Investigating Concussions and Internalising Behaviours in a sample of High School Rugby Players in Cape Town

Maymoonah Abrahams (ABRMAY002)

Nikita T. Tessendorf (TSSNIK001)

ACSENT Laboratory

Department of Psychology

University of Cape Town

Supervisor: Dr Leigh Schrieff

Co-Supervisor: Sarah Mc Fie

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NAME: Nikita Tessendorf and Maymoonah Abrahams

SIGNATURE: N. Tessendorf and M. Abrahams

STUDENT NUMBER: TSSNIK001 and ABRMAY002

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SUPERVISORS NAME: Dr Leigh Schrieff

CO-SUPERVISORS NAME: Sarah Mc Fie

Abstract

Concussions are a major public health concern, especially in rugby players. Although substantial literature exists on post-concussive sequelae, few studies investigate affective factors / internalizing behaviours (e.g., depression and anxiety) among adolescent rugby players. The limited literature suggests that athletes may experience such internalising behaviours, either directly or indirectly following a concussion. The current project aims to investigate the relationship between history of concussions and depression and anxiety in a sample of 26 high school male rugby players and 12 non-rugby (hockey/soccer) players, aged 16 to 18 years, recruited from 5 high schools in Cape Town. We used measures of depression, anxiety, alcohol use and along with history of concussion. In line with existing literature, we hypothesized that 1) rugby players would report higher levels of internalising behaviours than the non-rugby (hockey/soccer) group, and 2) that rugby players who sustained a concussion would report higher levels of internalizing behaviours than those players who had not. We ran two regression analyses to address each hypothesis, with depression and anxiety as dependent variables. Results revealed no significant between-group differences for the Rugby and Hockey/Soccer Control group. The Concussed (Rugby) group had significantly higher levels of depression than the Non-Concussed (Rugby) group. Our regression analyses found that trait anxiety and depression were significant predictors of each other. Additionally, the GHQ anxiety/insomnia component significantly predicted depression for the Rugby and Hockey/Soccer Control group. More research of this nature is needed given the effect that such internalizing behaviours can have on athletes, especially in adolescence.

Keywords: concussions, rugby, adolescents, internalising behaviours, depression, anxiety.

Traumatic brain injuries (TBI) are one of the leading causes of death in the United States (US), with nearly one third of injury-related deaths linked to a diagnosis of TBI (Faul & Coronado, 2015). In South Africa, TBI is known to be a leading cause of disability, with a previous report detailing nearly 89 000 cases of TBI being reported every year (Naidoo, 2013). TBI refers to a change in brain function which usually results from a violent blow to the head or the head coming to an abrupt stop, with associated acceleration, deceleration and rotational forces, resulting in varying degrees of loss of consciousness, amnesia and in some cases, death (Li, Zhao, Yu, & Zhang, 2016). In terms of severity, TBIs are classified as mild, moderate or severe, based on the duration of loss of consciousness and post-traumatic amnesia (period of confusion post TBI), and the level of consciousness post TBI (Li et al., 2016). Approximately 1.4 million TBIs occur yearly; of this nearly 75-90% can be classified as mild TBI (mTBI) or concussions (Chrisman & Richardson, 2013). One of the collision sporting codes in which concussion is frequently reported, is rugby. Furthermore, limited research has been conducted specifically on the psychological profiles of athletes (i.e. depression and anxiety) and particularly young athletes, following a concussion (Sandel, Reynolds, Cohen, Gillie, & Kontos, 2017). Young players are more susceptible to concussions than adults as their brains are still developing and thus more vulnerable to injury (Gardner et al., 2014). In sum, although substantial literature exists on post-concussive sequelae, more studies on affective factors and especially among adolescent rugby players, are needed.

Concussion: Definition, Symptoms and Prevalence

Concussion is a significant health problem faced by sports players all over the world due to the harmful and potentially chronic effects thereof (Manley et al., 2017). A concussion is defined as a "pathophysiological process resulting in functional neurological impairments as a consequence of forceful biomechanical impacts directly on or transmitted to the head, neck or face" (McCrory et al., 2017). Hence, concussions are not limited to head injuries exclusively, but also include direct or indirect impacts to the neck or shoulder region (Beakey, Tiernan, & Collins, 2018). In fact, concussions can result from impacts anywhere on the body that may transmit forces to the head, and consequently to the brain. These forces to the brain may or may not result in a loss of consciousness for a brief period of time with associated sequelae, the extent of which depends on factors like the severity of the blow to the individual (Marshall, 2012; Beakey et al., 2018). The associated symptoms can range from physical (nausea, headaches, dizziness) to emotional (depression, anxiety, irritability,

frustration) and cognitive (incoordination, memory impairment, processing speed and executive dysfunction) symptoms (Giza & Kutcher, 2014).

Concussion is a common occurrence in collision sports (Manley et al., 2017). Langlois, Rutland-Brown, and Wald (2006) found that between 1.6 to 3.8 million concussions that have been reported in the US are attributed to collision sports. This figure is possibly inaccurate as many sport-related concussions (SRCs) are not brought to medical attention (Giza & Kutcher, 2014). Players may think that the head injury sustained was not severe enough to warrant medical attention; they fear letting their team, parents or coach down, not wanting to miss out on games, or fear of what could potentially be wrong, should there be post-concussive investigations (Beakey et al., 2018).

Rugby and Concussions

Rugby is known for being a physical sport with a significantly high incidence rate of collision injuries (Beakey et al., 2018). Despite this, over 8.5 million people worldwide play rugby (Beakey et al., 2018). Concussion is one of the most commonly reported injuries in rugby (Kirkwood, Parekh, Ofori-Asenso, & Pollock, 2014). The high incidence rate is because players are not protected from collisions despite the use of mouth guards and scrumcaps (Menger, Menger, & Nanda, 2016). These often provide little to no protection against blows sustained to the head, neck and face. In TBI more generally, it is the acceleration, deceleration and rotational forces that act on the brain within the skull cavity. It is such forces that are believed to underly the sequelae associated with concussions (Li et al., 2016; McAllister, 2011).

Getting seriously injured in a sports match can be one of the most physically and emotionally devastating events that an athlete can experience (Li, Moreland, Peek-Asa, & Yang, 2017). Athletes face extreme pressure to perform which can take a significant toll on their general health, including their mental health. Increasing reports of mental health issues such as anxiety and depression are being reported within the concussion literature, although this remains limited (Mainwaring, Hutchison, Camper, & Richards, 2012; Li et al., 2017).

Depression and Anxiety and Sports Related Concussion

Research previously conducted on post-concussive symptoms has primarily been based on physical and cognitive functions (Mainwaring et al., 2012). However, there seems to be insufficient focus placed on the impact of SRCs on rugby players' affective functioning, and even less so among youth (Giza & Kutcher, 2014). Recently, studies have started to emerge in which depression and anxiety, as well as other mental health problems in athletes, are investigated (Wolanin, Gross, & Hong, 2015). Within this limited literature, depression

and anxiety are two of the most frequent areas of study in terms of these post-concussive affective sequelae. However, there is insufficient research done on such outcomes in relation to SRC and adolescent rugby players specifically (Mainwaring et al., 2012).

Collectively, depression and anxiety may be referred to as 'internalising behaviours' (Yang, Peek-Asa, Covassin, & Torner, 2015). Internalising behaviours are behaviours that are directed inwards and are not as apparent as externalizing behaviours (e.g., aggression, anger or impulsivity). It is important to acknowledge that internalising behaviours, specifically in relation to SRCs, often occur as short-term symptoms (Yang et al., 2015). Therefore, these behaviours are considered to be subclinical in nature, as they rarely develop into clinical disorders (e.g., major depressive disorder or anxiety spectrum disorder; Kontos, Deitrick, & Reynolds, 2015). However, even short-term anxiety and depression in athletes can be counterproductive and impact on athletes' general well-being and performance on the field.

Depression. There are a range of symptoms associated with depression, which can influence vital aspects of an individual's life (Proctor & Boan-Lenzo, 2010). For instance, behavioural and cognitive functioning are largely affected by symptoms of depression, such as sadness, irregular sleeping patterns, and isolation (Proctor & Boan-Lenzo, 2010). If such symptoms are left unidentified and untreated after an SRC, it could be threatening to the athlete's general health. Studies to date have focussed on professional and college athletes (Wolanin et al., 2015). Research also shows that athletes may be prone to depression (amongst other sequelae) following repeated concussions. In fact, post-concussive depression, and also anxiety, are two of the most common symptoms associated with repeated concussions (Chrisman & Richardson, 2013).

Anxiety. Mainwaring and colleagues (2012) report overlaps between anxiety and post-concussion symptoms (fatigue, sleep disturbances, irritability, nervousness or dysfunction in memory and concentration), making it challenging to differentiate between the symptoms. Symptoms of anxiety such as excessive worrying, difficulty concentrating, or tense muscles, can be experienced directly or indirectly following a concussion. In terms of direct effects, an individual may be experiencing physical anxiety-related symptoms (e.g., tense muscles), that could affect their performance during a game. Indirect effects of anxiety may be seen when an individual's ability to perform is undermined by their concern or worry (Li et al., 2017). Furthermore, there can also be anxiety around waiting for the results of post-concussion assessments, and establishing whether they will be able to play or not. Li and colleagues (2017) found that most of the studies that have been conducted looked at anxiety

in professional rugby players and athletes, with very little focusing on high school (adolescent) rugby players.

The Adolescent Brain

The adolescent brain is still in an immature state due to its on-going development. Furthermore, adolescents also have greater head to body ratios and weaker stabilizing neck muscles, which is proposed to increase the risk of concussion. Thus, injuries such as TBIs, sustained as an adolescent, may result in different pathophysiological consequences and risk of greater vulnerability, than if sustained as an adult (Figaji, 2017). These differences may be due to the sensitivity in the neuronal maturation of the adolescent brain (Figaji, 2017). In line with such findings, Chrisman and Richardson (2013) report on research suggesting that SRC-related symptoms among youth may persist for months or even years following the concussion, especially after an athlete has sustained multiple concussions. These athletes are at risk of experiencing long-term damage such as decreased mental speed, memory dysfunction, depression or loss of concentration (Kirkwood et al., 2014). Such findings underscore the need to investigate the effects of concussions in adolescents in order to gain a better understanding thereof, rather than trying to extrapolate from results for adults.

Rationale

Although post-concussion literature have largely focused on physical and cognitive sequelae, a body of literature, in which depression and anxiety, as well as other mental health problems in athletes, is emerging (Wolanin, Gross, & Hong, 2015). This emerging body of literature highlights a need for greater focus on the prevalence of internalising problems in adolescent athletes (specifically rugby players) in relation to concussion (Mainwairing et al. 2012; Junge & Feddermann-Demont, 2016). The lack of research in this area has implications for the understanding of the potential harmful and often unseen consequences of concussions that can arise in young rugby players, which can result in the dismissal of noteworthy sequelae after a SRC.

Aims and Hypotheses

Given the dearth of research in this area, we aimed to investigate internalising behaviours in relation to adolescent rugby players and concussions. Specifically, we examined the link between concussion and anxiety and depression in young rugby players and non-collision sport players (hockey/soccer control group).

This study tested the following hypotheses:

1. The Rugby group will perform worse on the depression and anxiety measures compared to the Hockey/Soccer Control group.
2. Rugby players who have a history of concussion will perform worse on the depression and anxiety measures compared to rugby players who have no history of concussion.

Further, we explored predictors of anxiety and depression from our study variables, for both of the abovementioned analyses.

Methods

Design and Setting

This study is a cross-sectional, quantitative study. The data collected for this research project is part of a larger Masters study, being conducted in the Psychology Department at the University of Cape Town (UCT) titled "Investigating the neuropsychological effect and long-term outcomes of concussions among high school rugby players". We recruited participants from five schools within the Cape Town area.

The participants made up two groups; the Hockey/Soccer Control group and the Rugby group. The Rugby group included participants who currently participated in rugby and either had a history of concussion or no history of concussion. Hence, we conducted between- (Rugby vs. Hockey/Soccer Control) and within- (Rugby: Concussion vs. No Concussion) group analyses. All procedures were conducted at the schools where participants were recruited from.

Participants

Recruitment. There were 38 male high school students recruited using purposive sampling from five high schools within Cape Town.

Eligibility criteria. Only male students, aged 16 to 19 years at the time of recruitment were included. Furthermore, participants were excluded if they had (a) prior or current diagnoses of psychiatric illnesses, learning disabilities, or neurological disease; (b) any history of, or current drug and/or alcohol abuse and; (c) sustained a concussion one year prior to their participation and sustained another within the space of a year. Additionally, for the Hockey/Soccer Control group specifically, participants were excluded if they (a) played any collision sport(s) and/or (b) had a history of concussion.

We recruited 44 participants, however after the criteria had been applied to the sample, 6 participants were excluded from the dataset, leaving us with 38. No exclusion criteria were included for the BDI-II measure as we needed to explore depression since it was

one of our variables of interest. However, participants who scored 21 and above were notified and were referred to the relevant school counsellor.

Materials

Screening measures. These measures were completed by the participants in order to acquire information for exclusion purposes and relevant demographics and medical history.

Demographic and medical history questionnaire. This questionnaire includes a series of questions asking participants about their age, weight, height, sex, language proficiency, any history of concussion, the use of chronic medication and any history of psychiatric disorder(s). Furthermore, this was used to inform us of any psychiatric disorders, learning disabilities or previous concussions that participant may have which may skew the results of the study.

General Health Questionnaire (GHQ-28). This screening measure is a self-administered questionnaire which comprises 28 items. These are divided into four different sub-scales: somatic symptoms, anxiety and insomnia, social dysfunction and severity of depression. For the purposes of this study we will be using the GHQ somatic symptoms, GHQ anxiety and insomnia, and GHQ social dysfunction subscales. This measure is used for classifying minor psychiatric disorders in adults and adolescents. The questions use a four-point Likert-type scale which assesses the participants' current condition compared to their 'normal' everyday state (Goldberg & Hillier, 1979). Higher scores indicate poorer general health. Reliability and validity studies of the GHQ-28 have shown that the test-retest reliability is high, which ranges between 0.78 to 0.95 (Sterling, 2011). This scale was used previously in research studies which explored TBIs and SRCs (Ghaffar, McCullagh, Ouchterlony, & Feinstein, 2006; Shayan et al., 2015). Furthermore, it has been used in a South African context (De Kock, Gorgens-Ekermans, & Dhladhla, 2013; Ward, Lombard, & Gwebushe, 2006).

Behavioural measures.

Alcohol Use Disorders Identification Test (AUDIT). This test includes 10 items that focus on alcohol consumption, drinking behaviour as well as alcohol-related problems (Saunders, Aasland, Babor, De La Ruente, & Grant, 1993). Responses for each item are scored on a scale from 0 to 4, with a maximum score of 40 (Saunders et al., 1993). A score of 8 or more indicates hazardous or harmful alcohol use (Saunders et al.,1993). Higher scores indicate more damaging alcohol consumption. A study conducted by Daeppen and colleagues (2000) calculated the reliability of the measure using internal consistency and test-retest reliability. For internal consistency, Cronbach's alpha (α) was .85 and for test-retest

reliability, Spearman's correlation (r) was 0.88. Both of these values obtained indicate that the measure was reliable and valid. According to McMillan et al (2017), this measure has been used within a South African context, specifically in adolescent research and SRC research.

Emotional measures.

Beck Depression Inventory-Second Edition (BDI-II). According to Smarr and Keefer (2011), the BDI-II was developed in accordance with the DSM-IV criteria for diagnosing major depressive disorder. The scale can be used to assess cognitive, affective, somatic and vegetative symptoms of depression and comprises of 21 items on a 4-point scale, ranging from 0 ("symptom absent") to 3 ("severe symptom") that best explains how the participants felt over the past 2 weeks (Jackson-Koku, 2016; Smarr & Keefer, 2011). A score of 21 on the BDI-II indicates a moderate level of depression. Higher scores indicate higher levels of depression. The BDI-II has a good test-retest reliability (r = .93) and high internal consistency, with alpha ranging between .73 and .92 (Bisson, 2017; Dozois et al., 1998; Yousefi et al., 2010). This measure has been used in SRC research within a South African context, looking specifically at a sample of adolescents and young adults (Covassin et al., 2012; Shuttleworth-Edwards, Whitfield-Alexander, Radloff, Taylor, & Lovell, 2009).

