's beneficial… so they don't have an injured player compromising the strength of the team"*, *"You're a hazard to others on the field [if concussed]")* as well as a potential disadvantage to the team (*"The team *might be relying on you, for example, if you're captain, and you aren't present to encourage them, it could affect the team on the field"*). Another frequently endorsed disadvantage was related to being negatively evaluated for reporting. For example, some athletes responded *"If you've already reported a few questionable hits, you don't want to seem like you're making it up"*, *"You've gotta push through it. You're a tough player and you can keep going"*, *"You don't want to seem dramatic"*, *"That lens being put on you looking weak… not as committed to the team if you're not willing to play through it", "I would be worried about looking weaker than fellow athletes, especially if it turned out to not be concussion… you don't want to look paranoid"*.

Of note, social referents such as coaches, teammates, and family were listed as parties who might both approve and disapprove of symptom reporting. That is, athletes believed some coaches, teammates, or family members would prioritize winning over safety in different contexts, such as providing approval for playing through symptoms in important games while valuing safety the rest of the season. Comments about coach approval were both positively and less positively framed *("The (redacted) team had big concussion issues with athletes, so the coach was very supportive of a … player in another sport when (they) got a concussion and was very supportive of (them) to report"*, *"My coach didn't care about the well-being of players")*. Athletes listed family and teammates as social referents who would approve without making further elaboration. In contrast, they provided some comments elaborating on the disapproval of parents and teammates. One athlete commented that some parents were unsupportive of reporting *"…especially during team try-outs or scouting events"*. Regarding teammates, some said *"[When they don't believe you're injured], you don't want to be the kid who cried wolf"*, and *"…especially with a good player… they want to know, can you still* *contribute something to the team"*. In contrast, top performing or competitive athletes were identified as social referents that would be both most and least likely to report. That is, some saw highly competitive athletes as more likely to report due to confidence they would not lose their spot on the team, whereas others viewed them as less likely to do so, stating they might *"…lose their chance at playing professional sports... there's a lot of pressure riding on your playing and getting points"*.

Factors making reporting easier included playing in lower stakes games (*"I'd report more in less important games"*), having an Athletic Trainer present as a more knowledgeable and less biased diagnostic resource (*"[It helps] having someone else make the call")*, having more personal/team knowledge about concussion and feeling supported by the team if they choose to report (*"It would be easier… if the team already experienced [and understood] concussion"*, *"…comfort with the team"*, *"Not feeling like you're letting the team down")*, and the perceived receptivity of the coach (*"When coaches make it known they want you to tell and won't get upset"*, *"When the coach is very vocal about how serious concussions are"*, *"When the coach is invested in players when injured")*.

Factors potentially preventing reporting included experiencing concussion symptoms during higher stakes games *("…playing in a big game and feeling like you're needed… you don't want to let anyone down"*, *"During a big game or when something's on the line")*; experiencing non-specific symptoms or symptoms that mimic other injuries or ailments *("[Concussion] can be a grey area… versus a broken bone that is more obvious"*, *"Are you throwing up because you trained hard or because of concussion?"*, *"What is [just feeling] dizzy versus concussion?"*, *"It's hard to convey how you're feeling, especially when the timeframe for symptom resolution can be so* *different for different people")*; worrying about the potential of being pulled from play *("A lot of it [not reporting] is [about] being able to play"*, *"I would report if I knew I'd be back in the next game")*; and feeling external pressure from various social referents not to disclose (*"Worrying the coach would yell at you", "If I felt pressure from my teammates [to stay in the game]", "If parents put a lot of pressure on you to stay in the game")*.

In response to a question asking if there was anything else that came to mind or that they associated with reporting symptoms, many athletes noted that having support in the form of an athletic therapist or health care professional would increase confidence in reporting ambiguous, non-specific symptoms and being assessed right away. For example, one athlete noted *"There's no physios or ATs at games or anyone to check a player out… if you're hurt and your coach still wants you to play, no one will pull you off"*. The most commonly endorsed themes are listed in Table 4 under the corresponding TPB construct.

On the basis of these themes, Indirect Measure items were constructed in TPB format as outlined by Ajzen (2006) and Francis and colleagues (2004), with each item being rated on a 7-point scale. The wording and number of items for the Direct Measures were based on Francis and colleagues' guidelines in their manual on constructing a TPB questionnaire (2004), whereas the number of items per Indirect Measure was based on the number of common themes within each construct that arose during the interviews (Ajzen, 2006; Francis et al., 2004). Indirect Attitude items target the behavioural beliefs and outcome evaluations of reporting, Indirect Subjective Norm items target the strength of the normative beliefs and motivation to comply with that person or group norm, and Indirect Perceived Behavioural Control questions target the strength and power of the

Table 4

Emergent Themes from Elicitation Interview Responses

TPB Construct		
Attitude	**Advantages of reporting**	**Disadvantages of reporting**
	Avoid short-term and long-term injury Decreased chance of further/serious injury Earlier/accurate diagnosis, faster care Decreased recovery time/better chance of recovery Best interest to team Academic accommodations	Missed play Negative image/conflict with team Disadvantage to team
Subjective Norm	**People or groups who would approve/think you should report**	**People or groups who would disapprove/think you should not report**
	Coach Teammates Parents/family Athletic Trainer and other healthcare professionals	Coach Teammates Parents/family Top players
	Individuals most likely to report	**Individual least likely to report**
	Top-performing players Non-competitive players	Competitive players Captains, top-performing players Some teammates

Perceived Behavioural Control	**Factors making it easier/enabling you to report**	**Factors making it difficult/preventing you from reporting**
	Less important games	More important games
	Availability of Athletic Trainer	Non-specific symptoms
	Being knowledgeable	Being pulled from play
	Coach approachability	External pressure (coach, parents, friends)
	Team support/not letting them down	

control belief. The complete preliminary Theory of Planned Behaviour – Concussion Reporting Questionnaire (TPB-CRQ-p) can be found in Appendix F.

Pilot Study

Participants

Francis and colleagues (2004) and Godin and Kok (1996) recommend a minimum of five participants for the pilot study component of the questionnaire development. Every athlete who participated in the first survey was asked at the time of the elicitation interview if they would be willing to participate in a pilot study involving additional questions about the questionnaire created from the elicitation interviews. All athletes said they would be willing to do so, and eight returned responses to the pilot study questions described below. These participants were from UNB ($N = 6$) and STU ($N = 2$) athletic teams and were between the ages of 18 and 24 ($M = 20.75$, $SD = 2.12$). See Table 2 for demographic information and Table 3 for concussion education and injury information pertaining to this sample.

Procedure

After participants signed and returned an electronic pilot study consent form (Appendix G), they were sent the initial questionnaire (Appendix F) and feedback form (Appendix H) by email. Participants were asked to complete the questionnaire in one sitting and then answer several questions about its content. They returned their answers to the researcher via email and were subsequently emailed the pilot study debriefing form (Appendix I).

Measures

Participants filled out the first draft of the TPB-CRQ-p, which included Direct and Indirect Measure items (included in Appendix F and further described below).

Participants answered six open-ended questions drawn from Francis and colleagues' manual on constructing a TPB questionnaire (2004) on the clarity and relevance of the overall measure. These included "Are any items ambiguous or difficult to answer?", "Does the questionnaire feel too repetitive?", "Does the questionnaire feel too long?", "Does the questionnaire feel too superficial?", "Are there any annoying features of the wording or formatting?", and "Are there inconsistent responses that might indicate changes in response endpoints are problematic for respondents who complete the questionnaire quickly?".

Analysis and Results

Participants did not identify any items that were ambiguous, confusing, or difficult to answer. Many commented they found the questionnaire lengthy and the Subjective Norm questions somewhat repetitive; however, they also noted they understood the necessity of similarly worded items related to a variety of social referents. Some respondents noted the majority of teams do not have access to trainers, therefore a "Not Applicable" option was added to items 33 and 47: "My athletic trainer would approve/disapprove of me not reporting" and "The approval of my athletic trainer is important to me". Several athletes noted they were initially caught off guard by changes in the direction of response endpoints (e.g., strongly agree/strongly disagree changing to strongly disagree/strongly agree), which is a recommended feature of TPB questionnaire format (Ajzen, 2006; Francis et al., 2004); therefore specific notes were made in the final online version alerting participants to pay close attention to these changes.

The resulting TPB-CRQ-p consisted of a total of 61 items, with 12 Direct Measure items, 46 Indirect Measure items, and 3 Generalized Intention items (see Table

5). The Direct Measure items were researcher-generated as per standard TPB questionnaire development, and were included in pilot studies for review by the target population (Francis et al., 2004; Godin & Kok, 1996). The Direct Measures include Attitude, Subjective Norms, Perceived Behavioural Control, and Generalized Intention and were adapted from Francis and colleagues' (2004) TPB questionnaire manual to reflect concussion reporting.

Minor changes were made to some item wording after the pilot group feedback. Specifically, contextual information emphasizing the importance of games or try-outs (e.g., "For me to report possible concussion symptoms *during an important game or try-out*…) was added to Direct Perceived Behavioural Control items 51 and 59 to better account for perceived control across contexts. An additional modification was also made to two other Direct Perceived Behavioural Control items. The phrase "Not including times when your coach or someone else sees a hit and pulls you from play…" was added to the beginning of items 17 ("*Not including times when your coach or someone else sees a hit and pulls you from play*, how much control do you feel you have over reporting possible concussion symptoms?") and 42 ("*Not including times when my coach or someone else sees a hit and pulls me from play*, whether I report concussion symptoms is entirely up to me"). This phrase was added to specifically target those instances when athletes were forced to make their own reporting decision based on their subjective experience of possible concussion symptoms. As per TPB questionnaire development protocol (Ajzen, 2006; Francis et al., 2004), Direct Measures are generated by the researcher and not elicited from the target population. Ideally, these minor changes to the Direct Perceived Behavioural Control items would have been included in the pilot study for review by the target population, but were added after the pilot study

Table 5

Description of TPB-CRQ-p Measures

	General Concept	Number of Items	Scoring
Direct Attitude	Evaluative Opposites (e.g., *reporting is good/bad*) that lead to a favorable or unfavorable assessment of reporting	5	7-point Likert scale
Indirect Attitude	Behavioural Beliefs and Outcome Evaluations (e.g., *it would be best for the team if I report*)	18	Bipolar scale ranging from -3 to +3
Direct Subjective Norms	Pressures athletes perceive from significant others in their life to report or refrain from reporting (e.g., *people who are important to me would approve of my reporting*)	3	7-point Likert scale
Indirect Subjective Norms	Normative Beliefs and Motivation to Comply (e.g., *my coach would approve of me reporting*)	14	Bipolar scale ranging from -3 to +3
Direct Perceived Behavioural Control	Athlete's confidence in ability to report, i.e., internal and external factors influencing athletes' ability to report (e.g., *whether I report possible concussion symptoms is up to me*)	4	7-point Likert scale
Indirect Perceived Behavioural Control	Control Belief Strength and Control Belief Power (e.g., *the possibility of letting the team down makes it easier/ more difficult to report*)	14	Bipolar scale ranging from -3 to +3
Generalized Intention	Assessing a plan to report, an intention to report, and an expectation to report (e.g., *I intend to immediately report any concussion symptoms I experience after a hit or blow to my coach or athletic trainer*)	3	7-point Likert scale

and prior to administering the TPB-CRQ-p to the larger population/sample. Since the purpose of the pilot study is to ensure items are understandable and straightforward, the addition of "…during an important game or practice", and "Not including times…" were expected to improve the clarity of the items and ensure specificity in athlete responses. See Appendix J for a flow chart detailing full item selection and removal for each stage of questionnaire development, including reliability testing, which is subsequently outlined in Chapter 3.

Discussion

The overarching aim of this dissertation was to determine the efficacy of an extended TPB in predicting athletes' intentions to report concussion symptoms, and, importantly, identify salient beliefs that may be used to more effectively direct education or awareness campaigns provided to athletes. The purpose of completing a systematic content- and population-specific TPB questionnaire development process, the focus of this chapter, is to ensure questionnaire items are straightforward, reflect salient beliefs of the target population, and are not based on investigator assumptions. Since a great deal of TPB concussion reporting research has been undertaken without direct athlete consultation, previous findings may not accurately reflect the constructs that define the TPB and ultimately influence intention to report. By using Ajzen's (2006) questionnaire development method, the current study elicited common beliefs directly from athletes, resulting in a more comprehensive and representative TPB questionnaire. Based on responses to the elicitation interview, a preliminary version of The Theory of Planned Behaviour and Concussion Reporting Questionnaire (TPB-CRQ-p) was created (Appendix F). This measure was subsequently reviewed by a subset of the initial participants for content clarity and relevance. The pilot study participants did not identify any concerns related to the content or clarity of the TPB-CRQ-p questions. Thus, no significant changes to the questionnaire were made.

Following the recommended questionnaire development process resulted in a TPB-CRQ-p with some items reflecting content similar to pre-existing TPB questionnaires, while also generating unique, previously uncovered content. Within the Indirect Attitude construct, advantages of reporting included themes of health and safety; expedited diagnosis, care, and recovery; appropriate academic accommodations; and reporting as being in the best interest of the team. Disadvantages included missed playing time; being seen as weak or a complainer; and disadvantaging the team by not being able to play. These themes have been previously identified and used in both systematic questionnaire development (Register-Mihalik, Linnan, et al., 2013) and researcher-generated questionnaires (Kroshus 2014, Chrisman, 2013). Register-Mihalik and colleagues' (2013) high school athlete elicitation interviews also generated "missing out on activities" as an important consideration, which was not an important consideration for the university-level athletes in the current study.

Social referents identified in the elicitation interview were seemingly consistent with those found in other TPB concussion literature and are reflected in the TPB-CRQ-p. The Indirect Subjective Norms construct (comprised of those who would approve or disapprove of reporting) included coaches, ATs and other healthcare professionals, teammates, top players (e.g., captains), and family. Interestingly, coaches, teammates, and family were each considered supporters of reporting depending on context, specifically, if reporting does not jeopardize a high stakes game or tournament. Unfortunately, sufficient details were not provided in Register-Mihalik and colleagues'

(2013) study regarding the distribution of the approve/disapprove categories across these social referents to make comparisons.

Something consistently missing in other questionnaires that was uncovered in the elicitation interviews used in the generation of the current TPB-CRQ-p is the aspect of the Subjective Norm pertaining to groups or individuals who are most and least likely to report. Participants believed those most likely to report would include top performing players and less competitive players and those least likely to report would include more competitive players, and, again, top performing players. The finding that top players are perceived as being both most and least likely to report highlights the fact that athletes can simultaneously hold contrasting views. Which view takes precedence depends on how they interpret the question at a specific moment in time. On the one hand, top players may be identified as most likely to report because their spot on the team is considered to be more secure and less impacted by a missed game. On the other hand, top players might also be perceived as being more ingrained in the 'culture of sport' which promotes ideals such as a desire to push through injury, stay in important games, and advance in their sporting career at any cost. Specifically eliciting this list provided information regarding team dynamics that may help explain complex social factors (e.g., aligning one's behaviour to perceived group norms) contributing to intention to report.

Perceived control factors enabling reporting included playing in lower stakes games, having an Athletic Trainer present, having more knowledge and understanding about concussion, feeling supported by the team if they choose to report, and the perceived receptivity of the coach. Factors potentially preventing reporting included experiencing concussion symptoms during higher stakes games, experiencing non-specific symptoms, the potential of being pulled from play, and external pressure from various social referents. The elicitation interview uncovered Indirect Perceived Behavioural Control factors diverging from those identified by high school athletes (Register-Mihalik, Linnan, et al., 2013), wherein control over reporting was almost exclusively associated with perceived pressure from social referents for the high school athletes versus the wider range of factors identified by the university athletes.

Of note, however, many of the control themes uncovered in the elicitation interview (including non-specific symptomatology, coach approachability, negative evaluation by peers, and maintaining a "tough image") have been identified in other studies with university-level athletes (Chrisman et al., 2013; Lininger et al., 2017), suggesting the factors impacting control beliefs may change with age or level of play. Athletes may become more competitive as they advance in their sporting career from high school to university as the likelihood of playing professional sports increases. In turn, this may contribute to a greater willingness to take risks. On the other hand, some research suggests athlete intentions align more closely to safety as they age and gain more concussion knowledge and experience (Beakey et al., 2016), highlighting again how contradictory beliefs can be held simultaneously. The elicitation interviews suggest that while safety is a concern for university-aged athletes, it carries more weight in lower stakes contexts. While the reason for the differences observed between the reporting motivations for university-level versus high school athletes could not be determined in this study, the observed differences highlight the importance of developing a population specific measure as recommended by Ajzen (2006).

Conclusions

The TPB-CRQ-p was generated based on responses to open-ended questions about concussion reporting from university level athletes with considerable experience playing their primary sport. The questionnaire benefitted from further refinement following athlete feedback about content and clarity when it was piloted. Overall, this measure appeared to cover salient areas of Attitude, Subjective Norms, and Perceived Behavioural Control related to concussion symptom reporting in this particular population and identified some social dynamics within Subjective Norms not identified in other studies.

Systematic TPB questionnaire development is necessary when a measure has not been developed for a target behaviour or population. Since the only existing concussion reporting questionnaire following an elicitation interview and pilot study used high school athletes, this was a necessary and beneficial step for research exploring university-level athletes' intention to report possible concussion symptoms. In doing so, the process differentiated a sub-section of social referents that may not have been otherwise identified, as well as a more dynamic set of control belief associated with reporting than was present in Register-Mihalik and colleagues' (2013) high school study. The content was otherwise very similar to existing measures (e.g., Kroshus et al., 2014), suggesting the literature may be close to establishing a valid questionnaire for this behaviour and population. The similar content also suggests greater confidence can be placed in the results of previous TPB and concussion reporting research. In sum, despite overlapping content, there was value in completing the recommended steps in solidifying themes and generating more applicable content for university-level athletes. TPB-CRQ-p measure development will require replication taking into account additional identified social referents; however, it is unlikely substantial new information will be generated by continued systematic questionnaire development unless the culture of sport changes substantially. Development of the TPB-CRQ-p brings this research one step closer to an established questionnaire. It should be noted that once a university-level athlete questionnaire is validated, it would be appropriate to use with Canadian athletes; however, due to differences between Canadian and American university sports (e.g., how sports scholarships are structured, pressure stemming from the popularity of college sports with fans outside the university population), American studies would benefit from further elicitation interviewing to determine whether any significant discrepancies in reporting beliefs exist between the two populations.

CHAPTER 3: EVALUATING THE EXTENDED TPB MODEL FOR CONCUSSION REPORTING INTENTION AMONG UNIVERSITY ATHLETES

The TPB-Concussion Reporting Questionnaire (TPB-CRQ-p), developed during the elicitation interviews and pilot study discussed in the previous chapter, was utilized with a large sample of university athletes to investigate whether extending the TPB model with the addition of EF would improve the prediction of intention to report possible concussion symptoms. Additional objectives included examining how other athletic and personal demographic factors impacted intention to report concussion symptoms. Prior to evaluating the EF-extended TBP model, the test-retest reliability and internal consistency of the TPB-CRQ-p were examined with a subsample of athletes who volunteered to complete the TPB-CRQ-p a second time two weeks after the first administration. A finalized version of the questionnaire, the TPB-CRQ-f-revised, was developed based on changes made to the questionnaire on the basis of this psychometric evaluation.

Participants

Following approval of the study's procedures by the UNB ethics board, recruitment was commenced by contacting all Canadian universities and colleges with competitive sports teams. Athletic directors were sent an email detailing the study and requesting they forward the information to their athletes (Appendix M). Ethical approval was sought and obtained for any universities or colleges requiring review by their own ethics boards. Recruitment materials invited athletes on university or college teams with or without concussion experience to participate in research on concussion reporting attitudes and beliefs. Recruitment materials included social media posts (i.e., Facebook, Twitter), UNB news posts, and posters placed on bulletin boards on UNB and STU campuses (Appendix K). Any English-speaking athlete on a Canadian university/college team or club, age 17 or older, with or without a history of concussion was eligible to participate. Exclusion criteria included participation in the elicitation interview and pilot study components of this dissertation.

As per Tabachnick and Fidell's (2019) recommended procedures, an a priori power analysis conducted using G*Power 3.1.9.7 software (Faul et al., 2009) determined that among all of the statistical analyses planned for the current study, the one-way ANOVA would require the largest sample size. With five groups, G*Power indicated a sample size of 275 was required for adequate (i.e., 80%) statistical power in detecting a medium sized effect using one-way ANOVA when employing a conservative .01 criterion of statistical significance (Tabachnick & Fidell, 2019). A more conservative alpha level of .01 was used to control for Type I error, as multiple analyses were employed to examine each research question. Participants included 264 (N = 168 female and 96 male) athletes, which is underpowered for the one-way ANOVA analysis, therefore those results were interpreted with caution. The hierarchical multiple regression with eight predictors was the analysis with the next largest required sample size, which, according to G* Power, required only 161 participants.

Demographic information for the full sample and the subsample who participated in reliability testing for the final version of the TPB-CRQ-f is presented in Table 6. As illustrated in Table 6, a range of sports were represented, with the largest percentage of athletes playing soccer, volleyball, hockey, basketball, and track and field, respectively. The majority of athletes (80.3%) played in sports with a higher probability of hits or blows, determined by the likelihood that athletes might collide with each other or athletic equipment. Overall, athletes reported high levels of self-rated competitiveness

Table 6

Demographic Characteristics of the Questionnaire Verification (Subsample) and Extended Model (Full Sample) Participants

Variable	Subsample (*N* = 32)	Full Sample (*N* = 264)
Age (years)		
M (*SD*)	20.75 (3.0)	20.7 (2.8)
Range (years)	18-30	17-30
Gender *n* (%)		
Female	23 (71.9)	168 (63.6)
Male	9 (28.1)	96 (36.4)
Other (e.g., transgender)	-	-
Years in University *M* (*SD*)	3.1 (1.9)	2.9 (1.9)
Level of participation *n* (%)		
Varsity team	29 (91)	213 (87)
Club	3 (9)	51 (19)
Self-Reported ADHD diagnosis *n* (%)		
Yes	-	13 (5.0)[a]
No	32 (100)	249 (95.0)
ASRS-5 total score *M* (*SD*)[b]	12.1 (3.6)	13.9 (3.8)
Sport played *n* (%)[c]		
Baseball[d]	-	5 (1.9)
Basketball[d]	5 (15.6)	28 (10.7)
Cheerleading	-	1 (0.4)
Cricket	-	2 (0.8)
Curling	-	2 (0.8)
Fencing	-	1 (0.4)
Field Hockey[d]	1 (3.1)	3 (1.1)
Football[d]	-	8 (3.1)
Golf	-	1 (0.4)
Hockey[d]	6 (18.8)	34 (13.0)
Judo/Karate[d]	-	2 (0.8)
Lacrosse[d]	-	2 (0.8)
Ringette[d]	-	1 (0.4)
Rugby[d]	1 (3.1)	9 (3.4)
Show Jumping	-	1 (0.4)
Soccer[d]	4 (12.5)	74 (28.2)
Squash	1 (3.1)	1 (0.4)
Swim	1 (3.1)	7 (2.7)
Track and Field	6 (18.8)	26 (9.9)

Volleyball[d]	6 (18.8)	50 (19.1)
Water polo[d]	1 (3.1)	1 (0.4)
Wrestling[d]	-	1 (0.4)
Years played primary sport		
M (*SD*)	10.0 (4.6)	9.0 (5.6)
Years playing on university team		
M (*SD*)	2.31 (1.2)	1.91 (1.5)
Year in university *n* (%)		
First year	6 (18.8)	80 (30.3)
Second year	8 (25.0)	57 (21.6)
Third year	10 (31.3)	44 (16.7)
Fourth year	1 (3.1)	35 (13.3)
Fifth year	3 (9.4)	18 (6.8)
Sixth year or higher	4 (12.5)	30 (11.3)
Team designation *n* (%)		
University/college varsity team	29 (90.6)	213 (80.7)
University/college club team	3 (9.4)	51 (19.3)
Type of team *n* (%)		
Women's team	19 (59.4)	143 (54.2)
Men's team	9 (28.1)	91 (34.5)
Co-ed team	2 (6.3)	16 (6.0)
Individual sport (i.e., does not compete on a team)[e]	2 (6.3)	14 (5.3)
Leadership role (e.g., team captain) *n* (%)		
Yes	10 (31.3)	73 (27.7)
No	22 (68.8)	191 (72.2)
Ranking on team *n* (%)		
Regular part of starting lineup	21 (65.6)	155 (58.7)
Regular substitute	3 (9.7)	32 (12.1)
Practicing but competing infrequently	3 (9.7)	38 (14.4)
Practicing and training but not competing	-	3 (1.1)
Does not apply to my sport	5 (16.1)	36 (13.7)
Importance on team *n* (%)		
Only player in my position	3 (9.4)	33 (12.6)[a]
Others can cover me, but I am the best player in my position	9 (28.1)	73 (27.9)

Others can cover me who have comparable skills	17 (53.1)	123 (46.9)
Others can cover me who are more skilled	3 (9.4)	33 (12.6)
Self-reported skill level (out of 5) M (*SD*)	4.06 (0.7)	3.85 (0.7)
Percent games played M (*SD*)	65.5 (41.0)	40.0 (44.4)
Self-rated level of competitiveness (0-100%) M (*SD*)	87.3 (8.3)	85.8 (13.8)
Athletic identity M (*SD*)[f]		
Females	37.9 (5.6)	36.4 (8.3)
Males	38.2 (7.8)	37.4 (8.3)

Note. [a]Missing two responses. [b]*Adult Attention-Deficit/Hyperactivity Disorder Self-Report Screening Scale for DSM-5 (range of scores 0-24)*. [c]Some athletes played multiple sports. [d]Sports considered high risk for hits/blows. [e]Self-reported individual sports included karate, judo, show jumping, fencing, pole vault, track and field, and swimming. [f]As measured by the Athletic Identity Measurement Scale (AIMS, total score; range of scores 7-49).

and average levels of athletic identity (relative to the norms of the Athletic Identity Measurement Scale; Brewer et al., 1993). Notably, although only 5% reported a formal ADHD diagnosis, athletes on average rated themselves just below the positive screening cut off for ADHD symptoms. Over half (58.7%) the sample endorsed a clinically significant degree of ADHD symptoms. Thus, a large percentage of the sample self-identified as having a high number of ADHD symptoms, though it must be noted that self-reported results from ADHD screening scales should not be interpreted as evidence of an ADHD diagnosis. Rather, high scores merely suggest further investigation by a psychologist or medical professional may be warranted.

Procedure

Athletes completed the online questionnaire using Checkbox Survey software. They provided informed consent (Appendix M) by ticking a box below the consent form prior to gaining access to the online questionnaire. Athletes answered demographic questions and were provided with a list of concussion symptoms from the SCAT-5 (Concussion in Sport Group, 2017) to ensure basic understanding of concussion symptoms while completing the questionnaire (Appendix N). Participants filled out the entire questionnaire package online, including measures of ADHD symptomatology (Appendix O), athletic identity (Appendix P), EFI (Appendix Q), and the TPB-CRQ-f (Appendix R).

