

Self- Reported Head Injury, Post-Concussion Symptoms and Crime



DOCTORATE IN CLINICAL PSYCHOLOGY

MAJOR RESEARCH PROJECT

Post-Concussion Symptoms after Self-Reported Head Injury, and Reactive
Aggression in Young Male Offenders

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Author: Hannah Meadham

Supervisors: Dr. A. J. Mewse and Prof. W. H. Williams

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Abstract

Objective

Adolescence is recognised as a risk period for offending and head injury (HI), with higher rates of HI found in the young offender (YO) population compared to the general population. Drug and alcohol use has also been associated with increased risk of offending. This study aims to explore the relationships between HI, Post-concussion symptoms (PCS), reactive and proactive aggression, and offending behaviour in YOs, whilst considering the effects of drug and alcohol use on these relationships.

Participants

A sample of ninety eight males was recruited from a Young Offender Institute: the age range was 16-18 years of age with an average age of 17.

Design

A between subjects cross sectional design was employed. Participants were recruited using an opportunistic sampling strategy.

Main Measures

Self-rated/report measures of: HI, Post-Concussion Symptoms (Adapted Rivermead Post-Concussion Symptom Questionnaire), Aggression (Reactive-Proactive Scale), criminal histories, and drug and alcohol history.

Results

HI was reported by 73.5% of the overall sample, with 61.1% reporting a “knock out”. Frequency and severity of HI was associated with significantly higher PCS scores. Examination of covariate- drug and alcohol use did not affect these relationships. PCS were a significant predictor of reactive aggression, total number of convictions and

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number of previous violent convictions. However, dosage of HI (severity and
frequency) was not a significant predictor of reactive aggression or criminal profiles.

Conclusions

There appears to be a dose-response effect of severity and frequency of HI on PCS,
with PCS predicting reactive aggression. Such symptoms may compromise functions
and lead to increased aggression. This highlights the need for better screening and
interventions for HI and on-going symptoms in YOs.

***Key Words: Head Injury, Post-Concussion Symptoms, Young Offenders,
Aggression.***

Introduction

Background

Head injury (HI)¹ is the leading cause of death and disability in individuals under 45 years of age in western societies (Bruns & Hauser, 2003; Fleminger & Ponsford, 2005). It can vary from mild to very severe depending on the loss of consciousness, often measured using the Glasgow Coma Scale score (GCS- Teasdale & Jennett, 1974). Major causes include road accidents, falls, sporting injury and assaults (Rosenthal & Ricker 2000). Deficits in individuals' cognitive and behavioural abilities, sometimes profound and enduring, can result².

A retrospective epidemiological study of an Emergency Departments' data base of HI attendances (Yates et al., 2006), found adolescent males were at increased risk compared to females. HI appears to be more common in adolescence, a time when risky behaviours are more frequently seen (Newacheck et al., 2003). Increasing attention has been given to the compelling finding that rates of HI are significantly higher in prison populations, including YO compared to the general population (Williams et al., 2010). This difference suggests a relationship between HI and offending behaviour. However, HI in the prison population and specifically the young

¹ This review will refer to HI as “nondegenerative, noncongenital, insult to the brain from an external mechanical force, possibly leading to permanent or temporary impairments of cognitive, physical and psychosocial functions with an associated diminished or altered state of consciousness” (Dawodu, 2007, p.1).

² Teasdale and Engberg (2005) found reduced employment, restricted social and family relations, and lower quality of life in those who had experienced a HI.

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offender (YO) population has, until recently, been a relatively neglected area in research and practice.