State-Trait Anxiety Inventory (STAI). This measure looks at both state and trait anxiety. State anxiety looks at the temporary psychological and physiological reactions that are directly related to adverse situations (Leal, Goes, da Silva, & Teixeira-Silva, 2017). Trait anxiety, however refers to a trait of personality. It refers to the differences that occur between people in terms of their tendency to experience state anxiety in response to a stressful event (Leal et al., 2017). The STAI is a 40-item self-report questionnaire that measures state and trait anxiety. For the purpose of this study we used the trait anxiety (T-STAI) measure exclusively, which comprised of items 21 to 40. These items specifically assess negative emotions such as worry, anxiety and fear. Participants must select the answer which is most applicable to them using a 4-point Likert-type scale (with 1 indicating "not at all" and 4 indicating "almost always") (Julian, 2011). Higher scores indicate higher levels of anxiety. The STAI has a high test retest reliability (S-Anxiety: r = .54 and T-Anxiety: r = .80) as well as high internal consistency (α = .88) (Spielberger & Vagg, 1984). This measure was used in studies based in South Africa which specifically explored the effects that physical activity has on anxiety (Paluska & Schwenk, 2000) as well as studies which looked at emotional stress management as a consequence of symptoms of depression and anxiety (Pretorius, 1993).

Procedure

Each school was approached individually. The researchers presented the purpose, aim, objectives, process and design of the study to the head of each school and the Head of Sport. Upon their consent to participation, an information session was held to inform students and their parents, when possible, about the study. The session included general information and the latest research findings about concussions in sports. The presentation was conducted by Professor Figaji, when available, or alternatively by Dr Sarah Mc Fie and Dr Leigh Schrieff. Consent forms were distributed at these sessions (Appendices A and B). We attended and assisted with the setup of these presentation sessions as well as the distribution of consent forms thereafter.

After consent had been given by the parents for their children to participate in the study, testing sessions were scheduled for the participants. The research assistant for the larger study was responsible for scheduling participants for testing. Most testing sessions were scheduled after school hours between 15:00 and 16:00. These assessments largely occurred before the start of the rugby season and were therefore considered baseline assessments for the larger study. Assent forms (Appendices C and D) were given to the participants at the start of each testing session. These forms explained what the study is about and what their participation entails. Furthermore, these forms also stated that the participants could withdraw from the study whenever and would not be punished for doing so as well as informing them that their responses would remain confidential. Upon completion of the Assent forms, the study had commenced. This process was the same for both the Hockey/Soccer Control and Rugby group.

Assessments for Rugby and Hockey/Soccer Control groups. We carried out the testing sessions in a computer room at each respective school. Assent forms were provided at the start of the session. Once assent forms had been signed, participants were asked to complete the demographic and medical history questionnaire, the GHQ-28, BDI-II, AUDIT and T-STAI measures. All of these questionnaires were completed by hand on paper. The duration of these sessions lasted approximately 90 to 120 minutes. The measures for the current study were completed within 60 mins.

Upon completion of the questionnaires, participants were debriefed and were provided with the debriefing form (Appendix E). Any questions and concerns that were raised, were answered during this time. All participants who completed the testing session received a R100 Sportsman’s Warehouse voucher to reimburse them for their participation.

Statistical Analyses and Data Management

All data were recorded and analysed using the statistical software SPSS version 25.0 with a significance level of $\alpha = .05$. We first generated descriptive statistics to ensure assumptions for our statistical tests were upheld and whether the data contained any outliers (defined as any score 3 SDs away from the mean) or missing data. A series of independent sample *t*-tests were used to establish if there were any significant between-group differences for BDI-II, T-STAI, AUDIT, GHQ-28, age, concussion and group. Following this, we ran four backwards linear regressions to determine the predictors of (a) depression (BDI-II) and (b) anxiety (T-STAI) for the Rugby/Hockey/Soccer Control groups and the Rugby Concussion/No Concussion groups. The predictor variables for the study included age, AUDIT, history of concussion, GHQ somatic symptoms, GHQ anxiety/insomnia and GHQ social dysfunction subscales and group. The raw data was stored in files and kept in a secured room in the Psychology Department at UCT.

Ethical Considerations

The parent study was granted ethical approval from the Western Cape Education Department (Appendix F) for the five participating schools as well as approval from the University of Cape Town's Faculty of Health Sciences Human Research Ethics Committee (REF: 785/2016, Appendix G).

Risks and benefits.

Potential risks and discomforts. The risks identified for this study were minimal. The questionnaires and ImPACT test took up 90 to 120 minutes of the students' time, outside of school hours. The duration of the testing sessions may have caused some irritation or restlessness as a result of possible fatigue. Breaks were given if needed.

Minimising risk. An information session was held to explain all information regarding the study. After the testing session commenced, an opportunity for questions and concerns were given. The consent and debriefing forms contained all the contact information of the researchers to whom all study-related queries may be directed.

Informed consent and assent process. Both consent and assent forms informed the participants and their parents about the scope of their participation and that they (the participants) could withdraw from the study without any repercussions at any given time. The assent forms were given to the participants at the start of the assessment sessions so that they could provide assent independently of their parents.

Privacy and confidentiality. The identities of each participant and their responses were kept confidential. Each participant was assigned a number to protect their identity

during the write-up of the project. Furthermore, should the research get published, the numbers assigned to each participant will be used instead of their names to protect them.

Reimbursement for participation. A gift voucher of R100.00 was given to all participants after the testing session concluded.

Referrals. In the event that a participant scored in the clinical ranges on the BDI-II, STAI or the AUDIT tests, they were referred to the school counsellor or to a sports psychologist at the Sports Science Institute of South Africa if no school counsellor is available.

Results

All participants (*N*=38) were 16 to 18 years old (mean age was 16.50 years old). Below we present the results for the Rugby/Hockey/Soccer Control groups and the Rugby Concussion/No Concussion groups, separately.

Rugby vs. Hockey/Soccer Control groups

Descriptive Statistics and Between-Group Differences. Table 1 shows the descriptive statistics and between-group differences for the participants in the Rugby (*n*= 26) and Hockey/Soccer Control (*n*= 12) groups. An independent samples t-test showed that there were no significant differences between the groups with regards to age, BDI-II, the GHQ subscales, T-STAI and AUDIT measures (p >.164 for all analyses). Despite there being no significant differences, the Hockey/Soccer Control group scored higher on the GHQ anxiety/insomnia, GHQ social dysfunction and BDI-II, descriptively. However, the Rugby group scored higher, descriptively, on GHQ somatic symptoms, T-STAI and AUDIT, as compared to the Hockey/Soccer Control group. The effect size estimates for all variables were small-to-medium (ranged from 0.02 to 0.39) (Table 1).

Internalising behaviours were equally prevalent in both the Rugby and Hockey/Soccer Control groups. The means for both the BDI-II and AUDIT measures were low and none of them fell within the clinical/hazardous range for both groups. However, the T-STAI means for both groups were high and fell within the clinical range (45-80). Within the Rugby vs. Hockey/Soccer group, 17 (65%) rugby players and 10 (83%) hockey/soccer players scored within the high anxiety range on the T-STAI measure. This suggests that 71% of the sample had high anxiety. Overall more than 2/3 of the sample had high anxiety which aligns with literature (Strydom, Pretorius & Joubert, 2012).

Table 1
Descriptive Statistics and Between-group Differences: Rugby Group and Hockey/Soccer Control Group (N=38)

Variable	Hockey/Soccer Control (n = 12)	Rugby (n = 26)	t	p	*ESE*
Age (years)					
M (*SD*)	16.50 (.52)	16.46 (.58)	-.20	.595	0.07
Range	16 – 18	16 - 18			
GHQ Somatic Symptoms					
M (*SD*)	12.25 (3.49)	12.42 (2.67)	.17	.164	0.05
GHQ Anxiety/Insomnia					
M (*SD*)	11.67 (3.96)	11.00 (3.39)	-.53	.319	0.18
GHQ Social Dysfunction					
M (*SD*)	14.25 (2.53)	13.35 (2.10)	-1.16	.814	0.39
BDI-II					
M (SD)	11.92 (6.52)	9.31 (7.76)	-1.01	.346	0.36
T-STAI					
M (SD)	47.50 (4.58)	47.58 (5.30)	.04	.198	0.02
AUDIT					
M (SD)	2.92 (4.23)	3.58 (4.04)	.46	.986	0.16

Note. For the variables, means are presented with standard deviations in parentheses. GHQ = General Health Questionnaire; BDI-II = Beck Depression Inventory; T-STAI = Trait-State-Trait Anxiety Inventory; AUDIT = Alcohol Use Disorders Identification Test; ESE = Estimated Size Effect. All *p*-values are one-tailed.

Correlations: Age, Concussion, GHQ subscales, BDI-II, T-STAI AUDIT and group. Table 2 shows the correlation output for the Hockey/Soccer Control and Rugby group and the predictors; age, group, concussion, GHQ subscales, BDI-II, T-STAI and AUDIT. This output was used to establish which predictors correlated with the outcome variables (BDI-II and T-STAI) and their significance. Looking at the table we can see that BDI-II was significantly, positively correlated with GHQ anxiety/insomnia, GHQ somatic symptoms, GHQ social dysfunction and T-STAI. Additionally, T-STAI was significantly, positively correlated with GHQ anxiety/insomnia and BDI-II.

This table was also used to determine if there was multicollinearity. Looking at the table we can see that there was no multicollinearity as none of the correlations were above r = .467.

Table 2
Bivariate Correlations: Rugby Group vs. Hockey/Soccer Control Group (N = 38)

Variable	1	2	3	4	5	6	7	8	9
1. Age	-								
2. Concussion	.142	-							
3. GHQ Somatic Symptoms	.123	.069	-						
4. GHQ Anxiety/Insomnia	.167	.061	.462**	-					
5. GHQ Social Dysfunction	.035	.086	.389**	.523**	-				
6. BDI-II	.109	.053	.412**	.656**	.526**	-			
7. T-STAI	-.222	.125	.224	.282*	.124	.467**	-		
8. AUDIT	.112	.049	.224	.310*	.086	.085	-.074	-	
9. Group	-.033	.351*	.028	-.089	-.189	-.166	.007	.077	-

Note. *Correlation is significant at the 0.05 level (1-tailed). **Correlation is significant at the 0.01 level (1-tailed). GHQ = General Health Questionnaire; BDI-II = Beck Depression Inventory; T-STAI = Trait-State-Trait Anxiety Inventory; AUDIT = Alcohol Use Disorders Identification Test.

Regression Analyses. All assumptions were checked and met (Durbin-Watson = 2.43 for BDI and 2.46 for T-STAI). Two separate backwards regression analyses were run (refer to Table 3). For the first regression with BDI-II as the outcome variable, we investigated the extent to which GHQ anxiety/insomnia, GHQ social dysfunction, GHQ social dysfunction, age, AUDIT, group and T-STAI contributed to the performance on the BDI-II measure. Therefore, all the predictors were added to the regression model. However, the results suggested a model containing only GHQ anxiety/insomnia, GHQ social dysfunction and T-STAI. Table 3 illustrated that the GHQ anxiety/insomnia and T-STAI were significant predictors of BDI-II ($p = .003$ and $p = .012$ respectively). Moreover, GHQ social dysfunction was not a significant predictor of BDI-II, however it is approaching significance ($p = .056$). This suggest that GHQ anxiety/insomnia and T-STAI explained 53% of the variance in BDI-II scores. Therefore, the final model for predicting BDI-II scores was statistically significant ($F(37) = 14.86$, $p < .001$)

Secondly, we investigated the extent to which GHQ anxiety/insomnia, GHQ social dysfunction, GHQ social dysfunction, age, AUDIT, group and BDI-II contributed to the performance on the T-STAI measure. The results, however suggested a model containing age and BDI-II (refer to Table 3). Looking at the table, we see that BDI-II was a significant predictor of T-STAI ($p = .001$), whereas age was not (it is however approaching significance, $p = .062$). This suggests that BDI-II explained 25% of the variance in the T-STAI scores. Therefore, the final model for predicting T-STAI scores was statistically significant ($F(37) = 7.28$, $p = .002$).

Table 3
Coefficients Output for Final Models: Hockey/Soccer Control Group vs. Rugby Group (N = 38)

	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Beta	*T*	*p*	Lower Bound	Upper Bound
BDI-II							
(Constant)	-33.71	9.17		-3.68	.001**	-52.34	-15.08
GHQ Anxiety/Insomnia	.90	.29	.43	3.15	**.003****	.32	1.48
GHQ Social Dysfunction	.86	.44	.26	1.98	.056	-.02	1.75
T-STAI	.46	.17	.31	2.67	**.012***	.11	.82
T-STAI							
(Constant)	85.14	21.16		4.02	.000**	42.18	128.10
Age	-2.49	1.29	-.28	-1.93	.062	-5.11	.13
BDI-II	.34	.10	.50	3.48	**.001****	.14	.53

Note. *. Correlation is significant at the 0.05 level (1-tailed). **. Correlation is significant at the 0.01 level (1-tailed). GHQ = General Health Questionnaire; BDI-II = Beck Depression Inventory; T-STAI = Trait-State-Trait Anxiety Inventory. All listed *p*-values are one-tailed. **p* =.012. ***p* < .001

Rugby: Concussion vs. No Concussion groups

The rugby group comprised of those who have previously been diagnosed with a concussion and those who have not. More specifically, the Concussion group is made up of participants who have been formally diagnosed with a concussion as well as those who have had a suspected concussion. Within the Rugby group, 17 (65%) participants reported having a history of concussion and 9 (35%) reported none.

Descriptive Statistics and Within-Group Differences. All participants were 16 to 18 years old (mean age was 16.40 years old). Table 4 shows the descriptive statistics and the within-group differences for the No Concussion (n= 9) vs. Concussion Rugby groups (n= 17). An independent samples t-test was run, which showed that there were no significant differences between the groups with regards to age, the GHQ subscales and T-STAI measures (p > .066 for all analyses). However, GHQ anxiety/insomnia is approaching significance (p = .066), which could indicate that the Concussed group has slightly higher levels of anxiety/insomnia than the Non-Concussed group. Furthermore, the table shows that there were significant differences between the groups for the BDI-II (p = .042) and AUDIT (p = .044). The means scores illustrate that the Concussion group had higher levels of depression and consumed more alcohol than the No Concussion group. Each of these significant results were associated with a small-to-medium effect size estimate (refer to Table 4).

The means for both the BDI-II and AUDIT measures were low and none of them fell within the clinical/hazardous range for both groups. However, the T-STAI means for both groups were high and fell within the clinical range (45-80). Within the Concussed vs. Non-Concussed Rugby sample, 12 (71%) concussed players and 5 (55%) non-concussed players scored within the high anxiety range (45-80) on the T-STAI measure. This suggests that 65% of the sample had high anxiety.