After completing the initial survey, participants were directed to a debriefing form (Appendix S) providing study information, a list of relevant web-based resources, as well as contact information for the researchers and UNB ethics board should they have questions or concerns about the study. Athletes were then asked if they would be willing to be re-contacted in approximately two weeks to complete just the TPB-CRQ-f portion of the questionnaire again to help assess test-retest reliability of the measure. Time 1 and 2 data were matched using a participant-generated code they were asked to remember and enter online each time they completed a component. Athletes took approximately 25 minutes to fill out the complete questionnaire package. Participants were eligible to win one of 25 Amazon gift cards ($25 value each) for participating. Participants who wished to receive a summary of the research findings were able to do so by providing their email address through a separate link at the end of the survey.

Those athletes who consented to participate in the re-test component of the study were sent an email (Appendix T) two-weeks following initial participation, with a link to the follow-up study (see Appendix U for the introduction to the re-test study). The TPB re-test content was identical to the TPB-CRQ-f used in the main study (see Appendix R), and participants were only asked to complete the TPB-CRQ-f portion of the questionnaire. Athletes took on average 10 minutes to complete the TPB-CRQ-f a second time. Following completion, they were provided with a debrief form (Appendix V) and given the option to enter an additional draw for one of four $25 Amazon gift cards.

Materials/Measures

***Demographic and background information*.**

A questionnaire was created to gather demographic information about the athletes including age, gender, self-reported attention or learning difficulties, and current year in university. Athletes were also asked about sport-related information, such as their primary sport and position on the team (if applicable), length of time playing their primary sport, how long they intend to continue playing, whether they play other sports, self-reported competitiveness (rated between 0-100%), whether they hold a leadership role such as captain (yes/no), self-reported skill level (rated on a 5-point scale from low to high), ranking on the team (regular part of the starting line-up, regular substitute, practicing but competing infrequently, practicing and training but not competing, or not applicable), percentage of games they play per season and if they wish they had more playing time compared to other teammates (yes, no, not applicable), and whether they intend to play professionally. Finally, they were asked concussion-specific information, including how much and what type of concussion education they have received (presentation/talk, video, handout, online module, or other open ended response), whether they have ever experienced either diagnosed or undiagnosed/suspected concussions (yes, no), how many diagnosed or undiagnosed/suspected concussions they have experienced within the past five years within their primary sport, other sport, or non-sport activity, whether they reported symptoms, whether they anticipated reporting in the future (yes, no, depends on the context), and whether they thought their teammates would report in the future (yes, no, depends on the context). They were also asked why they might not have reported in the past. Response options included: I didn't think it was a concussion at the time, I wasn't sure it was a concussion at the time, I didn't think it was serious enough, I didn't want to let my teammates down, I didn't want to look weak, I wanted to finish the game, It was during an important game or try-out, I felt pressure to finish the game, I felt expected to play through concussion symptoms, I worried that I wouldn't be allowed to go back to play when I felt ready/recovered, I didn't think a non-sports related concussion was relevant to report, or 'other' open ended option). For the complete demographics questionnaire, see Appendix N.

The World Health Organization Adult Attention-Deficit/Hyperactivity Disorder Self-Report Screening Scale for DSM-5 (ASRS; Ustun et al., 2017; Appendix O).

The DSM-5 ASRS is a 6-item adult ADHD screening scale for community samples, which improves upon the ASRS-V1.1 (Kessler et al., 2005), developed from the World Health Organization Composite International Diagnostic Interview and DSM-IV-TR criteria. The new version includes items assessing inattention and hyperactivity/impulsivity as well as two items that assess executive dysfunction (i.e., "How often do you put things off until the last minute?" "How often do you depend on others to keep your life in order and attend to details?"). These items are not part of the DSM-5 ADHD criteria, but have been found to better predict ADHD in adult populations (Ustun et al., 2017). Items are rated on a 5-point Likert scale with response categories of Never, Rarely, Sometimes, Often, and Very Often. The ASRS has excellent operating characteristics, with high sensitivity (91.4%) and specificity (96.0%) as well as positive predictive value (PPV; 67.3%) and area under the curve (AUC; 0.94). Given each item of the ASRS measures a different aspect of ADHD symptomatology, the items are not expected to be highly intercorrelated and thus internal consistency reliability is generally not reported for this measure (Ustun et al., 2017). ADHD symptoms were important to measure because, as noted in *Chapter 1*, ADHD has a significant negative impact on intention formation and is linked to impairments in a number of EFs. Measuring the relationship between intention and ADHD symptomatology in particular may help further illuminate the complex nature of intention formation when it comes to symptom reporting.

Athletic Identity Measurement Scale (seven-item revision; AIMS; Brewer & Cornelius, 2001; Appendix P).

The abbreviated AIMS is a 7-item self-report measure derived from the original 10-item scale (Brewer et al., 1993). It assesses the degree to which an athlete assumes a sport-specific self-identity. Items are rated on a 7-point Likert scale ranging from one (*Strongly Disagree*) to seven (*Strongly Agree*). The AIMS has a maximum score of 49, with higher scores indicating closer identification with the athlete role. Prior research has identified a multidimensional factor structure with three highly correlated first order factors: Social Identity, Exclusivity, and Negative Affectivity (Brewer & Cornelius, 2001). Total score and subscales were used in analyses described below. The abbreviated scale total score demonstrates good internal consistency in past research (α = .81; Brewer & Cornelius, 2001) as well as in the current study (α = .87). Internal consistency of the subscales in the current study ranged from good (Social Identity, α = .813, e.g., "I consider myself and athlete"; Exclusivity, α = .861, e.g., "Sport it the most important part of my life") to questionable (Negative Affectivity, α = .666, e.g. "I feel badly about myself when I do poorly in sport").

***The Executive Function Index (EFI; Spinella, 2005; Appendix Q*).**

The EFI is a 27-item self-report measure of EFs in daily life. It was developed from and is intended for use in a non-clinical population. Items are rated on a 5-point Likert scale ranging from one (*Not at All)* to five (*Very Much)*. Based on factor analysis, items are organized into five first-order scales (see Table 7) related to the following domains of executive functioning, which are mediated by prefrontal cortex systems: Empathy, Strategic Planning, Organization, Impulse Control, and Motivational Drive. The scale also provides a Total EF score with higher scores indicating better overall EF. In lieu of a first-order scale specifically measuring self-regulation, the Strategic Planning and Organization scales were used in this study to measure self-regulatory capacity because of their association with working memory (an important aspect of self-

Table 7

EFI Constructs and Loadings

First order scales	Content and associated EF domains	Second order factor loadings	Original Study Cronbach's alpha[a]	Current Study Cronbach's alpha
Empathy	Concern for the well-being of others, prosocial behaviours, and cooperative attitude. Self-regulation.	Orbitofrontal System	.76	.77
Strategic Planning	Ability to think ahead, plan, use strategies, and engage in self-monitoring. Self-regulation, planning and decision making.	Dorsolateral System	.70	.62
Organization	Follow-through, multitasking, sequencing, and holding information in mind when making decisions (i.e., working memory), self-regulation. Self-regulation, planning and decision making.	Dorsolateral System	.75	.67
Impulse control	Engaging in inappropriate behaviour (i.e., inhibition), risk taking, and social conduct such as controlling one's temper. Purposive action.	Orbitofrontal system	.69	.51
Motivational Drive	Behavioural drive, energy level, and interest in novel tasks. Purposive action.	Medial prefrontal system	.70	.56
Total EF	Combined score		.82	.76

Note. [a]Spinella, 2005.

regulation, as noted in *Chapter 1*) and their roles in self-monitoring and intention follow-through. In terms of validity, the EFI is correlated with other self-rating EF measures developed and validated in clinical populations, including the Frontal Systems Behavior Scale (FrSBe; Grace & Malloy, 2001), the Barratt Impulsiveness Scale (BIS-11; Patton et al., 1995), and the Interpersonal Reactivity Index (IRI; Davis, 1980).

The five EF domains are further divided into a second-order three factor model corresponding to regions of the prefrontal system (Cummings, 1993), as outlined in Table 7. Impulse Control and Empathy correspond to the orbitofrontal system, which mediates inhibition, social conduct, empathy, and decision making related to reward and punishment. Strategic Planning and Organization correspond to the dorsolateral system, which is associated with working memory, higher order reasoning, problem solving, mental flexibility, and planning. Lastly, Motivational Drive corresponds to the medial prefrontal system which is associated with emotional expression, drive, and motivation (Lezak, 2012; Malloy et al., 1993). A second-order factor analysis determined this three-factor solution accounted for 77.25% total variance in EF (Spinella, 2005).

Although past research has demonstrated satisfactory levels of internal consistency for the first order factors, internal consistency in the current study was lower than expected for the Strategic Planning, Organization, Impulse Control, Motivational Drive, and total EF score (see Table 7). Only the level of internal consistency for the Empathy scale in the present study was comparable to past research (see Table 7). Given Cronbach alpha values less than .60 demonstrate poor scale reliability, consideration was given to deleting the items that contributed to lower alpha values for each subscale.

While removal of one item from each of the Empathy, Strategic Planning, and Motivational Drive subscales, and three items from the Total EF score improved the internal consistency of those scales (see Table 8), the pattern of results in all subsequent analyses involving the EFI did not change regardless of whether the original or revised version of the EFI was used. Thus, the decision was made to utilize the unaltered, established questionnaire in the analyses to ensure the results would be comparable to existing research using this measure.

Thus, despite the observed weakness in internal consistencies, all of the analyses described below include the original EFI items. This ensured any results involving the EFI in the present study would be interpretable on the basis of the established scale and within the context of past research that has utilized the EFI. Nevertheless, it remains noteworthy that the low level of internal consistency obtained in this study sets a limit on the extent to which EFI can be expected to account for additional variance in the expanded TPB model. This limitation is discussed further in the next chapter.

Theory of Planned Behaviour and Concussion Reporting Questionnaire (TPB-CRQ).

The preliminary version of the TPB-CRQ-p (Appendix F), which was developed using elicitation interviews, underwent minor modifications as a result of the pilot study (see Chapter 2). The final version of the TPB-CRQ-f (Appendix R) was used to evaluate attitudes, social pressures or influences, and perceived control in forming an intention to report possible concussion symptoms to a coach or athletic trainer in the EF-extended TPB model. The TPB-CRQ-f was revised (TPB-CRQ-f-revised), as noted below, and both versions are represented in Appendix R. Italicized items in this appendix represent those items removed from the TPB-CRQ-f as noted below in the Data Screening section.

Table 8.

Internal Consistency of the EFI in Current Study (N = 264)

EFI Subscales	Number of Items per Scale	Current Study Cronbach's Alpha	Items Contributing to Low Alphas Removed	Alphas Following Removal of Lower Performing Items
Empathy	6	.77	Item 12	.82
Strategic Planning	7	.62	Item 13	.78
Organization	5	.67	None	-
Impulse control	5	.51	None	-
Motivational Drive	4	.56	Item 4	.72
Total EF	27	.76	Items 4, 12, 13	.79

Scoring the TPB-CRQ-f involves computing subscale scores for each of the Direct and Indirect Measure as outlined by Francis and colleagues (2004). First, negatively worded endpoints were reverse scored so higher numbers represent positive attitudes toward reporting, greater social pressure to report, or greater level of perceived control over reporting. Second, Direct Measure scores are generated by calculating the mean score for items corresponding to Attitude, Subjective Norm, Perceived Behavioural Control, and Generalized Intention. Finally, weighted Indirect Measure scores are generated by multiplying each belief by the corresponding evaluation. For example, for Indirect Attitude, the item "It would be best for the team if I report possible concussion symptoms (rated on a 7-point scale of unlikely to likely)" is multiplied by the item "Doing the best thing for the team is … (rated on a 7-point scale of extremely desirable to extremely undesirable)". The resulting products are then summed to create an overall score for each Indirect Measure.

Preliminary Analysis: Evaluating the Reliability of the TPB-CRQ-f

Prior to evaluating the extended TPB model, it was necessary to evaluate the psychometric qualities of the TPB-CRQ-f given it was created for the purposes of this research. While the first two steps outlined by Ajzen (2006) and Francis and Colleagues (2004) for generating the questionnaire (i.e., elicitation interviews and pilot study) were outlined in the previous chapter, the final step (i.e., evaluating the measure's reliability) was delayed until a sufficiently large sample size was obtained in the second phase of participant recruitment. For the purposes of psychometric evaluation, all of the participants who completed the study were invited to complete the TPB-CRQ-f a second time and 38 participants did so. Details about the demographic information for this subsample were presented previously (see Table 6).

Subsample (N = 32) Data Cleaning

Data from the subsample was examined to identify data entry errors, missing data, or random responding. Initially, 38 athletes were included in the sample. Four participants were subsequently deleted because they were missing values on the Time 1 or 2 TPB-CRQ-f scales. Random responding is a common concern when administering an anonymous online survey, thus, to identify participants who may be responding randomly or not paying close attention to the items, several questions were included in the survey to test attention (e.g., "which of the following is not food?" and "what is two plus one?"). Data from participants who answered these questions incorrectly was carefully examined for patterns indicating random responding, and one participant was removed. The Normative Belief item regarding athletic trainers (i.e., "My athletic trainer (or equivalent) would approve / disapprove / N/A of me reporting possible concussion symptoms") and the corresponding Motivation to Comply item (i.e., "The approval of my athletic trainer (or equivalent) is important to me") were removed prior to verification, as almost half the sample (43%) selected the "not applicable" option, indicating they did not have an Athletic Trainer for the team.

Outliers. As per recommendations by Tabachnick and Fidell (2019), univariate outliers were identified in cases whose standardized scores exceeded 3.29 ($p < .001$) and were discontinuous from the rest of the data. Upon examination, one outlier emerged for a participant on the Time 1 and Time 2 composite Direct Subjective Norm variables. Given there was a sufficiently large sample, this participant's data was removed. A conservative probability estimate (i.e., $p < .001$) was used to evaluate multivariate outliers, as recommended by Tabachnick and Fidell (2013). Using this criterion, no multivariate outliers were found; therefore, no further examination was required and all remaining cases were retained.

Normality. Normality of the TPB-CRQ-f subscale scores was assessed by examining histograms and skewness and kurtosis values. For small samples, an upper threshold of +/- 1.96 is recommended (Field, 2013). Based on this criterion, the following variables demonstrated negative skew: Time 2 Indirect Attitude variable (skew z-score = -2.68) and both Time 1 and 2 Generalized Intention variables (skew z-score = -2.65, and -2.74, respectively). Based on these findings, and because the sample was small, bivariate correlations for these variables using the non-parametric Spearman's rho statistic were calculated to determine test-retest reliability of the TPB constructs.

Linearity. Bivariate scatterplots of each pair of Time 1 and Time 2 variables were examined to determine linearity among the variables. No significant concerns with non-linearity (e.g., curvilinear relationships) or heteroscedasticity were found. In addition, there were no instances of heterogeneity of variance among the Time 1 and Time 2 variables.

Item redundancy. In examining the TPB-CRQ, some instances of item redundancy were found. Two items within the Direct Attitude scale ("Reporting possible concussion symptoms is good/bad" and "Reporting possible concussion symptoms is important/unimportant") were highly correlated ($r = .939$), Similarly, two items within the Indirect Subjective Norm scale ("Top players do/do not report symptoms" and "Competitive athletes do/do not report symptoms") were also highly correlated ($r = .95$). The inclusion of multiple, similar items was done to ensure salient information was fully captured, however this led to redundancy and the perception of multicollinearity. Removal of the redundant items eliminated the problem. In each case, the second item was removed to preserve the more straightforward evaluative opposite and the emphasis on highly skilled players who athletes may aspire to emulate, or positions (top player) for which they may aim.

Psychometric Evaluation of the TPB-CRQ-f

Test-Retest Reliability for the TPB-CRQ-f. Prior to evaluating test-retest reliability, participants' (N=32) scores on the Direct Attitude and Indirect Subjective Norm subscales were recalculated to reflect the deletion of the two redundant items noted in the previous section. Subsequently, test-retest reliability, as per the recommendations of Francis and colleagues (2004) as well as Godin and Kok (1996), were examined by calculating the correlations between each subscale at Time 1 and Time 2. With the exception of the Indirect Perceived Behavioural Control subscale, each of the Direct and Indirect measure subscales had adequate test-retest reliability (see Table 9) and large effect sizes (Cohen, 1988). Given the Indirect Perceived Behavioural Control subscale demonstrated questionable test-retest reliability (r = .59), the test-retest reliability of individual Perceived Behavioural Control items on the subscale were analysed. Removal of the lowest performing item from the Indirect Perceived Behavioural Control construct ("The probability of experiencing possible concussion symptoms during important games or try-outs makes it easier/more difficult to report") resulted in satisfactory test-retest reliability (r = .70) and thus was removed from the variable for subsequent analyses.

Internal Consistency for the TPB-CRQ-f. To evaluate internal consistency, Cronbach alphas were calculated for each of the three Direct Measure subscales. As illustrated in Table 9, internal consistency was acceptable for each subscale. Internal consistency was not evaluated for the Indirect belief-based measures because they are not expected to have high internal consistency given it is possible to hold both positive

Table 9

Psychometric Verification of the TPB-CRQ-f (N=32)

	Indirect Measure Test-Retest Reliability (*r*)	**Direct Measure Test-Retest Reliability (*r*)**	**Indirect and Direct Measure Bivariate Correlations (*r*)**	**Internal Consistency (α)**
Attitude	.70[a]**	.73[a]**	.21[a]	.74
Subjective Norms	.80[a]**	.91**	.60**	.74
Perceived Behavioural Control	.70**	.80**	.50**	.78
Generalized Intention	N/A	.80[a]**	N/A	.85

Note. [a]Attitude, Subjective Norms, and Generalized Intention reported as Spearman's rho (r_s). N/A values not applicable as Generalized Intention does not have an Indirect Measure equivalent.

**p < .01.

and negative views about the same behaviour. For this reason, Francis et al. (2004) recommend using test-retest reliability to ensure temporal stability of the Indirect Measures, as noted above. Bivariate correlations between the Direct and Indirect Measures (see Table 9) for each construct demonstrated large effects and confirmed the validity of the Indirect Subjective Norm and Perceived Behavioural Control Measures (Francis et al., 2004). The Indirect Attitude measure was not significantly correlated with the Direct Measure. While this correlation might not have been significant due to the small sample size, the effect was still small (Cohen, 1988), suggesting Direct Attitude may not adequately cover the breadth of the construct in the subsample.

***Conclusion and TPB-CRQ-f Revision*.** Based on the psychometric analysis some additional changes were made to the TPB-CRQ-f. Specifically, as detailed in the previous sections, four questions were deleted from the questionnaire and the relevant subscale scores (the Indirect Attitude, Subjective Norms, and Perceived Behavioural Control) were recalculated. For the sake of clarity, this version of the questionnaire is now referred to as the TPB-CRQ-f-revised and it is used in all subsequent analyses (see Appendix J for a flow chart detailing item selection and removal). The TPB-CRQ-f-revised (see Appendix R) consisted of a total of 54 items, with 11 Direct Measure items, 40 Indirect Measure items, and three Generalized Intention items (see Table 10).

Testing the Extended TPB Model

Full Sample (N=264) Data Cleaning

Prior to hypothesis testing, the complete data set (N = 273) was screened for data entry errors, completeness, random responding, outliers, and violations of statistical assumptions according to the procedures outlined by Tabachnick and Fidell (2019). Two participants were excluded from the analyses for missing 20% or more of the TPB-CRQ-

Table 10

Description of TPB-CRQ-f-revised

	General Concept	Number of Items	Scoring
Direct Attitude	Evaluative Opposites (e.g., good or bad) that lead to a favorable or unfavorable assessment of reporting	4*	7-point Likert scale
Indirect Attitude	Behavioural Beliefs and Outcome Evaluations	18	Bipolar scale ranging from -3 to +3
Direct Subjective Norms	Pressures athletes perceive from significant others in their life to report or refrain from reporting	3	7-point Likert scale
Indirect Subjective Norms	Normative Beliefs and Motivation to Comply	10*	Bipolar scale ranging from -3 to +3
Direct Perceived Behavioural Control	Athlete's confidence in ability to report, i.e., internal and external factors influencing athletes' ability to report	4	7-point Likert scale
Indirect Perceived Behavioural Control	Control Belief Strength and Control Belief Power	12*	Bipolar scale ranging from -3 to +3
Generalized Intention	Assessing a plan to report, an intention to report, and an expectation to report	3	7-point Likert scale

Note. *Denotes changes from TPB-CRQ-p items in Chapter 2, Table 5.

f-revised, EFI, AIMS, or ASRS scales according to a Missing Value Analysis in SPSS software. After these two participants were removed, a Missing Values Analysis revealed Little's MCAR test was significant (χ^2 = 5895.463, DF = 5413, $p < .001$), indicating data was not Missing Completely At Random (MCAR) and there may be a pattern to the missing values. However, no significant relationship was found between Generalized Intention to report concussion symptoms and missing data on the four scales (t = -1.186, p = .237) and the above results suggest the cases of missing data may be meaningful, such that removing them would skew results and limit the generalizability of the findings to other groups of athletes (thus the cases were not removed from the data analyses). Overall, the TPB-CRQ-f-revised scale was missing 13% of responses scattered across items, the EFI scale was missing 16% of responses across items, and the AIMS and ASRS scales were missing 1% and 0.8% of responses, respectively. No individual item on any scale was missing more than 1.5% of responses. Mean substitution was used to replace missing values at the individual item level across the data set. To identify participants who may have responded randomly or did not pay close attention to the items, questions were included in the survey to test attention (e.g., "Which of the following is not food?" and "What is two plus one?"). Data from participants who answered these questions incorrectly was carefully examined for patterns indicating random responding, and seven additional participants were removed.

Outliers. As per recommendations by Tabachnick and Fidell (2019), univariate outliers were identified in cases whose standardized scores exceeded 3.29 ($p < .001$) and were discontinuous from the rest of the data. Upon examination, outliers reflecting higher than average scores emerged for age (n = 3), number of years playing sports (n = 1), exposure to concussion education (n = 5), diagnosed concussions in primary sport (n

= 1), and undiagnosed concussions in primary sport (*n* = 1). Outliers reflecting lower than average scores emerged for the Indirect Attitude score (*n* = 1), Indirect Subjective Norm score (*n* = 1), Direct Attitude mean score (*n* = 1), Direct Subjective Norm mean score (*n* = 3), Direct Perceived Behavioural Control mean score (*n* = 1), Generalized Intention mean score (*n* = 3), EFI subscale Motivational Drive (*n* = 2), EFI subscale Organization (*n* = 1), EFI subscale Strategic Planning (*n* = 1), EFI subscale Empathy (*n* = 1), ASRS total sores (*n* = 3), and AIMS total scores (*n* = 2). Outliers were recoded one participant at a time, dealing with the most extreme cases first, so they remained the highest or lowest score, but were not discontinuous with the distributions (Field, 2013; Tabachnick & Fidell, 2019). For scales with more than one outlier, each outlier had to be recoded. Z-scores were generated for the new values and no univariate outliers remained.

Seven multivariate outliers were detected using Mahalanobis distance. To determine whether these outliers influenced results, the relevant hypotheses testing analyses (i.e., those involving the multivariate outliers) were run twice, once including and once excluding the outliers. In all analyses, the influence of the multivariate outliers was negligible and did not influence significance testing; therefore, those cases were retained for the purposes of preserving statistical power.

Normality. The continuous predictor and criterion variables were assessed for normality by examining histograms and skewness and kurtosis values. For large samples, it is recommended to use conservative alpha levels (.01 or .001) to evaluate the significance of skewness and kurtosis (Tabachnick & Fidell, 2019) and an upper threshold value of +/-3.29 (Field, 2009). Based on this criterion, several variables demonstrated large departures from normality. For the TPB-CRQ-f-revised subscales, Direct Subjective Norm was negatively skewed (z-score = -6.73), Indirect Attitude was negatively skewed (z-score = -5.26), and Generalized Intention was negatively skewed (z-score = -7.53). The Athletic Identity Measurement Scale's total score (z-score = -4.48), Social Identity subscale (z-score = -6.76) and Negative Affectivity subscale (z-score = -8.85) were negatively skewed, and the Empathy subscale of the EFI was also negatively skewed (z-score = -4.59). For demographic measures, overall level of competitiveness was strongly negatively skewed (-11.16) and had positive kurtosis (+12.18), with many athletes indicating a high level of competitiveness, and total number of sport-related concussions sustained had a positive skew (+8.57) and kurtosis (+8.68). A bimodal distribution emerged for percent of games played, in which 64.8% of athletes reported playing less than half of the time, and 35.2% reported playing more than half of the time. All other continuous variables were normally distributed.

To deal with normality assumptions, the above variables were transformed so they more closely fit a normal distribution. As per Tabachnick and Fidell (2019), negatively skewed variables were reflected before the appropriate transformation was applied. Square root transformations were calculated for the Athletic Identity Measurement Scale total score (skew z-score = -.033) and corresponding subscales (Social Identity skew z-score = -.347; Negative Affectivity skew z-score = -1.273), the Empathy variable (skew z-score = .147), and level of competitiveness (skew z-score = 2.08, kurtosis z-score = -.21). A logarithm transformation was calculated for the Direct Subjective Norm variable (skew z-score = 1.27) and total number of sport-related concussions sustained (skew z-score 1.83, kurtosis z-score = -.79), as these variables were not improved using a square root transformation. Percent of games played was recoded into a dichotomous variable to reduce the impact of its bimodal distribution. All relevant analyses were repeated with and without the above transformations, and the pattern of significant findings did not significantly differ with the transformations compared to analyses using the original, untransformed data. Therefore, to maintain interpretability of the data, the untransformed variables were used for the analyses reported below. Spearman's rho correlations were used where appropriate and regression results were interpreted with caution.

Normality for the Indirect Attitude variable was not improved with square root, logarithm, or inverse transformations. Therefore, all relevant analyses were repeated with and without the transformation that brought this variable closest to normality to determine whether this had an impact on the results. The pattern of significant findings also did not significantly differ with the transformation compared to the original, untransformed data. Thus, to maximize the psychometric properties of the variables and maintain interpretability of the data, and because MANOVA is robust to violations of normality, the untransformed Indirect Attitude variable was used for the final analyses. Spearman's rho correlations were used between other TPB and EF variables. The Indirect Attitude MANOVA was interpreted with caution.

Normality for the Generalized Intention variable was also not improved with square root, logarithm, or inverse transformations and thus the untransformed variable was used in subsequent analyses. Due to the variable's non-normal distribution, Spearman's rho correlation coefficient was used in all relevant correlation analyses. Given improvements were not made by transforming the variable, the untransformed Generalized Intention variable was also used for the one-way ANOVA and hierarchical multiple regression analyses. These results were interpreted with caution. Notably, the negative skew and restricted range of the Generalized Intention variable is likely an accurate representation of the sample and of athletes in general. Most athletes indicated stronger intention to report (6 or 7 on the Likert scale); however, participant ratings were also spread across scores in the lower range. Athletes undoubtedly understand concussion is dangerous and reporting symptoms is in their best interest, thus they may be unwilling to state they have absolutely no intention to report. Many athletes also indicated (on a separate item) their decision to report may be dependent on context (i.e., an important game), which may explain the scatter of scores on the lower range of intent.