Around 80% of all HIs are classified as mild (Fleminger & Ponsford, 2005). Mild HIs (mHI) are not usually associated with long term problems, however, when these injuries are complicated or accumulative, there can be neuropsychological sequelae, particularly involving attention and executive systems (Williams, Potter & Ryland, 2010). Moderate to severe HIs are typically associated with more neuropsychological deficits such as behavioural problems and poor social outcomes (Stamrook et al., 1990). From a neuropathological standpoint, HI severity can be viewed on a continuum and neuronal damage can occur through mechanical deformation from stretching, twisting and shearing actions brought on by head impact and acceleration/deceleration of the brain during the event that caused the concussion (Bigler, 2013). As summarised by Graham and Lantos (2002) shear and tensile strains at the axonal level are the “most important single factors contributing to the severity of brain damage in any patient who sustains a blunt head injury because it occurs at the moment of injury” (p.867). Thus, suggesting even though individuals who suffer mHIs are expected to make a full recovery, it is possible that some neurological damage may have occurred.

HI can have profound and lasting effects that negatively impact upon a person’s functioning. Research has resulted in inconsistent prevalence rates of effects of HI

Self- Reported Head Injury, Post-Concussion Symptoms and Crime symptoms post injury (Binder et al., 1997 and Frencham et al., 2005), with work by Pertab, James and Bigler (2009) attributing some of this variation to a lack of specificity of measures used in this area of research and the varying criteria employed to define HI: highlighting the difficulty of predicting on-going problems post HI.

Furthermore, there is evidence to suggest that in comparison to single concussions, repeat concussions appear to have increased negative effects upon cognitive and behavioural functioning (Wall et al., 2006). It is possible that those who have experienced mild repeated concussions may not be expected to suffer significant long term effects if their injuries are considered as isolated events and there are no apparent complications detected at the time of injury. However, the possible accumulative effect of repeated injuries may get overlooked and therefore assessment and interventions are not readily offered.

Head Injury and Post-Concussion Symptoms

Given the above, it appears important to consider the impact of mHI as well as more severe injuries. The difficulty arises with how to identify such injuries when immediate impact is not as obvious as that of moderate/severe HIs? PCS can offer a potential solution. Young people with mHI have been reported to display a variety of cognitive (problems with memory, attention and concentration, the performance of daily tasks, and decision making), somatic (headaches, sleep disturbance, dizziness, sensitivity to noise or light, visual problems and nausea), and affective symptoms

Self- Reported Head Injury, Post-Concussion Symptoms and Crime (depression, irritability, anxiety, poor frustration tolerance and loss of motivation or apathy) (Axlerod et al., 1996, Bohnen et al., 1995, Cicerone & Kalmar, 1995, Piland et al., 2006). Collectively these problems have been referred to as PCS. They are more frequent and severe than those reported by children with injuries not involving the head (Mittenberg et al., 1997, Ponsford et al., 1999, Rivara et al., 1994, Yeates et al., 1999). Although PCS typically resolve within several weeks (Carroll et al., 2004 & Light et al., 1998), they can persist for months and sometimes years following injury (Mittenberg et al., 1997, Yeates et al., 1999 and Yeates et al., 2009).

There is some debate whether PCS are due to biological factors from neural damage or psychological response to the HI (Mittenberg et al., 1992, Mulhern & McMillan, 2006). Some authors have argued that PCSs can reflect premorbid adjustment, post injury psychological or family factors or malingering in the context of litigation (Suhr & Gunstad, 2002, Less-Haley et al., 2001 and Mittenberg et al., 1997). However, Moran et al. (2011) propose elevated PCS can be attributed, in part, to actual changes in the brain structure or function. Evidence exists highlighting that people with PCS have deficits on standardized tests of cognitive function (Ryan & Warden, 2003) and score lower than controls on neuropsychological tests measuring attention, verbal learning, reasoning and information processing. This indicates that brain dysfunction could be a significant factor in PCS (Yeates & Taylor, 2005).