Table 4
Descriptive Statistics and Within-group Differences within the Rugby Group: No Concussions vs. Concussion (N=26)

Variable	Rugby		*t*	*p*	*ESE*
	No Concussion (*n* = 9)	Concussion (*n* = 17)			
Age (years)					
M (*SD*)	16.33 (.50)	16.53 (.62)	-.81	.204	0.05
Range	16 - 18	16 - 18			
GHQ Somatic Symptoms					
M (*SD*)	11.56 (3.05)	12.88 (2.42)	-1.22	.217	0.17
GHQ Anxiety/Insomnia					
M (*SD*)	10.00 (2.06)	11.53 (3.87)	-1.10	.066	0.24
GHQ Social Dysfunction					
M (*SD*)	12.67 (2.18)	13.71 (2.02)	-1.21	.897	0.43
BDI-II					
M (SD)	7.78 (5.33)	10.06 (8.84)	-.67	**.042***	0.27
T-STAI					
M (SD)	46.11 (5.35)	48.35 (5.27)	-1.03	.581	0.31
AUDIT					
M (SD)	2.22 (2.77)	4.29 (4.48)	-1.26	**.044***	0.42

Note. For the variables, means are presented with standard deviations in parentheses. GHQ = General Health Questionnaire; BDI-II = Beck Depression Inventory; T-STAI = Trait-State-Trait Anxiety Inventory; AUDIT = Alcohol Use Disorders Identification Test; ESE = Estimated Size Effect. All *p*-values are one-tailed. *$p < .05$.

Correlations: Age, Concussion, GHQ subscales, BDI-II, T-STAI and AUDIT.

Table 5 shows the correlation output for the No Concussions vs. Concussion Rugby groups and the predictors; age, group, concussion, GHQ subscales, BDI-II, T-STAI and AUDIT. This output was used to establish which predictors correlated with the outcome variables (BDI-II and T-STAI) and if they were significant or not. Looking at the table we can see that BDI-II was significantly, positively correlated with GHQ somatic symptoms, GQ anxiety/insomnia, GHQ social dysfunction and T-STAI. Additionally, T-STAI was significantly, positively correlated with GHQ anxiety/insomnia and BDI-II. Lastly, this table was also used to determine if there was any multicollinearity. Looking at the table, we can see that there was no multicollinearity as none of the correlations were above $r = .661$.

Table 5
Bivariate Correlations within the Rugby Group: No Concussion vs. Concussion (N = 26)

Variable	1	2	3	4	5	6	7	8
1. Age	-							
2. Concussion	.164	-						
3. GHQ Somatic Symptoms	.024	.241	-					
4. GHQ Anxiety/Insomnia	.041	.219	.437*	-				
5. GHQ Social Dysfunction	-.071	.240	.259	.483**	-			
6. BDI-II	-.033	.136	.381*	.661**	.497**	-		
7. T-STAI	-.220	.205	.313	.447*	.057	.528**	-	
8. AUDIT	.188	.249	.317	.178	.098	.106	.023	-

Note. *Correlation is significant at the 0.05 level (1-tailed). **Correlation is significant at the 0.01 level (1-tailed). GHQ = General Health Questionnaire; BDI-II = Beck Depression Inventory; T-STAI = Trait-State-Trait Anxiety Inventory; AUDIT = Alcohol Use Disorders Identification Test.

Regression Analyses. Once again, all assumptions were checked and met (Durbin-Watson = 2.57 for BDI and 2.44 for T-STAI). Two separate backwards regression analyses were run (refer to Table 6). For the first regression with BDI-II as the outcome variable, we investigated the extent to which GHQ anxiety/insomnia, GHQ social dysfunction, GHQ social dysfunction, age, AUDIT, concussion history and T-STAI contributed to the performance on the BDI-II measure. Therefore, all the predictors were added to the regression model. The results suggested a model containing only GHQ anxiety/insomnia, GHQ social dysfunction and T-STAI. Table 6 showed that only T-STAI was a significant predictor of BDI-II ($p = .038$). Furthermore, GHQ anxiety/insomnia and GHQ social dysfunction were not significant predictors of BDI-II, however they are approaching significance ($p = .063$ and $p = .074$ respectively). Therefore, T-STAI explained 51% of the variance in depression scores. The final model for predicting BDI-II scores was statistically significant ($F(25) = 9.83$, $p < .001$).

Secondly, we investigated the extent to which GHQ anxiety/insomnia, GHQ social dysfunction, GHQ social dysfunction, age, AUDIT, concussion history and BDI-II contributed to the performance on the T-STAI measure. The results suggested a model containing only BDI-II. Furthermore, we can also see that BDI-II is a significant predictor of T-STAI ($p = .006$). This suggests that BDI-II explained 25% of the variance of the T-STAI score. The final model for predicting T-STAI scores was statistically significant ($F(25) = 9.30$, $p = .006$).

Table 6
Coefficients Output for Final Models within the Rugby Group: Concussion vs. No Concussion (N = 26)

	Unstandardized Coefficients		Standardized Coefficients			95% Confidence Interval for B	
	B	Std. Error	Beta	*T*	*p*	Lower Bound	Upper Bound
BDI-II							
(Constant)	-39.24	12.62		-3.11	.005**	-65.42	-13.07
GHQ Anxiety/Insomnia	.81	.42	.36	1.96	.063	-.05	1.67
GHQ Social Dysfunction	1.13	.60	.31	1.88	.074	-.12	2.38
T-STAI	.52	.23	.35	2.21	**.038***	.03	1.00
T-STAI							
(Constant)	44.22	1.42		31.08	.000**	41.28	47.16
BDI-II	.36	.12	.53	3.05	**.006****	.12	.61

Note. *. Correlation is significant at the 0.05 level (1-tailed). **. Correlation is significant at the 0.01 level (1-tailed). GHQ = General Health Questionnaire; BDI-II = Beck Depression Inventory; T-STAI = Trait-State-Trait Anxiety Inventory. All listed *p*-values are one-tailed.

Discussion

A collision sport, such as rugby, increases the susceptibility of players sustaining a concussion. The heavy impact and force exerted on the head can result in trauma to the brain, which may increase the likelihood of mood disturbances, irritability, and risky behaviours. To date, literature on post-concussive symptoms has primarily focused on physical and cognitive functions, with little consideration of the impact of SRCs on rugby players' affective functioning or internalizing behaviours, particularly among youth.

The aim of the current project was therefore to investigate such internalizing behaviours, specifically, the link between concussion and anxiety and depression in young rugby players and non-collision sport players (Hockey/Soccer Control group). We tested two hypotheses: (1) the Rugby group would perform worse on the depression and anxiety measures compared to the Hockey/Soccer Control group, and (2) rugby players who had a history of concussion would perform worse on the depression and anxiety measures compared to rugby players who had no history of concussion. We investigated these hypotheses by examining descriptive statistics and correlation tables. Furthermore, we ran multiple regression analyses to explore which of our variables (age, concussion history, GHQ anxiety/insomnia, GHQ somatic symptoms, GHQ social dysfunction, group and AUDIT) predicted depression (BDI-II) and anxiety (T-STAI). We discussed each of these hypotheses below and the findings of these regression analyses.

Internalising Behaviours in Rugby and Non-Rugby Players

For the first hypothesis we predicted that there would be a significant difference between the Rugby and Hockey/Soccer Control groups on our measures of internalizing behaviour; however, our results indicated that the groups had similar scores across all measures.

Studies have shown that there have been premorbid reports of depression in athletes involved in collision sports (Mainwaring et al., 2012). The literature states that due to the nature of the sport (rugby), the brain experiences recurring trauma as a result of frequent hits to the head (Mainwaring et al., 2012; Yang et al., 2015). Consequently, athletes who play collision sports may experience an increase in their mood disturbances compared to athletes who play non-collision sports such as hockey or soccer. Therefore, our findings are not consistent with this literature. Our results showed that the Hockey/Soccer Control group scored slightly higher than the rugby on the BDI-II (depression) measure, but there was a minimal difference. However, both of these scores lie below the clinical range. This does not align with our hypothesis. Our study excluded psychiatric diagnoses and therefore, restricted

the range of mood disturbances which may have been measured. Therefore, hypothesis 1 was rejected.

Regression Analysis with BDI-II as the Outcome Variable. Further, our regression analysis showed that both measures of anxiety (T-STAI and GHQ anxiety/insomnia) were significant predictors of BDI-II (depression) between the two groups. This model suggests that anxiety scores on these measures are predictive of depression scores, which is to be expected. Moreover, both of these predictors are positively associated with depression. Therefore, the analyses suggested that individuals who reported more anxiety and insomnia on the GHQ reported a significantly higher chance of having depression as opposed to those who do not have an anxiety/insomnia component. Furthermore, those with higher trait anxiety scores reported higher depression scores on the BDI-II measure.

Studies show that if anxiety is left unidentified and untreated, it is more likely to lead to depression (Strydom et al., 2012). Furthermore, literature shows that anxiety and depression symptoms are highly comorbid. For example, both of these internal behaviours comprise of mood disturbances such as; fatigue, sleep disturbances, irritability, nervousness or dysfunction in memory and concentration (Mainwaring et al., 2012; Proctor & Boan-Lenzo, 2010). The symptoms of anxiety and depression are not only similar in nature, but they also have a tendency to co-occur. Additionally, this issue contributes to the problem of misidentification of symptoms (Proctor & Boan-Lenzo, 2010). This is problematic as these symptoms may then be overlooked and may not be diagnosed correctly. Therefore, our results are in line with these findings, as both these internalising behaviours are comorbid in nature.

Better results may have been observed with the inclusion of this population. In addition, a larger sample would be needed to identify if there are any significant differences between the groups.

Regression Analysis with T-STAI as the Outcome Variable. The second regression model produced similar but inverse results to the first regression analysis. This model indicated that BDI-II was the only significant predictor of T-STAI. This model suggests that depression was predictive of trait anxiety, which was to be expected. Furthermore, depression had been positively associated with trait anxiety, thus, as depression scores increase, trait anxiety symptoms will also increase.

For both regressions, the grouping variable was not a predictor for either BDI-II nor T-STAI, as the mean scores were very similar across both groups. Therefore, it did not make

a difference whether the participant was in the Hockey/Soccer Control group or the Rugby group.

Internalising Behaviours in Rugby Players: Concussion and Non-Concussion

For the second hypothesis we predicted that there would be a significant difference between the Concussion and No Concussion Rugby groups on our measures of internalizing behaviours. We predicted that participants who had a history of concussion would be more depressed and anxious than those who had no history of concussion. Our results showed that there was a significant difference between the Concussion and No Concussion Rugby group with regards to the BDI-II measure, with the Concussion group scoring higher on the depression measure compared to the No Concussion group. We, however, did not find the same significant result for our measures of anxiety, although the *p*-value approached significance. We also found that our Concussion group scored higher on the AUDIT than the No Concussion group, indicating that our Concussion group consumed more alcohol than the No Concussion Group.

Research indicates that there is greater chance that players who have a history of concussions are more likely to present with anxiety and depression symptoms (Chrisman & Richardson, 2013). In fact, depression and anxiety are two of the most frequent areas of study in terms of post-concussive affective sequelae (Mainwaring et al., 2012). In our results, although there was a significant difference in depression scores, the scores for both the Rugby Concussed and No Concussion groups were in the normal range for the BDI-II. Research suggests that internalising behaviours, specifically in relation to SRCs, often occur as short-term symptoms (Yang et al., 2015). In line with this, Mainwaring and colleagues (2012) also illustrated that symptoms of depression, which have occurred post-concussion, often resolve in a two to three-week period. In our study, the window in which the participant had received a concussion and the time they were assessed had been more than one or two years apart. The 'normal' range outcomes for depression found for these groups may thus be accounted for by the time since previous concussion. However, the Concussed group scores were significantly higher.

Regarding alcohol consumption between the groups, although the levels of alcohol observed in our study were below the hazardous score of 8 to 15 on the AUDIT measure for both groups, this finding of a significant difference in alcohol use (with the Concussion group scoring higher than the No Concussion group) is consistent with previous literature which indicates that players who have sustained a concussion have a greater tendency to engage in risky behaviours (Chrisman & Richardson, 2013). The fact that both groups report such low

levels of alcohol use may be a function of social desirability given that these were high school boys being assessed at school (Konrad et al., 2010). Overall these findings partially confirm hypothesis 2 as we only saw a significant difference between the two groups for the BDI-II measure, not the T-STAI measure.

Regression Analysis with BDI-II as the Outcome Variable. Our regression model showed that T-STAI was the only significant predictor of BDI-II. This suggested that trait anxiety was positively associated with depression scores for the Concussion and No Concussion Rugby group. Therefore, players with higher levels of trait anxiety had higher levels of depression.

Regression Analysis with T-STAI as the Outcome Variable. In the second regression, we found that BDI-II was the only significant predictor of T-STAI. Furthermore, depression scores were positively correlated with trait anxiety. For both regressions, the grouping variable was not a predictor for either BDI-II nor T-STAI, as the mean scores were very similar across both groups. Even though the Concussed group scored slightly higher than the No Concussed Rugby group on all the measures, there is no significant difference.

Literature shows that symptoms of anxiety and post-concussive symptoms (fatigue, sleep disturbances and irritability) are seen to be highly comorbid in nature (Proctor & Boan-Lenzo, 2010). This makes it difficult in classifying certain symptoms as a result of post-concussive effects or whether they experience symptoms of anxiety. Therefore, the results of these regressions for hypothesis two are in line with literature, as it shows that anxiety and insomnia are predictive of internalising behaviours.

Limitations and Recommendations for Future Research

This study has several limitations which need to be taken into consideration for future research. Firstly, our sample size was small and underpowered. This made it difficult to detect the effects under consideration. Future research studies should aim to have more participants.

Secondly, there was minimal range present within the scores obtained from the different measures used. There had been little to no fluctuations between the participant's total scores in the various measures. This was seen specifically, in the T-STAI measure. It was evident that 2/3 of the scores fell within the 'high anxiety' scale (45-80). This indicates that there is minimal variety in scores, which is a problem as anxiety is a variable of interest. Previous literature reports that anxiety is seen to be a common issue amongst senior high school students, such as the sample used in our study. Additionally, their study showed that

the academic workload was a major contributing stress which may account for the high levels of anxiety (Strydom et al., 2012).

Another limitation to this study is that we relied heavily on self-report measures to get an indication of our participants emotional and behavioural disturbances. Self-report measures are vulnerable to (1) participants being aware of the measure and what the outcome will be, (2) social desirability as well as (3) subjective interpretation (Konrad et al., 2010).

Similarly, we relied on self-report questions to obtain information about rugby players' concussion history. This is problematic for participants who suspected that they had sustained a concussion, as it is not a reliable measure and relied on their subjective experiences. Moreover, their accounts for their concussions were retrospective in nature which may have altered the reliability of the information provided. This results in inconsistencies of suspected concussions being reported due to lack of knowledge on concussions and its symptoms.

Finally, the parent study included multiple measures which were not required for our current study. Sessions were lengthy at times, depending on the speed at which participants completed the measures. Additionally, these sessions were conducted after school hours and lasted between 90 and 120 minutes and participants were at times, fatigued. Future studies should consider extending assessments over two days.

Summary and Conclusion

This study is one of the few studies which has been conducted specifically on adolescent high school players investigating the effects of concussions and internalising behaviours. Furthermore, studies focusing specifically on rugby are substantially limited. Findings suggest that anxiety and depression have long-term effects following multiple concussions and that rugby players (more so concussed players) are more anxious and depressed than non-rugby players. Our results were not consistent with previous literature as we only found a difference in depression rates for the Concussion and No Concussion group. Overall internalising behaviours were equally prevalent across the groups. We outlined the limitations which may have influenced our findings. Even though the findings may seem limited, studies of this nature encourage further and larger-scale exploration to explore in more detail these preliminary results. More research of this nature is needed given the effect that such internalizing behaviours can have on athletes, especially in adolescence.

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Appendices

Appendix A: Informed Consent Document for Non-Rugby (Control) Participants

Informed Assent Document for Non-rugby (Control) Participants

University of Cape Town
Psychology Department
Telephone: +27 21 650-3430
Fax: +27 21 650-4104

Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players

Informed consent for you to participate in research and authorisation for collection, use, and disclosure of protected health information

The neuropsychological (relationship between the brain and behaviour) effects of traumatic brain injuries (TBIs) are considered a public health concern, both in South Africa and around the world. A common form of TBI is concussion, which is known to be associated with neuropsychological (thinking and behavioural) difficulties. Some of the outcomes associated with concussion often include difficulties with attention and concentrating, higher order thinking skills (e.g., working with information in one's head), remembering information and the speed at which one thinks or processes information.

