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# The association between harm avoidance personality traits and self-reported concussion history in South African rugby union players

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ABSTRACT

*Objectives:* Personality traits have been proposed to affect the risk of sports concussion, but evidence is limited. Cloninger's Tridimensional Personality Questionnaire (TPQ) measures novelty seeking, harm avoidance (HA), and reward dependence traits. The aim of this study was to investigate the relationship between TPQ scores and concussion history in rugby union players.
*Design:* Cross-sectional study.
*Methods:* Rugby players from high schools, senior amateur clubs, and professional teams provided a self-reported concussion history and completed the TPQ. Participants reporting no previous concussions formed the control group, while participants reporting concussion formed the case group. A one-way analysis of covariance, with age as a covariate, was used to examine the differences in TPQ scores between groups.
*Results:* Of the 309 participants, 54% reported a minimum of one concussion (junior: 47%; amateur: 52%; professional: 72%). HA scores were significantly higher in junior players without a history of concussion compared to cases ($p = 0.006$). Specifically, the junior control group had higher "anticipatory worry" ($p = 0.009$) and "fear of uncertainty" ($p = 0.008$). In contrast, the professional control group had lower HA scores than cases ($p = 0.009$), while the amateur cohort displayed no differences between control and case groups.
*Conclusions:* This study identified a novel association between HA and concussion in rugby players, adding evidence to the role of personality in a multifactorial risk-model of concussion. The findings suggest that lower HA may lead to increased dangerous play in youth rugby, influencing concussion susceptibility. Contrasting associations in the professional cohort suggest further research is required to understand the role of personality in concussion.


## 1. Introduction

Concussion is defined as "a complex pathophysiological process affecting the brain, induced by traumatic biomechanical forces".[1] It is estimated that 1.6–3.8 million concussions occur annually in the USA.[2] A history of multiple concussions is suggested to increase the risk of developing long-term neurological and psychological complaints.[3] The incidence, time lost from participation, and potential long-term effects of concussion, highlight the importance of identifying risk factors for sport-related concussion.

Individual personality traits have been associated with an increased risk of acute sports injuries.[4–6] More specifically; impulsivity, neuroticism, anxiety, and extraversion were found to correlate with overall injury risk in sport.[4–6] In addition, ice-hockey players who claimed that they play in order get rid of excess aggression, were found to be four times more likely to be concussed.[7]

Rugby Union, hereafter referred to as rugby, is a game with frequent high impact collisions and therefore is associated with a relatively high concussion profile compared to other sports.[8] It has been proposed that the attitude and behaviour of rugby play-

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ers can affect their risk of injury.[9] Specifically, increased concussion rates were noted in rugby players with higher impulsivity scores.[10] The majority of concussions in rugby occur during player–player contact.[11] It may be possible that personality may impact on how a player approaches and engages in contact situations, and thereby modify their concussion susceptibility. For example, in soccer, players with higher extraversion scores were more likely to head the ball.[12]

Cloninger developed the Tridimensional Personality Questionnaire (TPQ), aimed at computing three facets of an individual's temperament, namely novelty seeking (NS), harm avoidance (HA), and reward dependence (RD).[13] NS is defined as a "tendency toward frequent exploratory activity and intense excitement in response to novel stimuli" and is indicative of risk-taking and impulsive behavior.[13] HA is the "tendency to avoid aversive situations" and is described as a measure of the perceived risk and anxiety of a given situation, whereas RD is "a tendency to respond intensely to signals of reward".[13] It may therefore be possible for these personality measures to indirectly quantify behaviours such as risk-taking, impulsivity, and perceived risk that could possibly affect concussion susceptibility.

The aim of this study was to explore the relationship between personality scores, as measured by Cloninger's TPQ,[13] and concussion history in rugby.

## 2. Methods

Whilst adhering to the Declaration of Helsinki ethical guidelines, and following approval from the Human Research Ethics Committee of the University of Cape Town, the Western Cape Education Department, and relevant school administrators, schools, senior community-level amateur clubs, and senior professional teams were approached to participate in the study between 2013 and 2015. A total of 487 apparently healthy active male rugby players volunteered to participate from four high schools ("junior": n = 248), three senior community-level amateur clubs ("amateur": n = 170), and two professional teams ("professional": n = 69). Participants gave written informed consent and in the case of minors, written informed assent from the minor and informed consent from a parent or legal guardian was obtained. Participants were then required to complete the study questionnaire containing; (i) personal details, medical, and sporting history questionnaire, (ii) a concussion history questionnaire, and (iii) Cloninger's TPQ. For junior participants, consent was first required before the study questionnaire was completed at a subsequent time point. Junior participants who had completed consent forms, but did not submit the study questionnaire were excluded (n = 70).