These findings also suggest that HI severity correlates with PCS (Yeates et al., 1999, Gowda, 2006, Agrawal et al., 2005, Wilde et al., 2008). Ponsford et al. (2000) suggested in the first few weeks following injury, somatic symptoms are best at

Self- Reported Head Injury, Post-Concussion Symptoms and Crime discriminating individuals with mHI from controls. Following mHI symptoms can be relatively subtle making it difficult therefore for others to recognise the association with previous HIs. As a result, they may not serve as an adequate warning sign to trigger appropriate interventions. It appears the assessment of PCS could be used as a measure to indicate severity of HI, particularly the subtle signs of mHI, and it can offer important information on the on-going problems that may serve as warning signs for compromised functioning.

Head Injury, Offending and PCS

Evidence suggests a history of HI is more common in offenders compared to the general population. Prevalence rates of self-reported HI of any severity in prison populations, including YOs, have been found to be between 65% and 87% (Williams et al., 2010; Schofield et al., 2006 & Slaughter, Fann & Ehde, 2003), which is considerably higher than the estimated rates of HI in the general population: these vary from 5-25% (Silver, Kramer, Greenwald, & Weissman, 2001; Farrer & Hedges, 2011, Slaughter et al., 2003).

Reliance upon self-reports to obtain HI information can pose a potential risk of report biases and difficulties with recollection. The inclusion of other sources of information such as medical records may provide further accuracy. However, there is a body of evidence to support the usefulness of self-report: Schofield, Butler, Hollis and D'Este (2011) found self-report of HI was similar in accuracy to hospital records in a group of prisoners. Furthermore, Jolliffe et al. (2003) demonstrated that the validity of self-

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reports of offending was high when they undertook a prospective longitudinal survey of 808 youths comparing annual court referral data to self-reported data.

As already suggested, adolescence is a risk factor for acquiring HI, it is also a risk factor for exhibiting offending behaviour (Forest, Tambor, Riley, et al., 2000, & Mobbs, 2008). Hux et al. (1998) reported a 50% prevalence rate of young offenders who had experienced a HI. One third of this sample were described by their parents as suffering adverse, long term HI related effects such as diminished ability to regulate behaviour and affect, difficulties with attention, interpersonal skills and school performance.

Exploration of the relationship between HI and offending in YOs is in its infancy. Explanations for this link are not conclusive, but various studies have offered some insights into the possible mechanisms by which HI influences offending behaviour. Diaz (1995) claimed that the most likely features that lead to future violence are severe HI with frontal lobe abnormalities, prolonged unconsciousness and temporal lobe epilepsy. This is supported by work by Raine et al., which has found damage to the frontal lobes in murderers (Raine, 2001; Raine, Lencz, Bihrlé, LaCasse, & Colletti, 2000). Identifying influences of HI on offending behaviour in YO is still largely inconclusive.

Various authors have explored the possible neurological abnormalities in the brain function of criminals and interactions between biological, neurological and social

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factors that may be associated with violent offending. Grafman, Schwab and Warden (1966) and Pagani and Pinard, (2001) found there was a positive correlation between frontal lobe damage and frequency of violence. Leon-Carrion and Ramos (2003) found that violent offenders in their sample reported experiencing significantly more blows to the head than non-violent offenders. Furthermore, a history of discrete neurological damage as a consequence of injury to the head was found to be more indicative of violent behaviour than academic and intellectual problems or medical or family background between the two groups. In addition, the research suggests that when the various above factors are combined, the risk of violent offending increases.

YOs with a reported history of HI, have been found to report an earlier onset of offending (Perron & Howard, 2008). Williams et al. (2010) found those male YO with repeated HI reported more convictions and greater violence in convictions compared to YO who'd suffered less than three HI or no HI. Fazel et al. (2011)

examined health care and criminal records in the Swedish general population.

Hospitalised HI participants were three times more likely to have committed a violent crime in comparison to the non-injured general population. Importantly, they also looked at the siblings of HI victims and found they too went on to offend at a higher rate than the general population. This highlighted the influence of social and familial factors on offending.