Some research suggests that exposure to concussive head injuries over a long period of time, especially when this starts at a young age like in the adolescent years, may result in permanent neuropsychological (thinking and behavioural) and emotional problems in the adult years. There have been some cases for which research has suggested that such long-term exposure to multiple concussions may also be associated with neurodegenerative (loss of structure and function of neurons (brain cells) over time) processes in later life.

Added to this, adolescent athletes seem to show more difficulties and longer recovery times compared to adults following concussion, suggesting that the injury and recovery process may be different between adolescents and adults. Therefore, investigating the effects of concussion among a young adolescent sample (aged 16 to 19 years) is of particular interest in this study. Younger athletes (e.g., adolescents) may be at greater risk for difficulties as compared to adults, for several reasons: 1) the brain is still maturing and developing during childhood and adolescence and thus an injury during this developmental period can interfere with this development; second, the differences in how intense and how long symptoms last in adolescents compared to adults suggests that the adolescent brain is different to that of the adult brain.

One sport in which concussion is frequently reported is that of rugby. Although many people play rugby, little research has been done to investigate the long-term outcomes of concussive injuries in an adolescent rugby-playing sample.

In order to investigate this you are invited to take part in a research study at your school with the University of Cape Town. This form provides you with information about the study and seeks your permission for the collection, use and disclosure of your neuropsychological and behavioural performance data, as well as other information necessary for the study. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also describe this study to you and answer all of your questions. Your participation is entirely voluntary. Before you decide whether or not to take part, read the information below and ask questions about anything you do not understand. Whether you do or do not decide to participate in this study you will not be penalized or lose any benefits to which you would otherwise be entitled.

This study will be conducted in a manner that adheres to the ethical guidelines and principles of the International Declaration of Helsinki (Fortaleza, Brazil, 2013).

1. **Title of Research Study**

   Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players.

2. **Principal Investigator(s) and Telephone Number(s)**

Dr. Leigh Schrieff
3.11 Department of Psychology
University of Cape Town
Rondebosch
7701
Tel: 021 650 3708
Email: leigh.schrieff-elson@uct.ac.za / leigh.schrieff@gmail.com

Research assistant

Dr Sarah McFie
Department of Psychology
University of Cape Town
Rondebosch
7701
Email: sarah.mcfie@gmail.com

3. **Source of Funding or Other Material Support**

National Research Foundation

Medical Research Council

4. What is a concussion?

A concussion is a traumatic brain injury that results in the changing of brain functioning. A concussion is typically caused by a direct impact to the head, but it can also occur when a force is applied to the body that results in the rapid rotation of the head. The most common symptoms of a concussion include headaches, dizziness, memory deficits, and balance disturbances.

5. What is the purpose of this research study?

The purpose of this research study is to investigate whether or not, and how instances of concussions contribute to brain functioning in adolescents, whose brains are still developing. More specifically the research intends to find out how these injuries may affect the way that an individual thinks, feels and behaves, and whether/how it impacts on the brain. Also, the purpose is to observe how individuals who sustain concussions compare to people who have had no such injuries.

6. Who is taking part in this study?

Because we would like to compare to individuals who sustain concussions to individuals who have had no such injuries, there will be two groups of participants in this study: a rugby group and a non-contact sports playing matched control group. In this study, the matched control group includes non-rugby sports players who are similar (matched) in terms of age, sex, baseline test scores and sport involvement to the players in the rugby group so that we can compare rugby players in our study to similar aged non-rugby players.

Rugby is a sport that involves a lot of impacts to the head, neck, and shoulder areas. These forces can at times lead to a concussion. The rugby group will be analyzed to see the effect of these concussions on tests of behaviour and cognitive (thinking) functioning, as well as the structure of the brain (using a brain scan). The non-contact sports group, the control group, will be included so that we can compare the outcomes of the rugby group to matched individuals who are not exposed to rugby and the associated injuries.

7. How many people are expected to participate in the research?

You will be one of 120 school-aged rugby and 120 non-contact sport players in this study. The maximum number of participants who will be screened at the baseline testing will be 120 for each group. You may be one of 16 control participants invited to take part in the testing and brain scan component of the study at the end of the season (explained below).

8. What will be done if you take part in this research study?

The reason that we are including non-rugby playing participants is so that we can compare the performances of high school learners who play rugby (and who may or may not have sustained a concussion) to the performances of those who do not play rugby and have not sustained concussions.

At the start of this study, you will be asked to complete a number of questionnaires and tests to obtain individual demographic information, personal characteristics, an estimate of your ability to think, as well as the different ways in which you act and feel.

At the end of the rugby season, we are going to do a similar set of tests to the baseline tests with rugby players that were concussed during the rugby season. Those players will also undergo a brain scan. At that point, we will also select and invite players from the matched control group, who match the rugby players that were concussed during the season, on age baseline testing, and sport involvement, to undergo the same tests and a brain scan so that we can have comparative data.

Therefore, following initial testing, the results of the baseline testing will be evaluated. You may be contacted to participate in another session of the same tests in September/October, 2019, where you may also be asked to undergo a brain scan, if you happen to match (in terms of age, baseline testing and activity levels) a rugby-playing participant at that time.

These testing procedures will be conducted in a private room at the Cape Universities Body Imaging Centre (CUBIC), Groote Schuur Hospital. We will ask for your assent again if you are asked to participate in the second set of assessments.

Tests and questionnaires that will be given to you:

Demographic and medical history questionnaire – This questionnaire asks for information about your age, height, weight, language ability, learning difficulties (if any), any current or previous concussions, any previous or current psychiatric disorder, and what (if any) medication your son is currently taking.

Alcohol Use Disorders Identification Test – This questionnaire measures your current and/or lifetime alcohol use. The researchers do not suspect you of consuming alcohol, however previous research has shown a strong relationship between concussions and substance use.

Barratt Impulsiveness Scale – This questionnaire looks at how impulsive your behaviour is, and how this may relate to concussion.

Beck Depression Inventory – This questionnaire looks at symptoms of depression. Concussion has been shown to be associated with depressive symptoms, and this questionnaire will be used to assess such symptoms.

General Health Questionnaire – This questionnaire is used to look at the overall psychological health in an individual. It will be used with the other psychological questionnaires to understand your general health.

Profile of Mood States (short form) – The profile of mood states is a measure of overall mood. Mood is different to psychological health because it is more variable. This will also be used to compliment the other psychological questionnaires.

State-trait Anger Expression Inventory – This questionnaire looks at the amount of anger expressed by you.

State-trait Anxiety Inventory – This questionnaire looks at the levels of anxiety you have, and how it is expressed.

The IMPACT – The IMPACT is a computerized test used to measure concussion symptoms. It has two parts to it. The first part measures the concussion symptoms of your son, such as nausea, sleep and headaches. The second part measures your son's cognitive performance.

Pocket Concussion Recognition Tool (PCRT). The PCRT, is a side-line evaluation which can be administered by medical or non-medical professionals to detect a probable concussion. A conclusion of a probable concussion should be made if one or more symptoms is present in the following categories; visible cues of suspected concussion (loss of consciousness, balance problems, dazed gaze), symptoms of a concussion (headache, dizziness, confusion), and memory function.

Brain Scan – Brain scans are computerized images of the brain generated by placing the participant on a padded plastic bed that slides into the scanner. The scan is non-invasive (does not enter or penetrate the body) and painless. These images are used to examine the brain for any possible abnormalities in the brain that may be causing some discomfort. The standard brain imaging techniques do not reveal any gross structural abnormalities associated with concussions. However, recent research indicates that there may be small changes following a concussion. If you are in the control group, the scan will be done in order to compare your brain structure to the rugby group participants'. If any abnormalities are discovered, a paediatric neurosurgeon will review the scans and advise you and your family on the best course of action.

9. What are the exclusion criteria for this study?

The exclusion criteria for the study include: (a) being of the female sex, (b) being older than 19 years and younger than 16 years at time of recruitment, (c) scoring 21 or more on the Beck Depression Inventory-Second Edition (BDI-II), (d) prior or current diagnosed psychiatric illnesses, learning disabilities, or neurological disease, (e) any history of, or current drug and/or alcohol abuse, (f) control participants with a history of a previous concussion.

Should you meet any of these criteria, you will not be contacted to partake in the second phase of the study.

10. If you choose to participate in this study, how long will you be expected to participate in the research?

You will be asked to be available for the initial scheduled testing session – this session will take approximately 2 hours. The study will run over the course of 6 months. You will however only participate in the baseline testing session unless you are selected as a matched control to participate in the end of season assessment and brain scan.

11. What are the possible discomforts and risks for your child?

There is minimal risk associated with this study. You may be required to return for a repeated assessment in September/October at CUBIC. You will be contacted by the Principal Investigator if this is the case. The testing procedures take approximately 1½ - 2 hours per person. Due to it being a lengthy process, you may feel fatigued or irritable during testing. However, you will be given breaks where necessary, as well as refreshments. The follow-up session is not as time consuming.

Some participants in the research study may feel anxious or claustrophobic with regards to the brain scan. To counter this, an assistant will explain the scanning procedure to you. The research assistant will also allow you to have a "mock scan" where you will experience what it is like to have a scan, before undergoing the actual scan. The scan will not hurt you and it will not be dangerous in any way. You will however need to take the following precautions.

During the MRI neuroimaging assessment, certain metal objects, such as watches, credit cards, hairpins, and writing pens, may be damaged by the MRI scanner or pulled away from the body by the magnet. For these reasons, you will be asked to remove these objects before entering the scanner. When the scanner takes the images, the bed may vibrate, and you will hear loud banging noises. You will be given earplugs or earphones to protect your ears. Also, some people feel nervous in a small-enclosed space such as that of the scanner. You will be able to see out of the scanner at all times, and the radiographer will not start the procedure until you are comfortable. You will be able to stop the procedure at any time by squeezing a ball and can talk to the radiographers using an intercom that is built into the scanner. There are no known harmful long-term effects of the scanner used in this study. Scans will take no longer than 1 hour.

In the process of testing and scanning, researchers may come across incidental findings. Incidental findings are discoveries that are made that do not relate to the research study, and may be potentially harmful. For example, these may relate to findings on brain scan, where, in the process of completing the scan at the end of the season for this research study (if you are selected to participate in that component), researchers may come across other findings on the scan that may be of concern. (Below we include referral information in the event of such incidental findings).

If you wish to discuss the information above or any discomforts you may experience, you may ask questions now or call the Principal Investigators listed on this form.

12. Referrals

Given that we are administering tests of thinking and behaviour and brain scans as part of the study, there may be outcomes following those tests, for which further follow-up by health professionals may be advisable. We will not impose these referrals but we provide the necessary information for you and your parents in your best interest. We outline these referrals below.

Referrals related to baseline testing and exclusion criteria

We noted under point 8 above that there are certain exclusion criteria for this study and we outlined those points there. Two of these exclusion criteria related to your scores on a test of depression symptoms and a test related to alcohol usage. If participants score within certain ranges on these tests, they will be referred to a Sports Psychologist at the Sports Science Institute of South Africa. In the event that you score 21 or more on the Beck Depression Inventory and/or report any history of, or current drug and/or alcohol abuse, as reported on the AUDIT (see exclusion criteria), you will be referred to Clinton Gahwiler (see details below) by the Principal Investigator.

Psychological management:

Clinton Gahwiler (BA hons MA)

Sport Psychologist at the Sport Science Institute of South Africa

Tel: 021 659 5655

Fax: 086 624 7988

Email: sportpsych@xsinet.co.za

Website: www.performingmind.co.za

Referrals related to incidental findings on MRI scans

Incidental findings are discoveries that are made that do not relate to the research study, and may be potentially harmful. A radiologist on the CUBIC staff and linked to this study, is going to review all the participants' brain scans for such incidental findings. In an unfortunate case of an incidental finding you will be referred for further evaluation to Professor Anthony Figaji. Professor Figaji is a paediatric neurosurgeon, and he will undertake to consult, examine and counsel you were necessary, as well as determine any further course of management that may be needed.

13. What if something goes wrong?

This research study is covered by an insurance policy taken out by the University of Cape Town if you suffer a bodily injury because you are taking part in the study.

The insurer will pay for all reasonable medical costs required to treat your bodily injury, according to the SA Good Clinical Practice Guidelines 2006, which are based on the Association of the British Pharmaceutical Industry Guidelines. The insurer will pay without you having to prove that the research was responsible for your bodily injury. You may ask the study doctor for a copy of these guidelines.

The insurer will *not* pay for harm if, during the study, you:

- Use medicines or other substances that are not allowed
- Do not follow the study doctor's instructions

- Do not tell the study doctor that you have a bad side effect from the study medicine
- Do not take reasonable care of yourself and your study medicine

If you are harmed and the insurer pays for the necessary medical costs, usually you will be asked to accept that insurance payment as full settlement of the claim for medical costs. However, accepting this offer of insurance cover does not mean you give up your right to make a separate claim for other losses based on negligence, in a South African court.

It is important to follow the study doctor's instructions and to report straightaway if you have a side effect from the study medicine.

14. What are the possible benefits of this study to you, and others?

There is no potential for direct individual benefit by you taking part in this study.

After the completion of each testing session, participants will be given a restaurant voucher as compensation for their time.

Overall, this research aims to contribute to practical information regarding return-to-play decisions, thresholds of concussion injuries, and diagnostic guides of concussion that are important for player safety. It will provide all those involved with contact sport, including medical teams, information regarding the cognitive, behavioural and brain scan findings associated with concussion.

15. If you choose to participate in this research study, will it cost you anything?

Participating in this research study will not cost you anything. However, the cost of any referrals for further management will be for the personal account of parents/legal guardians and the participants.

16. Can you withdraw from this research study?

You may withdraw your consent and assent and stop participating in this research study at any time, without any penalty to you. At the beginning of each testing session you will be asked if you want to continue with the study. Should you say no, there will be no punishment or penalty placed on you.

If you have a complaint or complaints about your rights and wellbeing as a research participant, please contact the Human Research Ethics Committee.

Tel: 021 406 6492

E-mail: sumaya.ariefdien@uct.ac.za

17. If you withdraw, can information about you still be used and/or collected?

Information that has already been collected will be removed from the data set. Should you withdraw from the study, your data will be removed from the data set.

18. Once personal and performance information is collected, how will it be kept secret (confidential) in order to protect your privacy?

If you agree to participate in this research study, it is possible that some of the information collected might be copied into a "limited data set" to be used for other research purposes. If so, the limited data set will only include information that does not directly identify you – your identity will remain confidential. Data will be labeled using participant numbers rather than names, so that they cannot be used to directly identify any particular individual. A separate and private log will be used simply to relate participant names to numbers in the event that a participant needs to be contacted or contacts the Principal Investigator. This log will only be accessible to the Principle Investigator.

All hard copy data collected will be stored in a locked filing cabinet in the ACSENT Laboratory located in the Department of Psychology UCT. All electronic data will be stored on a password protected hard drive. Only the primary researcher and select individuals involved in the collection and analysis of the data will have access to these files. Your research records will not be released without your permission unless required by law or a court order. These measures do not however guarantee complete privacy, given the small cohort of participant. It may therefore not be possible to guarantee individual privacy. However, published data will not contain any identifiable information other than participant numbers.

19. How will the researcher benefit from you participating in this study?

The researcher may choose to present this research at a conference or in a scientific journal.

20. Dissemination of research findings

You and your school will be provided with a report on the analysis of the data collected in this study. It is the aim that this report be published in an academic journal in order to widen the knowledge base of concussion in rugby. The report is based on the overall statistical findings, and will not reveal any personal details.

Signatures

You have been informed about this study's purpose, procedures, possible benefits, and risks; and how your responses and performance and other data will be collected, used and shared with others. You have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time.

You voluntarily agree to participate in this study. You hereby authorize the collection, use and sharing of your performance and other data. By signing this form, you are not waiving any of your legal rights.