To determine the specific beliefs with the greatest influence on Generalized Intention, Francis and colleagues (2004) recommend dichotomising the intention variable to identify which beliefs discriminate between groups of intenders. For these analyses, the Generalized Intention variable was dichotomized into groups representing higher and lower intention (range of scores 2-5 'lower intention' versus 6 and 7 'higher intention'). This approach to grouping higher versus lower intention scores has been used in other TPB and concussion research (Register-Mihalik et al., 2020). Furthermore, because using the skewed distribution of the continuous Generalized Intention variable in correlational analyses would restrict the range of variability in which the Generalized Intention variable could relate to other variables, the dichotomized variable was also used in analyses examining how the various demographic factors differed between groups of intenders. In sum, the dichotomized variable is used in analyses seeking to determine which TPB beliefs discriminated between higher and lower intenders and whether any categorical demographic variables differed between higher and lower intenders. The non-parametric (Spearman's rho) continuous Generalized Intention variable is used in regressions and correlational analyses with continuous variables.

Linearity. To examine linearity, bivariate scatterplots for the continuous variables were generated. No significant concerns with non-linearity (e.g., curvilinear relationships) were identified among the variables. To examine multicollinearity, correlations between all predictor variables were examined. As per recommendations by Tabachnik and Fidell (2019), correlations above 0.8 are considered problematic. The highest zero-order correlations in the sample were $r = .71$, indicating no concerns with multicollinearity.

Homogeneity of variance. Homogeneity of variance (or equality of covariance matrixes) was tested using Box's *M* test for each MANOVA. This procedure tests homogeneity of variance at the multivariate level to determine whether the relationship between the dependent variables is the same across cells. Box's M was violated for Indirect Attitude items, *Box's M* = 152.67, $F(45, 157305) = 3.26$, $p < .01$. However, Box's M test is highly sensitive to differences, especially in the context of large sample size such as the current data. Additionally, MANOVA is fairly robust to violations of homogeneity of variance with large, fairly equal samples sizes. Therefore, results of the MANOVA analyses were interpreted despite this violation. Levene's test was used to assess for homogeneity of variance for t-tests. For variables in which there was significant heterogeneity of variance, the values for which equal variances are not assumed are reported.

Descriptive Information

Table 11 presents a summary of participants' history with sustaining and reporting concussion experiences. Given the full sample (N=264) was utilized to test the extended TPB model, their data is summarized here (related data pertaining to the subsample used to validate the TBP-CRQ questionnaire is provided in Table 11 for

Table 11

Participant Concussion Experiences

Variable	**Subsample (*N* = 32)**	**Full Sample (*N* = 264)**
Concussion education *n* (%)		
Yes	22 (68.8)	174 (65.9)
No	10 (31.3)	90 (34.1)
Number of times they received concussion education M (*SD*)	2.57 (1.5)	3.5 (2.7)
Ever had a concussion *n* (%)		
Yes	16 (50.0)	129 (48.9)
No	16 (50.0)	135 (51.1)
Of those with positive concussion history, sustained concussion in the past five years *n* (%)		
Yes	14 (87.5)	108 (83.7)
No	2 (12.5)	21 (16.3)
Average number sport concussions overall M (*SD*)	2.9 (2.0)	3.3 (2.9)
Symptom reporting behaviour *n* (%)		
Always reported	6 (18.8)	46 (17.4)
Never reported	1 (3.1)	18 (6.8)
Sometimes reported	6 (18.8)	33 (12.5)
Total *N*	13	97
Would you always report symptoms *n* (%)		
Yes	19 (59.4)	176 (66.7)
No	-	3 (1.1)
Depends on context	13 (40.7)	82 (31.1)
Other[a]	-	3(1.1)
Would teammates always report symptoms *n* (%)		
Yes	5 (15.6)	89 (33.7)
No	8 (25.0)	28 (10.6)
Depends on context	19 (59.4)	144 (54.5)
Other[b]	-	3 (1.1)

Note. [a]Reporting dependent on whether the concussion is diagnosed or merely suspected. [b]Reporting would depend on the teammate.

informational purposes only). Just over half (58.2%) of the athletes who participated in sports with a higher likelihood of contact or collision (N = 152) had received formal concussion education at least once. A much smaller number (8%) of those playing lower contact or collision sports (*N* = 21) had received some form of concussion education. Almost half of the total sample (48.9 %; *N* = 129) had experienced at least one concussion in their lifetime. Within this subgroup, the majority (*N* = 108 [83.7% of those with a history of concussion and 40.9% of the entire sample]) experienced at least one diagnosed concussion within the past five years. Athletes indicated past symptom reporting behaviour for up to three diagnosed or undiagnosed/suspected sport-related concussions, not including times when they were pulled from a game or practice before they could report. Behaviour was coded as always reported, never reported, and sometimes reported. The top three reasons for not reporting included not thinking the injury was serious, being unsure whether they had sustained a concussion, and wanting to finish the game.

In terms of concussion reporting intentions, athletes had a more positive view of their own intentions versus those of teammates: a majority (66.7%) indicated they intended to always report future concussions but only 33.7% believed their teammates would always report future concussions. Similarly, while only 25.8% of the athletes responded that their own reporting would be context dependant (e.g., taking into account important games, try-outs, etc.), 49.6% believed their teammates reporting would be context dependant. Similarly, only 1.1% responded they did not intend to report future concussion while 10.6% believed their teammates would not report future concussions.

At the end of the survey, athletes were given the opportunity to include any qualitative information they would care to add. One wrote: *"Not being able to play due* *to a concussion often feels like a cop-out"*. Another commented on teammates' attitudes, such as "*I've had teammates in other sports play with concussions, as they did not care about the risks… they were not educated or did not care".* One athlete detailed their experience intentionally not disclosing symptoms following a hit, as well as not disclosing another possible concussion due to uncertain symptom etiology:

Both of the concussions I suffered had a delay on when I told trainers. I waited until the end of the game to report symptoms. I had just earned a starting position and I did not want to give it up. I remember the exact hit that started the symptoms and I tried to be away from the trainers on the sideline for the rest of the game. I suffered 2 more hits in the same spot during the remainder of the game. That is when the symptoms got worse and I told the trainers what I was feeling. The second concussion took me 2 weeks to report. I ran into a teammate at practice and suffered whiplash which caused another concussion. It was in the springtime and I have environmental allergies. I was under the impression that the symptoms were allergy related so I did not report anything.

Other responses included statements outlining coach complacency, such as *"Some coaches let us keep playing"*, and a longer response detailing an experience of a coach's disregard for an athlete's concerns:

I obtained a concussion in warm up before [a] game, I notified my coach that I felt sick and was dizzy and she then continued to put me down on the scoresheet to start that game and I asked her several times to please take me out. She made me play all five sets, I lost my memory for the whole day, and then she continued to, after the game, report my concussion to the athletic trainer on duty but didn't feel the need to report my concussion before the game or during the game.

Finally, two athletes included information about the serious consequences they faced following concussive injury:

(1) *The reason track and field is now my primary sport is due to concussions sustained during ice hockey and football, and a fear of sustaining more concussions/more severe concussions.*

(2) I had to quit playing hockey this year due to sustaining multiple SRCs. I now experience post-concussion syndrome. Before this had happened, I was a lot less likely to report concussion symptoms.

TPB-CRQ-f-revised Psychometric Qualities and Descriptive Data

The internal consistency of the TPB-CRQ-f-revised subscales as well as the bivariate correlations between the Direct and Indirect Measures for each construct are presented in Table 12. As illustrated, the internal consistency of the Direct Measures was acceptable with the exception of Direct Attitude; therefore, the findings relating to this measure were interpreted with caution. There were significant correlations between the Direct and Indirect Measures confirming validity of each Indirect Measure (Francis et al., 2004). Adhering to established TPB scoring procedures (Francis et al., 2004), the mean of the Direct Measure items was calculated for each construct, which yielded a score out of seven for Attitude (M = 5.71, SD =.96), Subjective Norm (M = 6.06, SD = .87), Perceived Behavioural Control (M = 4.67, SD = 1.45), and Generalized Intention (M = 5.86, SD = 1.20). Details pertaining to Direct and Indirect Measure scoring is described in the *Measures* section in *Chapter 2.*

Since Indirect Measures are rated on a bipolar scale ranging from -3 to +3, positive scores indicate the athlete is in favour of reporting symptoms and negative

Table 12

Reliability of the TPB-CRQ-f-revised

	Indirect and Direct Measure Bivariate Correlations (*r*)	**Internal Consistency (α)**
Attitude	.55 [a]**	.60
Subjective Norms	.39[b]**	.71
Perceived Behavioural Control	.50**	.73
Generalized Intention	N/A	.89

Note. [a]Attitude reported as Spearman's rho (r_s). [b]Subjective Norms reported as Spearman's rho (r_s). N/A values not applicable as Generalized Intention does not have an Indirect Measure equivalent.

**$p < .01$.

scores indicate they are not in favour of reporting. Athletes' average score for Indirect Attitude was 100.70 (*SD* = 32.44; possible range = -189 to +189), reflecting a strong positive attitude in favour of reporting symptoms. Athletes' average score for Indirect Subjective Norm was 47.82 (*SD* = 29.36; possible range = -105 to + 105), reflecting a moderate to weak level of positive social pressure to report symptoms. Athletes' average score for Indirect Perceived Behavioural Control was 42.55 (*SD* = 35.97; possible range of -147 to +147), reflecting a weak level of positive control in reporting symptoms. As illustrated in Table 13, Indirect Attitude was most highly correlated with Generalized Intention, followed in order of magnitude by Indirect Perceived Behavioural Control, Direct Perceived Behavioural Control, Direct Attitude, Direct Social Norms, and Indirect Social Norms. Correlations between Generalized Intention and the rest of the TPB-CRQ-f-revised subscales were strong, with the exception of Direct and Indirect Subjective Norms, which fell in the medium correlation range.

Main Analyses

Multiple analyses were employed to examine each of the research questions below. Conservative alpha levels using Bonferroni corrections were considered to control for Type I error, however, because many of the research questions were exploratory it was considered too prohibitive to use a Bonferroni corrected alpha for every analysis. Thus, to control for Type I error, a conservative alpha level of .01 was used and effect sizes were examined to further interpret whether findings were meaningful.

RQ1: Do demographic factors (e.g., years of sport experience, concussion history, previous concussion symptom reporting, etc.) influence intention to report?

Bivariate correlations using Spearman's rho were used to examine the association between some athlete demographic factors and reporting intention, as

Table 13

Bivariate Associations between TPB Variables

	Generalized Intention[a]	Indirect Attitude[b]	Indirect SN	Indirect PBC	Direct Attitude	Direct SN[c]	Direct PBC[d]
Generalized Intention[a]	_						
Indirect Attitude[b]	.63***	_					
Indirect SN[c]	.40***	.38***	_				
Indirect PBC	.59***	.60***	.52***	_			
Direct Attitude	.52***	.55***	.51***	.60***	_		
Direct SN[cd]	.49***	.47***	.39***	.52***	.48***	_	
Direct PBC[e]	.57***	.42***	.33***	.50***	.49***	.48***	_

Note. [a]Generalized Intention correlations reported as Spearman's rho (r_s). [b]Indirect Attitude correlations reported as Spearman's rho (r_s). [c]Subjective Norms. [d]Direct Subjective Norms correlations reported as Spearman's rho (r_s). [e]Perceived Behavioural Control.

***$p < .001$.

measured by the TPB-CRQ-f-revised Generalized Intention (continuous) variable (categorical demographic variables are described below). None of the continuous variables examined (i.e., age, total number of sport-related concussions, level of competitiveness, ADHD symptomatology, and athletic identity [total AIMS score and Social Identity, Affectivity, and Exclusivity subscales]), were associated with intention to report ($p > .04$). All effect sizes were small, with $r_s = .12$ as the largest correlation coefficient.

A one-way between-groups ANOVA was conducted to explore the impact of number of years playing on a university-level team on athletes' Generalized Intention. Subjects were divided into five groups (one year or less, two years, three years, four years, and five or more years). A statistically significant difference was not found in level of Generalized Intention $F(5, 259) = .103$, $p = .98$. Eta squared values were examined to determine effect size by identifying small (.01), medium (.06) and large (.14) effect sizes (Cohen, 1988). The effect size for this analysis was very small at .002.

To predict demographic differences between groups of intenders, the Generalized Intention variable was recoded into a dichotomous variable as described in the *Data Cleaning* section, such that higher intention ($N = 161$) was represented by athletes rating their average intention as a 6 (*Agree*) or 7 (*Strongly Agree*) on the 7-point Likert scale, and lower intention ($N = 103$) was represented by athletes rating their average intention between 1 (*Strongly Disagree*) and 5 (*Somewhat Agree*) on the 7-point Likert scale. No athlete rated Intention as 1 (*Strongly Disagree*), therefore the scale was representative of 2-point through 7-point responses. The categorical demographic variables examined included gender, leadership role on team, ranking on team, importance on team, percent of games played (i.e., less than 60% or more than 60%), concussion education (yes/no), concussion history (yes/no), reporting history (always/never/sometimes), and whether athletes indicated they would always report in the future (yes/no/depends on context).

As would be expected, a Chi-square test for independence indicated a significant medium association ($\phi_c = .41$)[3] between Generalized Intention scores and the item directly asking athletes if they plan to report in the future, χ^2 (2, n = 264) = 45.01, p < .001, Cramer's V = .41. That is, those endorsing higher Generalized Intention on the TPB-CRQ-f-revised were more likely to respond "Yes" to a separate question about always reporting in the future (z-score = 2.4), and those with lower TPB-CRQ-f-revised Generalized Intention scores indicated their future reporting would more likely depend on context (z-score = 4.0; see Table 14). In terms of the association between Generalized Intention scores and past concussion reporting, results of the Chi-square analysis were not significant at the p < .01 level, however significance at the p = .01 level was observed. Specifically, there was a trend toward a significant medium association (ϕ_c = .30) between Generalized Intention scores and concussion reporting history (i.e., whether they always reported, never reported, or sometimes reported across all concussions within the past 5 years), χ^2 (2, n = 97) = 8.79, p = .01, Cramer's V = .30. Those with higher Generalized Intention scores indicated they were less likely to have never reported in the past (z-score = -1.7) relative to those with lower Generalized Intention scores. In contrast, those with lower Generalized Intention scores were more likely to endorse never reporting in the past (z-score = 2.0) relative to those with higher Generalized Intention scores. That is, athletes who have future Intention to report tended to have a history of reporting at least some of the time, and those who indicated lower

[3] For 2x3 Chi Square tables, Cramer's V values were examined to determine effect size by identifying small (.01), medium (.30) and large (.50) effect sizes (Cohen, 1988).

Table 14

Chi-Square Test of Independence for Intention to Report and Future/Historical Reporting

	Generalized Intention – Dichotomous			
	Higher Intention	Lower Intention	χ^2	ϕ_c
Future Reporting				
Yes	132 (2.4)	44 (-3.0)	45.01***	.41
No	0 (-1.4)	3 (1.7)		
Depends on context	29 (-3.2)	56 (4.0)		
Reporting History				
Consistently reported	30 (0.6)	16 (-0.7)	8.77*	.30
Consistently did not report	5 (-1.7)	13 (2.0)		
Inconsistently reported	22 (0.6)	11 (-0.7)		

Note. Adjusted standardized residuals appear in parentheses below group frequencies.

*$p < .05$. ***$p < .001$.

future Intention to report tended to have never reported past concussions. None of the other demographic variables (all 2x2 Chi Square tables) were significant ($p > .04$) and all demonstrated small effect sizes (largest phi = .25)[4].

RQ 2: Does EF play a role in reporting possible concussion symptoms?

Hypothesis 2A: Athletes with higher overall EF will be more likely to indicate stronger Generalized Intention to report than athletes with lower overall EF. Participants' scores on the EFI are presented in Table 15 alongside the EFI normative data (Spinella, 2009) for comparison. Results of z tests comparing the participants' mean scores for each EF domain and EFI Total score to the normative data revealed that, except for Impulse Control, athlete EFI scores were statistically significantly higher than those found in the general population (see Table 15). The magnitude of these effects ranged from small ($d = 0.2$) to medium ($d = 0.5$). Consistent with the hypothesis, higher Generalized Intention to report was correlated with higher scores on the Total EFI ($r_s = .21$, $p < .001$), although the relationship was weak. Generalized Intention to report was also weakly, significantly correlated with the EFI Empathy ($r_s = .20$, $p < .01$) and Motivational Drive ($r_s = .19$, $p < .001$; see Table 16) subscales but not the remaining subscales. T-tests were used to examine whether there were significant differences in EF between those who were classified as having higher intention to report compared to those who were classified as having lower intention to report (i.e., the dichotomous Generalized Intention variable). The results, presented in Table 17, indicate those with higher intention to report had higher Total EFI scores ($t = 2.73$, $p = .007$) and higher levels of Empathy ($t = 3.06$, $p = .002$); however Cohen's d was examined to determine

[4] For 2x2 Chi Square tables, phi coefficients were examined to determine effect size by identifying small (.01), medium (.30) and large (.50) effect sizes (Cohen, 1988).

Table 15

EFI Descriptive Statistics

	Athlete Sample *Mean (SD)*	EFI Norms *Mean (SD)*	Z-Scores (*d*)
Motivational Drive	15.6 (2.6)	14.6 (2.6)	6.3 (0.4)**
Organization	16.8 (3.4)	15.7 (4.1)	4.4 (0.3)**
Strategic planning	24.9 (3.9)	23.6 (4.0)	5.2 (0.3)**
Impulse control	16.8 (3.2)	16.1 (4.5)	2.5 (0.2)*
Empathy	24.9 (3.8)	23.7 (3.8)	5.2 (0.3)**
EFI Total	99.0 (10.3)	93.8(11.9)	8.1 (0.5)**

Note. *$p < .05$, two-tailed, **$p < .01$, two-tailed.

Table 16

Correlations among TPB-CRQ-f-revised and EFI Variables

	EFI Total	MD	ORG	SP	IC	EM[d]
Indirect Attitude[a]	.30**	.16**	.09	.13	.28**	.28**
Indirect Subjective Norm	.26**	.15**	.03	.14	.10	.32**
Indirect PBC	.29**	.16**	.09	.11	.18**	.35**
Direct Attitude	.23**	.15	.04	.10	.11	.25**
Direct Subjective Norm[b]	.25**	.10	.12	.20**	.09	.29**
Direct PBC	.16**	.04	.15	.08	.17**	.06
Generalized Intention[c]	.21**	.19**	.03	.12	.11	.20**

Note. [a]Indirect Attitude correlations reported as Spearman's rho (r_s). [b]Direct Subjective Norms correlations reported as Spearman's rho (r_s). [c]Generalized Intention (continuous variable) reported as Spearman's rho. [d]Empathy correlations reported as Spearman's rho (r_s).

**$p < .01$.

Table 17

Differences in EF Domains for Higher and Lower Intention to Report

Domain	Higher Intenders		Lower Intenders		*t* [a]	*p*
	M	*SD*	*M*	*SD*		
MD	15.88	2.43	15.21	2.76	2.05	.042
ORG	16.83	3.38	16.84	3.50	-0.03	.977
SP	25.21	3.61	24.43	4.32	1.58	.115
IC	16.99	3.22	16.42	3.21	1.40	.162
EM	25.46	3.41	24.01	4.25	3.06	.002
Total EF	100.35	9.77	96.84	10.79	2.73	.007

Note. Motivational Drive (MD), Organization (ORG), Strategic Planning (SP), Impulse Control (IC), Empathy (EM).

[a]*df* = 262.

the strength of the comparison by identifying small (.20), medium (.50), and large (.80) effect sizes (Cohen, 1988), and the strength of both analyses were small (d = .34 and .35, respectively).

Hypothesis 2B: Athletes with higher EFI Total scores will indicate a history of reporting concussion symptoms more so than athletes with lower EFI Total scores.

A one-way between-groups ANOVA was conducted to explore the impact of EF on concussion symptom reporting history within the past 5 years, as designated by consistently always reporting, never reporting, or sometimes reporting. A statistically significant difference was not found in level of overall EF and reporting history $F(2, 102) = .438$, $p = .65$. The effect size, calculated using eta squared, was small at .009.

RQ3: Does the extended TPB model better explain university athlete's intention to report concussion symptoms?

Hypothesis 3A: The extended TPB model will account for significant additional variance in intention to report possible concussion symptoms over and above the original TPB model.

A hierarchical multiple regression analysis was used to examine EF predictors of Generalized Intention after controlling for the original TPB variables (see Table 18). The TPB Direct Measures were entered at Step 1 and the five EF domains (Motivational Drive, Strategic Planning, Organization, Impulsivity, and Empathy) were entered at Step 2. At Step 1, the TPB Direct Measures accounted for 35.1% of the variance in intention to report, $F(3, 260) = 46.87$, $p < .001$. Direct Attitude, Direct Subjective Norm, and Direct Perceived Behavioural Control were each significant individual predictors, with Direct Perceived Behavioural Control recording a higher beta value (beta = .304, p <

Table 18

Hierarchical Regression Results Predicting Generalized Intention with TPB and EF Domains (N = 264)

Predictor	***B***	***SE B***	***β***	***F Change***	***R*²**	**Δ*R*²**
Step 1				46.87***	.35	.35
Direct Attitude	0.32	0.07	0.26***			
Direct Subjective Norm	0.24	0.08	0.17**			
Direct Perceived Behavioural Control	0.25	0.05	0.30***			
				1.07	.36	.01
Step 2						
Direct Attitude	0.29	0.08	0.24***			
Direct Subjective Norm	0.24	.08	0.17**			
Direct Perceived Behavioural Control	0.26	0.05	0.31***			
Motivational Drive	0.05	0.03	0.11			
Organization	-0.02	0.02	-0.07			
Strategic Planning	-0.001	0.02	-0.003			
Impulse Control	0.02	0.02	0.06			
Empathy	0.01	0.02	0.004			

$^{**}p < .01$. $^{***}p < .001$.

.001) than Direct Attitude (beta = .260, $p < .001$) and Subjective Norm (beta =.170, $p < .01$). In contrast to the hypothesis, however, the block of EF factors added in Step 2 did not significantly add to the equation, F_{change} (5, 255) = 1.07, $p = .376$. The effect size attributable to the addition of the second step was small (Cohen's $f^2 = .02$), as per small (.02), medium (.15), and large (.35) effect size magnitudes (Cohen, 1988).

A second exploratory post hoc multiple regression analysis was run to examine whether the EFI Total score alone would add to the variance accounted for by the original TPB variables. As shown in Table 19, the addition of the EFI Total score in Step 2 also did not significantly add to the equation, F_{change} (1, 259) = 1.16, $p = .284$. The magnitude of the addition of EF was also small (Cohen's $f^2 = .005$).

Hypothesis 3B: Impulsivity, Organization, and Strategic Planning will account for a significant amount of variance in the relationship between the TPB and intention to report concussion symptoms.

According to the hierarchical multiple regression discussed above, none of the EF domains significantly added to the model over and above the original TPB variables. A separate post hoc multiple regression analysis was run to examine only the EF predictors (i.e., not including TPB variables; see Table 20), resulting in EF domains accounting for only 5% of the variance in intention to report, $F(5, 258) = 2.76$, $p = .02$. None of the individual domains were statistically significant, and the effect was small (Cohen's $f^2 = .05$).

RQ4: Do the Indirect Beliefs discriminate between athletes with higher and lower Generalized Intention?

Hypothesis 4A: All Indirect Beliefs will significantly discriminate intenders.

Table 19

Hierarchical Regression Results Predicting Generalized Intention with TPB and Total EFI (N = 264)

Predictor	***B***	***SE B***	***β***	***F Change***	R^2	ΔR^2
Step 1				46.864***	.35	.35
Direct Attitude	0.32	0.07	0.26***			
Direct Subjective Norm	0.24	0.08	-0.17**			
Direct Perceived Behavioural Control	0.25	0.05	0.30***			
Step 2				1.155	.35	.003
Direct Attitude	0.31	0.08	0.25***			
Direct Subjective Norm	0.22	0.08	-0.16**			
Direct Perceived Behavioural Control	0.25	0.05	0.30***			
EFI Total	0.01	0.01	0.06			

**$p < .01$. ***$p < .001$.

Table 20

Regression Results Predicting Generalized Intention with EF Domains Only (N = 264)

Predictor	***B***	***SE B***	***β***	***F Change***	R^2	ΔR^2
Constant	3.45	.71		2.76*	.05	.05
Motivational Drive	0.06	.03	.13			
Organization	-0.01	.02	-.02			
Strategic Planning	0.01	.02	.02			
Impulse Control	0.04	.03	.12			
Empathy	0.03	.02	.09			

*$p < .05$.

Three MANOVAs were used to determine whether each group of Indirect beliefs (i.e, behavioural beliefs, normative beliefs, or perceived control beliefs) discriminated between athletes who endorsed higher intention versus those who endorsed lower intention. If the Indirect beliefs did significantly discriminate between groups (i.e., a multivariate effect was found), each belief was then examined to determine whether it was more or less important based on effect size. In the first analysis (see Table 21), the extent to which the Indirect Attitude items from the TPB-CRQ-f-revised differed between those with high intentions versus low intentions to report was examined. Similarly, the impact of Indirect Subjective Norms (see Table 22) and Indirect Perceived Behavioural Control (see Table 23) were examined in the second and third MANOVAs. Levene's Test of Equality of Error Variances was not significant for the Attitude and Perceived Behavioural Control multivariate effects; therefore, a more conservative alpha level ($p < .01$) was set for determining significance. Ultimately, significant findings for all three MANOVAs occurred at the $p < .005$ level. Since the multivariate effects were significant for each construct, the items were then examined to determine which most strongly differentiated higher from lower intenders. Partial Eta Squared values were examined to discriminate the strength of endorsed beliefs by identifying small (.01), medium (.06), and large (.14) effect sizes (Cohen, 1988).

Table 21

Multivariate Effect of Intention to Report (High Intention vs. Low Intention) on Weighted Items Contributing to Indirect Attitude

	Pillai's V	Multivariate *F*	High Intention (n = 161) *M* (*SD*)	Low Intention (n = 103) *M* (*SD*)	Univariate *F*	Partial Eta Squared
	.27	10.39***				
1. Reporting would be best for the team			16.75 (0.49)	12.56 (0.61)	28.51***	.098
2. Reporting would reduce chances of another injury in the short-term			17.82 (0.50)	13.03 (0.63)	35.48***	.119
3. Teammates will have a negative view of me[a]			-3.39 (0.38)	-5.34 (0.48)	10.33***	.038
4. I will lose playing time[b]			-7.49 (0.69)	-10.97 (0.86)	9.92***	.036
5. Reporting will help me maintain long-term health			19.57 (0.39)	16.54 (0.49)	23.49***	.082
6. Reporting will lead to an accurate diagnosis			15.21 (0.56)	10.82 (0.70)	24.30***	.085
7. Reporting will help maintain good academic standing			16.89 (0.43)	13.08 (0.54)	30.73***	.105
8. Reporting will prevent serious injury			18.88 (0.45)	15.47 (0.56)	22.33***	.079
9. Reporting will give me a better chance of recovering			19.25 (0.36)	15.30 (0.46)	45.81***	.149

Note: a. The negative mean score reflects the belief that teammates having a negative view of the athlete is undesirable and thus would deter reporting.

b. The negative mean score reflects the belief that losing playing time as a result of reporting is undesirable and thus would deter reporting.