The prevalence rates and above research findings suggests a relationship between HI and worse offending profiles. However, caution is required when attempting to

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establish the direction of causality between HI and offending given the relatively sparse research in this area. Furthermore, consideration should be given to the possible impact of multiple co-morbid factors. Turkstra, Jones and Toler (2003), suggested a number of risk factors related to both HI and offending, including; increased rates of substance abuse and aggression and dysfunctional family background. This suggests a possible epiphenomenon occurring within the original highlighted phenomenon between HI and offending.

The prevalence of substance abuse and dependence is significantly higher in offenders than the general population (Fazel, Bains & Doll, 2006). Furthermore, substance use and HI are highly co-morbid: Schofield et al, (2006) found illicit drug use was associated with an increased likelihood of HI in a group of adult offenders. Williams et al, (2010) found more frequent cannabis use in a sample of YOs with HI than YO without HI. Peron and Howard (2008) provided evidence to suggest earlier onset of substance misuse was associated with HI.

Kenny et al. (2007) studied a sample of 242 YOs in Australia of which 85 had a history of HI and were 2.37 times more likely to have committed a serious violent crime. This risk was increased when hazardous alcohol consumption was also reported. The authors suggested HI impairs inhibition of aggressive impulses, especially in the presence of alcohol misuse further raising the risk of offending. This study identifies alcohol as an independent risk factor for severe violent offending, viewing HI as a contributory factor rather than causal. Similarly, Lubman, Yucci and Hall, (2007) suggested HI and substance misuse may reduce inhibition of

Self- Reported Head Injury, Post-Concussion Symptoms and Crime inappropriate responses leading to an increase in aggressive offences. Research looking at the relationship between substance misuse, offending and HI in YO is required to further understand the interplay.

Head Injury, Reactive and Proactive Aggression, and Offending

As already suggested, there is good evidence those with HI have an increased risk of aggression³ and agitation. For example, when compared with patients with multiple traumas without HI, three times as many HI patients showed significant aggression during the first 6 months post injury (Tateno, 2003). This aggression can become a long term difficulty. For example a quarter of patients from an in-patient rehabilitation unit displayed aggressive behaviour at follow-up 6, 24 and 60 months after discharge (Baguley, 2006).

Studies of adults have shown that damage to the frontal area results in recurrent impulsive, aggressive and antisocial behaviour, immature moral reasoning and a poor appreciation for the subjective experience of others (Raine et al., 1994, Brower and Price, 2001, Duncan, Kosmidis & Mirsky, 2003). Interestingly, persistent offenders are often described as impulsive and lacking effective empathy (Colantonio et al., 2007 & Joliffe and Farrington, 2004). This substantial evidence highlights accumulative injuries can impact on the frontal limbic system, which can result in individuals having significant difficulties in managing their behaviour appropriately,

³ The definition of aggression encompasses both verbal and physical aggression against self, objects and other people (Yudofsky, 1986).

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suggesting a possible explanation for the manifestation of aggression in those with
HI: leading to significant problems such as offending behaviour.

A distinction between proactive and reactive aggression can offer an interesting insight into the varying origins of aggression and subsequent offending. Proactive aggression has been characterised as instrumental, organised and “cold-blooded”, with little evidence of autonomic arousal (Dodge, 1991, Meloy, 1988, Mirsky & Siegel, 1994). In contrast, reactively aggressive children tend to have information-processing deficits (Crick & Dodge, 1996, Dodge & Cole, 1987) and has been conceptualised as a fear-induced, irritable, and hostile affect-laden defensive response to provocation (Dodge, 1991, Meloy, 1988, Volavka, 1995), links to a lack of inhibitory functions, reduced self-control, and increased impulsivity (Raine et al., 1998). It has previously been suggested that proactive, not reactive aggression predisposes to offending (Pulkkinen, 1996). Dooley, Anderson et al. (2008) found an adolescent HI group, compared to non-injured controls, were significantly more likely to engage in reactive aggressive behaviours, characterised by emotional lability, inability to tolerate frustration and anger. Aggression was typically in response to provocation, but not purposive, that is, not to display interpersonal dominance or object acquisition. It would appear therefore, injuries to frontal systems, required for executive functions, may alter an individual’s self-regulatory capacity, which could be relevant to the origins of offending.