Participants previously diagnosed with meningitis (n = 6), epilepsy (n = 3), stroke (n = 2), mood or psychiatric disorders (n = 2), or a non-rugby related concussion (n = 24) were excluded. Seventeen junior participants without a self-reported English language comprehension were also excluded. The TPQ contained two validation items (blank questions with answer boxes) to test for inaccuracy of responses. Participants answering these validation items were omitted (all levels: n = 54; junior: n = 30; amateur: n = 14; professional: n = 10). A total of 309 participants were included in the study (junior: n = 107, age: 16.5 ± 1.3 years; amateur: n = 145, age: 21.6 ± 4.4 years; professional: n = 57, age: 24.5 ± 3.6 years).

All participants were enrolled using identical methods, with control and case groups assigned after recruitment based on self-reported concussion history. We defined concussions according to the Zurich Consensus statement[1] as a direct, or indirect, blow to the head during a rugby-related activity, that resulted in a set of clinical signs and symptoms that may or may not have involved loss of consciousness. The self-reported concussion history questionnaire required participants to provide details of their four most recent concussions. Specifically, information was collected on the date and mechanism of concussion injury, whether the concussion was diagnosed by a medical professional, the occupation of that medical professional (medical doctor, physiotherapist, nurse, paramedic), the symptoms experienced, and the duration of symptoms. Participants selected the relevant symptoms from a concussion symptom list, which was constructed from the Sports Concussion Assessment Tool (3rd edition).[14]

"Diagnosed concussions" were defined as concussions diagnosed by a medical professional and qualified by one or more concussion symptoms. "Suspected concussions" were defined as concussions that were not diagnosed by medical personnel, but were described in conjunction with concussion symptoms.

The control group included individuals reporting no suspected or diagnosed concussions (n = 142), while the case group included participants with a minimum of one suspected or diagnosed concussion (n = 167). The case subgroup, "case (diagnosed)", only included participants with one or more diagnosed concussions (n = 134), thus excluding suspected concussions.

Participants were asked to disclose previously diagnosed medical conditions and describe details of their lifetime sporting participation, including the total years of participation, highest level of play, and playing position.

Cloninger's 96-item true/false, self-administered TPQ[13] comprises of 33 NS, 34 HA, and 29 RD questions, with zero or one scored for each question. Within each of the three dimensions (NS, HA, and RD) are four subscales, as described in Supplementary Table S1. Higher scores indicate increased HA, NS, and RD behaviors. For example, an individual with a high HA score would be more reluctant to partake in risky activities compared to someone with a low HA score. In the case of incomplete questionnaires, completed sections were included, while incomplete sections were excluded from the analysis. The NS section was completed by 92% (NS1: 97%; NS2: 96% NS3: 98%; NS4: 96%), the HA section by 94% (HA1: 97%; HA2: 98%; HA3: 99%; HA4: 99%), and the RD section by 94% (RD1: 98%; RD2: 97%; RD3: 97%; RD4: 99%) of participants.

The Shapiro Wilk test determined whether the data sets were normally distributed. A one-way analysis of variance (ANOVA), with Tukey's post-hoc test, or a Mann Whitney U test observed differences in participant characteristic data between groups. As a result of negligible differences between ANOVA and Mann Whitney U results, all data was represented as being normally distributed with the ANOVA results displayed.

Due to the possible effect of age on personality traits,[15] a one-way analysis of covariance (ANCOVA), with age as a covariate, examined the differences in TPQ scores between groups. If significant differences were found in any of the three TPQ dimensions, additional analysis was completed on the four corresponding subscales. In addition, a Fisher's exact test observed differences in the distribution of TPQ scores between groups. Participants were subdivided into age cohorts for analysis. Furthermore, because of differences in the level of competition, senior amateur and professional players were analysed in separate cohorts. P values less than 0.05 were accepted as statistically significant. All statistical analysis was done using STATISTICA (Version 11, StatSoft Inc., Tulsa, OK, USA).

## 3. Results

Fifty-four percent of participants (n = 167) reported a previous suspected or diagnosed concussion (junior: 47%, n = 50; amateur: 52%, n = 76; professional: 72%, n = 41) and 43% (n = 134) reported a prior diagnosed concussion (junior: 35%, n = 37; ama-

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