***p < .001.

Table 22

Multivariate Effect of Intention to Report (High Intention vs. Low Intention) on Weighted Items Contributing to Indirect Subjective Norms

	Pillai's V	Multivariate *F*	High Intention (n = 161)	Low Intention (n = 103)	Univariate *F*	Partial Eta Squared
			M (*SD*)	*M* (*SD*)		
	.18	9.64***				
1. Coach would approve of reporting			12.96 (0.92)	9.89 (1.15)	4.32	.016
2. My teammates report			7.53 (0.70)	3.35 (0.88)	13.89***	.050
3. My teammates think I should report			10.68 (0.63)	6.75 (0.79)	14.97***	.054
4. My family thinks I should report			14.50 (0.85)	12.88 (1.07)	1.40	.005
5. Top players report			9.81 (0.66)	2.63 (0.83)	46.04***	.149

Note. ***p < .001.

Table 23

Multivariate Effect of Intention to Report (High Intention vs. Low Intention) on Weighted Items Contributing to Indirect Perceived Behavioural Control

	Pillai's V	Multivariate *F*	High Intention (n = 161) *M* (*SD*)	Low Intention (n = 103) *M* (*SD*)	Univariate *F*	Partial Eta Squared
	.27	15.42***				
1. I feel comfortable reporting to my coach			11.73 (0.77)	5.82 (.96)	23.28***	.082
2. Having an AT or doctor at games makes it easier to report			13.73 (0.57)	10.53 (0.71)	12.24***	.045
3. Teammate concussion knowledge makes it easier to report			10.26 (0.64)	3.49 (0.80)	43.80***	.143
4. Knowing for sure makes it easier to report			11.40 (0.57)	6.51 (0.71)	29.04***	.100
5. Letting the team down makes it more difficult to report[a]			-2.22 (0.45)	-5.43 (0.56)	20.02***	.071
6. Team support makes it easier to report			13.16 (0.67)	4.72 (0.84)	61.86***	.191

Note. [a]The negative mean score reflects the belief that letting the team down is undesirable and thus would deter reporting. "If I report possible concussion symptoms, I will be letting the team down/The possibility of letting the team down makes it easier to report".

***$p < .001$.

As per H4 and illustrated in Table 21, each of the behavioural beliefs associated with the Indirect Attitude Measure significantly impacted reporting intentions. Effect sizes ranged from small to large with the largest effect observed for the belief that reporting would improve recovery and the smallest effect observed for the belief that reporting would lead to lost playing time. In terms of Indirect Subjective Norms (i.e., social pressures to report; see Table 22), the largest influence on Intentions to Report were norms related to the belief that top players and teammates would report/believe athletes should report. Contrary to H4, normative beliefs related to the views of coaches and family members did not significantly impact Intentions to Report. Lastly, the results presented in Table 23 show that each of the Indirect Perceived control beliefs influenced Intentions to Report with effect sizes ranging from large (support from the team and greater teammate concussion knowledge makes it easier to report) to small (having an AT or health care professional present makes it easier to report).

CHAPTER 4: GENERAL DISCUSSION

Concussion non-reporting among university-level athletes is an important safety concern due to the potential short- and long-term health risks associated with symptomatic return to play (McCrory et al., 2017). While most athletes appear to demonstrate some degree of knowledge and understanding about the symptoms and risks of concussion (Beidler et al., 2018; Doucette et al., 2020; Miyashita et al., 2013; Register-Mihalik, Guskiewicz, et al., 2013), they often conceal symptoms following suspected concussive injury (Broglio et al., 2010; Kaut et al., 2003; Kerr et al., 2014; Kroshus et al., 2017, 2020; Kroshus, Garnett, Hawrilenko, et al., 2015; Williamson & Goodman, 2006). The TPB has been used to help explain some of the variance in this risky behaviour, but has emerged as only partially accountable in explaining athletes' reporting decisions about possible concussion symptoms (Beakey et al., 2016; Carpenter et al., 2020; Kroshus et al., 2014; Rawlins et al., 2020; Register-Mihalik, Guskiewicz, et al., 2013).

The only study investigating the role of the TPB in concussion reporting most closely following suggested methodological guidelines (Ajzen, 2006; Francis et al., 2004) involved high school athletes (Register-Mihalik, Linnan, et al., 2013). In that study, the model accounted for 58% of the variance in intention to report (Register-Mihalik, Linnan, et al., 2013). More information is needed to understand university-level athlete symptom reporting and the addition of new predictors to the original TPB model holds promise in further explaining the mechanisms behind this behaviour. Ajzen (1991) notes additional predictors may be added to extend the TPB if they significantly add to the variance in intention or behaviour over and above the original variables. Since the effective use of one's EF abilities (i.e., decision making, remembering previous intentions) is an important consideration in deciding to report, it was hypothesized the addition of EF as an extension to the traditional TPB model would help explain added variance in athletes' intention to report possible symptoms and inform more efficacious interventions to promote reporting among university-level athletes.

Prior to testing the proposed EF-extended TPB model, it was necessary to develop a TPB questionnaire for concussion reporting in university-level athletes. No questionnaires have previously been developed for this population following the systematic methods put forth by Ajzen (2006) and outlined by Francis and colleagues (2004). Once the initial questionnaire was developed, the finalized measure (the TPB-CRQ-f-revised) was used in the evaluation of the proposed EF-extended TPB model. Other potentially relevant demographic and sport-related background factors were also explored as important considerations in the understanding of reporting behaviour. Finally, the salient TPB beliefs discriminating between athletes with higher and lower intention to report were used to inform a suggested intervention.

Development of the TPB-CRQ Questionnaire

Ajzen (2006) outlines a three-step procedure for developing an efficacious TPB questionnaire for a new behaviour or population: conducting an elicitation interview, having a small number of participants from the elicitation interviews take part in a pilot study to review the questionnaire for clarity and salient content, and determining the reliability of the measure to ensure the final version of the questionnaire is psychometrically sound. Descriptions and conclusions pertaining to the first two steps are described in *Chapter2*. Given the final step (i.e., testing of the internal consistency of the Direct Measures and test-retest reliability of the Direct and Indirect Measures) was undertaking with a subsample of the larger sample recruited to test the extended model, the discussion below focuses mainly on the reliability testing and considerations of the final questionnaire version.

TPB-CRQ-f Considerations

As noted in *Chapter 2,* contradictory beliefs and social referents emerged as supportive of reporting depending on the context, which highlights the complexity of the decision-making process and the importance of considering context when trying to understand reporting behaviour. Contradictory beliefs introduce a challenge in creating a cohesive questionnaire, since those beliefs, which may be true or false depending on context, make these items difficult to answer. This may have impacted the test-retest reliability of the questionnaire by increasing the probability of inconsistent answers across administrations of the measure. It may also make completing the questionnaire more difficult in general and lead to more mid-point scores if athletes average out their experiences, for example by choosing midrange options such as "neither likely or unlikely". Alternatively, responses to these items may depend on athletes' most recent experiences, so even if reporting is largely seen as an advantage to the team, recently receiving negative feedback on reporting may cause an athlete to generalize all experiences as negative. In future research, if contradictory responses are found in elicitation interviews, researchers should ask athletes for more information to clarify the contexts under which the contradictory beliefs are relevant to create questionnaire items specific to context.

In terms of reliability, adequate internal consistency was found for the Direct Subjective Norm and Perceived Behavioural Control constructs but not the Direct Attitude Measure. Thus, more work refining the Attitude construct needs to be completed to establish a psychometrically stronger measure. Results related to the Direct

Attitude Measure must additionally be interpreted with caution, as the Measure may not be a cohesive representation of athletes' beliefs about reporting. Nevertheless, the latter is an interesting and important finding in itself. Whereas the aim of the Direct Attitude Measure is traditionally to discover where an individual falls along the continuum between bipolar opposite descriptors such as good versus bad, the elicitation interviews/Indirect Measure emphasized the fact that athletes view reporting as both good *and* bad depending on the context in which they are injured. As noted above, this potentially made the Direct Attitude items more difficult to answer, thus impacting the internal consistency of the Direct Measure, and limiting its contribution to the extended model. This, in turn, negatively impacted the ability of the model to explain a substantial amount of variance in intentions to report. Although Direct Attitude items are traditionally generated by the researcher, the range of emotions and evaluations about reporting elicited directly from athletes could be more effectively used to strengthen the Direct Attitude Measure. Conversely, the bipolar opposite structure of Direct Attitude items may not be as suitable for concussion symptom reporting as it is for other health behaviours due to the ambiguity associated with both concussion symptoms and best practices for addressing concussion in RTP protocols.

Another potential area for improvement of the questionnaire is in the Indirect Attitude items related to the disadvantages of reporting. In the TPB-CRQ-f-revised, the Indirect Attitude items were compiled of a larger ratio of advantages to disadvantages for reporting concussion, potentially leading to more positive attitudes toward reporting than may realistically exist. While the advantages and disadvantages came directly from athletes in the elicitation interview, the only frequently endorsed disadvantages of reporting included missed play and negative evaluation from the team. Asking athletes to further unpack how reporting might disadvantage the team or generate several reasons why missing play would be aversive may uncover more nuanced, diverse themes to balance the Indirect Attitude Measure.

In addition, being removed from play was considered as both a potential advantage and disadvantage to the team in the elicitation interview; however, it was worded in the final questionnaire as an advantage (*"It would be best for the team if I report"*). This may have led participants to consider only the benefits of reporting when rating their agreement with this statement. Including both versions (*"It would be best for the team to report symptoms…"* and *"It would disadvantage the team to report symptoms…"*) might have allowed athletes to consider which statement they feel is more true the majority of the time, providing a more balanced representation of athletes' beliefs. Including both options may wash out any directional results but could further highlight the dynamic and challenging decision-making process athletes engage in when experiencing concussion symptoms.

Development of the TPB-CRQ Questionnaire: Conclusions

The purpose of developing the TPB-CRQ-f-revised was to establish an appropriate TPB measure for concussion symptom reporting among university-level athletes to fill an existing gap in the field. Following Ajzen's (2006) recommendations, the TPB-CRQ-f-revised took considerable time and effort to develop, and despite engaging in elicitation interviews, a pilot study, and reliability testing, limitations in the reliability of the Direct Attitude subscale meant results of hypothesis testing using the TPB-CRQ-f-revised in the present study had to be interpreted cautiously. Given the time and resources needed to follow the recommended process for creating a TBP questionnaire (Ajzen, 2006; Francis et al., 2004), it is understandable researchers look for readily available tools and have historically adapted existing measures. Results from the present study, however, highlight why this recommendation has been made: important new information about athletes' beliefs, concerns, pressures, and perceived control was generated during the questionnaire development process that would have otherwise been missed. Specifically, the importance of context and the fact that athletes can simultaneously hold contradictory attitudes are important considerations when developing a measure to study university-level concussion symptom reporting. Further revision remains necessary to develop a psychometrically stronger questionnaire representing context-dependent salient concerns and beliefs of university athletes. Despite these limitations, the problems with the Attitude construct were informative in highlighting the dynamic manner in which athletes use context dependent information in decision making.

Association between Demographic Variables and Intention to Report Future Concussions

The association between demographic factors and Generalized Intention to report (Research Question 1) revealed the majority of demographic and sporting variables were not significantly associated with Generalized Intention. These null findings are consistent with a few studies similarly reporting non-significant results (Doucette et al., 2020; Kroshus, Baugh, Hawrilenko, et al., 2015; Lempke et al., 2020). Nevertheless, there remains considerable inconsistency in the findings making it difficult to draw firm conclusions about the association between demographic variables and intentions to report. For example, some research has found female (versus male) athletes (Kroshus et al., 2017; Weber et al., 2019) express higher intentions to report while athletes with greater knowledge/concussion education sometimes report higher intentions (Kroshus, Daneshvar, et al., 2014; Rawlins et al., 2020) and sometimes do not (Conway et al., 2018; Kerr et al., 2014; Kroshus et al., 2015, 2017; Llewellyn et al., 2014; Meehan et al., 2013; Meier et al., 2015; Register-Mihalik, Guskiewicz, et al., 2013; Register-Mihalik et al., 2017). In addition, some research has found athletes with a previous history of concussion (Anderson et al., 2021; Baugh et al., 2019; Register-Mihalik et al., 2017), higher levels of competitiveness (Doucette et al., 2020), stronger athletic identity (Wayment et al., 2019), and a higher level of perceived importance to the team (e.g., team captains, star players; Bissett & Tamminen, 2020) have expressed lower intentions to report. The inconsistency in findings likely reflects the ambiguous nature concussion symptoms, uncertainty about how to report, assumptions about expectations of teammates and coaches, etc. The results of this dissertation further suggest that inconsistencies in the literature might also reflect the fact that athletes appear to simultaneously hold contradictory beliefs about the benefits of reporting depending on context and thus may interpret questions or respond to questions in various ways across studies.

One unique and particularly relevant demographic variable examined in the current dissertation was ADHD symptomology, which has not been previously studied in relation to concussion symptom reporting. There is evidence adults with ADHD experience increased difficulty with aspects of EF relevant to intention such as prospective-memory, anticipation of consequences, and forward planning (Altgassen et al., 2019), which may impact reporting intention and decision making. For this reason, ADHD was considered an important variable to measure. Finding ADHD was not associated with Generalized Intention was unexpected, especially since athletes on average rated ADHD symptomatology on the ASRS as only slightly less than the predicted probability of being clinically diagnosed with ADHD. Concussion and ADHD symptoms also overlap (Iverson et al., 2015; Littleton et al., 2015), especially cognitive domain symptoms (Asken et al., 2017), to the degree that the specificity of computerized neurocognitive tests used in some concussion assessment is poor for athletes with ADHD (Adams et al., 2017; Manderino et al., 2019; Nelson et al., 2015). Because symptoms are similar, athletes with ADHD may be more likely to base reporting decisions on their own propensity toward risk taking, how knowledgeable they believe their coach or athletic trainers are about concussion/ADHD symptom overlap, or, most importantly, the context in which they are injured. That is, if an athlete with higher overall ADHD symptomatology experiences concussion symptoms in a higher stakes situation, they may be more likely to assign non-specific cognitive symptoms to ADHD rather than concussion. The presence of pre-existing ADHD symptoms may provide athletes with a plausible alternative explanation for ambiguous concussion-related symptoms, enabling them to better justify continued play (i.e., not reporting) to themselves. Given this study is the first to examine the relationship between ADHD and concussion symptom reporting intention, further research is needed to confirm the lack of association found in the current dissertation.

Consistent with the findings discussed above, the results of this study also confirm that the association between demographic variables and Generalized Intentions to report concussion is inconsistent. Given this inconsistency, there is little support for targeting specific demographic characteristics to improve reporting intention. For example, ensuring education reaches certain demographic groups (e.g., males, those with a history of concussion or ADHD, those with higher athletic identity or more importance to team) is unlikely to improve outcomes. Ajzen (1991) describes such variables as ‘background factors’ and notes they are generally of little consequence within the conceptualization of the TPB compared to Attitudes, Subjective Norms, and Perceived Behavioural Control. As emphasized during the elicitation interviews and in answering questions about predicted future behaviour, the observed inconsistencies and null findings may be in large part due to the importance of context. In fact, a correlation approaching significance ($p = .01$) was observed between Generalized Intention and an item assessing whether athletes would consider context in future reporting decisions. This is supported by recent research examining the association between EF and other health behaviours, which found the environment in which people are making decisions plays an important role in determining whether they behave in health-protective or health-damaging ways (Gray-Burrows et al., 2019).

Other than desire to stay in the game, athletes choosing not to report in some contexts may relate to the ambiguity of concussion symptoms in much the same manner described above with ADHD, such that when stakes are high they may be more likely or willing to attribute symptoms such as dizziness, for example, to hot weather, insufficient caloric intake, etc. (Chrisman et al., 2013). In addition, one third of the sample reported having never received formal concussion education, which increases the likelihood of misattributing or ignoring less obvious symptoms. This figure includes 23.1% of athletes playing sports with a higher risk of collision, a surprisingly high number given the move toward integrating safety and RTP guidelines following the most recent consensus statement on concussion in sport (McCrory et al., 2017; Parachute, 2017). Clearly, recommendations have not translated to national university sports policy, though this will hopefully improve with the dissemination of the pan-Canadian Concussion Guidelines included in the Canadian Institutes of Health Research’s Strategic Plan 2020-

2022 (Government of Canada, 2020).

Despite the high reports of lack of exposure to concussion education, sport-related concussion is already such a highly publicized topic that it is unlikely athletes are completely unaware there are serious consequences related to symptomatic RTP. A more probable explanation (than lack of concussion education) for low reporting intentions is fluid intention. That is, most athletes appear to have some understanding regarding the consequences of continuing to play (or at least have a general idea they probably should not do so) but are willing to prioritize immediate rewards over safety if it helps them succeed in higher stakes situations. Risking long-term consequences for short-term gain is certainly not new in the study of health behaviour (e.g., smoking, sun tanning, unhealthy eating) and based on the current findings it is evident that context supersedes demographic variables. The implication of this finding is that interventions need to target contextual factors rather than athlete characteristics to increase the likelihood of safer play. This might include increased vigilance on the part of athletic trainers, coaches, and other support staff during higher stakes games or practices, in addition to pre-game review of safety protocol and previously made intentions to report.

Given past behaviour is generally found to be the best predictor of future health behavior (Sutton, 1994), understanding how athletes have behaved in the past is important. Of note, the best predictor of Generalized Intention to report future symptoms in the current study was past reporting behaviour. Understanding how athletes have behaved in the past is essential to encourage continued reporting or to target those who have not consistently reported past symptoms. This is particularly important considering past experience with concussion has been associated with lower likelihood of athletes holding a future intention to report (Anderson et al., 2021; Baugh et al., 2019; Register-

Mihalik et al., 2017), with one study finding athletes with a concussion history concealed symptoms up to 2.6 times more often than those who had never sustained a concussion (O'Connor et al., 2020). To gain a clearer picture of the nuanced considerations pertaining to context, future research might explore how context impacted past reporting behaviour.

The Role of EF on Intentions to Report and Past Symptom Reporting

EF is implicated in emotional reasoning and related to the formation and stability of intention (Lezak, 2012). Therefore, it held promise in adding explanatory power to understanding athletes' intentions to report possible concussion symptoms, especially in higher stakes situations. The role of EF was examined as both a potential direct (Research Question 2) and indirect (Research Question 3) contributor to intentions to report and to past symptom reporting. Prior to examining the results, however, it is important to highlight some methodological limitations that were encountered in the assessment of EF in the current study.

First, scores on the EFI demonstrated variable reliability in the current sample, ranging from acceptable (EM, Total EF score), to questionable (SP, ORG), to poor (IC, MD). This signifies items on some subscales may not have uniformly measured their respective construct, and thus EF domains that may have been important contributions to stronger intention formation may not have been adequately represented in the EFI. For example, the variable with the lowest internal consistency was Impulse Control (α = .51), meaning only 51% of the variability in Impulse Control was available for correlation with other measures, setting an upper limit on correlations of $r = 0.5$.

EF is notoriously challenging to measure, given it is a broad-based, multifaceted construct with a definition not universally agreed upon by cognitive scientists (Barkley, 2011). EF is measured in two ways: using self-report rating scales to assess everyday EF, which relies on a subjective report and understanding of one's experienced difficulties, or performance-based tests administered by a trained professional and designed to assess domains of EF proficiency across specific tasks. The methods are found to overlap in some ways, but are not interchangeable (Barkley & Murphy, 2010; Barkley & Fischer, 2011; Buchanan, 2016; Burgess et al., 1998; Chaytor et al., 2006; McAuley et al., 2010; Toplak et al., 2013). A self-report rating scale was selected for this dissertation because self-report measures have been found to better predict impairment in activities of daily life, as real-life difficulties are poorly measured by relatively short performance tasks assessed in highly controlled environments (Barkley & Murphy, 2010; Teglasi et al., 2017).

The EFI was selected because it was designed to measure EF in a non-clinical population. Aside from the prohibitive nature of collecting performance-based testing results from athletes across the country, performance-based measures were also less desirable because the results do not translate well to emotion- or behaviour-regulation under highly emotional or uncertain conditions (Ganesalingam et al., 2011; Silver, 2000) such as reporting symptoms in the heat-of-the-moment. However, based on results of this dissertation, the EFI was not an ideal measure of EF. Whether an alternative self-report measure of EF would be a more valid and reliable measure of EF in university athletes or whether a combination of self-report and performance-based measures is necessary to more accurately assess EF in university athletes requires further investigation. It would be of interest to specifically measure certain EF domains in a smaller population with additional performance-based tests tapping into strategic planning approaches to problem solving, abstract and flexible thinking, switching/shifting cognitive set, inhibition and impulse control, or organized searching. Suggested tests might include the Wisconsin Card Sorting Test (Heaton et al., 1993; Heaton, 1981) or subtests from the Delis-Kaplan Executive Function System, such as Sorting, Trail Making, Colour-Word Interference, or Tower tests (Delis et al., 2001). Establishing a valid and reliable means of assessing EF will be a necessary precursor to any future research examining the role of EF in athlete's decision-making process about concussion symptom reporting.

Another potential methodological consideration pertains to the athletes in this study scoring higher than the normative population used to develop the EFI. This may signify the athletes were in some way different from the general population in terms of EF. It is important to note, however, the sample's mean scores all fell within the Average range and effect sizes were small to medium in magnitude. Therefore, although the differences between the sample and the EF normative group were statistically significant, they do not necessarily represent clinically meaningful differences (Ranganathan et al., 2015). That said, two factors were considered in speculating potential reasons this sample may have been statistically superior to the normative group: opportunity for honing higher level thinking (e.g., level of education) and experience in executing complex behaviour though involvement in competitive sports. Years of education were comparable for the athlete and normative samples, but a body of research suggests there may be differences between athlete and non-athlete EF capabilities. While some studies have not evidenced superior athlete EF (Beavan et al., 2020; Kida et al., 2005; Lundgren et al., 2016; Nakamoto & Mori, 2008), several have identified better cognitive abilities with respect to processing speed, attention, visual scanning, inhibitory control, problem solving, cognitive flexibility, working memory, and executing responses in the face of distraction (Jacobson & Matthaeus, 2014; Scharfen & Memmert, 2019; Vestberg et al., 2012; Voss et al., 2010; Wylie et al., 2018). Past research has also examined EF across levels of athletic expertise and found superior EF in more elite players (Holfelder et al., 2020; Huijgen et al., 2015; Vestberg et al., 2012; Wang et al., 2020), suggesting the above domains improve with experience and exposure to complex mental and physical demands. Due to these methodological considerations, all findings relating to EF discussed below are interpreted cautiously and are, at best, preliminary. Furthermore, emphasis is placed on findings pertaining to the total EFI score as this was the most reliable EF variable.

The Direct Effect of EF on Intentions to Report and Past Symptom Reporting

Prior to testing the EF-extended TPB model, the direct effect of EF on intentions to report and past reporting behaviour (Research Question 2) was examined. Given the role of EF in emotional reasoning and the formation and stability of intention through its impact on planning, decision making, self-regulation, and execution of previously formed intentions (Lezak, 2012), it was hypothesized athletes with higher everyday EF, as measured by the EFI, would demonstrate higher Generalized Intention to report (H2A) and have a history of reporting more often (H2B) than those with lower EF. These analyses were completed separately from the evaluation of the EF-extended TPB model.

Executive Function and Generalized Intention to Report

Consistent with Hypothesis 2A, athletes with higher overall EF endorsed greater Generalized Intention to report possible concussion symptoms, although this association was weak in strength. EF determines how we engage in behaviour in purposeful, strategic, self-regulated, and self-serving ways; therefore it was unsurprising athletes with better higher order reasoning would be more likely to use available evidence (i.e., playing with symptoms is dangerous) to intend on performing safer behaviour. While there is no available research examining EF and concussion reporting intention or behaviour, Gray-Burrows and colleagues (2019) analyzed a large body of health behaviour research and found higher EF was positively associated with performance of a wide range of health-protective behaviours (i.e., those behaviours people are generally encouraged to engage in more often) and negatively associated with performance of health-damaging behaviours (i.e., those behaviours people are generally encouraged to engage in less). For example, past research has found intention to perform sun protection behaviours and subsequently following through on this intention are dependent on cognitive flexibility and the ability to self-regulate (Allom et al., 2013). In fact, Allom and colleagues describe one's ability to shift thinking and behaviour to adapt to the environment (i.e., changing weather) as particularly important in engaging in health-protective behaviour. That is, aspects of EF help people adapt to contextual factors, further supporting EF as an important aspect of concussion symptom reporting across high and low stakes situations.

While the EFI subscales (apart from EM) showed low to poor reliability, their relationship to concussion reporting intentions were examined on an exploratory basis. The most notable (and unexpected) finding was that Empathy (EM) and Motivational Drive (MD) presented as relevant EF domains, while Organization (ORG), Strategic Planning (SP), and Impulse Control (IC) were not significantly correlated with Generalized Intention. While it is possible these findings are an accurate reflection of the EF-intention relationship, the magnitude of effects were small and as noted, only the EM score demonstrated acceptable reliability in the current sample.

Although unexpected, there may be theoretical grounds for the observed EM and MD findings. Empathy and Intention emerging as interrelated constructs may reflect the importance of teammate relationships, group cohesion, and a sense of belonging that often accompanies competitive sports (Eys et al., 2019), in addition to the influence of perceived Subjective Norms on reporting behaviour (i.e., pressure to conform to what we think others would do and would want us to do). On a neurological level, there is a body of evidence related to the effects of sporting group membership on empathic responses. Hein and colleagues (2010) found members of the same teams displayed activation in empathy-related brain regions when teammates experienced pain, but did not demonstrate the same activation in response to pain experiences among members of another team. During the development of the TPB-CRQ, teammates and top players were identified as influential social referents related to symptom reporting, underscoring the importance of interpersonal relationships in decision making. In addition, feeling more control over reporting when teammates were more supportive was an important Perceived Behavioural Control belief identified by athletes in the elicitation interviews, emphasizing interpersonal factors as key components in higher order decision making processes related to intention to report.

The MD subscale of the EFI, which measures energy level, behavioural drive, and interest in novel tasks (Spinella, 2005), was also associated with higher intention to report, although these results are preliminary and interpreted with caution, as this scale had lower than expected internal consistency in the current study. The significant finding may be related to reasons athletes become involved in sports, such as having higher energy levels, lower tolerance for inactivity, and more engagement in active goal pursuit.