Post-Concussion Symptoms, Aggression and Crime

As already cited, there is substantial literature exploring some of the long term effects of HI, further studies have found similar findings specific to adult offenders.

Schofield et al. (2006) found 52% of participants reported on-going sequelae as a result of HI. Likewise, Kenny and Lennings (2007) found over half of a YO sample reported continuing PCS after HI. Furthermore, this study demonstrated a significant positive relationship between the number of unconscious episodes and the persistence of symptoms of HI within participants, which suggests a 'dose-response' effect, whereby those with greater frequency of HI experienced greater symptoms.

With numerous risk factors for HI and offending behaviour, it is difficult to determine the nature of the relationship and causality: investigating the link between HI, PCS and offending behaviour, may highlight PCS to be a more reliable indicator of offending than self-report HI. Furthermore, if recognition and treatment of HIs within the youth justice system is currently considered as lacking, then there is a need to further explore the prevalence and potential effects of PCS in the YO population.

Summary and Hypotheses

The literature highlights profound and lasting effects of HI, as well as the high prevalence rate of HI within YO. Consideration should be given to the co-occurrence of other variables within this population such as substance and alcohol misuse, which can be additional risk factors for HI and offending behaviour. Research into PCS has

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shown that HI ought to be viewed as a chronic health condition, with symptoms impacting on an individual's ability to function effectively in their environment.

The research literature focusing on effective interventions and rehabilitation schemes for young offenders is relatively scant. Currently there is little routine neurological rehabilitation for YO. Increased understanding of the interplay between HI, substance misuse, PCS, aggression and offending, could provide scope for identifying at risk groups to direct prevention and intervention strategies. This study aims to explore this multi-faceted area in one YO sample.

Hypothesis 1. Greater dosage of HI (frequency and severity) will be associated with higher levels of PCS.

Hypothesis 2. Greater dosage of HI (frequency and severity) and higher levels of PCS will be associated with higher scores on the measure of reactive aggression; there will be no association with proactive aggression.

Hypothesis 3. Greater dosage of HI (frequency and severity) and higher levels of PCS will be associated with earlier age of first offence, higher total number of convictions and a higher number of previous violent convictions.

Method

Participants

Ninety eight male YOs were recruited from a Young Offenders Institute (YOI) which accommodates males between the ages of 15 and 21 years who have been convicted of an offence. The mean custodial sentence served in this facility is three months. One hundred and five participants were asked to participate, six declined, giving a 94.3% response rate. One participant was excluded due to not meeting the inclusion criteria resulting in a final sample of 98 (93.3% of all those approached). Of those recruited, the age range was 16 to 18 years of age (M 16.87, SD .64). The majority of participants described their ethnicity as White (56.8%).

Inclusion/ Exclusion Criteria

Participants were included if they were male, aged 16-21 years. They were excluded if they had a congenital learning disability, active suicidal ideation, active psychosis, English not as first language, severe visual or hearing impairments which would preclude their ability to complete the tasks and any medical health condition that may affect cognitive functioning, e.g. epilepsy, diabetes⁴.

Design

A between subjects cross sectional design was employed. Participants were recruited using an opportunistic sampling strategy.

⁴ See Appendix 1 point 1

Measures

The following measures were administered:

Head Injury Information

Participants were asked 'Have you ever had a blow to the head causing you to be knocked out, and/ or dazed and confused, for a period of time?' If participants answered yes to this question, severity was recorded by asking the participants to estimate the length of time they experienced being dazed or loss of consciousness (LOC) from: up to five minutes, 5-10 minutes, 10-30 minutes, 30-60 minutes or over 60 minutes⁵. They were also asked to report the frequency of injuries ('Once', 'Twice', 'Three times', 'Four Times' or 'More than four times'). They were also asked their age in years when they had their first and worst injury (worst being the greatest LOC).