Signature of Person Assenting and Authorizing Date

_____ _____

Name of Participant ("Study Participant" – the child)

_____

Participant cellphone number: _____

Participant email address: _____

Appendix B: Informed Consent Document for Rugby Participants

Informed Assent Document for Rugby Participants

University of Cape Town
Psychology Department
Telephone: +27 21 650-3430
Fax: +27 21 650-4104

Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players

Informed consent for you to participate in research and authorisation for collection, use, and disclosure of protected health information

The neuropsychological (relationship between the brain and behavior) effects of traumatic brain injuries (TBIs) are considered a public health concern, both in South Africa and around the world. A common form of TBI is concussion, which is known to be associated with neuropsychological (thinking and behavioural) difficulties. Some of the outcomes associated with concussion often include difficulties with attention and concentrating, higher order thinking skills (e.g., working with information in one's head), remembering information and the speed at which one thinks or processes information.

Some research suggests that exposure to concussive head injuries over a long period of time, especially when this starts at a young age like in the adolescent years, may result in permanent neuropsychological (thinking and behavioural) and emotional problems in the adult years. There have been some cases for which research has suggested that such long-term exposure to multiple concussions may also be associated with neurodegenerative (loss of structure and function of neurons (brain cells) over time) processes in later life.

Added to this, adolescent athletes seem to show more difficulties and longer recovery times compared to adults following concussion, suggesting that the injury and recovery process may be different between adolescents and adults. Therefore, investigating the effects of concussion among a young adolescent sample (aged 16 to 19 years) is of particular interest in this study. Younger athletes (e.g., adolescents) may be at greater risk for difficulties as compared to adults, for several reasons: 1) the brain is still maturing and developing during childhood and adolescence and thus an injury during this developmental period can interfere with this development; second, the differences in how intense and how long symptoms last in adolescents compared to adults suggests that the adolescent brain is different to that of the adult brain.

One sport in which concussion is frequently reported is that of rugby. Although many people play rugby, little research has been done to investigate the long-term outcomes of concussive injuries in an adolescent rugby-playing sample.

In order to investigate this you are invited to take part in a research study at your school with the University of Cape Town. This form provides you with information about the study and seeks

your permission for the collection, use and disclosure of your neuropsychological and behavioural performance data, as well as other information necessary for the study. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also describe this study to you and answer all of your questions. Your participation is entirely voluntary. Before you decide whether or not to take part, read the information below and ask questions about anything you do not understand. Whether you do or do not decide to participate in this study you will not be penalized or lose any benefits to which you would otherwise be entitled.

This study will be conducted in a manner that adheres to the ethical guidelines and principles of the International Declaration of Helsinki (Fortaleza, Brazil, 2013).

21. Title of Research Study

Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players.

22. Principal Investigator(s) and Telephone Number(s)

Dr. Leigh Schrieff
3.11 Department of Psychology
University of Cape Town
Rondebosch
7701
Tel: 021 650 3708
Email: leigh.schrieff-elson@uct.ac.za / leigh.schrieff@gmail.com

Research assistant
Dr Sarah McFie
Department of Psychology
University of Cape Town
Rondebosch
7701
Email: sarah.mcfie@gmail.com

23. Source of Funding or Other Material Support

Medical Research Council

24. What is a concussion?

A concussion is a traumatic brain injury that results in the changing of brain functioning. A concussion is typically caused by a direct impact to the head, but it can also occur when a force is applied to the body that results in the rapid rotation of the head. The most common symptoms of a concussion include headaches, dizziness, memory deficits, and balance disturbances.

25. What is the purpose of this research study?

The purpose of this research study is to investigate whether or not, and how, instances of concussions contribute to brain functioning in adolescents, whose brains are still developing. More specifically the research intends to find out how these injuries may affect the way that an individual thinks, feels and behaves, and whether/how it impacts on the brain. Also, the purpose is to observe how individuals who sustain concussions compare to people who have had no such injuries.

26. Who is taking part in this study?

Because we would like to compare to individuals who sustain concussions to individuals who have had no such injuries, there will be two groups of participants in this study: a rugby group and a non-contact sports playing matched control group.

Rugby is a sport that involves a lot of impacts to the head, neck, and shoulder areas. These forces can at times lead to a concussion. The rugby group will be analyzed to see the effect of these concussions on tests of behavior and cognitive (thinking) functioning, as well as the structure of the brain (using a brain scan). The non-contact sports group (the control group), will be included so that we can compare the outcomes of the rugby group to matched individuals who are not exposed to rugby and the associated injuries. By matched participants we mean that participants in the control group who are similar to participants in the rugby group based on their age, sex, baseline test scores and sport involvement.

27. How many people are expected to participate in the research?

You will be one of 120 school-aged rugby and 120 school-aged non-contact sport players in this study. The maximum number of participants who will be screened at the baseline testing will be 120 for each group; but only 16 participants per group will be requested to complete the full study procedures.

28. What will be done if you take part in this research study?

During this study, you will be asked to complete a number of questionnaires and tests to obtain individual demographic information, personal characteristics, an estimate of your ability to think, as well as the different ways in which you act and feel. Following the start of the season, should you sustain a concussion, you will then be contacted for repeated testing in the 24-72 hours following the injury, and you will also be asked to undergo a brain scan. Following the conclusion of the rugby

season, you may be contacted for repeated testing in September/October, 2019, where you may be asked to undergo another brain scan. These testing procedures will be conducted in a private room at the Cape Universities Body Imaging Centre (CUBIC), Groote Schuur Hospital.

Tests and questionnaires that will be given to you:

Demographic and medical history questionnaire – This questionnaire asks for information about your age, height, weight, language ability, learning difficulties (if any), any current or previous concussions, any previous or current psychiatric disorder, and what (if any) medication you are currently taking.

Alcohol Use Disorders Identification Test – This questionnaire measures your current and/or lifetime alcohol use. The researchers do not suspect you of consuming alcohol, however previous research has shown a strong relationship between concussions and substance use.

Barratt Impulsiveness Scale – This questionnaire looks at how impulsive your behavior is, and how this may relate to concussion.

Beck Depression Inventory – This questionnaire looks at symptoms of depression. Concussion has been shown to be associated with depressive symptoms, and this questionnaire will be used to assess for the possible presence of any such symptoms.

General Health Questionnaire – This questionnaire is used to look at the overall psychological health in an individual. It will be used with the other psychological questionnaires to understand your general health.

Profile of Mood States (short form) – The profile of mood states is a measure of overall mood. Mood is different to psychological health because it is more variable. This will also be used to compliment the other psychological questionnaires.

State-trait Anger Expression Inventory – This questionnaire looks at the amount of anger expressed by you.

State-trait Anxiety Inventory – This questionnaire looks at the levels of anxiety you have, and how it is expressed.

The IMPACT – The IMPACT is a computerized test used to measure concussion symptoms. It has two parts to it: the first part measures any concussion symptoms, such as nausea, sleep and headaches; the second part measures your cognitive performance.

Pocket Concussion Recognition Tool (PCRT). The PCRT, is a side-line evaluation which can be administered by medical or non-medical professionals to detect a probable concussion. A conclusion of a probable concussion should be made if one or more symptoms is present in the following categories: visible cues of suspected concussion (loss of consciousness, balance problems, dazed gaze), symptoms of a concussion (headache, dizziness, confusion), and poor memory function.

Brain Scan – Brain scans are computerized images of the brain generated by having you lie on a padded plastic bed that slides into the scanner. The scan process is non-invasive (does not enter or penetrate the body) and painless. These images are used to examine the brain for any possible

abnormalities that may be causing some discomfort. The standard brain imaging techniques do not reveal any obvious big negative changes in the structure of the brain associated with concussions. However, recent research indicates that there may be smaller changes following a concussion. The brain scans will be conducted in order to see if there are any small changes to your brain structure as a result of the concussion. Any small structural changes after concussion will be recorded, and reports will be forwarded on to the medical teams employed by your parents and/or your school. If any abnormalities are discovered, a pediatric neurosurgeon will review the scans and advise you and your family on the best course of action. It is important to note that as with the other assessment measures, the brain scan is part of the research assessment and not part of clinical management of the concussion injury.

29. What are the exclusion criteria for this study?

The exclusion criteria for the study include: (a) being of the female sex, (b) being older than 19 years or younger than 16 years at time of recruitment, (c) scoring 21 or more on the Beck Depression Inventory-Second Edition (BDI-II), (d) prior or current diagnosed psychiatric illnesses, learning disabilities, or neurological disease, (e) any history of, or current drug and/or alcohol abuse, (f) Participants who do not have a clear referral process to an adequately qualified clinician following a concussive episode, for a formal diagnosis of concussion.
Should you meet any of these criteria, you will not be contacted to partake in the second phase of the study.

Discharge points

We have also included what we refer to as 'discharge' or exit points in the study. In their Concussion Guidance document, World Rugby (2017) note the following about multiple concussions: "Players with a history of two or more concussions within the past year are at greater risk of further brain injury and slower recovery and should seek medical attention from practitioners experienced in concussion management before return to play". Given the potential risk of a participant sustaining multiple concussions and the possibility that they may be returning to play prematurely following a concussion, and in an effort to adhere to the World Rugby guidelines which are in the player's best interest (i.e., for their protection), we will include the following discharge points in the study:

1) If an individual has previously been concussed in the year leading up to the study and is concussed again during the course of the study, and those two concussion points fall within a one-year period, then they will need to be discharged from the study in accordance with the World Rugby guidelines, mentioned before.

2) If an individual is concussed twice within the course of the study, then they will be discharged from the study thereafter, again, in accordance with the World Rugby guidelines, mentioned before.

3) If standard return to play guidelines, as put forward by World Rugby (as outlined in the information sheets distributed on return-to-play guidelines) (Gomez and Hergenroeder 2012, Kutcher and Giza 2014) are not followed before a player returns to play following a concussion, then they will also be discharged from the study. We will ask your attending doctor, managing the concussion, to oversee a return-to-play protocol checklist used in this study.

Again, these discharge points are included as a measure of precaution, with participants' best interest in mind.

30. If you choose to participate in this study, how long will you be expected to participate in the research?

You will be asked to be available for each scheduled of the testing sessions – each session will take approximately 2 hours. The study will run over the course of 6 months. There will be only one testing session around the start of the season if you do not sustain a concussion. Should you sustain a concussion during the course of the rugby season, you will be asked to participate in the post-concussion and end of season assessments and brain scans.

31. What are the possible discomforts and risks for you?

There is minimal risk associated with this study. You may be required to return for a repeated assessment in September/October 2018 at CUBIC, should you sustain a concussion during the season. You will be contacted by the Principal Investigator if this is the case. The testing procedures take approximately 1½ - 2 hours per person. Due to it being a lengthy process, you may feel fatigued or irritable during testing. However, you will be given breaks where necessary, as well as refreshments. The follow-up session is not as time consuming.

All return-to-school and play decisions will be made by the medical team employed by your school, and not the researchers. Your testing results will be made available to the medical team, as well as comparisons between your baseline scores and your injury scores. Findings from the study are not primarily intended to determine whether you return to play or not - that is the goal of the clinical assessors. Clinical assessors might however use the data we collect to inform return-to-play decisions.

Some participants in the research study may feel anxious or claustrophobic with regards to the brain scan. To counter this, an assistant will explain the scanning procedure to you. The research assistant will also allow you to have a "mock scan" where you will experience what it is like to have a scan, before undergoing the actual scan. The scan will not hurt you and it will not be dangerous in any way. You will however need to take the following precautions.

During the MRI neuroimaging assessment, certain metal objects, such as watches, credit cards, hairpins, and writing pens, may be damaged by the MRI scanner or pulled away from the body

by the magnet. For these reasons, you will be asked to remove these objects before entering the scanner. When the scanner takes the images, the bed may vibrate, and you will hear loud banging noises. You will be given earplugs or earphones to protect your ears. Also, some people feel nervous in a small-enclosed space such as that of the scanner. You will be able to see out of the scanner at all times, and the radiographer will not start the procedure until you are comfortable. You will be able to stop the procedure at any time by squeezing a ball and can talk to the radiographers using an intercom that is built into the scanner. There are no known harmful long-term effects of the scanner used in this study. Scans will take no longer than 1 hour.

In the process of testing and scanning, researchers may come across incidental findings. Incidental findings are discoveries that are made that do not relate to the research study, and may be potentially harmful. For example, these may relate to findings on brain scan, where, in the process of investigating the outcomes of concussion, researchers may come across other findings on the scan that may be of concern. (Below we include referral information in the event of such incidental findings).

If you wish to discuss the information above or any discomforts you may experience, you may ask questions now or call the Principal Investigators listed on this form at any point during the study.

Because this study involves on-going brain scans and cognitive testing related to concussion, this may give you the incorrect impression or misconception that we are providing care for, or clinical management of, your concussion injury. It is important to note that this is however not the case as this is a research study and it is therefore not providing any clinical care or management of the concussion injury. We are not replacing any existing medical/care structures that the schools and/or you may have in place, but rather working in conjunction with them. All decisions on whether to return to school and play will be made by the medical structures already employed by the schools and/or you. Your test and brain scan results will be made available to the medical professionals employed by the you and/or your school should it be required, as well as comparisons between your baseline scores and your scores from any testing after a concussion. Before we collect any data, we will hold an information session with you and your parents to talk about this potential misconception.

It is important to note that if you do suffer a concussion injury, findings from tests conducted as part of this research study might impact on your ability to continue playing rugby or other contact sports in the future. The implications of the test findings for thinking and behaviour and brain scan findings should be discussed with health professionals as part of the referral process (described below).

32. Referrals

Given that return-to-play decisions are part of the job of the clinical assessors, we, as researchers, cannot and should not make any such decisions on the basis of our data. However, clinical assessors might however use the data we collect to inform return-to-play decisions. However, given that we are administering tests of thinking and behavior, post-concussion tests, and brain scans as part of the

study, there may be outcomes following those tests, for which further follow-up by health professionals may be advisable. We will not impose these referrals but we provide the necessary information for you and your parents in your best interest. We outline these referrals below.

Referrals related to baseline testing and exclusion criteria

We noted under point 8 above that there are certain exclusion criteria for this study and we outlined those points there. Two of these exclusion criteria related to your scores on a test of depression symptoms and a test related to alcohol usage. If participants score within certain ranges on these tests, they will be referred to a Sports Psychologist at the Sports Science Institute of South Africa. In the event that you score 21 or more on the Beck Depression Inventory and/or report any history of, or current drug and/or alcohol abuse, as reported on the AUDIT (see exclusion criteria), you will be referred to Clinton Gahwiler (see details below) by the Principal Investigator.

Psychological management:

Clinton Gahwiler (BA hons MA)

Sport Psychologist at the Sport Science Institute of South Africa

Tel: 021 659 5655

Fax: 086 624 7988

Email: sportpsych@xsinet.co.za

Website: www.performingmind.co.za

Referrals related to concussion diagnoses and post-concussion testing

It is important to note that a suspected concussion requires a clinical assessment by a doctor skilled in the management of concussion. We include the details of doctors below, who specialize in concussion diagnoses and management, should you or the school not currently have such a management system in place.

As noted, we will share your performances on the behavior and cognitive tests administered , and on the brain scan, with the health professional managing your concussion. That health professional will decide whether you may need further medical management, either by the school's medical team or another medical team, should the school not have one.

Please note that the costs of referrals for further management will be for the personal account of your parents/legal guardians and the participants.

In the event that your school does not have a medical team in place to assist in your care, please see the details below, which can be passed on to the health professional attending to you.