The potential of being unable to play for an extended period (or in extreme circumstances having to discontinue sports altogether) as a result of ignoring safety guidelines may represent an even greater risk for some athletes than losing play in the current game, thus increasing intention to report in order to facilitate a speedier and long-term return to play after a potential concussion. That is, they may lean toward caution/safer play so they do not lose the ability to participate in sports down the road. Indeed, reporting as facilitating the best chance for recovery was identified as an important Attitude belief in the elicitation interview. Greater intrinsic motivation to succeed in sports has also been associated with increased cohesion among teammates (Halbrook et al., 2012), suggesting there may be a connection between the roles of MD and EM in reporting intention, and may bolster the suggested explanations for why these two EF constructs emerged as somewhat influential.

The lack of association observed between Generalized Intention to report and the impulse control, planning, and organizational domains of EF was unexpected given they are important aspects of intention formation (Gawrilow et al., 2013; Hofmann et al., 2011, 2012; Kliegel et al., 2002; Lezak, 2012; Schmeichel et al., 2008; Schmeichel & Demaree, 2010; Willcutt et al., 2005). However, in Gray-Burrows and colleagues' (2019) recent meta-analysis on EF and health behaviour, moderator effects for health-protective behaviours were found for cognitive flexibility and response inhibition, but not planning, working memory, or combined EF measures. This may partially explain why Strategic Planning and Organization were not significantly associated with Generalized Intention in this dissertation, but less clearly explains the insignificant correlation between intention and Impulse Control. Since the reliability of the IC subscale of the EFI was unsatisfactory, it would be worthwhile to further examine the role of impulse control/response inhibition more directly in future studies. The finding that the Total EFI score was both reliable and significantly (although weakly) associated with Generalized Intention strengthens the hypothesis that one's abilities to regulate thoughts and behaviour very likely plays a role in concussion reporting intention and should be further investigated.

Executive Function and Past Symptom Reporting

Contrary to Hypothesis 2B, higher EFI Total scores (that is, overall EF) were not associated with past reporting behaviour. While comparative research examining the link between EF and concussion symptom reporting is missing from the literature, the meta-analysis by Gray-Burrows and colleagues (2019) indicates people with better EF capabilities tend to make better health-related decisions in general. The lack of association observed in the present study could reflect the complex and inter-related nature between current EF and past concussion experiences (and hence retrospective concussion reporting). Specifically, concussion disrupts many aspects of EF and several studies have found long-term negative consequences of multiple (i.e., two or more) concussions on EF (Covassin et al., 2008; Hume et al., 2017; Tapper et al., 2017; Vynorius et al., 2016). Thus, past concussion experiences, regardless of whether they were reported, could impact present day EF. Despite the majority of athletes in the current dissertation demonstrating EF scores within the Average range, and although all participants were enrolled in university-level academics and actively playing on university-level teams at the time of completing the measure, it cannot be ruled out that some athletes may have been experiencing worse current EF than they were when making past reporting decisions. This seems unlikely, however, given there were no significant differences in EF between athletes with and without a history of concussion.

Thus, rather than past concussions disrupting current EF and diminishing the association between EF and concussion reporting history, it is more likely current EF is truly unrelated to past reporting behaviour. Nevertheless, given the unreliability of the EFI in this study, further research is needed to corroborate this finding. Moreover, given a key finding of this dissertation is the importance of context in reporting, contextual considerations may also override EF when making symptom reporting decisions.

Evaluation of the EF-Extended TPB Model

Since EF plays a role in intention formation and execution, it was considered as a potentially meaningful variable to extend the TPB. Therefore, the ability of an EF-extended TPB model to better explain university-level athletes' intention to report concussion symptoms compared to the original TPB model was examined in Research Question 3. EF was hypothesized to add significant variance to the extended model to more comprehensibly explain concussion reporting intention (H3A), with particular emphasis on the roles of impulsivity, organization, and strategic planning (H3B).

Evaluation of the original TPB components in the first step of the regression analysis revealed Attitude, Subjective Norms, and Perceived Behavioural Control accounted for 35.1% of the variance in intention to report. Contrary to expectations, however, the addition of EF to the regression model (EFI Total or the EFI subscales) did not significantly improve the variance accounted for by the original model. The amount of variance accounted for by the original components of the TPB model in this study is higher than that found in Kroshus and colleagues' (2014) study of university athletes (22%). In both studies however, the amount of variance accounted for is considerably lower than that found in studies with high school athletes (i.e., 58% in studies by Register-Mihalik et al., 2013 and Beakey et al., 2016). Given the context in which university-level athletes compete, reporting concussion symptoms may have higher costs (e.g., loss of scholarships, reduced possibility of going pro, greater pressure from coaches/teammates) compared to high school level athletes. As a result, the context of university sport culture may decrease the extent to which the TPB can account for reporting among university athletes. This once again highlights the importance of studying the TPB within specific populations and contexts and why studies investigating university-level athletes should use a TPB questionnaire developed with that population.

One possible explanation for why an EF-extended model did not explain additional variance in Generalized Intention may be because EF is already represented within TPB constructs. Certainly, EF is involved in the formation of and ability to access attitudes and beliefs, the weighing of social referent pressures, and in determining the degree of control over performing a behaviour. Nevertheless, correlations between the EF domains and TPB measures were small, suggesting the shared variance is limited and cannot fully account for the lack of significant EF findings (see Table 16). Another possible explanation may be the methodological limitations of using the EFI noted previously. Given the poor internal consistency of most of the EFI subscales, EF may not have been adequately represented in the model. Still, this cannot fully explain the null findings since the total EFI score was reliable and did not add to the model, even when tested individually in a post hoc analysis. The finding that higher EFI total scores were directly correlated with greater intention to report (separate from the regression model) suggests EF does play some role in intention formation but the EFI may not have been a robust enough measure for extrapolating the underlying mechanisms driving these associations within the regression models.

The TPB posits intention is the best predictor of behaviour (Ajzen, 1991) and it is generally accepted that successful execution of behaviour is dictated by EF (Lezak, 2012), therefore the possibility that EF plays no part in the TPB is highly unlikely. Although Empathy and Motivational Drive may play some role in intentions to report as discussed above, the mechanisms by which EF influences intentions remain unclear at this time. Pertinent next steps would be to investigate EF using a different self-report measure or using a combination of self-report and performance-based tasks, as noted above. Alternatively, future research may investigate the role of EF as a mediator between intention to report and actual reporting behaviour. This will provide important additional information since the ability to optimize EF in a low-stress environment (e.g., completing a questionnaire while not concussed) is anticipated to be quite different than during a high-stakes game while experiencing concussion symptoms.

The Role of the Original TPB Variables

On average, athletes held moderately strong intentions to report. All Direct Measures were associated with intention, with Perceived Behavioural Control demonstrating the highest correlation, followed by Attitude, then Subjective Norms. This is consistent with the most recent body of TPB literature addressing sport-related concussion reporting (Beakey et al., 2016; Carpenter et al., 2020; Lininger, Wayment, Huffman, et al., 2019; Milroy et al., 2020; Rawlins et al., 2020; Register-Mihalik et al., 2020; Warmath & Winterstein, 2019) and is in line with historical TPB research (Armitage & Conner, 2001).

Perceived Behavioural Control

Within the TPB model, Perceived Behavioural Control helps account for behaviour that is difficult to perform or not completely under volitional control (i.e., those behaviours requiring opportunity, help from others, or specific resources; Ajzen,

1991) such as an athlete's appraisal of their ability to report under challenging conditions like higher stakes games or try-outs. Perceived Behavioural Control's role as the most influential contributor to intention reflects the importance of both internal and external control factors in reporting. This is because 'ability to report' may be more or less difficult depending on an athlete's competing interests at the time of injury. That is, ease of reporting appears to depend on what the athlete has to win or lose within the specific context in which they are injured. In this regard, Perceived Behavioural Control being the most closely associated with intention makes sense given the importance athletes place on context, and is in line with the prioritization of short term gain for long term risk evident across a number of health behaviours (Armitage & Conner, 2001; Basch et al., 2017; Goodwin et al., 2017).

Degree of perceived control, reflected by the Indirect Perceived Behavioural Control Measure, is influenced by beliefs related to the ease or difficulty of carrying out the behaviour. While having control over reporting was strongly associated with intending to report, athletes endorsed experiencing an overall weak level of actual control over this behaviour. Athletes had lower confidence in their ability to report if they perceived coaches as unapproachable, did not have ATs or other health care professionals at games or practices, experienced ambiguous and confusing symptoms, felt they would be letting the team down, or felt their teammates do not understand concussion and would be unsupportive of them reporting. Providing athletes with more explicit direction on *how* to report (e.g., identify who to tell and what to say) has been suggested as a first step in addressing problems with confidence and self-efficacy, which play an important role in translating intention to behaviour (Notani, 1998; Rawlins et al., 2020; Warmath & Winterstein, 2019).

While all control beliefs significantly differentiated degree of intent, team support when reporting followed by teammate concussion knowledge demonstrated the first two largest effects. This suggests athletes feel less able to report and experience lower intention when they believe their teammates do not understand concussion and feel the team does not want them to report. As previously noted, most athletes in this study did intend to report in the future but assumed their teammates would not. This highlights a dangerous misjudgement of teammates as greater risk takers unlikely to support each other in reporting and presents a situation in which erroneous beliefs may unnecessarily lower perceived confidence and control. These specific control beliefs overlap with findings pertaining to normative beliefs and are thus discussed in more detail in the Subjective Norms section below.

The third most salient control belief, demonstrating a medium effect in differentiating higher and lower intenders, was related to experiencing ambiguous symptoms. This belief was similarly an important contributor to past non-reporting and indicates the more straightforward it is for athletes to determine if they are concussed, the easier they find reporting. Although coach pressure was not identified as a salient Subjective Norm belief (noted below), coach *approachability* was the fourth most salient Perceived Behavioural Control belief, indicating that how receptive a coach is to an athlete's concerns is more important in feeling *able* to report than how they think the coach wants them to behave. Finally, the potential of letting the team down also discriminated between higher and lower intenders, further emphasizing the importance of team dynamics and relationships for this particular behaviour.

The Perceived Behavioural Control findings identify important areas to continue to address with targeted education. If hesitation in reporting is the result of inaccurate assumptions about teammate expectations and knowledge, not feeling they can rely on those in leadership positions (i.e., coaches are unapproachable or there are no available athletic trainers), and symptom uncertainty, these topics can be addressed by athlete and coach education and through intervention such as open, facilitated, discussion with team members. The best indicator of intention translating to behaviour appears to be the stability of the intention over time (Ajzen, 2011; McEachan et al., 2011; Sheeran & Webb, 2016); therefore, these discussions are likely to be most impactful if they take place pre-season and are periodically reviewed (e.g., prior to important games).

Attitude

Attitude emerged as the second strongest Direct Measure associated with Generalized Intention. Athletes endorsed holding an overall favourable assessment of reporting, viewing the behaviour as leading to positive outcomes over and above potential negative outcomes. This finding does need to be interpreted cautiously, however, given the majority of Indirect Attitude items on the questionnaire were framed towards the more positive aspects of reporting. As such, the findings may overestimate the level of positivity associated with reporting.

Among the (Indirect Attitude) behavioural beliefs discriminating those with higher and lower intention to report, the belief that reporting provides athletes a better chance of recovering from a concussive injury was the most salient. The next most salient beliefs included reporting as reducing chances of short-term re-injury and helping athletes maintain good academic standing. Fully understanding the short-term benefits of reporting, including the indirect benefit to one's sporting career by avoiding significant academic disruption, appears to be associated with higher intention to report, whereas the belief about maintaining long-term health demonstrated a smaller effect. This finding is consistent with the vast amount of research demonstrating that the evaluation of short-term consequences has a much stronger impact on health behaviours than does the evaluation of potential long-term consequences (Armitage & Conner, 2001; Basch et al., 2017; Goodwin et al., 2017; Sandberg & Conner, 2008). Following, concussion awareness initiatives may be more effective by emphasizing or shifting the focus from the potential long-term risks of concussion to the more immediate benefits of reporting. Other salient beliefs included reporting being best for the team, increasing the likelihood of an accurate diagnosis, and preventing serious injury.

Although the salient beliefs relating to negative consequences of reporting (teammates viewing them negatively or losing playing time) demonstrated small effects, they are still important considerations. While most athletes indicated they did not believe their teammates would view them in a negative light, those athletes who were worried about negative peer evaluation indicated lower intention to report. This suggests conversations amongst team members about reporting beliefs and how they view teammates who report may be helpful in strengthening intention in a subset of athletes.

It is noteworthy that while the athletes in this study viewed reporting as being in their best interest, 24% of those with a concussion history either did not report or inconsistently reported in the past. This is in line with the larger reporting literature demonstrating pervasive symptom concealment to stay in the game (e.g., see Kroshus et al., 2020). While a body of health research has discussed the prioritization of short-term gains at the expense of long-term consequences (e.g., Armitage & Conner, 2001; Basch et al., 2017; Goodwin et al., 2017; Sandberg & Conner, 2008), the salient attitude beliefs about reporting suggest potential educational approaches to increase the likelihood of strengthening intention. Focusing less on "concussion is dangerous" and more on “reporting is good for you in the short-term for the following reasons…” may be a first step. For example, reporting also lowers chances of sustaining non-TBI injuries, which athletes may not have considered (Gilbert et al., 2016). It would be useful for elicitation interviews to include consideration of the more specific ways reporting benefits athletes both on and off the field.

Subjective Norms

Finally, Subjective Norms were also moderately associated with Generalized Intention, but results reflected a moderate to weak level of perceived social pressure to report. This means that while athletes felt people who are important to them would want them to report, they were not particularly motivated to comply with them. This does not mean Subjective Norms are inconsequential. Instead, it suggests social pressures to report are not as influential as attitudes toward reporting or feeling control over one’s ability to report under challenging circumstances.

The group who appears to have more influence on reporting and thus discriminates higher from lower intenders was ‘top players’ (i.e., captains, star players). That is, athletes who believe top players report and are more influenced by what top players do were more likely to intend to report, themselves. All other beliefs about social referents demonstrated small effects. Two normative beliefs, relating to coach approval and family pressure, did not significantly discriminate higher intenders from lower intenders, indicating that although coaches and family are important referents, having more support or feeling pressured by these groups does not necessarily impact degree of reporting intention.

It has been suggested that parental pressure is often implicit and not directly communicated, such that athletes consider parental investment in their sporting career as an indication that their parents would prefer they play at all costs (Kroshus, Garnett, Hawrilenko, et al., 2015); therefore, parental education about implicit influences may need to receive higher priority in pre-season planning. Parental pressure may be more salient for high school athletes, which may partly explain why the TPB model accounted for more variability in intention to report in Register-Mihalik and colleagues' (2013) study. The absence of coach influence as a discriminating factor is notable, as previous research found the beliefs athletes hold about their coach's attitude toward reporting significantly impact their own behaviour (Baugh et al., 2014; Chrisman et al., 2013; Kroshus, Baugh, et al., 2014; Schmidt et al., 2020).

Although coach influence did not discriminate higher from lower intenders, it was identified as a key consideration in symptom reporting, mirroring previous research (Chrisman et al., 2013; Register-Mihalik, Linnan, et al., 2013). Unfortunately, the structural manner in which sports are organized often designates coaches as responsible for athletic performance and puts athletic trainers in charge of concussion education and assessment (Corman et al., 2019). The separation between coaches and trainers has been found to distance coaches from both concussion education and intervention, which can lead to negative athlete assumptions about expectations and approachability when it comes to concussions (Corman et al., 2019). Concussion education presented in the format of online modules athletes complete outside games and practices further distances coaches from this important aspect of play. In teams with access to athletic trainers, trust between athletes, coaches, and trainers has been noted as an important interpersonal factor in reporting (Baugh et al., 2020; Corman et al., 2019; Register-Mihalik et al., 2017), with higher levels of athlete trust translating to increased reporting intention and decreased incidence of symptomatic play (Baugh et al., 2020). However, there exists real and perceived conflicts of interest for athletic trainers who are often pressured by coaches to medically clear athletes for return to play following concussion, especially when athletic trainers report to the athletic department rather than an independent medical institution (Kroshus, Baugh, Daneshvar, Stamm, et al., 2015). Critically, when this dynamic is experienced by athletes it leads to lower trust and lower incidence of reporting (Baugh et al., 2020). One suggestion pertaining to the conflict of interest experienced by athletic trainers has been having sports medicine departments associated with university health centres instead of athletic departments (Laursen, 2010). It is extremely important to minimize all factors contributing to low athlete reporting intention, including structural changes affecting other stakeholders.

The other two significant normative beliefs pertained to teammate reporting and perceived pressure from teammates to report. Although they demonstrated small effects, the impact that teammate behaviour and pressure have on intention are worth noting, as the strong influence of interpersonal dynamics on reporting was present across TPB constructs: teammate support strongly differentiated higher from lower intenders within the perceived control beliefs and social factors played a role in several behavioural (Attitude) beliefs. Strong associations have also been found between team cohesion and behaviour in other research (Neighbors et al., 2010; Waldron, 2015), suggesting that when athletes perceive teammates as not reporting, they are less likely to form strong personal intention to report.

An interesting related finding was that while the majority of athletes planned to report in the future, they predicted their teammates would be less likely to do so. This is important because, according to social identity and self-categorization theories, individuals categorize and internalize in-group norms and values such that group membership partly defines their identity and self-concept (Tajfel, 1974; Tajfel & Turner, 1986; Trepte & Loy, 2017). Past TPB research has also found that group norms (i.e., what others do) are predictive of intention and behaviour over subjective norms (i.e., feelings of social pressure) when one's social identity with the group is strong (Rabinovich et al., 2012; Rise et al., 2010; White et al., 2008). Since team cohesion does tend to be robust and lead to conformity with many perceived normative behaviours (e.g., hazing [Waldron, 2015]; alcohol consumption [Neighbors et al., 2010]), there is a risk an individual's intention to report will decrease if they think their teammates, and in particular, top players, do not report or would not intend to do so.

Previous research (Chrisman et al., 2013; Kroshus, Garnett, Baugh, et al., 2015) also found misperceptions about reporting norms, which suggest athletes may be adjusting their own intentions based on incorrect assumptions about what their teammates are doing. Baugh and colleagues (2021) suggest pluralistic ignorance, where group members believe their peers hold a more or less extreme attitude than themselves and adjust their behaviour and beliefs accordingly (Miller & McFarland, 1987, 1991), may be at play in these situations, with errors in social norm estimation leading to dangerous behaviour change. Findings in the athlete substance use literature further support the importance of perceived norms, as student-athletes' alcohol consumption appears to increase when teammates are perceived as approving of and using greater amounts of alcohol, regardless of the accuracy of these assumption (Fitzpatrick & Olthuis, 2021; Graupensperger et al., 2021; Hummer et al., 2009; Olthuis et al., 2011; Turrisi et al., 2007). In terms of concussion reporting, Baugh and colleagues' (2021) found players who believed most athletes would report were more likely to report themselves, regardless of the strength of their own intention at the beginning of the season. This holds promise for stronger athlete intention when teammates are on the same page about their plans to report. Unfortunately, the assumption held by the current sample that most athletes *do not* report may translate to individual attitudes being overruled by incorrect perceived social norms ("my teammates will not report"). This may subsequently lead to feeling unsupported by teammates, resulting in the low levels of perceived control endorsed in the current dissertation. Ensuring athletes have an accurate understanding about what teammates should expect from each other is an important consideration in pre-season planning and intervention. These findings highlight the need to directly address perceived norms and avoid misperceived peer pressure to conceal symptoms.

While the perceived social pressure of top players and teammates has been part of past TPB research, the *reporting behaviour* of these groups has not been directly addressed. This was elicited in TPB-CRQ development by specifically asking athletes to identify groups they anticipated would be most or least likely to report. The fact that reporting behaviour itself emerged as significant further highlights the important role of team dynamics in university-level sports, and the need for better communication among teammates. In terms of intervention, Register-Mihalik and colleagues (2020) recently reported the importance of perceived favorable social norms specifically within first year university student-athletes, highlighting a potential window of opportunity for the modelling of safe behaviour by more seasoned teammates.

The Interconnectedness of TPB Constructs

Although it is useful to identify which TPB Measures are more or less associated with intention, it is important to remember the theoretical constructs are interconnected. TPB research suggests the conceptualization of a behaviour based on isolated constructs misses important relationships between attitudes, norms, and perceived control (Montanaro et al., 2018). This supposition was reinforced in this study, which identified similar themes across the three TPB constructs: athletes reported feeling more or less able to report (i.e., perceived control) based on assumptions about what they think teammates want them to do (i.e., group norms) and whether reporting is in the best interest of the team (i.e., behavioural beliefs). Perceived Behavioural Control beliefs were also thematically closely related to other constructs. For example, part of the control athletes felt over reporting was determined by the social support they felt from other athletes. The connectedness of these factors is further supported by Bandura's (1989) theory that attitudes are controlled by self-efficacy, such that those with higher perceived control over reporting (especially in higher stakes situations) would have a more positive attitude toward reporting than those with lower perceived control.

Past research has demonstrated shifts in attitudes occurring by group members merely sharing their beliefs (Stangor et al., 2001), suggesting possible avenues for intervention in strengthening intention to report by drawing on the associations between TPB constructs. Montanaro and colleagues (2018) suggest the need for a more nuanced qualitative understanding of the relationships between the constructs for optimal behaviour change. To that end, successful interventions based on TPB research must incorporate each construct as well as consider how they are related to each other.

A Missing Construct: Emotion

A limitation of relying solely on concussion knowledge and understanding to increase intention and safe RTP behaviour is that it is unreasonable to assume athletes make deliberate, rational decisions in high stakes situations (Kroshus & Chrisman, 2019); instead, emotional aspects and contextual cues likely override previously set intentions (Gerrard et al., 2008; Kroshus & Chrisman, 2019). This may be due to concussion's pathophysiological effects on one's ability to engage in wise decision making (EF), as well as the emotional aspects pertaining to potential consequences of reporting, such as being pulled from play or losing one's position on the team. Emotion is an important domain of EF (Barkley, 2011; Lezak, 2012) and was expected to be represented in the extended model. Unfortunately, the measurement issues with the EFI limited its contribution, and, as a result, emotion was most likely not sufficiently accounted for.

Some also argue there is a lack of affective representation across social cognition models and have called on researchers to reconceptualise the TPB's Direct Attitude Measure to include a wider range of emotional options (Lawton et al., 2009). Keer and colleagues (2010) have advocated for a separate 'Direct Affect Measure', discreet from Attitude, to obtain a more comprehensive understanding of intention and behavioural enactment. In the current dissertation, affect is represented by only one item in the Direct Attitude Measure (i.e., unpleasant versus pleasant dimensions of reporting), which was likely insufficient to tap into the emotional complexity of reporting. As previously noted, Direct Measure development is typically researcher-generated; however eliciting a variety of emotions associated with reporting directly from athletes and either incorporating them as affective items in the Direct Attitude Measure or extending the model with a separate "Affect" variable may improve the predictive ability of the TPB for symptom reporting intention and behaviour.

Clinical Implications

The TPB was selected to investigate concussion reporting to elicit and illuminate relevant constructs underlying intention to report in university-level athletes. The beliefs elicited directly from athletes were tested to determine whether they differentiated higher from lower intenders in order to inform interventions to enhance safe behaviour. Although the role of EF in concussion reporting intention formation remains unclear, several important clinical implications emerged from this dissertation pertaining to concussion education, teammate misconceptions, and reporting self-efficacy. Of course, it will be important for future studies to investigate the effectiveness of the following recommendations.

Concussion Education

Ensuring concussion education is available to all athletes is the first important step in protecting their short- and long-term health. It was noted up to 30% of athletes in the current sample reported never receiving formal concussion education, and while education alone has not been sufficient to improve symptom reporting, it is necessary to first recognize that certain symptoms (especially those that are ambiguous or could be attributed to/overlap with other factors) following a hit always warrant further assessment. In the current sample, lower intenders did not agree as strongly as higher intenders with the Indirect Attitude behavioural beliefs reflecting accurate concussion reporting statements (e.g., reporting improves chances of recovery, reduces further injury in the short term, helps them maintain good academic standing, is best for the team, leads to more accurate diagnoses, and helps maintain long-term health), suggesting potentially insufficient knowledge and understanding which could be addressed with targeted educational interventions. It will be important for educational interventions to shift the emphasis from negative consequences of concussion to integrating positive outcomes and emotions associated with reporting, since short-term outcomes often have a stronger impact on health behaviour (Armitage & Conner, 2001;

Basch et al., 2017; Goodwin et al., 2017; Sandberg & Conner, 2008) and emotion plays an important role in binding people to their intentions (Keer et al., 2014; Sandberg & Conner, 2008). It is also recommended that in addition to pre-season education, athletes are re-engaged with safety education throughout the season.

Future interventions may also need to be more engaging, employing something closer to an interactive workshop for more effective knowledge transfer. This is important in light of recent evidence that intention to report symptoms becomes stronger with increased enjoyment of concussion education (Daneshvar et al., 2021). In-person education also allows facilitators to challenge athletes' inaccurate beliefs and to incorporate coaches into the learning process. As described in previous research (Baugh et al., 2020; Corman et al., 2019; Register-Mihalik et al., 2017) and the current dissertation, reporting is partly dependent on athletes trusting their coaches enough to approach them with possible concussion symptoms. Symptom reporting discussions involving coaches, athletic trainers, and athletes that clearly prioritize safety would help build this trust, demystify coach expectations, and increase athletes' sense of support. Unfortunately, a body of evidence, including qualitative information obtained in the elicitation interviews for this study, indicates coaches do not unanimously prioritize athlete safety, nor do they necessarily have a good understanding of concussion signs, symptoms, dangers, or safe reporting procedures (Kerr et al., 2020; Kirk et al., 2018, 2018). Milroy and colleagues (2020) suggest an additional necessary component of coach concussion education should include a focus on the harmful effects of sporting culture that encourages athletes to play through injuries. As such, annual coach education, facilitated by in-person learning, is also recommended. While some universities are organized such that athletic trainers provide concussion education to athletes *and* coaches, many are not, and this is an area clearly requiring further intervention and systemic change. Finally, if educational information is provided to families, it should include emphasis on the potential for athletes making implicit assumptions that their family would prefer they play through symptoms.

Addressing Misconceptions

Social identity and perceived teammate norms emerged as important considerations in reporting, indicating that what athletes think their teammates do significantly impacts their own behaviour. The current study found athletes who believed teammates will report symptoms held higher intention to personally report; however, the majority of athletes also indicated inaccurate social norm estimation, rating the likelihood of teammate reporting lower than their own. For this reason, directly addressing misconceptions that negatively impact intention to report will be extremely important. This may require intervening at the level of team dynamics using facilitated conversations among teammates about their attitudes toward concussion and the degree of support they would provide their peers. Such interventions could be incorporated as a component of pre-season team building.