Post-Concussion Symptoms

The Rivermead Post-concussion Symptoms Questionnaire (RPSQ, King et al., 1995) is a 16-item self-rating scale measuring post-concussive symptomatology in people with HI. Participants reporting a history of HI use a scale to rate the presence of symptoms over the past 24-hour period⁶. The scale has limitations relating to a

⁵ There are various classification systems for LOC as a measure of severity, in general: up to 10 minutes = mild; 10-30 minutes = considered mild but may be typically admitted into emergency department for observations; 30 minutes- 6 hours= moderate; over 6 hours = severe (e.g. Sanders, 2008 & Williams et al., 2010). For the current study, we further classed the 0-60 minutes banding to grade mild to moderate injuries more effectively. This is in keeping with a number of previous studies in this area i.e. Davies et al., (2012), who demonstrated that greater LOC resulted in more PCS in bands considered as mild HI.

⁶ A scale of 1-5 is utilized ('Not experienced at all'=1 to 'A severe problem'= 5)

Self- Reported Head Injury, Post-Concussion Symptoms and Crime possible lack of specificity due to its absence of clinical cut-offs. However, the measure is considered to have both good reliability and validity (King et al., 2005)⁷ and further research has proposed classification bands for minimal, mild, moderate and severe categories (Potter et al., 2006)⁸. A modified version of this measure was used in this study (Herrmann et al., 2009): four items measure cognitive symptoms (forgetfulness, poor concentration, confusion, difficulty recalling everyday events) and three items measure somatic symptoms (headaches, feelings of dizziness, nausea or vomiting). Mounce et al. (2009) found these items to be more closely related to HI than the remaining 9 items which were more generic symptoms. A further item was added after Mounce et al. (2009) found fogginess to be a good indicator of on-going symptoms of HI. Participants were asked to rate the extent to which they experience each symptom in everyday life and how much it is a problem⁹. The responses were totalled into a single measure of PCS¹⁰.

Criminal Profiles

Total Number of Convictions

Participants were asked what their current conviction was for from a selection of offences (burglary, shoplifting/ theft, violent offences, joyriding, fraud/ deception, drug offences, sexual offences, other). They were then asked to record the frequency of previous convictions they had for these offences (0= none, 1= once, 2= twice, 3= three times, 4= more than three time). The number of convictions was summed to create a Total Convictions score¹¹.

⁷ King et al. (2005) found the scale to have a Cronbach's alpha coefficient of 0.78.

⁸ 0-12, 13-24, 25-32, and 33 or more respectively.

⁹ See Appendix 2.

¹⁰ The reliability of the scale was $\alpha = 0.69$.

¹¹ One missing score n=97

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Age of First Offence

Participants were asked their age when they received their first conviction¹².

Previous Violent Convictions

Participants were asked to indicate the number of previous convictions for violent offences from: 'None' (score 0), 'Once' (score 1), 'Twice' (score 2), 'Three times' (score 3) or 'More than three times' (score 4).

Reactive and Proactive Aggression

Nature of violence was recorded using the 23-item self-report Reactive-Proactive Questionnaire (RPQ, Raine et al., 2006). It includes items designed to assess the frequency of reactive aggression (11 items) and proactive aggression (12 items) in general behaviour¹³. Raine et al., (2006) reported that the RPQ has good internal reliability for reactive aggression ($\alpha=.84$), proactive aggression ($\alpha=.86$), and total aggression (.90), good convergent and divergent validity. It was also reported to have good discriminate validity as the reactive, proactive or total aggression scales do not correlate with non-externalizing behaviour problems¹⁴.