Concussion management:

Sports Medicine department at the Sports Science Institute of South Africa

Tel: 021 659 5644

Email: info@cape-sportsmed.com

Neurosurgery Clinic (with Prof Anthony Figaji)
Red Cross War Memorial Children's Hospital
021 658 5434

Referrals related to incidental findings on MRI scans

Incidental findings are discoveries that are made that do not relate to the research study, and may be potentially harmful. A radiologist on the CUBIC staff and linked to this study, is going to review all the participants' brain scans for such incidental findings. In an unfortunate case of an incidental finding you will be referred for further evaluation to Professor Anthony Figaji. Professor Figaji is a pediatric neurosurgeon, and he will undertake to consult, examine and counsel you where necessary, as well as determine any further course of management that may be needed.

33. What if something goes wrong?

This research study is covered by an insurance policy taken out by the University of Cape Town if you suffer a bodily injury because you are taking part in the study. The insurer will pay for all reasonable medical costs required to treat your bodily injury, according to the SA Good Clinical Practice Guidelines 2006, which are based on the Association of the British Pharmaceutical Industry Guidelines. The insurer will pay without you having to prove that the research was responsible for your bodily injury. You may ask the study doctor for a copy of these guidelines.

The insurer will *not* pay for harm if, during the study, you:

- Use medicines or other substances that are not allowed
- Do not follow the study doctor's instructions
- Do not tell the study doctor that you have a bad side effect from the study medicine
- Do not take reasonable care of yourself and your study medicine

If you are harmed and the insurer pays for the necessary medical costs, usually you will be asked to accept that insurance payment as full settlement of the claim for medical costs. However, accepting this offer of insurance cover does not mean you give up your right to make a separate claim for other losses based on negligence, in a South African court. It is important to follow the study doctor's instructions and to report straightaway if you have a side effect from the study medicine.

34. What are the possible benefits of this study to you, and others?

After the completion of each testing session, participants will be given a restaurant voucher as compensation for their time. In the event that you sustain a concussion, your individual brain scans and test results will be sent to the medical team at your school following testing and imaging.

Overall, this research aims to contribute to practical information regarding return-to-play

decisions, thresholds of concussion injuries, and diagnostic guides of concussion that are important for player safety. It will provide all those involved with contact sport, including medical teams, information regarding the cognitive, behavioural and brain scan findings associated with concussion.

35. If you choose to participate in this research study, will it cost you anything?

Participating in this research study will not cost you anything. However, the cost of any care arising from a concussion injury (over and above what is done in the study), i.e., the clinical management of a concussion, or the costs of referrals for further management, will be for the personal account of parents/legal guardians and the participants.

36. Can you withdraw from this research study?

You may withdraw your consent and assent and stop participating in this research study at any time, without any penalty to you. At the beginning of each testing session you will be asked if you want to continue with the study. Should you say no, there will be no punishment or penalty placed on you.

If you have a complaint or complaints about your rights and wellbeing as a research participant, please contact the Human Research Ethics Committee.
Tel: 021 406 6492
E-mail: sumaya.ariefdien@uct.ac.za

37. If you withdraw from the study, can information about you still be used and/or collected?

Information that has already been collected will be removed from the data set. Should you withdraw from the study, your data will be removed from the data set.

38. Once personal and performance information is collected, how will it be kept secret (confidential) in order to protect your privacy?

If you agree to participate in this research study, it is possible that some of the information collected might be copied into a "limited data set" to be used for other research purposes. If so, the limited data set will only include information that does not directly identify you – your identity will remain confidential. Data will be labeled using participant numbers rather than names, so that they cannot be used to directly identify any particular individual. A separate and private log will be used simply to relate participant names to numbers in the event that a participant needs to be contacted or contacts the Principal Investigator. This log will only be accessible to the Principle Investigator.

All hard copy data collected will be stored in a locked filing cabinet in the access-controlled ACSENT Laboratory located in the Department of Psychology UCT. All electronic data will be stored on a password protected hard drive. Only the primary researcher and select individuals involved in the collection and analysis of the data will have access to these files. Your research

records will not be released without your permission unless required by law or a court order. These measures do not however guarantee complete privacy, given the small cohort of rugby-playing participants, as players may be inherently identifiable. It may therefore not be possible to guarantee individual privacy. However, published data will not contain any identifiable information other than participant numbers.

39. How will the researcher benefit from you participating in this study?

The researcher may choose to present this research at a conference or in a scientific journal.

40. Dissemination of research findings

You and your school will be provided with a report on the analysis of the data collected in this study. It is the aim that this report be published in an academic journal in order to widen the knowledge base of concussion in rugby. The report is based on the overall statistical findings, and will not reveal any personal details

Signatures

You have been informed about this study's purpose, procedures, possible benefits, and risks; and how your responses and performance and other data will be collected, used and shared with others. You have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time.
You voluntarily agree to participate in this study. You hereby authorize the collection, use and sharing of your performance data and other data. By signing this form, you are not waiving any of your legal rights.

Signature of Person Assenting and Authorizing Date

_____ _____

Name of Participant ("Study Participant" – the child)

Participant cellphone number: _____

Participant email address: _____

Appendix C: Informed Assent Document for Non-Rugby (Control) Participants

Informed Assent Document for Non-rugby (Control) Participants

University of Cape Town
Psychology Department
Telephone: +27 21 650-3430
Fax: +27 21 650-4104

Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players

Informed consent for you to participate in research and authorisation for collection, use, and disclosure of protected health information

The neuropsychological (relationship between the brain and behaviour) effects of traumatic brain injuries (TBIs) are considered a public health concern, both in South Africa and around the world. A common form of TBI is concussion, which is known to be associated with neuropsychological (thinking and behavioural) difficulties. Some of the outcomes associated with concussion often include difficulties with attention and concentrating, higher order thinking skills (e.g., working with information in one's head), remembering information and the speed at which one thinks or processes information.

Some research suggests that exposure to concussive head injuries over a long period of time, especially when this starts at a young age like in the adolescent years, may result in permanent neuropsychological (thinking and behavioural) and emotional problems in the adult years. There have been some cases for which research has suggested that such long-term exposure to multiple concussions may also be associated with neurodegenerative (loss of structure and function of neurons (brain cells) over time) processes in later life.

Added to this, adolescent athletes seem to show more difficulties and longer recovery times compared to adults following concussion, suggesting that the injury and recovery process may be different between adolescents and adults. Therefore, investigating the effects of concussion among a young adolescent sample (aged 16 to 19 years) is of particular interest in this study. Younger athletes (e.g., adolescents) may be at greater risk for difficulties as compared to adults, for several reasons: 1) the brain is still maturing and developing during childhood and adolescence and thus an injury during this developmental period can interfere with this development; second, the differences in how intense and how long symptoms last in adolescents compared to adults suggests that the adolescent brain is different to that of the adult brain.

One sport in which concussion is frequently reported is that of rugby. Although many people play rugby, little research has been done to investigate the long-term outcomes of concussive injuries in an adolescent rugby-playing sample.

In order to investigate this you are invited to take part in a research study at your school with the University of Cape Town. This form provides you with information about the study and seeks your permission for the collection, use and disclosure of your neuropsychological and behavioural performance data, as well as other information necessary for the study. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also describe this study to you and answer all of your questions. Your participation is entirely voluntary. Before you decide whether or not to take part, read the information below and ask questions about anything you do not understand. Whether you do or do not decide to participate in this study you will not be penalized or lose any benefits to which you would otherwise be entitled.

This study will be conducted in a manner that adheres to the ethical guidelines and principles of the International Declaration of Helsinki (Fortaleza, Brazil, 2013).

1. **Title of Research Study**

   Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players.

2. **Principal Investigator(s) and Telephone Number(s)**

Dr. Leigh Schrieff
3.11 Department of Psychology
University of Cape Town
Rondebosch
7701
Tel: 021 650 3708
Email: leigh.schrieff-elson@uct.ac.za / leigh.schrieff@gmail.com

Research assistant
Dr Sarah McFie
Department of Psychology
University of Cape Town
Rondebosch

7701
Email: sarah.mcfie@gmail.com

3. Source of Funding or Other Material Support

National Research Foundation
Medical Research Council

4. What is a concussion?

A concussion is a traumatic brain injury that results in the changing of brain functioning. A concussion is typically caused by a direct impact to the head, but it can also occur when a force is applied to the body that results in the rapid rotation of the head. The most common symptoms of a concussion include headaches, dizziness, memory deficits, and balance disturbances.

5. What is the purpose of this research study?

The purpose of this research study is to investigate whether or not, and how instances of concussions contribute to brain functioning in adolescents, whose brains are still developing. More specifically the research intends to find out how these injuries may affect the way that an individual thinks, feels and behaves, and whether/how it impacts on the brain. Also, the purpose is to observe how individuals who sustain concussions compare to people who have had no such injuries.

6. Who is taking part in this study?

Because we would like to compare to individuals who sustain concussions to individuals who have had no such injuries, there will be two groups of participants in this study: a rugby group and a non-contact sports playing matched control group. In this study, the matched control group includes non-rugby sports players who are similar (matched) in terms of age, sex, baseline test scores and sport involvement to the players in the rugby group so that we can compare rugby players in our study to similar aged non-rugby players.

Rugby is a sport that involves a lot of impacts to the head, neck, and shoulder areas. These forces can at times lead to a concussion. The rugby group will be analysed to see the effect of these concussions on tests of behaviour and cognitive (thinking) functioning, as well as the structure of the brain (using a brain scan). The non-contact sports group, the control group, will be included so that we can compare the outcomes of the rugby group to matched individuals who are not exposed to rugby and the associated injuries.

7. How many people are expected to participate in the research?

You will be one of 120 school-aged rugby and 120 non-contact sport players in this study. The maximum number of participants who will be screened at the baseline testing will be 120 for each group. You may be one of 16 control participants invited to take part in the testing and brain scan component of the study at the end of the season (explained below).

8. What will be done if you take part in this research study?

The reason that we are including non-rugby playing participants is so that we can compare the performances of high school learners who play rugby (and who may or may not have sustained a concussion) to the performances of those who do not play rugby and have not sustained concussions.

At the start of this study, you will be asked to complete a number of questionnaires and tests to obtain individual demographic information, personal characteristics, an estimate of your ability to think, as well as the different ways in which you act and feel.

At the end of the rugby season, we are going to do a similar set of tests to the baseline tests with rugby players that were concussed during the rugby season. Those players will also undergo a brain scan. At that point, we will also select and invite players from the matched control group, who match the rugby players that were concussed during the season, on age baseline testing, and sport involvement, to undergo the same tests and a brain scan so that we can have comparative data.

Therefore, following initial testing, the results of the baseline testing will be evaluated. You may be contacted to participate in another session of the same tests in September/October, 2019, where you may also be asked to undergo a brain scan, if you happen to match (in terms of age, baseline testing and activity levels) a rugby-playing participant at that time.

These testing procedures will be conducted in a private room at the Cape Universities Body Imaging Centre (CUBIC), Groote Schuur Hospital. We will ask for your assent again if you are asked to participate in the second set of assessments.

Tests and questionnaires that will be given to you:

Demographic and medical history questionnaire – This questionnaire asks for information about your age, height, weight, language ability, learning difficulties (if any), any current or previous concussions, any previous or current psychiatric disorder, and what (if any) medication your son is currently taking.

Alcohol Use Disorders Identification Test – This questionnaire measures your current and/or lifetime alcohol use. The researchers do not suspect you of consuming alcohol, however previous research has shown a strong relationship between concussions and substance use.

Barratt Impulsiveness Scale – This questionnaire looks at how impulsive your behaviour is, and how this may relate to concussion.

Beck Depression Inventory – This questionnaire looks at symptoms of depression. Concussion has been shown to be associated with depressive symptoms, and this questionnaire will be used to assess such symptoms.

General Health Questionnaire – This questionnaire is used to look at the overall psychological health in an individual. It will be used with the other psychological questionnaires to understand your general health.

Profile of Mood States (short form) – The profile of mood states is a measure of overall mood. Mood is different to psychological health because it is more variable. This will also be used to compliment the other psychological questionnaires.

State-trait Anger Expression Inventory – This questionnaire looks at the amount of anger expressed by you.

State-trait Anxiety Inventory – This questionnaire looks at the levels of anxiety you have, and how it is expressed.

The IMPACT – The IMPACT is a computerized test used to measure concussion symptoms. It has two parts to it. The first part measures the concussion symptoms of your son, such as nausea, sleep and headaches. The second part measures your son's cognitive performance.

Pocket Concussion Recognition Tool (PCRT). The PCRT, is a side-line evaluation which can be administered by medical or non-medical professionals to detect a probable concussion. A conclusion of a probable concussion should be made if one or more symptoms is present in the following categories; visible cues of suspected concussion (loss of consciousness, balance problems, dazed gaze), symptoms of a concussion (headache, dizziness, confusion), and memory function.

Brain Scan – Brain scans are computerized images of the brain generated by placing the participant on a padded plastic bed that slides into the scanner. The scan is non-invasive (does not enter or penetrate the body) and painless. These images are used to examine the brain for any possible abnormalities in the brain that may be causing some discomfort. The standard brain imaging techniques do not reveal any gross structural abnormalities associated with concussions. However, recent research indicates that there may be small changes following a

concussion. If you are in the control group, the scan will be done in order to compare your brain structure to the rugby group participants'. If any abnormalities are discovered, a paediatric neurosurgeon will review the scans and advise you and your family on the best course of action.

9. What are the exclusion criteria for this study?

The exclusion criteria for the study include: (a) being of the female sex, (b) being older than 19 years and younger than 16 years at time of recruitment, (c) scoring 21 or more on the Beck Depression Inventory-Second Edition (BDI-II), (d) prior or current diagnosed psychiatric illnesses, learning disabilities, or neurological disease, (e) any history of, or current drug and/or alcohol abuse, (f) control participants with a history of a previous concussion.

Should you meet any of these criteria, you will not be contacted to partake in the second phase of the study.

10. If you choose to participate in this study, how long will you be expected to participate in the research?

You will be asked to be available for the initial scheduled testing session – this session will take approximately 2 hours. The study will run over the course of 6 months. You will however only participate in the baseline testing session unless you are selected as a matched control to participate in the end of season assessment and brain scan.

11. What are the possible discomforts and risks for your child?

There is minimal risk associated with this study. You may be required to return for a repeated assessment in September/October at CUBIC. You will be contacted by the Principal Investigator if this is the case. The testing procedures take approximately 1½ - 2 hours per person. Due to it being a lengthy process, you may feel fatigued or irritable during testing. However, you will be given breaks where necessary, as well as refreshments. The follow-up session is not as time consuming.

Some participants in the research study may feel anxious or claustrophobic with regards to the brain scan. To counter this, an assistant will explain the scanning procedure to you. The research assistant will also allow you to have a "mock scan" where you will experience what it is like to have a scan, before undergoing the actual scan. The scan will not hurt you and it will not be dangerous in any way. You will however need to take the following precautions.

During the MRI neuroimaging assessment, certain metal objects, such as watches, credit cards, hairpins, and writing pens, may be damaged by the MRI scanner or pulled away from the body by the magnet. For these reasons, you will be asked to remove these objects before entering the scanner. When the scanner takes the images, the bed may vibrate, and you will hear loud banging noises. You will be given earplugs or earphones to protect your ears. Also, some people feel nervous in a small-enclosed space such as that of the scanner. You will be able to see out of the scanner at all times, and the radiographer will not start the procedure until you are comfortable. You will be able to stop the procedure at any time by squeezing a ball and can talk to the radiographers using an intercom that is built into the scanner. There are no known harmful long-term effects of the scanner used in this study. Scans will take no longer than 1 hour.

In the process of testing and scanning, researchers may come across incidental findings. Incidental findings are discoveries that are made that do not relate to the research study, and may be potentially harmful. For example, these may relate to findings on brain scan, where, in the process of completing the scan at the end of the season for this research study (if you are selected to participate in that component), researchers may come across other findings on the scan that may be of concern. (Below we include referral information in the event of such incidental findings).

If you wish to discuss the information above or any discomforts you may experience, you may ask questions now or call the Principal Investigators listed on this form.