The finding that athletes hold normative beliefs about their teammates wanting them to report while simultaneously holding beliefs that their teammates would not report, further highlights the need to integrate facilitated conversations about teammate attitudes and support into pre-season activities. While it is possible these discussions could lead to lower intention to report if the majority of a team holds negative or unsafe attitudes and beliefs, this might be avoided by employing anonymous exploratory surveys about concussion beliefs and the degree to which athletes support their teammates in reporting, and then subsequently dispelling inaccurate beliefs and assumptions during facilitated conversation. Athletic trainers are likely in the best position to facilitate such discussions given the degree of interaction they have with the team and their training in concussion and RTP protocol (Register-Mihalik et al., 2017); however, for reasons described above, coaches should be present and participate to build trust and comfort in reporting (Baugh et al., 2020). While many athletes in the current study indicated they did not have access to an athletic trainer, employing athletic trainers or other health professionals is an organizational approach that may be necessary across Canadian university-level sports to protect athlete health.

Self-efficacy in Reporting

Perceived Behavioural Control, along with intention, is considered to be a ‘proximal determinant of behaviour’ (see Figure 2; Ajzen, 1991), therefore interventions aimed at changing behaviour ought to consider the important implications of control factors identified in the current dissertation. It is extremely difficult to report symptoms if an athlete does not feel they have the power or resources to do so, especially if they are uncertain if they have a concussion. The importance of feeling confident and prepared for reporting in high stakes contexts is supported in both Bandura’s (1989) work on the role of self-efficacy in sustaining motivation to persevere when faced with obstacles, and in Meichenbaum’s Stress Inoculation hypothesis (1977) suggesting previous exposure to coping in stressful situations helps manage future stressors. Thus, interventions designed to increase athletes’ perceived control over the reporting process hold promise in strengthening intention to report (Milroy et al., 2020). In fact, intention has been demonstrated to increase up to 140% with improved reporting self-efficacy (Rawlins et al., 2020) and a recent study found that knowing the actions to take to report symptoms was more important than concussion knowledge in forming strong reporting intentions (Warmath & Winterstein, 2019). Since the effect of intention on behaviour may be moderated by actual control, developing a script or standardized communication strategy to help athletes alert their coach, athletic trainer, or teammates of potential symptoms may be an important recommendation. Doing so may act as an implementation intention (i.e., 'if-then plan') by making explicit the protocol of when, to whom, and how to report. This approach has been found to increase intention follow through and goal attainment in general (Gollwitzer, 1999). To gain better control over the reporting process, athletes would benefit from practice using this script throughout the sporting season.

The integration of pregame safety huddles, as suggested by Kroshus and Chrisman (2019), may also be advantageous in regularly re-establishing values and commitment to uphold concussion safety protocols, while also boosting individual athlete confidence and self-efficacy in the act of reporting. Team support emerged in the current dissertation as an important control belief and teammates/top players were identified as particularly influential social referents in reporting, suggesting the integration of a supportive team approach to safety is an important consideration in strengthening concussion reporting intention. A limitation to current concussion intervention is that education is typically presented once and then forgotten (Corman et al., 2019; Kroshus & Chrisman, 2019). Therefore, it would be important to re-engage athletes with reporting strategy and practice implementing safety huddles often, if not before every game. This is especially important as the intention-behaviour link is strongest when the temporal gap is smaller (Ajzen, 1991, 2011).

Finally, recent research has found athletes with greater reporting self-efficacy are more likely to encourage teammates to report (Milroy et al., 2020). Kroshus and

Chrisman (2019) have suggested adoption of a bystander model wherein athletes engage in supportive roles encouraging teammate reporting if they become aware of a possible concussion injury, since it may be unreasonable to consistently expect athletes to report their own symptoms due to the emotional consequences of reporting and the disorienting effects of concussion. Given the importance of social identity and group membership in sports, encouraging athletes to be responsible for each other's safety may also bolster perceived control over self-reporting. A recent study found support for athletes encouraging teammates to report when someone on the team was experiencing possible symptoms, but not for reporting on the behalf of others (Milroy et al., 2020). Additional research in this area may provide further approaches to athlete concussion safety that do not rely solely on self-report.

Theoretical Implications

Since EF impacts intention formation through execution and is implicated in emotional reasoning, it does seem likely EF plays some role in a TPB-conceptualization of concussion symptom reporting. Unfortunately, due to EFI measurement issues, the mechanisms underlying its role in the TPB could not be determined from this research, but should be further investigated in future studies. Nevertheless, some insights into the theoretical implications of using the TPB to understand concussion reporting were still evident.

One possibility for why the current dissertation was unable to explain more variance in reporting intention is that the theoretical conceptualization of the TPB may not be as robust at predicting concussion symptom reporting intention as it is in understanding other health behaviours. For example, the elicitation interviews demonstrated overlap in the advantages and disadvantages of reporting, and some social referents were seen as both approving and disapproving of reporting. These discrepancies inherent in concussion reporting considerations likely influenced the reliability of TPB-CRQ-f-revised and limited the ability of the traditional TPB model to provide a full account of reporting intention.

Unlike other health behaviours previously explained by the TPB (e.g., cardiac health; Blanchard, 2008; Sukohar, 2021), concussion reporting in particular appears to be largely context dependent, meaning how “good” or “bad” an athlete considers symptom reporting changes depending on what they have to gain or lose in the present moment, meaning two separate models may be needed to account for the same behaviour across high and low stakes situations. In addition, the traditional TPB does not sufficiently account for the competing goals athletes have when forming and carrying out an intention to report, namely, “safety” versus “play”, and this may be partly responsible for the limited variability TPB constructs have been able to account for thus far.

After the current study was underway, Ajzen and Kruglanski (2019) proposed an extension to the TPB, the Theory of Reasoned Goal Pursuit, which they posit offers better predictive ability by taking into account the importance of motivation to obtain a goal as a proximal determinant of intention. The theory acknowledges that in circumstances where individuals have multiple goals (or, it could be extrapolated, when goals are context-dependent), they have stronger intention and higher probability of performing *currently active or relevant goals*. Ajzen and Kruglanski (2019) elaborate:

…a behavior is chosen in pursuit of two kinds of currently active goals: (a) desired outcomes and experiences that follow from performing the behavior, termed *procurement goals*, and (b) goals of gaining the approval of personally significant others, termed *approval goals* (p. 779).

Active procurement and approval goals directly affect Attitude and Subjective Norms while also moderating the effect of these two traditional TPB constructs on motivation to perform the behaviour. Since motivation directly predicts intention in this model, Perceived Behavioural Control now moderates the effect of motivation on intention (see Figure 4).

Notably, athlete motivation and intention to report do not remain static across time or context, such that the active goal at the beginning of the season might be "safety", but during higher stakes games may adjust to "play". The Theory of Reasoned Goal Pursuit may more accurately reflect the mechanisms underlying athlete intention to report and further highlights the importance of revisiting athlete motivation for safe play throughout the season, if not before each game (e.g., safety huddles), increasing the likelihood of maintaining "safety" as the most salient, active goal. Since the "safety goal" must be more desirable or valuable to athletes than the "play goal" to maintain motivation and thus intention to report, and since perceived norms (in this new theory, the *approval goals*) were found to play an important role in the findings of this dissertation, the Theory of Reasoned Goal Pursuit may be more appropriate for this behaviour than the traditional TPB and worth exploring in future concussion reporting research.

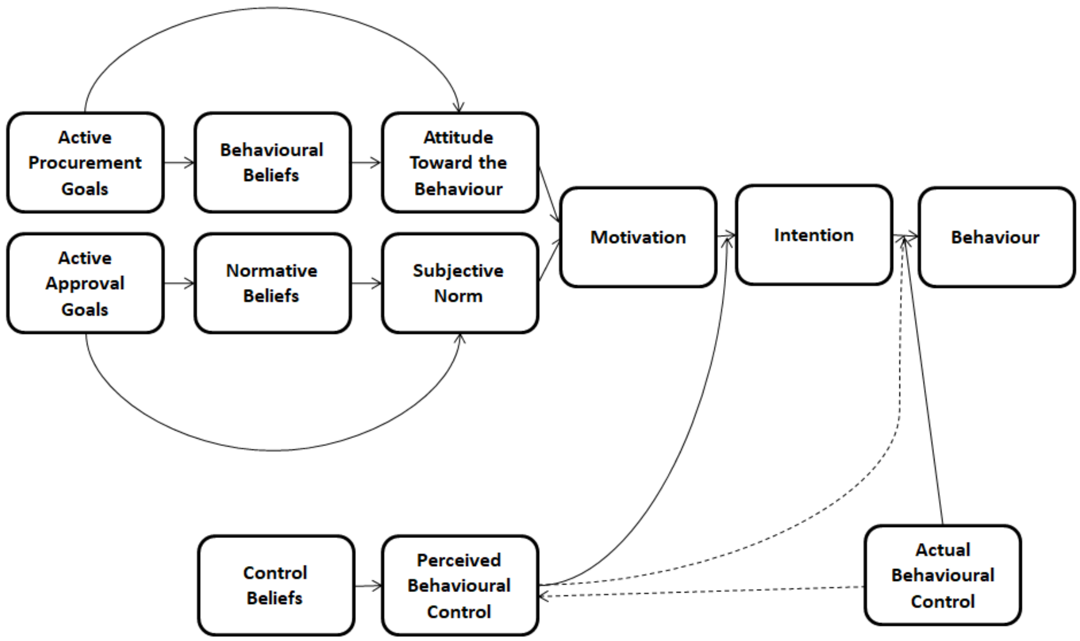
Limitations

Sample Characteristics

The vast majority of participants in the TPB-CRQ-p development sample (76% in the elicitation interview and 87.5% in the pilot study) indicated having experienced a

Figure 4

Theory of Reasoned Goal Pursuit



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concussion at least once in the past. This distribution may be the result of athletes personally affected by concussion being more eager to participate in hopes of providing future assistance to fellow athletes. Similarly, athletes who were unsure whether previous symptoms were due to concussion may not have been as motivated to participate. Nevertheless, individuals without direct concussion experience are not as well represented. Certainly, a measure based primarily on hypothetical assumptions made by a group of athletes who had never faced the multifaceted challenges associated with symptom reporting may be less helpful in examining this specific behaviour; however it is possible that eliciting attitudes, important social referents, and perceived control over reporting from a greater number of individuals without a concussion history may have illuminated unique themes not included in the TPB-CRQ-f-revised. Recruiting a more evenly distributed athlete sample to ensure salient constructs were not missed is an important consideration for future questionnaire development.

Unfortunately, athlete ethnicity was not included in the demographic questionnaire. This oversight means the populations to which the results generalize cannot be determined. Future research would benefit from inclusion of this information, especially in light of a relatively recent report out of the University of Toronto’s Centre for Sport Policy Studies which found university-level athletic programs of nine Canadian universities were not representative of the larger student bodies and were populated predominantly by white athletes (Danford & Donnelly, 2018). Because the distribution of ethnicity in the current dissertation is unknown, the data may or may not have been collected from a representative sample of the Canadian athlete population. As such, results should be interpreted with caution when considering applicability to diverse populations.

Another limitation pertaining to participant demographics is that athletes were not asked to differentiate whether they played on university or college teams. Due to differences between these groups in terms of sporting culture (university sports being a more competitive and higher-pressure environment), information illuminating important group differences in concussion reporting may be missing. Furthermore, the samples included athletes playing on club and varsity teams combined. While both types of teams play at a competitive level, varsity team sports are regulated by one governing body (USports in Canada) and are comprised of athletes who compete at a higher level and are more likely to go on to a professional sporting career. As such, varsity athletes would be under more pressure to perform, which may translate into different concussion reporting intentions and behaviours than athletes on club sports. Combining these groups may have added statistical noise to the analyses; therefore, the results should be interpreted with caution and future studies would benefit from investigating how the contextual differences between these groups impacts intentions to report. To help maintain confidentiality, athletes also were not asked to indicate which university or college they attended. As a result, the institutional or provincial representativeness of the sample is unknown.

Measurement Issues

In the larger sample used to evaluate the extended model, a Missing Values Analysis indicated there may be a pattern to the missing values. No significant relationship was found between the Generalized Intention variable and the questionnaires used in the study, suggesting there may be uncovered meaningful reasons for missing data. Instead of deleting cases with missing responses, mean substitution was used to replace missing values at the individual item level across the data set. While this is a conservative method for dealing with missing data, using the mean of the distribution can reduce variance within a variable, thus reducing correlations with other variables (Tabachnick & Fidell, 2019). Although no individual item on any scale was missing more than 1.5% of responses, relationships between variables may have been subject to Type II error.

The most significant limitation of the current dissertation pertains to the psychometric quality of some of the variables, which must be considered in interpreting results. The Direct Subjective Norms variable, Indirect Attitude variable, and the Generalized Intention variable of the TPB-CRQ-f-revised were not normally distributed, with mean scores on all reflecting more positive views about reporting (i.e., negative skew). While the distribution is unsurprising, as outlined in data screening sections in *Chapter 3*, caution must be used in interpreting the results involving these variables, as non-normally distributed variables restrict the range of variability in which Generalized Intention can relate with other study variables. In addition, the Direct Attitude measure did not have acceptable internal consistency in the larger sample, suggesting the set of bipolar adjectives used on the scale may not have adequately measured the same construct. Strategies for addressing this are discussed above, but this is an additional limitation to be considered in interpreting the extended model results.

The EFI, which was used to assess the main variable of interest in the study (i.e., EF), demonstrated unacceptable levels of internal consistency, precluding interpretation of the proposed EF-extended TPB model. As a result, the central research question remains unanswered. This also limited the interpretation of how specific EF domains related to forming an intention to report. Of particular importance, without the EFI, the model was missing a conceptualization of emotion, which, as described throughout this dissertation, is an important component of reporting. Due to these unfortunate methodological considerations, all EFI-related findings can only be interpreted with caution.

Finally, this research measured intentions to report, not actual reporting behaviour. While the TPB posits intention is the best predictor of behaviour (Ajzen, 1991), there does exist an intention-behaviour gap wherein people act in opposition to previously formed intentions (Sheeran et al., 2017; Sheeran & Webb, 2016). Indeed, despite one's intentions, individuals are faced with a number of challenges in striving to achieve a goal or carry out a pre-planned behaviour, such as competing goals/temptations, bad habits, disruptive thoughts and emotions, or low willpower/ego depletion, all of which have the potential to automatically guide behaviour (Sheeran & Webb, 2016). Lower EF may also impact each of these areas, leading to poor translation of intention to behaviour (Allan et al., 2011; Hall et al., 2008). This is one reason EF was incorporated to extend the traditional TPB model. Unfortunately, because behaviour was not directly assessed, no claims can be made about whether the findings pertaining to EF, Attitude, Subjective Norms, or Perceived Behavioural Control extend to actual symptom reporting.

Future Directions

To address limitations and build on the findings of the current dissertation, a number of research directions are recommended.

Refining the TPB-CRQ

In this dissertation, context arose as an important consideration in symptom reporting. Future elicitation interviews and TPB questionnaires would benefit from using context-specific language about reporting (e.g., under challenging conditions, in high stakes situations, when you do not want to report, etc.) to generate richer, more salient content and develop more robust measures. More broadly, symptom reporting research in general needs to be specific about context when surveying the incidence of reporting behaviour to capture a more accurate picture of when athletes report symptoms versus when they conceal. For example, if a study surveys athletes who happen to have only experienced symptoms in lower stakes situations, they may find unrealistically higher rates of reporting. More nuanced information about this behaviour would allow for better testing and development of novel interventions.

Further elicitation interviews and more in-depth focus groups also have the potential to clarify and confirm salient themes for university level athletes. Although not part of typical questionnaire development protocol, the TPB-CRQ could be strengthened by including Direct Measure development with athletes during the elicitation interview. The Direct Attitude Measure in particular may be more robust if athletes provide input into the descriptors for the bipolar descriptive anchors, and in particular help identify salient emotional content for this measure. Future researchers may then decide if they feel the newly generated Direct Attitude items sufficiently address emotion or whether the model would benefit from the addition of a separate Affect Measure. Furthermore, developing an Indirect Attitude Measure taking into account a more balanced ratio of advantages and disadvantages of reporting would improve future research by ensuring a more comprehensive representation of beliefs.

Measuring Executive Function

Once a more robust TPB-CRQ is developed, future research would benefit from re-examining the role of EF in intention to report, especially since poor internal consistency of EFI subscales with the current population may have limited the extended model findings. No prior studies using the EFI with athlete populations could be found at the time of writing, therefore an investigation into using the EFI with athletes separate from TPB research may help explain these findings and determine underlying reasons for the poor reliability in this scale. If the EFI is deemed an inappropriate measure with this population, another measure may be considered. The Barkley Deficits in Executive Functioning Scale (Barkley, 2011), for example, has satisfactory psychometric properties and was normed on a representative general population sample; however, the length of the Long Form version (89 items and taking up to 20 minutes to complete) may prove arduous for athletes also completing a TPB-CRQ. While a Short Form exists, taking approximately five minutes to complete, it contains only 13 items which may not be sufficient for measuring the nuances of EF, as is likely needed for investigating an EF-extended TPB model.

As previously noted, a self-report measure alone may not be comprehensive enough for the purpose of further understanding intention to report and incorporating both self-report and performance-based EF assessments into a smaller-scale TPB-CRQ study may be necessary to fully delineate as yet uncovered relationships with intention. Future studies may also compare TPB models extended with EF versus a more specific affect measure. Emotion appears to play an important role in symptom reporting intention and behaviour and, while affect is an aspect of EF, measuring it more directly may be a better approach.

A prudent next step in extending the TPB model will be examining symptom reporting behaviour, including the role of EF as a mediator between intention and behavioural enactment. Since EF has already demonstrated efficacy in moderating intention and behaviour for other health behaviours such as physical activity and diet

(Hall et al., 2008), it holds promise for concussion reporting behaviour. Structural equation modeling would be an appropriate statistical approach to test the relationships between TPB measures, EF, and reporting behaviour to determine whether the data fit the proposed model (Worthington & Whittaker, 2006). Alternatively, if obtaining a large enough sample is unfeasible, researchers may first examine a TPB model including Attitude, Subjective Norms, Perceived Behavioural Control, and Generalized Intention to determine discriminating beliefs, then use a randomly selected subsample to run a mediation analysis. The impact of emotion in the time between holding an intention, sustaining an injury, and considering difficult response options may also illuminate processes not captured in the current dissertation.

Conclusions

This research sought to fill an identified gap in existing TPB research by first developing a questionnaire to assess athlete concussion symptom reporting at the university level, then using the final, revised version (TPB-CRQ-f-revised) to test an EF-extended TPB model. Understanding how EF contributes to reporting intention was expected to uncover underlying mechanisms driving reporting behaviour. Although EF did not significantly contribute to the extended TPB model, this research makes important contributions to understanding symptom reporting at the university level.

Following the recommended TPB questionnaire development protocol increased the probability that content specific to university-level athletes was represented in the questionnaire. It also provided important information about beliefs that differentiated between athletes with higher and lower intention to report. These discriminating behavioural, normative, and control beliefs informed recommendations and identified crucial areas of intervention for novel approaches to concussion safety.

Three key findings were highlighted in the current dissertation. The first was the importance of context and past behaviour in making reporting decisions. Intentions to report appear to be fluid and made in the moment depending on what is at stake (i.e., athletes are more likely to report in lower stakes contexts and less likely to do so in important games or try-outs), and are influenced by their previous experiences of symptom reporting. This suggests a more strategic and dynamic approach to concussion reporting may need to be implemented to increase athlete safety. A second important finding was a crucial misperception among participants that most athletes would not report in the future. The role of social norms in team sports, coupled with the third key finding that athletes value the reporting attitudes and behaviour of teammates and top players, suggest positive gains may be made by capitalizing on the significant influence these groups have in setting positive examples for other players by increasing transparency among teammates.

Although no specific conclusions can be made about EF's contribution to reporting intention at this time, the results of the current dissertation are valuable in proposing new approaches to how concussion education and intervention is delivered and integrated throughout the season. This includes providing more engaging and interactive education to all university-level athletes; incorporating facilitated discussions about reporting beliefs and intentions among the team, athletic trainers, and coaches; increasing athlete reporting self-efficacy by explicitly outlining how to report; including pre-game safety huddles to re-establish commitment to safety procedures; and removing the burden of symptom reporting solely from athletes by integrating a bystander model of reporting into concussion protocols.

An almost universal conclusion among recent concussion researchers is that the culture of concussion reporting needs to change in order to see a decrease in symptom concealment and symptomatic RTP (Baugh et al., 2020; Corman et al., 2019; Kroshus & Chrisman, 2019; Lininger, Wayment, Craig, et al., 2019). To protect athletes' short-term safety and prevent long-term negative consequences, concussion education and intervention must adapt to address athlete concerns and biases in meaningful ways. Future research into the proposed recommendations and continued investigation into the role of EF in reporting will ultimately bring university-level sports closer to safe and responsible play.

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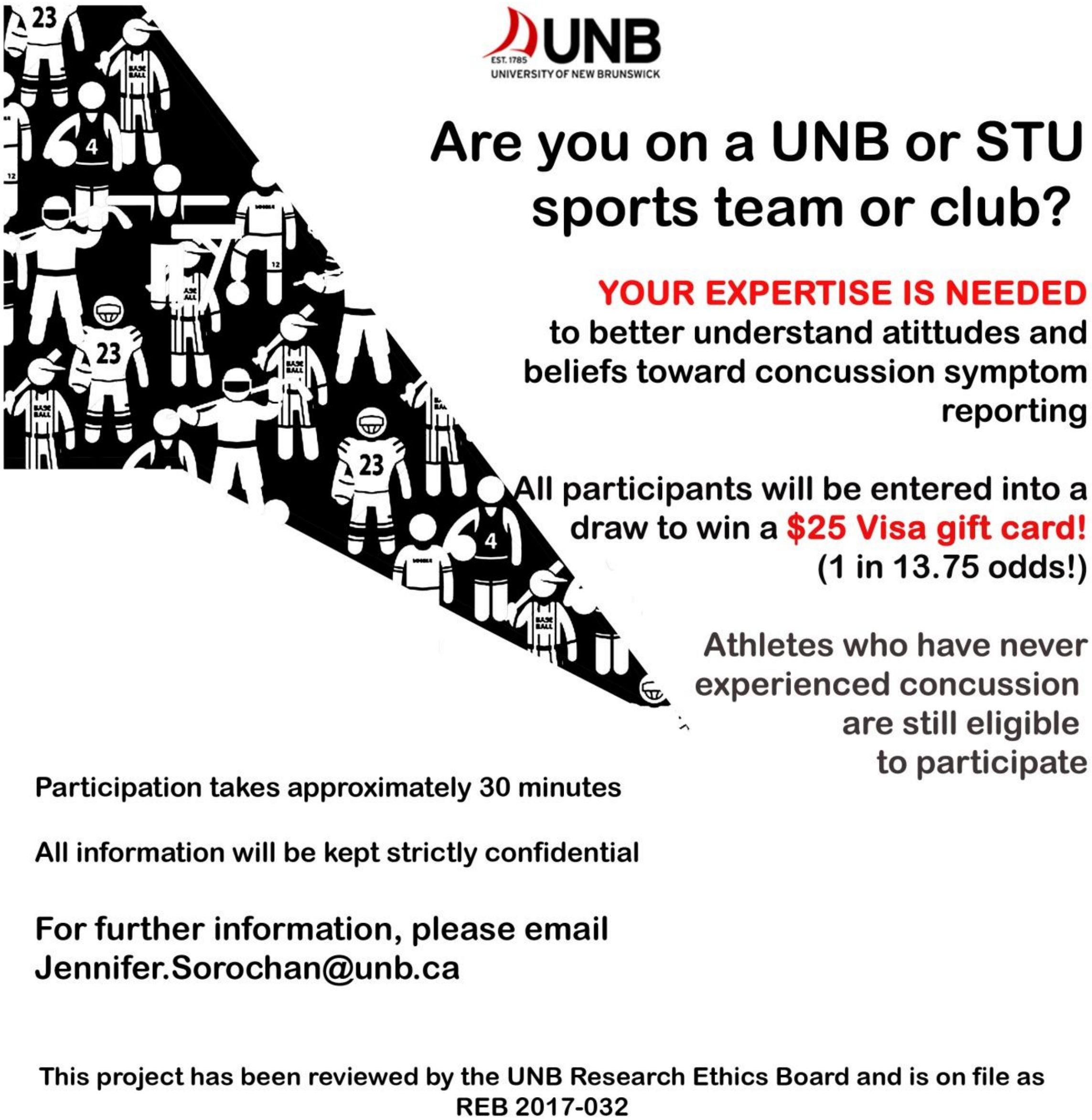
APPENDICES

Appendix A: Recruitment Email to Athletic Directors and Coaches

Good day!
I am a Clinical Psychology student at UNB beginning my dissertation work on concussion symptom reporting under the supervision of Dr. Ryan Hamilton and Dr. Troy Harker. Specifically, I am using a theoretical framework to identify variables involved in athlete decisions to report and not report concussion symptoms after a hit, blow, or fall. The ideal population for this research is university level student athletes who both have and have not experienced a concussive injury. In order to proceed with this project, I will be creating and validating a questionnaire asking student athletes about attitudes and beliefs related to symptom reporting.

There are three stages to the questionnaire validation. First, I will be recruiting 25 student athletes to participate in a short interview where I will ask about their attitudes and beliefs related to concussion symptom reporting. Second, I will ask 5 athletes from the same group of 25 to review and provide feedback on questionnaire items based on their initial interviews. Third, I will recruit 30 separate student athletes to complete the revised questionnaire twice, two weeks apart. Each stage should take no longer than 25 minutes to complete.
This research aims to identify psychological variables that may help explain the gap between being knowledgeable about symptom recognition and safe return to play procedures and making decisions not to report possible concussion symptoms after a hit, blow, or fall. I am contacting you to request your support in passing the information below on to your athletes.
Thank you for your consideration of this project!

Appendix B: Elicitation Interview Recruitment Poster



Appendix C: Elicitation Interview Consent Form

This study is being conducted by Jennifer Sorochan, B.A. (jennifer.sorochan@unb.ca), a doctoral graduate student in Clinical Psychology at the University of New Brunswick (UNB) and K. Troy Harker, PhD (kharker@unb.ca), assistant professor at UNB.

Currently, the primary strategy to prevent serious harm following concussion is to provide education to athletes about how to identify concussion symptoms and what to do afterward (i.e., report symptoms, do not return to play the same day, follow return to play (RTP) protocol and engage in graded return to activities). There is evidence that despite being knowledgeable about symptom recognition and RTP protocol, athletes still do not always report symptoms or follow safe RTP guidelines. Researchers at UNB are interested in gaining a better perspective on symptom reporting and RTP adherence by using a theoretical framework to identify attitudes and beliefs about reporting behaviours. Using the Theory of Planned Behaviour, strategies may be employed to provide student athletes with more effective pre-season intervention than education, alone.

Participation includes answering questions about your experience with concussion and the reasons why you think athletes might decide not to report suspected concussion symptoms or return to play before advisable. Athletes who have never experienced concussion are still eligible to participate. As thanks for your participation, you will be awarded 1 point toward your UNB/STU psychology class through the SONA Research Participation System OR entered into a draw to win one of two $25 Visa gift cards (1 in 13.75 odds of winning)!