Substance Abuse

¹² Six participants could not recall their age at first offence, n=92 for analysis.

¹³ See appendix 3

¹⁴ One participant refused to answer one item on the proactive aggression subscale, n=97 for all analyses.

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An adapted version of Maudsley Addiction Profile (Marsden et al., 1998)¹⁵ was used to record substance use, as used in Williams et al., (2010). Participants were asked to rate their frequency of use of each drug during their most intense period (0= never, 1= once per year, 2= once per month, 3= weekends, 4= most days, 5= everyday) from a range of drugs (heroin, drugs prescribed for someone else, crack cocaine, amphetamine, ecstasy, cannabis, and other). If participants stated yes to other, they were asked what type of drug and how frequently they used it. These scores were then summed to provide a total drug use score.

Frequency and type of alcohol use were measured using the same frequency scale but with a choice of alcoholic drinks (beer, wine, spirits, alco-pops, cider, and other). The scores were summed to provide an alcohol use score.

Procedure

Ethical approval was granted by the School of Psychology Ethics Committee¹⁶ at the University of Exeter and by the Director of the YOI. The research proposal was sent to the Director and Lead Psychologist at the YOI¹⁷. The researchers met with the Psychology Team at the YOI on a number of occasions to discuss the proposed research and provided training in interview administration and data collection¹⁸.

Following the training, there was a period of observation of data collection to ensure

¹⁵ Internal reliability and feasible concurrent validity assessments of the items in the full Maudsley Addiction Profile were found to be highly satisfactory and test-retest reliability was good (see Marsden et al., 1998).

¹⁶ See Appendix 4

¹⁷ See Appendix 1 point 2

¹⁸ Due to security restrictions and time constraints only one researcher in the team could administer the structured interview, consequently the staff members of the Psychology Team at the YOI assisted with administering these interviews.

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high quality data was being obtained. Participants were recruited to take part in the study when they were on a free period from their educational activities. Either a member of the research team or a member of staff from the Psychology team in the YOI administered the interview to individual participants with one other member of staff from the Psychology team at the YOI present. The interviews took place in a private room, and participants were encouraged to take breaks if necessary. Interviews took approximately 30 minutes¹⁹. After completing the interviews participants were debriefed²⁰ and were given two pounds phone credit as payment for their participation.

¹⁹ See Appendix 1 point 3

²⁰ See Appendix 7

Results

Analysis Strategy

Demographic characteristics for frequency and severity of HI, PCS, offending profiles, reactive and proactive aggression and drug and alcohol use are reported.

Bivariate correlational analyses were undertaken looking at the relationships between the variables as indicated in the hypotheses. A univariate ANOVA was conducted to explore the effect of frequency and severity of HI on PCS, while controlling for the effects of drug and alcohol use, in accordance with H1. H 2 and H3 were tested using hierarchical linear regressions to explore the predictive power of independent variables on the outcomes while controlling for the effect of drug and alcohol use.

Demographic Characteristics

Frequency of Head Injury

Of the sample 73.5% (n=72) reported a history of one or more HI, 25.5% (n=25) experienced one HI, 15.4% (n=15) experienced two HI, 11.2% (n=11) three HI, 4.1% (n=4) four HI and 17.3% (n=17) reported more than four HI²¹.

Severity of Head Injury

Of those who had reported suffering a HI 38.9% (n=28) reported their worst HI to have resulted in being dazed and confused, 34.7% (n=25) reported knock out for less than five minutes, 4.16% (n= 3) unconscious for between 5 and 10 minutes, 12.5% (n=9) 10-30 minutes, 5.6% (n=4) 30-60 minutes, 4.15% (n=3) more than 60

²¹ For all further analysis this variable was dichotomised into no HI or 1 HI (n= 51) and 2 or more HI (n=47) for regression analysis to be undertaken.