12. Referrals

Given that we are administering tests of thinking and behaviour and brain scans as part of the study, there may be outcomes following those tests, for which further follow-up by health professionals may be advisable. We will not impose these referrals but we provide the necessary information for you and your parents in your best interest. We outline these referrals below.

Referrals related to baseline testing and exclusion criteria

We noted under point 8 above that there are certain exclusion criteria for this study and we outlined those points there. Two of these exclusion criteria related to your scores on a test of depression symptoms and a test related to alcohol usage. If participants score within certain ranges on these tests, they will be referred to a Sports Psychologist at the Sports Science Institute of South Africa. In the event that you score 21 or more on the Beck Depression

Inventory and/or report any history of, or current drug and/or alcohol abuse, as reported on the AUDIT (see exclusion criteria), you will be referred to Clinton Gahwiler (see details below) by the Principal Investigator.

Psychological management:

Clinton Gahwiler (BA hons MA)

Sport Psychologist at the Sport Science Institute of South Africa

Tel: 021 659 5655

Fax: 086 624 7988

Email: sportpsych@xsinet.co.za

Website: www.performingmind.co.za

Referrals related to incidental findings on MRI scans

Incidental findings are discoveries that are made that do not relate to the research study, and may be potentially harmful. A radiologist on the CUBIC staff and linked to this study, is going to review all the participants' brain scans for such incidental findings. In an unfortunate case of an incidental finding you will be referred for further evaluation to Professor Anthony Figaji. Professor Figaji is a paediatric neurosurgeon, and he will undertake to consult, examine and counsel you where necessary, as well as determine any further course of management that may be needed.

13. What if something goes wrong?

This research study is covered by an insurance policy taken out by the University of Cape Town if you suffer a bodily injury because you are taking part in the study.

The insurer will pay for all reasonable medical costs required to treat your bodily injury, according to the SA Good Clinical Practice Guidelines 2006, which are based on the Association of the British Pharmaceutical Industry Guidelines. The insurer will pay without you having to prove that the research was responsible for your bodily injury. You may ask the study doctor for a copy of these guidelines.

The insurer will *not* pay for harm if, during the study, you:

- Use medicines or other substances that are not allowed
- Do not follow the study doctor's instructions
- Do not tell the study doctor that you have a bad side effect from the study medicine

- Do not take reasonable care of yourself and your study medicine

If you are harmed and the insurer pays for the necessary medical costs, usually you will be asked to accept that insurance payment as full settlement of the claim for medical costs. However, accepting this offer of insurance cover does not mean you give up your right to make a separate claim for other losses based on negligence, in a South African court.

It is important to follow the study doctor's instructions and to report straightaway if you have a side effect from the study medicine.

14. **What are the possible benefits of this study to you, and others?**

There is no potential for direct individual benefit by you taking part in this study.

After the completion of each testing session, participants will be given a restaurant voucher as compensation for their time.

Overall, this research aims to contribute to practical information regarding return-to-play decisions, thresholds of concussion injuries, and diagnostic guides of concussion that are important for player safety. It will provide all those involved with contact sport, including medical teams, information regarding the cognitive, behavioural and brain scan findings associated with concussion.

15. If you choose to participate in this research study, will it cost you anything?

Participating in this research study will not cost you anything. However, the cost of any referrals for further management will be for the personal account of parents/legal guardians and the participants.

16. Can you withdraw from this research study?

You may withdraw your consent and assent and stop participating in this research study at any time, without any penalty to you. At the beginning of each testing session you will be asked if you want to continue with the study. Should you say no, there will be no punishment or penalty placed on you.

If you have a complaint or complaints about your rights and wellbeing as a research participant, please contact the Human Research Ethics Committee.

Tel: 021 406 6492

E-mail: sumaya.ariefdien@uct.ac.za

17. If you withdraw, can information about you still be used and/or collected?

Information that has already been collected will be removed from the data set. Should you withdraw from the study, your data will be removed from the data set.

18. Once personal and performance information is collected, how will it be kept secret (confidential) in order to protect your privacy?

If you agree to participate in this research study, it is possible that some of the information collected might be copied into a "limited data set" to be used for other research purposes. If so, the limited data set will only include information that does not directly identify you – your identity will remain confidential. Data will be labeled using participant numbers rather than names, so that they cannot be used to directly identify any particular individual. A separate and private log will be used simply to relate participant names to numbers in the event that a participant needs to be contacted or contacts the Principal Investigator. This log will only be accessible to the Principle Investigator.

All hard copy data collected will be stored in a locked filing cabinet in the ACSENT Laboratory located in the Department of Psychology UCT. All electronic data will be stored on a password protected hard drive. Only the primary researcher and select individuals involved in the collection and analysis of the data will have access to these files. Your research records will not be released without your permission unless required by law or a court order. These measures do not however guarantee complete privacy, given the small cohort of participant. It may therefore not be possible to guarantee individual privacy. However, published data will not contain any identifiable information other than participant numbers.

19. How will the researcher benefit from you participating in this study?

The researcher may choose to present this research at a conference or in a scientific journal.

20. Dissemination of research findings

You and your school will be provided with a report on the analysis of the data collected in this study. It is the aim that this report be published in an academic journal in order to widen the knowledge base of concussion in rugby. The report is based on the overall statistical findings, and will not reveal any personal details.

Signatures

You have been informed about this study's purpose, procedures, possible benefits, and risks; and how your responses and performance and other data will be collected, used and shared with others. You have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time.

You voluntarily agree to participate in this study. You hereby authorize the collection, use and sharing of your performance and other data. By signing this form, you are not waiving any of your legal rights.

Signature of Person Assenting and Authorizing Date

_____ _____

Name of Participant ("Study Participant" – the child)

_____

Participant cellphone number: _____

Participant email address: _____

Appendix D: Informed Assent Document for Rugby Participants

Informed Assent Document for Rugby Participants

University of Cape Town
Psychology Department
Telephone: +27 21 650-3430
Fax: +27 21 650-4104

Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players

Informed consent for you to participate in research and authorisation for collection, use, and disclosure of protected health information

The neuropsychological (relationship between the brain and behaviour) effects of traumatic brain injuries (TBIs) are considered a public health concern, both in South Africa and around the world. A common form of TBI is concussion, which is known to be associated with neuropsychological (thinking and behavioural) difficulties. Some of the outcomes associated with concussion often include difficulties with attention and concentrating, higher order thinking skills (e.g., working with information in one's head), remembering information and the speed at which one thinks or processes information.

Some research suggests that exposure to concussive head injuries over a long period of time, especially when this starts at a young age like in the adolescent years, may result in permanent neuropsychological (thinking and behavioural) and emotional problems in the adult years. There have been some cases for which research has suggested that such long-term exposure to multiple concussions may also be associated with neurodegenerative (loss of structure and function of neurons (brain cells) over time) processes in later life.

Added to this, adolescent athletes seem to show more difficulties and longer recovery times compared to adults following concussion, suggesting that the injury and recovery process may be different between adolescents and adults. Therefore, investigating the effects of concussion among a young adolescent sample (aged 16 to 19 years) is of particular interest in this study. Younger athletes (e.g., adolescents) may be at greater risk for difficulties as compared to adults, for several reasons: 1) the brain is still maturing and developing during childhood and adolescence and thus an injury during this developmental period can interfere with this development; second, the differences in how intense and how long symptoms last in adolescents compared to adults suggests that the adolescent brain is different to that of the adult brain.

One sport in which concussion is frequently reported is that of rugby. Although many people play rugby, little research has been done to investigate the long-term outcomes of concussive injuries in an adolescent rugby-playing sample.

In order to investigate this you are invited to take part in a research study at your school with the University of Cape Town. This form provides you with information about the study and seeks your permission for the collection, use and disclosure of your neuropsychological and behavioural performance data, as well as other information necessary for the study. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also describe this study to you and answer all of your questions. Your participation is entirely voluntary. Before you decide whether or not to take part, read the information below and ask questions about anything you do not understand. Whether you do or do not decide to participate in this study you will not be penalized or lose any benefits to which you would otherwise be entitled.

This study will be conducted in a manner that adheres to the ethical guidelines and principles of the International Declaration of Helsinki (Fortaleza, Brazil, 2013).

1. **Title of Research Study**

   Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players.

2. **Principal Investigator(s) and Telephone Number(s)**

Dr. Leigh Schrieff
3.11 Department of Psychology
University of Cape Town
Rondebosch
7701
Tel: 021 650 3708
Email: leigh.schrieff-elson@uct.ac.za / leigh.schrieff@gmail.com

Research assistant
Dr Sarah McFie
Department of Psychology
University of Cape Town
Rondebosch

7701
Email: sarah.mcfie@gmail.com

3. Source of Funding or Other Material Support

Medical Research Council

4. What is a concussion?

A concussion is a traumatic brain injury that results in the changing of brain functioning. A concussion is typically caused by a direct impact to the head, but it can also occur when a force is applied to the body that results in the rapid rotation of the head. The most common symptoms of a concussion include headaches, dizziness, memory deficits, and balance disturbances.

5. What is the purpose of this research study?

The purpose of this research study is to investigate whether or not, and how, instances of concussions contribute to brain functioning in adolescents, whose brains are still developing. More specifically the research intends to find out how these injuries may affect the way that an individual thinks, feels and behaves, and whether/how it impacts on the brain. Also, the purpose is to observe how individuals who sustain concussions compare to people who have had no such injuries.

6. Who is taking part in this study?

Because we would like to compare to individuals who sustain concussions to individuals who have had no such injuries, there will be two groups of participants in this study: a rugby group and a non-contact sports playing matched control group.

Rugby is a sport that involves a lot of impacts to the head, neck, and shoulder areas. These forces can at times lead to a concussion. The rugby group will be analysed to see the effect of these concussions on tests of behaviour and cognitive (thinking) functioning, as well as the structure of the brain (using a brain scan). The non-contact sports group (the control group), will be included so that we can compare the outcomes of the rugby group to matched individuals who are not exposed to rugby and the associated injuries. By matched participants we mean that participants in the control group who are similar to participants in the rugby group based on their age, sex, baseline test scores and sport involvement.

7. How many people are expected to participate in the research?

You will be one of 120 school-aged rugby and 120 school-aged non-contact sport players in this study. The maximum number of participants who will be screened at the baseline testing will be 120 for each group; but only 16 participants per group will be requested to complete the full study procedures.

8. What will be done if you take part in this research study?

During this study, you will be asked to complete a number of questionnaires and tests to obtain individual demographic information, personal characteristics, an estimate of your ability to think, as well as the different ways in which you act and feel. Following the start of the season, should you sustain a concussion, you will then be contacted for repeated testing in the 24-72 hours following the injury, and you will also be asked to undergo a brain scan. Following the conclusion of the rugby season, you may be contacted for repeated testing in September/October, 2019, where you may be asked to undergo another brain scan. These testing procedures will be conducted in a private room at the Cape Universities Body Imaging Centre (CUBIC), Groote Schuur Hospital.

Tests and questionnaires that will be given to you:

Demographic and medical history questionnaire – This questionnaire asks for information about your age, height, weight, language ability, learning difficulties (if any), any current or previous concussions, any previous or current psychiatric disorder, and what (if any) medication you are currently taking.

Alcohol Use Disorders Identification Test – This questionnaire measures your current and/or lifetime alcohol use. The researchers do not suspect you of consuming alcohol, however previous research has shown a strong relationship between concussions and substance use.

Barratt Impulsiveness Scale – This questionnaire looks at how impulsive your behaviour is, and how this may relate to concussion.

Beck Depression Inventory – This questionnaire looks at symptoms of depression. Concussion has been shown to be associated with depressive symptoms, and this questionnaire will be used to assess for the possible presence of any such symptoms.

General Health Questionnaire – This questionnaire is used to look at the overall psychological health in an individual. It will be used with the other psychological questionnaires to understand your general health.

Profile of Mood States (short form) – The profile of mood states is a measure of overall mood. Mood is different to psychological health because it is more variable. This will also be used to compliment the other psychological questionnaires.

State-trait Anger Expression Inventory – This questionnaire looks at the amount of anger expressed by you.

State-trait Anxiety Inventory – This questionnaire looks at the levels of anxiety you have, and how it is expressed.

The IMPACT – The IMPACT is a computerized test used to measure concussion symptoms. It has two parts to it: the first part measures any concussion symptoms, such as nausea, sleep and headaches; the second part measures your cognitive performance.

Pocket Concussion Recognition Tool (PCRT). The PCRT, is a side-line evaluation which can be administered by medical or non-medical professionals to detect a probable concussion. A conclusion of a probable concussion should be made if one or more symptoms is present in the following categories: visible cues of suspected concussion (loss of consciousness, balance problems, dazed gaze), symptoms of a concussion (headache, dizziness, confusion), and poor memory function.

Brain Scan – Brain scans are computerized images of the brain generated by having you lie on a padded plastic bed that slides into the scanner. The scan process is non-invasive (does not enter or penetrate the body) and painless. These images are used to examine the brain for any possible abnormalities that may be causing some discomfort. The standard brain imaging techniques do not reveal any obvious big negative changes in the structure of the brain associated with concussions. However, recent research indicates that there may be smaller changes following a concussion. The brain scans will be conducted in order to see if there are any small changes to your brain structure as a result of the concussion. Any small structural changes after concussion will be recorded, and reports will be forwarded on to the medical teams employed by your parents and/or your school. If any abnormalities are discovered, a paediatric neurosurgeon will review the scans and advise you and your family on the best course of action. It is important to note that as with the other assessment measures, the brain scan is part of the research assessment and not part of clinical management of the concussion injury.

9. What are the exclusion criteria for this study?

The exclusion criteria for the study include: (a) being of the female sex, (b) being older than 19 years or younger than 16 years at time of recruitment, (c) scoring 21 or more on the

Beck Depression Inventory-Second Edition (BDI-II), (d) prior or current diagnosed psychiatric illnesses, learning disabilities, or neurological disease, (e) any history of, or current drug and/or alcohol abuse, (f) Participants who do not have a clear referral process to an adequately qualified clinician following a concussive episode, for a formal diagnosis of concussion.
Should you meet any of these criteria, you will not be contacted to partake in the second phase of the study.

Discharge points

We have also included what we refer to as 'discharge' or exit points in the study. In their Concussion Guidance document, World Rugby (2017) note the following about multiple concussions: "Players with a history of two or more concussions within the past year are at greater risk of further brain injury and slower recovery and should seek medical attention from practitioners experienced in concussion management before return to play". Given the potential risk of a participant sustaining multiple concussions and the possibility that they may be returning to play prematurely following a concussion, and in an effort to adhere to the World Rugby guidelines which are in the player's best interest (i.e., for their protection), we will include the following discharge points in the study:

1) If an individual has previously been concussed in the year leading up to the study and is concussed again during the course of the study, and those two concussion points fall within a one-year period, then they will need to be discharged from the study in accordance with the World Rugby guidelines, mentioned before.

2) If an individual is concussed twice within the course of the study, then they will be discharged from the study thereafter, again, in accordance with the World Rugby guidelines, mentioned before.

3) If standard return to play guidelines, as put forward by World Rugby (as outlined in the information sheets distributed on return-to-play guidelines) (Gomez and Hergenroeder 2012, Kutcher and Giza 2014) are not followed before a player returns to play following a concussion, then they will also be discharged from the study. We will ask your attending doctor, managing the concussion, to oversee a return-to-play protocol checklist used in this study.

Again, these discharge points are included as a measure of precaution, with participants' best interest in mind.

10. If you choose to participate in this study, how long will you be expected to participate in the research?

You will be asked to be available for each scheduled of the testing sessions – each session will take approximately 2 hours. The study will run over the course of 6 months. There will be only one testing session around the start of the season if you do not sustain a concussion. Should you sustain a concussion during the course of the rugby season, you will be asked to participate in the post-concussion and end of season assessments and brain scans.