To participate, you must be a college or university student athlete. If you choose to participate, you will be interviewed by the student researcher about attitudes and opinions, social norms, and perceived control over reporting concussion symptoms to your coach or athletic trainer. Most people take between 30-40 minutes to answer all questions. All answers are kept private and confidential. At no point will any identifying information such as your name be connected to your answers. Your questionnaire will be assigned a number for anonymous analysis purposes and kept confidential. The information collected in this study will be used to create and validate a concussion questionnaire for student athletes, which will be used in a larger dissertation study on concussion reporting behaviour among college and university student athletes across Canada.

Participation is completely voluntary and you may discontinue at any time, for any reason, without explanation, and without penalty. This project has been reviewed by the Research Ethics Board of the University of New Brunswick and is on file as REB 2017-032.

If you have any concerns about your rights or treatment as a research participant in this study, please contact the Acting Chair of the Psychology Research Ethics Committee, Dr. Sandra Byers at (506) 458-7697 (psychair@unb.ca). If you would like to be sent a copy of the results once data collection is finished for the final dissertation research, please email Jennifer Sorochan at jennifer.sorochan@unb.ca.

I have read the above form, understand the information, and understand I can withdraw from this study at any time.

Appendix D: Elicitation Interview Guide

Demographic/Background Information

1. Age

2. Gender
a. Male b. Female c. Other

3. Have you been diagnosed with Attention Deficit/Hyperactive Disorder (ADHD)

4. What year of university are you currently in?

5. What university do you attend?
a. University of New Brunswick
b. St. Thomas University

6. What team do you play on

7. What type of sport do you play as your <u>primary competitive sport?</u>
a. University/college team
b. University/college club
c. Intramural sports
d. Other

8. Please rate your level of competitiveness on a scale from 0-100

9. What is your <u>primary competitive</u> college/university club or sports team

10. How many years have you played your primary competitive sport?

11. Have you been provided concussion education (i.e., symptom recognition and return to play protocol) at any time during your experience playing <u>your current primary competitive sport</u>?

    A <u>CONCUSSION</u> IS: **an injury caused by a blow to the head or sudden movement of the body followed by a variety of signs and symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, ''seeing stars'', feeling in a fog or slowed down, memory problems, poor concentration, nausea, or throwing up. Getting ''knocked out'' or losing consciousness is a symptom but does NOT always occur with a concussion.**

12. Have you experienced any of the above symptoms following a hit or blow?

13. How many <u>diagnosed</u> sport-related concussions have you had in your primary competitive sport?

14. Did you report your symptoms to your coach, athletic trainer, parent, medical professional?

a. If not, why didn't you report your symptoms? Indicate all that apply
i. Didn't think it was a concussion at the time
ii. Wasn't sure it was a concussion at the time
iii. Didn't think it was serious enough
iv. Didn't want to let my teammates down
v. Didn't want to look weak
vi. Wanted to finish the game
vii. It was during an important game
viii. I felt pressure to finish the game
ix. I felt expected to play though concussion symptoms
x. I worried that I wouldn't be allowed to go back to play when I felt ready/recovered
xi. Other (please describe):

15. How many <u>suspected/undiagnosed</u> sport-related concussions have you reported to your coach or athletic trainer?

16. Did you report your symptoms to your coach, athletic trainer, parent, medical professional?

a. If not, why didn't you report your symptoms? Indicate all that apply
i. Didn't think it was a concussion at the time
ii. Wasn't sure it was a concussion at the time
iii. Didn't think it was serious enough
iv. Didn't want to let my teammates down
v. Didn't want to look weak
vi. Wanted to finish the game
vii. It was during an important game
viii. I felt pressure to finish the game
ix. I felt expected to play though concussion symptoms
x. I worried that I wouldn't be allowed to go back to play when I felt ready/recovered
xi. Other (please describe)

17. If you had a concussion in the future, would you always tell your coach or athletic trainer?
a. Yes
b. No
c. It depends on the context (i.e., important game, try-outs, etc.)
d. Other

18. If one of your teammates had a concussion, do you think they would always tell the coach or athletic trainer?
a. Yes
b. No
c. It depends on the context (i.e., important game, try-outs, etc.)

d. Other

Elicitation Interview

Please take a few minutes to tell us what you think about reporting symptoms from a possible concussion to your coach or athletic trainer (athletic trainer).

As a reminder, **a concussion is an injury caused by a blow to the head or sudden movement of the body followed by a variety of signs and symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, ‘‘seeing stars’’, feeling in a fog or slowed down, memory problems, poor concentration, nausea, or throwing up. Getting ‘‘knocked out’’ or losing consciousness does NOT always occur with a concussion.**

When you experience possible concussion symptoms after a hit or blow, what do you see as the **advantages** of reporting your concussion symptoms to your coach or athletic trainer?

When you experience possible concussion symptoms after a hit or blow what are the **disadvantages** of reporting your concussion symptoms to your coach or athletic trainer?

When you experience possible concussion symptoms after a hit or blow, what do you see as the **advantages** of NOT reporting your concussion symptoms to your coach or athletic trainer?

When you experience possible concussion symptoms after a hit or blow what are the **disadvantages** of NOT reporting your concussion symptoms to your coach or athletic trainer?

When it comes to reporting a possible concussion to your coach or athletic trainer, there might be individuals or groups who think you should or should not perform this behaviour.

Please list the individuals or groups who would **approve** or think you **should** report possible concussion symptoms after a hit or blow to your Coach or athletic trainer:

Please list the individuals or groups who would **disapprove** or think you **should not** report possible concussion symptoms after a hit or blow to your Coach or athletic trainer:

Sometimes, when we are not sure what to do, we look to see what others are doing. Please list the individuals or groups who, after a hit or blow, are **most likely to report** possible concussion symptoms:

Please list the individuals or groups who, after a hit or blow, are **least likely to report** possible concussion symptoms:

Please list any factors of circumstances that would make it **easy or enable you** to report possible concussion symptoms to your coach or athletic trainer after a hit or blow:

Please list any factors of circumstances that would make it **difficult or prevent you** from reporting possible concussion symptoms to your coach or athletic trainer after a hit or blow:

Are there any other issues that come to mind when you think about reporting possible concussion symptoms after a hit or blow to your coach or athletic trainer? Is there anything else you associate with reporting possible concussion symptoms to your coach or athletic trainer?

Appendix E: Elicitation Interview Debrief Form

Thank you for your participation! You have made an important contribution to this study's questionnaire validation!

The information you provided today will be used to develop and validate a concussion questionnaire for student athletes. This questionnaire will be used in a larger dissertation study on concussion reporting behaviour in college and university student athletes across Canada. The aim of this study is to use a theoretical model to understand the reasons athletes do not report suspected concussion symptoms and/or follow safe return to play (RTP) procedures after a hit or blow.

Concussion reporting research to this point has focused primarily on qualitative reasons for non-adherence to RTP protocol, however some theory-based studies have begun investigating non-reporting behaviours using the Theory of Planned Behaviour (TPB). According to the TPB, the best predictor of human behaviour is one's intention to perform that behaviour (Ajzen, 1985; Kroshus, Baugh, Daneshvar, Nowinski, & Cantu, 2015; Webb & Sheeran, 2006). In this model, intention is influenced by one's beliefs about and attitude toward the behaviour, in combination with what they believe significant others expect them to do and the degree of control they feel they have over actually performing the behaviour (Ajzen, 1991).

TPB questionnaire development must be conducted with the target group of participants (i.e., student athletes). There are three stages to this process: 1) conducting an elicitation interview where participants identify relevant beliefs regarding attitudes, social norms, and perceived behavioural control, 2) pilot testing the questionnaire for confirmation of clarity and quality with a small group of athletes, and 3) having a separate group of participants complete the revised questionnaire on two occasions, several weeks apart.

You participated in the **elicitation interview** portion of this research where you used your unique position as a student athlete to identify relevant beliefs about attitudes toward reporting symptoms, social pressure athletes perceive to report/not report symptoms, and how easy or difficult reporting symptoms is. Based on your responses, a sample questionnaire will be created to explore the influence of TPB constructs on concussion symptom reporting and safe RTP behaviours. If you would like to participate in the **pilot test study**, further applying your expert insight by reviewing the questions generated by your responses today, please let the student researcher know. The pilot testing session should take about 10-15 minutes. As with each stage of data collection, your responses will be kept completely confidential, and at no point will your name be associated with your responses.

Concussion is a medical condition that should be taken seriously. For more information on concussion recognition and RTP recommendations, please see the Heads Up: Concussion webpage (https://www.cdc.gov/headsup/index.html), an easy to use resource created by the Center for Disease Control and Prevention.

If you have any questions or concerns about the study at any time, you may contact the student researcher, Jennifer Sorochan, at jennifer.sorochan@unb.ca, or Dr. K. Troy Harker, at kharker@unb.ca. If you would like to be sent a copy of the results once data collection is finished for the final dissertation research, please email Jennifer Sorochan. If you have any ethical concerns about your participation in this study and would like to speak to someone who is not involved in this research, you may contact the Acting Chair of the Department of Psychology's Ethics Review Committee at the University of New Brunswick, Dr. Sandra Byers at psychair@unb.ca or (506) 458-7697. Again, your participation is greatly appreciated!

Appendix F: Preliminary Theory of Planned Behaviour and Concussion Reporting Questionnaire (TPB-CRQ-p)

[Italicized words in brackets are for reference only and were not included in the participant version]

Please answer the following questions about reporting possible concussion symptoms to your coach or athletic trainer by clicking on the number that best describes your opinion. Each question is rated on a 7-point scale. Some questions may appear to be similar, but they do address somewhat different issues. Please read each question carefully.
A **CONCUSSION** is an injury caused by a blow to the head or sudden movement of the body followed by a variety of signs and symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, ‘‘seeing stars’’, feeling in a fog or slowed down, memory problems, poor concentration, and nausea or throwing up. Getting ‘‘knocked out’’ or losing consciousness is a symptom of concussion but does NOT always occur with a concussion.

[Behavioural Beliefs]

1. It would be best for the team if I report possible concussion symptoms
Unlikely 1 2 3 4 5 6 7 Likely

2. Reporting possible concussion symptoms will reduce the chances of suffering another injury in the short term (e.g., same game, tournament, season)
Unlikely 1 2 3 4 5 6 7 Likely

3. If I report possible concussion symptoms, my teammates will have a negative view of me
Unlikely 1 2 3 4 5 6 7 Likely

4. Reporting possible concussion symptoms will cause me to lose playing time
Unlikely 1 2 3 4 5 6 7 Likely

5. Reporting possible concussion symptoms will help me maintain my long-term health
Unlikely 1 2 3 4 5 6 7 Likely

6. If I report possible concussion symptoms, I will receive an accurate diagnosis (i.e., I would know if it was a concussion or something else)
Unlikely 1 2 3 4 5 6 7 Likely

7. Reporting possible concussion symptoms will help maintain good academic standing/performance
Unlikely 1 2 3 4 5 6 7 Likely

8. Reporting possible concussion symptoms will prevent serious injury
Unlikely 1 2 3 4 5 6 7 Likely

9. I will have a better chance of recovering if I report possible concussion symptoms
   Unlikely 1 2 3 4 5 6 7 Likely

   [Control Belief Strength]

10. The probability of experiencing possible concussion symptoms during an important game or try-out is
    Unlikely 1 2 3 4 5 6 7 Likely

11. I would feel comfortable reporting possible concussion symptoms to my coach
    Unlikely 1 2 3 4 5 6 7 Likely

12. There is usually an athletic trainer/therapist or other health professional (physiotherapist, doctor, etc.) present at games and/or practices
    Unlikely 1 2 3 4 5 6 7 Likely

13. My teammates have a good understanding of concussion
    Unlikely 1 2 3 4 5 6 7 Likely

14. I would know for sure if I were experiencing concussion symptoms after a hit or blow
    Unlikely 1 2 3 4 5 6 7 Likely

15. If I report possible concussion symptoms, I will be letting the team down
    Unlikely 1 2 3 4 5 6 7 Likely

16. My team would support me if I reported possible concussion symptoms
    Unlikely 1 2 3 4 5 6 7 Likely

    [Direct Perceived Behavioural Control]

17. How much control do you feel you have over reporting possible concussion symptoms?
    No control 1 2 3 4 5 6 7 Complete control

    [Generalized Intention]

18. I plan to immediately report any concussion symptoms I experience after a hit or blow during practice or games to my coach or athletic trainer
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

    [Direct Subjective Norms]

19. People who are important to me would approve of my reporting possible concussion symptoms
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

    [Behavioural Outcome Evaluations]

20. Doing the best thing for the team is extremely
    Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

21. Preventing further injury in the short-term (e.g., same game, tournament, season) is extremely

Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

22. Maintaining my long-term health is extremely
    Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

23. Preventing serious injury is extremely
    Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

24. My teammates having a negative view of me is extremely
    Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

25. Losing playing time is extremely
    Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

26. Having an accurate diagnosis of concussion (i.e., knowing if it is concussion) is extremely
    Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

27. Maintaining good academic standing/performance is extremely
    Unimportant to me 1 2 3 4 5 6 7 Important to me

28. Having a better chance of recovery from concussion is extremely
    Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

[Normative Beliefs]

29. My coach would approve / disapprove of me reporting possible concussion symptoms
    Approve 1 2 3 4 5 6 7 Disapprove

30. My teammates do / do not report possible concussion symptoms
    Do report 1 2 3 4 5 6 7 Do not report

31. My teammates think I should / should not report possible concussion symptoms
    Should 1 2 3 4 5 6 7 Should not

32. My family thinks I should not / should report possible concussion symptoms
    Should not 1 2 3 4 5 6 7 Should

33. My athletic trainer (or equivalent) would approve / disapprove of me reporting possible concussion symptoms
    Approve 1 2 3 4 5 6 7 Disapprove

34. Top players do not / do report possible concussion symptoms
    Do not report 1 2 3 4 5 6 7 Do report

35. Competitive athletes do not / do report possible concussion symptoms
    Do not report 1 2 3 4 5 6 7 Do report

[Direct Attitude]

* Overall, reporting possible concussion symptoms to my coach or athletic trainer is:

36. Good 1 2 3 4 5 6 7 Bad

37. Unimportant 1 2 3 4 5 6 7 Important

38. Pleasant 1 2 3 4 5 6 7 Unpleasant

39. Harmful 1 2 3 4 5 6 7 Beneficial

40. Cowardly 1 2 3 4 5 6 7 Brave

[Direct Perceived Behavioural Control]

41. Whether I report possible concussion symptoms is entirely up to me
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

[Generalized Intention]

42. I will make an effort to immediately report any concussion symptoms I experience after a hit or blow during practice or games to my coach or athletic trainer
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

[Motivation to Comply]

43. The approval of my coach is important to me
    Not at all 1 2 3 4 5 6 7 Very much

44. Doing what my teammates do is important to me
    Not at all 1 2 3 4 5 6 7 Very much

45. Doing what my teammates think I should do is important to me
    Not at all 1 2 3 4 5 6 7 Very much

46. Doing what my family thinks I should do is important to me
    Not at all 1 2 3 4 5 6 7 Very much

47. The approval of my athletic trainer (or equivalent) is important to me
    Not at all 1 2 3 4 5 6 7 Very much

48. Doing what top players do is important to me
    Not at all 1 2 3 4 5 6 7 Very much

49. Doing what competitive athletes do is important to me
    Not at all 1 2 3 4 5 6 7 Very much

[Generalized Intention]

50. I intend to immediately report any concussion symptoms I experience after a hit or blow during practice or games to my coach or athletic trainer
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

[Direct Perceived Behavioural Control]

51. For me to report possible concussion symptoms
    Easy 1 2 3 4 5 6 7 Difficult

[Control Belief Power]

52. Experiencing possible concussion symptoms during an important game or try-out makes it <u>easier / more difficult</u> to report possible concussion symptoms
    Easier 1 2 3 4 5 6 7 More difficult

53. My coach's approachability or support makes it <u>more difficult / easier</u> to report possible concussion symptoms
    More difficult 1 2 3 4 5 6 7 Easier

54. Having an athletic trainer/therapist or other health professional (physiotherapist, doctor, etc.) present at games or practices would make it much <u>more difficult / easier</u> to report possible concussion symptoms
    More difficult 1 2 3 4 5 6 7 Easier

55. The level of knowledge and understanding my teammates have when it comes to concussion makes it <u>easier / more difficult</u> to report possible concussion symptoms
    Easier 1 2 3 4 5 6 7 More difficult

56. Knowing for sure if I were experiencing concussion symptoms after a hit or blow would make it <u>easier / more difficult</u> to report possible concussion symptoms
    Easier 1 2 3 4 5 6 7 More difficult

57. The possibility of letting the team down makes it <u>more difficult / easier</u> to report possible concussion symptoms
    More difficult 1 2 3 4 5 6 7 Easier

58. The level of support I would receive from my team makes it <u>easier / more difficult</u> to report possible concussion symptoms
    Easier 1 2 3 4 5 6 7 More difficult

[Direct Perceived Behavioural Control]

59. I am confident I can report possible concussion symptoms
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

[Direct Subjective Norms]

60. Athletes I know report possible concussion symptoms
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

61. It is expected of me to report possible concussion symptoms
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

Appendix G: Pilot Study Consent Form

This study is being conducted by Jennifer Sorochan, B.A. (jennifer.sorochan@unb.ca), a doctoral graduate student in Clinical Psychology at the University of New Brunswick (UNB) and K. Troy Harker, PhD (kharker@unb.ca), assistant professor at UNB.

You previously completed an interview where you identified attitudes and beliefs about reporting possible concussion symptoms. Participation in this next step includes reviewing questionnaire items based on the previous student athlete interviews for content, clarity, and quality. If you choose to participate, you will fill out a questionnaire and comment on the quality of the items. This stage should take approximately 15 minutes. All answers are kept private and confidential, and your name will never be attached to your questionnaire answers. All questionnaire materials will be stored in a locked filing cabinet in the Clinical Neuropsychology and Neuroscience Lab at UNB. The information collected in this study will be used to validate a concussion questionnaire for university student athletes, which will be used in a larger dissertation study on concussion reporting behaviour in college and university student athletes across Canada.

Participation is completely voluntary and you may discontinue at any time, for any reason, without explanation, and without penalty. This project has been reviewed by the Research Ethics Board of the University of New Brunswick and is on file as REB 2017-032.

If you have any concerns about your rights or treatment as a research participant in this study, please contact the Acting Chair of the Psychology Research Ethics Committee, Dr. Sandra Byers at (506) 458-7697 (psychair@unb.ca). If you would like to be sent a copy of the results once data collection is finished for the final dissertation research, please email Jennifer Sorochan at jennifer.sorochan@unb.ca.

I have read the above form, understand the information, and understand I can withdraw from this study at any time.

Appendix H: Pilot Study Open Ended Questions

Please comment on the following:

1. Are any items ambiguous or difficult to answer?

2. Does the questionnaire feel too repetitive?

3. Does it feel too long?

4. Does it feel too superficial?

5. Are there any annoying features of the wording or formatting?

6. Are there inconsistent responses that might indicate changes in response endpoints are problematic for respondents who complete the questionnaire quickly?

Appendix I: Pilot Study Debrief Form

Thank you for your participation! You have made an important contribution to this study's questionnaire validation!

The information you provided today will be used to develop and validate a concussion questionnaire for student athletes. This questionnaire will be used in a larger dissertation study on concussion reporting behaviour in college and university student athletes across Canada. The aim of this study is to use a theoretical model to understand the reasons athletes do not report suspected concussion symptoms and/or follow safe return to play (RTP) procedures after a hit or blow.

Concussion reporting research to this point has focused primarily on qualitative reasons for non-adherence to RTP protocol, however some theory-based studies have begun investigating non-reporting behaviours using the Theory of Planned Behaviour (TPB). According to the TPB, the best predictor of human behaviour is one's intention to perform that behaviour (Ajzen, 1985; Kroshus, Baugh, Daneshvar, Nowinski, & Cantu, 2015; Webb & Sheeran, 2006). In this model, intention is influenced by one's beliefs about and attitude toward the behaviour, in combination with what they believe significant others expect them to do and the degree of control they feel they have over actually performing the behaviour (Ajzen, 1991).

TPB questionnaire development must be conducted with the target group of participants (i.e., student athletes). There are three stages to this process: 1) conducting an elicitation interview where participants identify relevant beliefs regarding attitudes, social norms, and perceived behavioural control, 2) pilot testing the questionnaire for confirmation of clarity and quality, and 3) having a separate group of participants complete the revised questionnaire on two occasions, several weeks apart.

You participated in the **pilot study** portion of this research where you used your unique position as a student athlete to provide feedback on the first version of our TPB concussion questionnaire. Based on your responses, a revised version will be validated and administered to Canadian college and university student athletes as part of a larger study on concussion symptom reporting and adherence to RTP protocol.

Concussion is a medical condition that should be taken seriously. For more information on concussion recognition and RTP recommendations, please see the Heads Up: Concussion webpage (https://www.cdc.gov/headsup/index.html), an easy to use resource created by the Center for Disease Control and Prevention.

If you have any questions or concerns about the study at any time, you may contact the student researcher, Jennifer Sorochan, at jennifer.sorochan@unb.ca, or Dr. K. Troy Harker, at kharker@unb.ca. If you would like to be sent a copy of the results once data collection is finished for the final dissertation research, please email Jennifer Sorochan. If you have any ethical concerns about your participation in this study and would like to speak to someone who is not involved in this research, you may contact the Acting Chair of the Department of Psychology's Ethics Review Committee at the University of New Brunswick, Dr. Sandra Byers at psychair@unb.ca or (506) 458-7697.

Again, your participation is greatly appreciated!

Appendix J: Questionnaire Development and Item Selection Flow chart

Item Selection Process

Elicitation Interview (*n* = 25) & Pilot Study (*n* = 8)

Preliminary Theory of Planned Behaviour Concussion Reporting Questionnaire (TPB-CRQ-p) items developed based on results of the elicitation interviews

61 Items

All items retained with minor changes made to wording of some items based on pilot study

*Items 33 & 47: Include N/A option, as many teams do not have athletic trainers
*Items 17 & 42: Include "Not including times when your coach or someone else sees a hit and pulls you from play…" to target athletes' subjective experience of possible concussion symptoms
*Items 51 & 59: Include "…during an important game or try- out" to account for perceived control in specific contexts

↓

Reliability Testing (*n* = 32)

Final version of the Theory of Planned Behaviour Concussion Reporting Questionnaire (TPB-CRQ-f)

7 items removed from the initial 61 Items

*Items 33 & 47 because few teams had athletic trainers
*Item 37 because it was highly correlated with item 36
*Item 35 because it was highly correlated with item 34
*Items 10 & 52 because they contributed to low test-retest reliability of Indirect Perceived Behavioural Control

↓

TPB-CRQ-f-revised (*n* = 264)

Final Revised version of the Theory of Planned Behaviour Concussion Reporting Questionnaire (TPB-CRQ-f-revised) used in evaluation of the extended TPB Model.

54 Items

Appendix K: Athletic Director Letter for Extended Model Study

Good day,
I am a University of New Brunswick Psychology PhD student conducting research on concussion reporting and brain functioning among Canadian university and college athletes. Specifically, I'm looking at what motivates athletes to report or not report concussion symptoms, in an effort to decrease the number of athletes returning to play while at risk of serious consequences. I am looking to identify beliefs and cognitive processing leading to safe or unsafe behaviour so modifications may be made to better target athletes who are more likely to not report. All student athletes, including those who have or have not experienced a concussion, are invited to participate.
This project is solely for my dissertation. That is, data is not being collected for UNB or any other university. Furthermore, all information collected is completely confidential and any shared or published results will not single out or highlight an individual athlete, team, or university. In fact, we remind students not to let us know which university they attend. This project has been reviewed by the Research Ethics Board of the University of New Brunswick and is on file as REB 2018-082.

I am contacting you to ask if you would be willing to pass on information to the coaches in your program letting them know about this study, and if you would give me permission to reach out to the coaches directly, some time after. If this is acceptable, I would also ask if you would please cc me on the email you send, so I have accurate coach contact information.

Thank you for considering assisting with my research! I am more than happy to address any questions or concerns you may have. I have attached the recruitment poster to this email, and the link to the online questionnaire is
https://survey.psyc.unb.ca/ConcussionReporting.aspx

Sincerely,
Jennifer Sorochan
Who: Canadian athletes on university/college teams and clubs - you don't need to have had a concussion to participate and will be entered in a draw for a **$25 Amazon gift card**, with opportunities to be entered into additional draws!
What: Fill out an online survey on concussion reporting and brain functioning (takes between 15-30 minutes depending on your concussion history)
When: At your earliest convenience from your home computer or device
Where: https://survey.psyc.unb.ca/ConcussionReporting.aspx
Why: Your participation will help improve concussion initiatives to make university sports safer!

Appendix L: Extended Model Study Recruitment Poster

Appendix M: Extended Model Study Consent Form

Understanding Concussion Reporting Among Student Athletes

This study is being conducted by Jennifer Sorochan, BA (jennifer.sorochan@unb.ca), a doctoral graduate student in Clinical Psychology at the University of New Brunswick (UNB), and K. Troy Harker, PhD (kharker@unb.ca), assistant professor at UNB.

There is evidence that despite being knowledgeable about symptom recognition and return to play (RTP) protocol, athletes still do not always report symptoms or follow RTP protocol. Researchers at UNB are interested in gaining a better perspective on symptom reporting and RTP adherence by using a theoretical framework to identify attitudes and beliefs about reporting behaviours. From these findings, strategies may be employed to provide student athletes with more effective pre-season intervention.

To participate, you must be a student athlete on a Canadian college or university <u>competitive team or club</u> (unfortunately, intramural and community athletes are not eligible for this study). Both athletes who have and have never experienced concussion are eligible and encouraged to participate.

Participation is voluntary. You may decline to answer any questions, and you are free to withdraw from the research, and to withdraw any data pertaining to yourself, at any time, without penalty. If you choose to participate, you will be asked to fill out an online survey about attitudes and beliefs regarding symptom reporting, as well as questions about every-day functioning, like problem solving and staying organized. At the end of the survey you will be asked if you would like to be sent a copy of the results.

Most people take between 20-30 minutes to answer all questions, depending on their concussion history. All responses are kept private and confidential and at no point will any identifying information such as your name be connected to your answers. As thanks for your participation, you will be entered into a draw to win a $25 Amazon gift card.

This project has been reviewed by the Research Ethics Board of the University of New Brunswick and is on file as REB 2018-082. If you have any concerns about your rights or treatment as a research participant in this study, please contact the Acting Chair of the Psychology Research Ethics Committee, Dr. Biljana Stevanovski at 506-458-7693 (bstevano@unb.ca).

I have read the above form, understand the information, and understand I can withdraw from this study at any time.

By clicking "I agree", you consent to participate in this study. By clicking "I do not agree", you do not consent to the above and will be redirected out of the survey.

- I agree
- I do not agree

Appendix N: Extended Model Study Demographic Information

First, we would like to know a little bit about you. Please complete the following to the best of your abilities.