11. What are the possible discomforts and risks for you?

There is minimal risk associated with this study. You may be required to return for a repeated assessment in September/October 2018 at CUBIC, should you sustain a concussion during the season. You will be contacted by the Principal Investigator if this is the case. The testing procedures take approximately 1½ - 2 hours per person. Due to it being a lengthy process, you may feel fatigued or irritable during testing. However, you will be given breaks where necessary, as well as refreshments. The follow-up session is not as time consuming.

All return-to-school and play decisions will be made by the medical team employed by your school, and not the researchers. Your testing results will be made available to the medical team, as well as comparisons between your baseline scores and your injury scores. Findings from the study are not primarily intended to determine whether you return to play or not - that is the goal of the clinical assessors. Clinical assessors might however use the data we collect to inform return-to-play decisions.

Some participants in the research study may feel anxious or claustrophobic with regards to the brain scan. To counter this, an assistant will explain the scanning procedure to you. The research assistant will also allow you to have a "mock scan" where you will experience what it is like to have a scan, before undergoing the actual scan. The scan will not hurt you and it will not be dangerous in any way. You will however need to take the following precautions.

During the MRI neuroimaging assessment, certain metal objects, such as watches, credit cards, hairpins, and writing pens, may be damaged by the MRI scanner or pulled away from the body by the magnet. For these reasons, you will be asked to remove these objects before entering the scanner. When the scanner takes the images, the bed may vibrate, and you will hear loud banging noises. You will be given earplugs or earphones to protect your ears. Also, some people feel nervous in a small-enclosed space such as that of the scanner. You will be able to see out of the scanner at all times, and the radiographer will not start the procedure until you are comfortable. You will be able to stop the procedure at any time by squeezing a

ball and can talk to the radiographers using an intercom that is built into the scanner. There are no known harmful long-term effects of the scanner used in this study. Scans will take no longer than 1 hour.

In the process of testing and scanning, researchers may come across incidental findings. Incidental findings are discoveries that are made that do not relate to the research study, and may be potentially harmful. For example, these may relate to findings on brain scan, where, in the process of investigating the outcomes of concussion, researchers may come across other findings on the scan that may be of concern. (Below we include referral information in the event of such incidental findings).

If you wish to discuss the information above or any discomforts you may experience, you may ask questions now or call the Principal Investigators listed on this form at any point during the study.

Because this study involves on-going brain scans and cognitive testing related to concussion, this may give you the incorrect impression or misconception that we are providing care for, or clinical management of, your concussion injury. It is important to note that this is however not the case as this is a research study and it is therefore not providing any clinical care or management of the concussion injury. We are not replacing any existing medical/care structures that the schools and/or you may have in place, but rather working in conjunction with them. All decisions on whether to return to school and play will be made by the medical structures already employed by the schools and/or you. Your test and brain scan results will be made available to the medical professionals employed by the you and/or your school should it be required, as well as comparisons between your baseline scores and your scores from any testing after a concussion. Before we collect any data, we will hold an information session with you and your parents to talk about this potential misconception.

It is important to note that if you do suffer a concussion injury, findings from tests conducted as part of this research study might impact on your ability to continue playing rugby or other contact sports in the future. The implications of the test findings for thinking and behaviour and brain scan findings should be discussed with health professionals as part of the referral process (described below).

12. Referrals

Given that return-to-play decisions are part of the job of the clinical assessors, we, as researchers, cannot and should not make any such decisions on the basis of our data. However,

clinical assessors might however use the data we collect to inform return-to-play decisions. However, given that we are administering tests of thinking and behaviour, post-concussion tests, and brain scans as part of the study, there may be outcomes following those tests, for which further follow-up by health professionals may be advisable. We will not impose these referrals but we provide the necessary information for you and your parents in your best interest. We outline these referrals below.

Referrals related to baseline testing and exclusion criteria

We noted under point 8 above that there are certain exclusion criteria for this study and we outlined those points there. Two of these exclusion criteria related to your scores on a test of depression symptoms and a test related to alcohol usage. If participants score within certain ranges on these tests, they will be referred to a Sports Psychologist at the Sports Science Institute of South Africa. In the event that you score 21 or more on the Beck Depression Inventory and/or report any history of, or current drug and/or alcohol abuse, as reported on the AUDIT (see exclusion criteria), you will be referred to Clinton Gahwiler (see details below) by the Principal Investigator.

Psychological management:

Clinton Gahwiler (BA hons MA)

Sport Psychologist at the Sport Science Institute of South Africa

Tel: 021 659 5655

Fax: 086 624 7988

Email: sportpsych@xsinet.co.za

Website: www.performingmind.co.za

Referrals related to concussion diagnoses and post-concussion testing

It is important to note that a suspected concussion requires a clinical assessment by a doctor skilled in the management of concussion. We include the details of doctors below, who specialize in concussion diagnoses and management, should you or the school not currently have such a management system in place.

As noted, we will share your performances on the behaviour and cognitive tests administered, and on the brain scan, with the health professional managing your concussion. That health professional will decide whether you may need further medical management, either by the school's medical team or another medical team, should the school not have one.

Please note that the costs of referrals for further management will be for the personal account of your parents/legal guardians and the participants.

In the event that your school does not have a medical team in place to assist in your care, please see the details below, which can be passed on to the health professional attending to you.

Concussion management:

Sports Medicine department at the Sports Science Institute of South Africa

Tel: 021 659 5644

Email: info@cape-sportsmed.com

Neurosurgery Clinic (with Prof Anthony Figaji)

Red Cross War Memorial Children's Hospital

021 658 5434

Referrals related to incidental findings on MRI scans

Incidental findings are discoveries that are made that do not relate to the research study, and may be potentially harmful. A radiologist on the CUBIC staff and linked to this study, is going to review all the participants' brain scans for such incidental findings. In an unfortunate case of an incidental finding you will be referred for further evaluation to Professor Anthony Figaji. Professor Figaji is a paediatric neurosurgeon, and he will undertake to consult, examine and counsel you were necessary, as well as determine any further course of management that may be needed.

13. What if something goes wrong?

This research study is covered by an insurance policy taken out by the University of Cape Town if you suffer a bodily injury because you are taking part in the study. The insurer will pay for all reasonable medical costs required to treat your bodily injury, according to the SA Good Clinical Practice Guidelines 2006, which are based on the Association of the British Pharmaceutical Industry Guidelines. The insurer will pay without you having to prove that the research was responsible for your bodily injury. You may ask the study doctor for a copy of these guidelines.

The insurer will *not* pay for harm if, during the study, you:

- Use medicines or other substances that are not allowed
- Do not follow the study doctor's instructions
- Do not tell the study doctor that you have a bad side effect from the study medicine

- Do not take reasonable care of yourself and your study medicine

If you are harmed and the insurer pays for the necessary medical costs, usually you will be asked to accept that insurance payment as full settlement of the claim for medical costs. However, accepting this offer of insurance cover does not mean you give up your right to make a separate claim for other losses based on negligence, in a South African court. It is important to follow the study doctor's instructions and to report straightaway if you have a side effect from the study medicine.

14. **What are the possible benefits of this study to you, and others?**

After the completion of each testing session, participants will be given a restaurant voucher as compensation for their time. In the event that you sustain a concussion, your individual brain scans and test results will be sent to the medical team at your school following testing and imaging.

Overall, this research aims to contribute to practical information regarding return-to-play decisions, thresholds of concussion injuries, and diagnostic guides of concussion that are important for player safety. It will provide all those involved with contact sport, including medical teams, information regarding the cognitive, behavioural and brain scan findings associated with concussion.

15. If you choose to participate in this research study, will it cost you anything?

Participating in this research study will not cost you anything. However, the cost of any care arising from a concussion injury (over and above what is done in the study), i.e., the clinical management of a concussion, or the costs of referrals for further management, will be for the personal account of parents/legal guardians and the participants.

16. Can you withdraw from this research study?

You may withdraw your consent and assent and stop participating in this research study at any time, without any penalty to you. At the beginning of each testing session you will be asked if you want to continue with the study. Should you say no, there will be no punishment or penalty placed on you.

If you have a complaint or complaints about your rights and wellbeing as a research participant, please contact the Human Research Ethics Committee.
Tel: 021 406 6492

E-mail: sumaya.ariefdien@uct.ac.za

17. If you withdraw from the study, can information about you still be used and/or collected?

Information that has already been collected will be removed from the data set. Should you withdraw from the study, your data will be removed from the data set.

18. Once personal and performance information is collected, how will it be kept secret (confidential) in order to protect your privacy?

If you agree to participate in this research study, it is possible that some of the information collected might be copied into a "limited data set" to be used for other research purposes. If so, the limited data set will only include information that does not directly identify you – your identity will remain confidential. Data will be labeled using participant numbers rather than names, so that they cannot be used to directly identify any particular individual. A separate and private log will be used simply to relate participant names to numbers in the event that a participant needs to be contacted or contacts the Principal Investigator. This log will only be accessible to the Principle Investigator.

All hard copy data collected will be stored in a locked filing cabinet in the access-controlled ACSENT Laboratory located in the Department of Psychology UCT. All electronic data will be stored on a password protected hard drive. Only the primary researcher and select individuals involved in the collection and analysis of the data will have access to these files. Your research records will not be released without your permission unless required by law or a court order. These measures do not however guarantee complete privacy, given the small cohort of rugby-playing participants, as players may be inherently identifiable. It may therefore not be possible to guarantee individual privacy. However, published data will not contain any identifiable information other than participant numbers.

19. How will the researcher benefit from you participating in this study?

The researcher may choose to present this research at a conference or in a scientific journal.

20. Dissemination of research findings

You and your school will be provided with a report on the analysis of the data collected in this study. It is the aim that this report be published in an academic journal in order to widen the knowledge base of concussion in rugby. The report is based on the overall statistical

findings, and will not reveal any personal details

Signatures

You have been informed about this study's purpose, procedures, possible benefits, and risks; and how your responses and performance and other data will be collected, used and shared with others. You have received a copy of this form. You have been given the opportunity to ask questions before you sign, and you have been told that you can ask other questions at any time.

You voluntarily agree to participate in this study. You hereby authorize the collection, use and sharing of your performance data and other data. By signing this form, you are not waiving any of your legal rights.

Signature of Person Assenting and Authorizing Date

_____ _____

Name of Participant ("Study Participant" – the child)

Participant cellphone number: _____

Participant email address: _____

Appendix E: Debriefing Form

Debriefing Form

University of Cape Town
Psychology Department
Telephone: +27 21 650-3430
Fax: +27 21 650-4104

Formal Study Debriefing Form

Thank you for participating in the research study.

This form provides you with information about the study in which you have just participated. The Principal Investigator (the person in charge of this research) or a representative of the Principal Investigator will also explain this study to you in full and answer all of your questions.

1. Name of Participant ("Study Subject")

_____

2. Title of Research Study

Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players, and their associated predictors.

3. What is the purpose of this research study?

The purpose of this research study was to investigate whether or not, and how, instances of concussions contribute to brain functioning in adolescents. More specifically the research intends to find out how these injuries may affect the way that an individual thinks, feels and behaves, and whether/how it impacts on the brain. Also, the purpose is to observe how individuals who sustain concussions compare to people who have had no such injuries.

4. What was done during this research study?

During this study, you were required to participate in one study, completing numerous questionnaires and scales to obtain individual demographic information, personal

characteristics, an approximation of your ability to think, as well as the different ways in which you act and feel. Following initial testing and if there was a diagnosis of a concussion, you underwent similar testing procedures as the baseline phase, as well as undergoing additional brain scans. Following the completion of the rugby season, if you sustained a concussion, you underwent an additional testing and scanning session.

5. Was any deception used in this research study?

No.

6. Is anything further required of you?

There is nothing further required of you. If you do however have any questions or concerns regarding my research you may contact the Principle Investigator involved: either Nicholas Reid (Nicholas.reid@alumni.uct.ac.za) or Dr. Leigh Schrieff-Elson (leigh.e.elson@gmail.com).

7. Confidentiality

All data collected for the study will be kept confidential – this is not to be confused with the results of the study which will be made available. Data will be labelled using participant numbers rather than names, so that they cannot be used to directly identify any particular individual. Furthermore, all data will be stored in a locked filing cabinets in the department. Data will also be stored on a password-protected computer. Only certain people – the researchers for this study and certain University of Cape Town officials – are afforded the legal right to review these research records.

8. **Signatures**

As a representative of this study, I have explained to the participant, in detail, the purpose, the procedures, and any deception used in this research study.

_____ _____

Signature of Person Obtaining Consent/Assent Date

I have been informed, in detail, about this study's purpose, procedures, and deceptions. I have been given the opportunity to ask questions before I sign. By signing this form, I am not waiving any of my legal rights.

_____ _____

Signature of Person Assenting Date

Appendix F: Approval from the Western Cape Government

Directorate: Research

Audrey.wyngaard@westerncape.gov.za
tel: +27 021 467 9272
Fax: 0865902282
Private Bag x9114, Cape Town, 8000
wced.wcape.gov.za

REFERENCE: 20170320 –9296
ENQUIRIES: Dr A T Wyngaard

Dr Leigh Schrieff-Elson
3.11 Department of Psychology, UCT
Woolsack Drive
Rondebosch
7700

Dear Dr Leigh Schrieff-Elson

RESEARCH PROPOSAL: INVESTIGATING THE NEUROPSYCHOLOGICAL EFFECT AND LONG TERM OUTCOMES OF MULTIPLE CONCUSSIONS AMONG HIGH SCHOOL RUGBY PLAYERS

Your application to conduct the above-mentioned research in schools in the Western Cape has been approved subject to the following conditions:

1. Principals, educators and learners are under no obligation to assist you in your investigation.
2. Principals, educators, learners and schools should not be identifiable in any way from the results of the investigation.
3. You make all the arrangements concerning your investigation.
4. Educators' programmes are not to be interrupted.
5. The Study is to be conducted from **04 February 2019 till 27 September 2019**
6. No research can be conducted during the fourth term as schools are preparing and finalizing syllabi for examinations (October to December).
7. Should you wish to extend the period of your survey, please contact Dr A.T Wyngaard at the contact numbers above quoting the reference number?
8. A photocopy of this letter is submitted to the principal where the intended research is to be conducted.
9. Your research will be limited to the list of schools as forwarded to the Western Cape Education Department.
10. A brief summary of the content, findings and recommendations is provided to the Director: Research Services.
11. The Department receives a copy of the completed report/dissertation/thesis addressed to:

    The Director: Research Services
    Western Cape Education Department
    Private Bag X9114
    CAPE TOWN
    8000

We wish you success in your research.

Kind regards.
Signed: Dr Audrey T Wyngaard
Directorate: Research
DATE: 31 January 2019

Appendix G: Approval for Parent Study

HUMAN RESEARCH ETHICS COMMITTEE
17 MAY 2018
HEALTH SCIENCES FACULTY
UNIVERSITY OF CAPE TOWN

UNIVERSITY OF CAPE TOWN — FACULTY OF HEALTH SCIENCES
Human Research Ethics Committee

FHS016: Annual Progress Report / Renewal

HREC office use only (FWA00001637; IRB00001938) This serves as notification of annual approval, including any documentation described below.			
☑ Approved	Annual progress report	Approved until/next renewal date	30/05/2019
☐ Not approved	See attached comments		
Signature Chairperson of the HREC		Date Signed	17/5/2018

Comments to PI from the HREC

Principal Investigator to complete the following:

1. Protocol information

Date (when submitting this form)	16 May 2018		
HREC REF Number	785/2016	Current Ethics Approval was granted until	30 May 2018
Protocol title	Investigating the neuropsychological effect and long term outcomes of concussions among high school rugby players		
Protocol number (if applicable)			
Are there any sub-studies linked to this study?	☐ Yes X No		
If yes, could you please provide the HREC Ref's for all sub-studies? **Note:** A separate FHS016 must be submitted for each sub-study.			
Principal Investigator	Dr Leigh Schrieff-Elson		
Department / Office Internal Mail Address	Department of Psychology, Office 3.11, P D Hahn Building, Upper Campus		

1.1 Does this protocol receive US Federal funding?	☐ Yes	X No