1. **Age**

2. **Gender**

3. **Have you ever been diagnosed with Attention Deficit/Hyperactivity Disorder (ADHD)?**
   Yes
   No

4. **What year of college/university are you currently in?**
   1st year
   2nd year
   3rd year
   4th year
   5th year
   6th year or higher

5. **What type of sport do you play as your primary competitive sport?**
   University/college team
   University/college club
   Other:

6. **Please rate your level of competitiveness on a scale from 0-100**

7. **What is your primary competitive college/university sport?**
   E.g., Soccer (do not identify your school name)

8. **Do you play on a**
   Women's team
   Men's team
   Co-ed team
   I do not play on a team (i.e., I play an 'individual sport')

9. **For those who play 'individual sports' (i.e., you do not compete on a team), to what extent do you perceive yourself as a member of a team? (e.g., 90 would equal 90%)**

10. **If applicable, what position do you play on your primary competitive sport team?**

11. **Do you have a leadership role on your team (e.g., team captain)?**
    Yes
    No

12. If applicable, on average, what percentage of all games do you play in per season?

13. If applicable, do you wish you had more play time compared to other teammates?

Yes
No
Not applicable

14. To help us keep out spam bots, please answer the following question correctly.
Please pick an answer that is NOT a food

Apple
Bread
Umbrella
Ice cream

15. If applicable, what is your ranking on the team (which describes you best)?

Regular part of the starting line-up
Regular substitute
Practicing but competing infrequently
Practicing and training but not competing
This does not apply to my sport

16. Please rate your skill level between 1 (low) to 5 (high)

17. Which best describes you in your primary competitive sport?

I am the only player in my position (athletes in individual sports: choose this option if others don't apply to you)
There are other players who could cover me, but I am the best player in my position
There are other players who could cover me and who have comparable skills
There are other players who could cover me and are more skilled than I am

18. How many years have you played your primary competitive sport?

19. How many years have you played your primary competitive sport on your current college/university team?

20. Have you been provided concussion education (i.e., symptom recognition and return to play protocol) at any time during your experience playing your current primary competitive sport?

Yes
No

21. How many times?

22. What format of education did you receive?

Presentation/talk
Video
Handout

Online module
Other:

23. Not including any concussion education you received in your primary competitive sport, have you had any other experiences with concussion education?
Yes
No

24. In what setting?
i.e., another sport, training to be a coach, from a medical professional after you sustained a concussion, school (e.g., Kinesiology student)

25. How many times?

26. What format of concussion education did you receive?
Presentation/talk
Video
Handout
Online module
Other:

A CONCUSSION IS: **an injury caused by a blow to the head or sudden movement of the body followed by a variety of signs and symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, ''seeing stars'', feeling in a fog or slowed down, memory problems, poor concentration, nausea, or throwing up. Getting ''knocked out'' or losing consciousness is a symptom but does NOT always occur with a concussion.**

27. Have you ever had a diagnosed or suspected/undiagnosed sport-related concussion?
Yes
No

28. How many years ago?
If you have experienced multiple diagnosed or suspected/undiagnosed concussions, please list multiple years. For example, if you had a concussion 3 years ago and 6 years ago, please list as: 3, 6.

29. Within the past 5 years, have you had a diagnosed or suspected/undiagnosed sport-related concussion?
Yes
No
Thinking about the past 5 years, please answer the following questions about **diagnosed** concussions and your **primary competitive sport**

30. How many diagnosed sport-related concussions have you had in your primary competitive sport?

Concussions may be diagnosed by an athletic trainer, physiotherapist, or medical professional

31. **How many diagnosed sport-related concussions have you reported to your coach or athletic trainer (not including times when someone else, such as the coach, athletic trainer, etc., pulled you from play because of suspected concussion)?**

32. **Of your diagnosed concussions, how many times were you pulled from a game or practice by your coach, athletic trainer, concussion spotter, etc., because of suspected concussion (i.e., they saw the event and pulled you before you had a chance to report any symptoms)?**

33. **How many diagnosed sport-related concussions have you NOT reported to your coach or athletic trainer (not including times when someone else, such as the coach, athletic trainer, etc., pulled you from play because of suspected concussion)?**

The number of concussions you reported, did not have the opportunity to report (you were pulled before you could report), and did not report should add up to the total number of diagnosed concussions you listed at the top of this page. Do not count a concussion more than once.

For example, if you reported 1 concussion, were pulled from play 1 time by a coach before you could report, and did not report 2 concussions, your total number of concussions at the top of the page should be 4.

Thinking about the past 5 years, please answer the following questions about **suspected or undiagnosed** concussions and your primary competitive sport

34. **How many suspected/undiagnosed sport-related concussions have you had in your primary competitive sport?**

35. **How many suspected/undiagnosed sport-related concussions have you reported to your coach or athletic trainer (not including times when someone else, such as the coach, athletic trainer, etc., pulled you from play because of suspected concussion)?**

36. **Of your suspected/undiagnosed concussions, how many times were you pulled from a game or practice by your coach, athletic trainer, concussion spotter, etc., because of suspected concussion (i.e., they saw the event and pulled you before you had a chance to report any symptoms)?**

37. **How many suspected/undiagnosed sport-related concussions have you NOT reported to your coach or athletic trainer (not including times when someone else, such as the coach, athletic trainer, etc., pulled you from play because of suspected concussion)?**

The number of suspected/undiagnosed concussions you reported, did not have the opportunity to report (you were pulled before you could report), and did not report should add up to the total number of suspected/undiagnosed concussions you listed at the top of this page. Do not count a concussion more than once.

For example, if you reported 1 potential concussion, were pulled from play 1 time by a coach before you could report, and did not report 2 potential concussions, your total number of concussions at the top of the page should be 4.

Thinking about the past 5 years , please answer the following questions about concussions or possible concussions **sustained in other activities** (i.e., not sport related)

38. How many concussions have you sustained in another activity/accident (i.e., not sport-related)?

39. If the recovery period for a non-sport related concussion overlapped with sport practices, training, or games, did you report your symptoms to your coach or athletic trainer?

Yes, I reported them right away
Yes, I reported them after the practice/game
No, I did not report my symptoms

40. If there were times you did NOT report possible concussion symptoms in the past 5 years, please choose up to four reasons why you did not report

If you reported every suspected concussion, please skip this question
I didn't think it was a concussion at the time
I wasn't sure it was a concussion at the time
I didn't think it was serious enough
I didn't want to let my teammates down
I didn't want to look weak
I wanted to finish the game
It was during an important game or try-out
I felt pressure to finish the game
I felt expected to play through concussion symptoms
I worried that I wouldn't be allowed to go back to play when I felt ready/recovered
I didn't think a non-sports related concussion was relevant to report
Other:

41. If you had a concussion in the future, would you always tell your coach or athletic trainer?

Yes
No
It depends on the context (important game, try-outs, etc.)
Other:

42. If one of your teammates had a concussion, do you think they would always tell the coach or athletic trainer?

Yes
No

It depends on the context (important game, try-outs, etc.)
Other:

43. Do you have any other information to add about your previous sport or non-sport related concussions?

Appendix O: The World Health Organization Adult Attention-Deficit/Hyperactivity Disorder Self-Report Screening Scale for DSM-5 (Ustun et al., 2017)

Please answer the questions below, rating yourself on each of the criteria shown using the scale on the right side of the page that best describes how you have felt and conducted yourself over the past 6 months.	**Never**	**Rarely**	**Sometimes**	**Often**	**Very Often**
1. How often do you have difficulty concentrating on what people say to you, even when they are speaking to you directly?	0	1	2	3	4
2. How often do you leave your seat in meetings or other situations in which you are expected to remain seated?	0	1	2	3	4
3. How often do you have difficulty unwinding and relaxing when you have time to yourself?	0	1	2	3	4
4. When you’re in a conversation, how often do you find yourself finishing the sentences of the people you are talking to before they can finish them themselves?	0	1	2	3	4
5. How often do you put things off until the last minute?	0	1	2	3	4
6. How often do you depend on others to keep your life in order and attend to details?	0	1	2	3	4

Appendix P: The Athletic Identity Measurement Scale (Brewer & Cornelius, 2001) Please indicate the number that best reflects the extent to which you agree or disagree with each statement regarding your sport participation

1. I consider myself an athlete
Strongly disagree 1 2 3 4 5 6 7 Strongly agree
2. I have many goals related to sport
Strongly disagree 1 2 3 4 5 6 7 Strongly agree
3. Most of my friends are athletes
Strongly disagree 1 2 3 4 5 6 7 Strongly agree
4. Sport is the most important part of my life
Strongly disagree 1 2 3 4 5 6 7 Strongly agree
5. I spend more time thinking about sport than anything else
Strongly disagree 1 2 3 4 5 6 7 Strongly agree
6. I feel bad about myself when I do poorly in sport
Strongly disagree 1 2 3 4 5 6 7 Strongly agree
7. I would be very depressed if I were injured and could not compete in sport
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

Appendix Q: The Executive Function Index (Spinella, 2005)

Rate how well each of the following statements describes you	Not at all		Somewhat		Very much
1. I have a lot of enthusiasm to do things	1	2	3	4	5
2. When doing several things in a row, I mix up the sequence	1	2	3	4	5
3. I try to plan for the future	1	2	3	4	5
4. I can sit and do nothing for hours	1	2	3	4	5
5. I take risks, sometimes for fun	1	2	3	4	5
6. I have trouble when doing two things at once, multi-tasking	1	2	3	4	5
7. I'm interested in doing new things	1	2	3	4	5
8. I have a lot of concern for the well-being of other people	1	2	3	4	5
9. I'm an organized person	1	2	3	4	5
10. I save money on a regular basis	1	2	3	4	5
11. I do or say things that others find embarrassing	1	2	3	4	5
12. People who are foolish enough to be taken advantage of deserve it	1	2	3	4	5
13. I only have to make a mistake once in order to learn from it	1	2	3	4	5
14. I tend to be an energetic person	1	2	3	4	5
15. I make inappropriate sexual advances or flirtatious comments	1	2	3	4	5
16. To help us keep out spam bots and computers please answer the following question correctly: what is one plus two?	1	2	3	4	5
17. When someone is in trouble, I feel the need to help them	1	2	3	4	5
18. I sometimes lose track of what I'm doing	1	2	3	4	5
19. I feel protective towards a friend who is being treated badly	1	2	3	4	5
20. I think about the consequences of an action before I do it	1	2	3	4	5
21. I lose my temper when I get upset	1	2	3	4	5
22. I take other people's feelings into account when I do something	1	2	3	4	5
23. I have trouble summing up information in order to make a decision with it	1	2	3	4	5
24. I start things but then lose interest and do something else	1	2	3	4	5
25. I swear/use obscenities	1	2	3	4	5
26. I don't like it if my actions or words hurt someone else	1	2	3	4	5
27. I use strategies to remember things	1	2	3	4	5
28. I monitor myself so that I can catch any mistakes	1	2	3	4	5

Appendix R: Theory of Planned Behaviour and Concussion Reporting Questionnaire, final revised version (TPB-CRQ-f-revised)

Italicized items represent those items removed from the TPB-CRQ-f as noted in the Data Screening section

[Italicized words in brackets are for reference only and were not included in the online version]

Please answer the following questions about reporting possible concussion symptoms to your coach or athletic trainer by clicking on the number that best describes your opinion.

Each question is rated on a 7-point scale. Some questions may appear to be similar, but they do address somewhat different issues. Please read each question carefully.

As a reminder, a **CONCUSSION** is an injury caused by a blow to the head or sudden movement of the body followed by a variety of signs and symptoms that may include any of the following: headache, dizziness, loss of balance, blurred vision, ‘‘seeing stars’’, feeling in a fog or slowed down, memory problems, poor concentration, and nausea or throwing up. Getting ‘‘knocked out’’ or losing consciousness is a symptom of concussion but does NOT always occur with a concussion.

[Behavioural beliefs]

1. It would be best for the team if I report possible concussion symptoms
   Unlikely 1 2 3 4 5 6 7 Likely

2. Reporting possible concussion symptoms will reduce the chances of suffering another injury in the short term (e.g., same game, tournament, season)
   Unlikely 1 2 3 4 5 6 7 Likely

3. If I report possible concussion symptoms, my teammates will have a negative view of me
   Unlikely 1 2 3 4 5 6 7 Likely

4. Reporting possible concussion symptoms will cause me to lose playing time
   Unlikely 1 2 3 4 5 6 7 Likely

5. Reporting possible concussion symptoms will help me maintain my long-term health
   Unlikely 1 2 3 4 5 6 7 Likely

6. If I report possible concussion symptoms, I will receive an accurate diagnosis (i.e., I would know if it was a concussion or something else)
   Unlikely 1 2 3 4 5 6 7 Likely

7. Reporting possible concussion symptoms will help maintain good academic standing/performance

Unlikely 1 2 3 4 5 6 7 Likely

8. Reporting possible concussion symptoms will prevent serious injury
Unlikely 1 2 3 4 5 6 7 Likely

9. I will have a better chance of recovering if I report possible concussion symptoms
Unlikely 1 2 3 4 5 6 7 Likely

[Control Belief Strength]
The probability of experiencing possible concussion symptoms during an important game or try-out is
Unlikely 1 2 3 4 5 6 7 Likely

10. I would feel comfortable reporting possible concussion symptoms to my coach
Unlikely 1 2 3 4 5 6 7 Likely

11. There is usually an athletic trainer/therapist or other health professional (physiotherapist, doctor, etc.) present at games and/or practices
Unlikely 1 2 3 4 5 6 7 Likely

12. My teammates have a good understanding of concussion
Unlikely 1 2 3 4 5 6 7 Likely

13. I would know for sure if I were experiencing concussion symptoms after a hit or blow
Unlikely 1 2 3 4 5 6 7 Likely

14. If I report possible concussion symptoms, I will be letting the team down
Unlikely 1 2 3 4 5 6 7 Likely

15. My team would support me if I reported possible concussion symptoms
Unlikely 1 2 3 4 5 6 7 Likely

[Direct Perceived Behavioural Control]

16. <u>Not including</u> times when your coach or someone else sees a hit and pulls you from play, how much control do you feel you have over reporting possible concussion symptoms *during an important game or try-out*?
No control 1 2 3 4 5 6 7 Complete control

[Generalized Intention]

17. I plan to immediately report any concussion symptoms I experience after a hit or blow during practice or games to my coach or athletic trainer
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

[Direct Subjective Norms]

18. People who are important to me would approve of my reporting possible concussion symptoms

Strongly disagree 1 2 3 4 5 6 7 Strongly agree

[Behavioural Outcome Evaluations]

19. Doing the best thing for the team is extremely
Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

20. Preventing further injury in the short-term (e.g., same game, tournament, season) is extremely
Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

21. Maintaining my long-term health is extremely
Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

22. Preventing serious injury is extremely
Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

23. My teammates having a negative view of me is extremely
Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

24. Losing playing time is extremely
Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

25. Having an accurate diagnosis of concussion (i.e., knowing if it is concussion) is extremely
Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

26. Maintaining good academic standing/performance is extremely
Unimportant to me 1 2 3 4 5 6 7 Important to me

27. Having a better chance of recovery from concussion is extremely
Bad/Undesirable 1 2 3 4 5 6 7 Good/Desirable

[Normative Beliefs]

*On this page, please pay attention to the **descriptions of the endpoints** on the 1-7 scale (e.g., should not/should vs should/should not)

28. My coach would approve / disapprove of me reporting possible concussion symptoms
Approve 1 2 3 4 5 6 7

29. My teammates do / do not report possible concussion symptoms
Do report 1 2 3 4 5 6 7 Do not report

30. My teammates think I should / should not report possible concussion symptoms
Should 1 2 3 4 5 6 7 Should not

31. My family thinks I should not / should report possible concussion symptoms
Should not 1 2 3 4 5 6 7 Should

My athletic trainer (or equivalent) would approve / disapprove of me reporting possible concussion symptoms
Approve 1 2 3 4 5 6 7 Disapprove

32. Top players do not / do report possible concussion symptoms
    Do not report 1 2 3 4 5 6 7 Do report

    Competitive athletes do not / do report possible concussion symptoms
    Do not report 1 2 3 4 5 6 7 Do report

    [Direct Attitude]
    * Overall, reporting possible concussion symptoms to my coach or athletic trainer is:

    Unimportant 1 2 3 4 5 6 7 Important

33. Good 1 2 3 4 5 6 7 Bad

34. Pleasant 1 2 3 4 5 6 7 Unpleasant

35. Harmful 1 2 3 4 5 6 7 Beneficial

36. Cowardly 1 2 3 4 5 6 7 Brave

    [Direct Perceived Behavioural Control]
37. Not including times when my coach or someone else sees a hit and pulls me from play, whether I report possible concussion symptoms is entirely up to me
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

    [Generalized Intention]
38. I will make an effort to immediately report any concussion symptoms I experience after a hit or blow during practice or games to my coach or athletic trainer
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

    [Motivation to Comply]
39. The approval of my coach is important to me
    Not at all 1 2 3 4 5 6 7 Very much

40. Doing what my teammates do is important to me
    Not at all 1 2 3 4 5 6 7 Very much

41. Doing what my teammates think I should do is important to me
    Not at all 1 2 3 4 5 6 7 Very much

42. Doing what my family thinks I should do is important to me
    Not at all 1 2 3 4 5 6 7 Very much

The approval of my athletic trainer (or equivalent) is important to me
Not at all 1 2 3 4 5 6 7 Very much

43. Doing what top players do is important to me
Not at all 1 2 3 4 5 6 7 Very much

Doing what competitive athletes do is important to me
Not at all 1 2 3 4 5 6 7 Very much

[Generalized Intention]
44. I intend to immediately report any concussion symptoms I experience after a hit or blow during practice or games to my coach or athletic trainer
Strongly disagree 1 2 3 4 5 6 7 Strongly agree

[Direct Perceived Behavioural Control]
45. For me to report possible concussion symptoms *during an important game or try-out* is
Easy 1 2 3 4 5 6 7 Difficult

[Control Belief Power]
*On this page, please pay attention to the **descriptions of the endpoints** on the 1-7 scale (e.g., easy/more difficult vs more difficult/easy)

Experiencing possible concussion symptoms during an important game or try-out makes it <u>easier / more difficult</u> to report possible concussion symptoms
Easier 1 2 3 4 5 6 7 More difficult

46. My coach's approachability or support makes it <u>more difficult / easier</u> to report possible concussion symptoms
More difficult 1 2 3 4 5 6 7 Easier

47. Having an athletic trainer/therapist or other health professional (physiotherapist, doctor, etc.) present at games or practices would make it much <u>more difficult / easier</u> to report possible concussion symptoms
More difficult 1 2 3 4 5 6 7 Easier

48. The level of knowledge and understanding my teammates have when it comes to concussion makes it <u>easier / more difficult</u> to report possible concussion symptoms
Easier 1 2 3 4 5 6 7 More difficult

49. Knowing for sure if I were experiencing concussion symptoms after a hit or blow would make it <u>easier / more difficult</u> to report possible concussion symptoms
Easier 1 2 3 4 5 6 7 More difficult

50. The possibility of letting the team down makes it <u>more difficult / easier</u> to report possible concussion symptoms
More difficult 1 2 3 4 5 6 7 Easier

51. The level of support I would receive from my team makes it easier / more difficult to report possible concussion symptoms
    Easier 1 2 3 4 5 6 7 More difficult

    [Direct Perceived Behavioural Control]
52. I am confident I can report possible concussion symptoms *during an important game or try-out*
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

    [Direct SN]
53. Athletes I know report possible concussion symptoms
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

54. It is expected of me to report possible concussion symptoms
    Strongly disagree 1 2 3 4 5 6 7 Strongly agree

Appendix S: Extended Model Study Debrief Form

Thank you for your participation! You have made an important contribution to improving concussion management in college/university sports!

The aim of this study is to understand the reasons athletes do not report suspected concussion symptoms and/or follow safe return to play (RTP) procedures after a hit or blow, using a theoretical model.

Concussion reporting research to this point has focused primarily on qualitative reasons for non-adherence to RTP protocol, however some theory-based studies have begun investigating non-reporting behaviours using the Theory of Planned Behaviour (TPB). According to the TPB, the best predictor of human behaviour is one's intention to perform that behaviour (Ajzen, 1985; Kroshus, Baugh, Daneshvar, Nowinski, & Cantu, 2015; Webb & Sheeran, 2006). In this model, intention is influenced by one's attitude toward the behaviour in combination with what they believe significant others expect them to do and the degree of control they feel they have over actually performing the behaviour (Ajzen, 1991).

This study looks to extend the TPB by incorporating executive functioning abilities into the model. Executive function can be described as our brain's 'air traffic control system', or the strategies we use to carry out goal-directed behaviour such as reporting concussion symptoms after a hit or blow. Because executive function is such a significant part of decision making processes, we propose it will add to the TPB and help explain symptom reporting behaviour.

Concussion is a medical condition that should be taken seriously. For more information on concussion recognition and RTP recommendations, please see the Heads Up: Concussion webpage (https://www.cdc.gov/headsup/index.html), an easy to use resource created by the Center for Disease Control and Prevention.

If you have any questions or concerns about the study at any time, you may contact the head researcher, Jennifer Sorochan, at jennifer.sorochan@unb.ca, or Dr. K. Troy Harker at kharker@unb.ca. If you have any ethical concerns about your participation in this study and would like to speak to someone who is not involved in this research, you may contact the Acting Chair of the Department of Psychology's Ethics Review Committee at the University of New Brunswick, Dr. Biljana Stevanovski at 506-458-7693 (bstevano@unb.ca). Again, your participation is greatly appreciated!

Request for follow-up participation!

We are looking for a smaller group of athletes to help strengthen our Theory of Planned Behaviour Questionnaire by completing just that portion again in two weeks' time. This would only take approximately 8 minutes. If you chose to participate, you would be entered to win an ***additional*** $25 gift card.

Your participation in this component will help make our research more valid and useful for all athletes!

□ I would be willing to be contacted again to answer some short follow-up questions,
□ I would prefer not to be re-contacted
□ NEXT

Thank you for your participation! If you would like to receive a short write up of the results once this study is completed, and if you would like to be entered in the draws for the $25 gift cards please leave your email address below. Your email address will NOT be associated with your survey answers in any way.

□ Please send me results of this research once it is completed
□ Please enter my email address for the $25 gift card draw

Appendix T: Email for Time 2 Participation (Test-Retest)

Hello! Two weeks ago, you completed an online survey about concussion symptom reporting and indicated you would be willing to fill out a shorter follow-up survey to help us strengthen the new questionnaire. This survey includes only one portion of the previous questionnaire you competed and should only take about **8-10 minutes** to complete. Please try to complete it within 5 days from today.
In appreciation, you will be entered into ***another*** draw to win an additional $25 gift card.
If you do not wish to participate in this short follow-up component, please disregard this email. Thank you for your initial participation!

If you do wish to complete the second component and be entered into another draw, please click on the link below. Your consent to participate in this component will be assumed by the completion of the following survey.
Please note that although the researchers are happy to respond to any questions or comments, and will do our best to keep all correspondences confidential, the confidentiality of any exchanges of information between yourself and the researchers cannot be guaranteed due to the inherent insecurity of email.
Thank you very much for supporting this research!
They survey can be found here:
https://survey.psyc.unb.ca/Survey.aspx?s=1ac701f0d4c84bdabf5798170dbbb4dc

Appendix U: Time 2 (Test-Retest) Introduction and Code Request

Thank you for participating in the second part of this study!

This time, you will only be filling out a section of the previous questionnaire, which should take about 8-10 minutes to complete.

All answers are kept private and confidential. Your name will never be attached to your responses. Below, please enter the unique code you created two weeks ago so your responses can be matched. Your code consisted of the **first three** characters of your postal code and the **last five digits** of your phone number. If you have moved or changed your phone number since creating your unique code, please use your previous information so the codes are the same.
If you need help remembering your postal code, click here to open a new window and access Canada Post's 'Find a Postal Code' page.

Please enter your code below. For example, if your postal code is V9T 5H0 and your phone number is 979-3033, your code would be V9T93033 (no spaces).

Please enter
The **first three** characters of your postal code and **last five** digits of your phone number: ____

First, have you sustained one or more diagnosed concussions since completing the first part of this study approximately two weeks ago?

Yes
No

How many?

In what sport(s)?

Appendix V: Time 2 (Test-Retest) Debrief Form

You have made an important contribution to this study's questionnaire validation! The information you provided today will be used to further validate the new Theory of Planned Behaviour Questionnaire. Part of questionnaire validation involves assessing the test-retest reliability of the measure. This means assessing how similar a participant scores on each item when they complete the questionnaire on two separate dates.

As noted in the debrief form you were provided after completing the first survey, the aim of the overall study is to utilize a theoretical model to understand the reasons athletes do not report suspected concussion symptoms and/or follow safe return to play (RTP) procedures after a hit or blow. Concussion is a medical condition that should be taken seriously. For more information on concussion recognition and RTP recommendations, please see the *Heads Up: Concussion* website (https://www.cdc.gov/headsup/index.html), an easy to use resource created by the Center for Disease Control and Prevention.

If you have any questions or concerns about the study at any time, you may contact the student researcher, Jennifer Sorochan, at jennifer.sorochan@unb.ca, or Dr. K. Troy Harker at kharker@unb.ca. If you would like to be sent a copy of the results once data collection is finished for the final dissertation research, please email Jennifer Sorochan. If you have any ethical concerns about your participation in this study and would like to speak to someone who is not involved in this research, you may contact the Acting Chair of the Department of Psychology's Ethics Review Committee at the University of New Brunswick, Dr. Biljana Stevanovski at 506-458-7693 (bstevano@unb.ca)

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Publications:

Hirst, S. A., O'Neill, M. L., & **Sorochan, J.** (2020). *Mental Illness*. In F. Maggino (Ed.), *Encyclopedia of Quality of Life and Well-Being Research* (pp. 1–7). Springer International Publishing. https://doi.org/10.1007/978-3-319-69909-7_1791-2

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O'Neill, M, & **Sorochan, J.**, (2014). *Anxiety.* In A.C. Michalos (Ed.) *The encyclopedia of quality of life and well-being research* (pp. 95-97). Dordrecht, Netherlands: Springer.

Conference Presentations*:*

Wright, J., **Sorochan, J.** & Harker, K.T. (2017, June). *Double jeopardy: The impact of early adversity on specific executive functions in adults with chronic illness.* Poster presented at the 78th Annual Convention of the Canadian Psychological Association, Toronto, ON.

Sorochan, J. & Harker, K.T. (2016, June). *Hitting them over the head with it: Concussion knowledge does not lead to RTP compliance.* Poster presented at the 77th Annual Convention of the Canadian Psychological Association, Victoria, BC.

Sorochan, J., Elleker, D., Rivest, J., Hunt, T., & O'Neill, M. (2011, November). *The relationship between perceived control, optimism, social support, and PTSD in survivors of traumatic motor vehicle accidents*. Poster presented at the 45th annual convention of the Association of Behavioral and Cognitive Therapies, Toronto, ON.

Sorochan, J., Elleker, D., Hunt, T., Rivest, J., & O'Neill, M. (2011, November). *The role of phobic avoidance and perceived control in motor vehicle accident-related PTSD symptomatology*. Poster presented at the 45th annual convention of the Association of Behavioral and Cognitive Therapies, Toronto, ON.

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