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minutes.²² For those who had a HI, 6.1% reported their worst HI involved being knocked out.

Demographics

The mean age of first HI was 11.17 (SD 3.68) and their worst HI was 13.44 years (SD 3.06)²³. The most common cause of participants' worst HI was a fight (50%, n=36), followed by a fall when sober (15.3%, n=11)²⁴.

Post-Concussion Symptoms

The mean post-concussion score was 14.14 (SD 4.29).

Criminal Profile

The mean age of first conviction was 12.98 (SD 2.2). The mean number of convictions was 9.45 (SD 9.05), violent offences were found to be the most common (50%, n=49), followed by burglary (21.4%, n=21), robbery (12.2%, n=12), drug offences (7.1%, n=7), and sexual offences (2%, n=2). The remaining offences were marked as 'other' 7.1%, n=7, and included breach of conditions on release and possession of a firearm.

Thirty one participants had no previous conviction for a violent offence (31.6%), thirty-four had one or two (34.7%) and 33 had three or more (33.7%)²⁵.

²² For all further analysis this variable was dichotomised into no HI (n= 26), dazed and confused (n= 28), LOC up to 10 minutes (n=28) and LOC over 10 minutes (n=16) for regression analysis to be undertaken.

²³ Missing data n=1

²⁴ Other causes of worst HI were: road accident 12.5%, other non-criminal activity 11.1%, sports injury 8.3% and other criminal activity 2.8%.

²⁵ For further analysis total number of convictions was dichotomised into 3 and under convictions (n=24), 4-7(n=27), 8-11 (n=25) and 12 and over (n=22). Previous violent convictions was dichotomised into 0 or 1 (n=50) and 2 or more convictions (n=48).

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Reactive and Proactive Aggression

The mean reactive aggression score was 13.63 (SD 4.49) and mean proactive score was 7.59 (SD 4.49). The two sub scales were significantly positively correlated ($r=.63$, $p<0.01$).

Drug and Alcohol Use

The mean total drug use (excluding cannabis) score was 2.7 (SD 4.23), mean total cannabis score was 4.16 (SD 1.51) and the mean total alcohol use score was 6.48 (SD 4.44). Fifty nine participants claimed they never used drugs (excluding cannabis) (60.2%), whereas only nine participants stated they never used cannabis (9%). Of the listed drugs which excluded cannabis, the most frequently used drug was cocaine, with thirty nine participants reported using it (37.8%). Fourteen participants reported never using alcohol (14.3 %) and spirits were reported as being used the most frequently, forty two participants reporting using it on weekends (42.9%).

Bivariate Simple Correlations

Simple correlations were undertaken between the following variables (see table 1): severity of head injury, frequency of head injury, post concussive symptoms, reactive aggression, proactive aggression, age of first conviction, total convictions, previous violence, total drug use (excluding cannabis), cannabis use and alcohol use.

Hypothesis 1. Greater dosage of HI (frequency and severity) will be associated with higher levels of PCS.

Both severity of HI and frequency of HI were significantly positively associated with PCS ($r=.38$, $p<0.01$, $r=.27$, $p<0.01$, respectively) as predicted.

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Hypothesis 2. Greater dosage of HI (frequency and severity) and higher levels of PCS will be associated with higher scores on the measure of reactive aggression; there will be no association with proactive aggression.

Both severity of HI and frequency of HI were significantly positively associated with reactive aggression ($r=.23$, $p<0.05$, $r=.25$, $p<0.05$, respectively) and not to proactive aggression, as hypothesised. Increasing reactive aggression was also positively associated with increasing PCS ($r=.39$, $p<0.01$). Contrary to the hypothesis, proactive aggression was positively correlated to PCS ($r=.23$, $p<0.05$).

Hypothesis 3. Greater dosage of HI (frequency and severity) and higher levels of PCS will be associated with earlier age of first offence, higher total number of convictions and a higher number of previous violent convictions.

Increasing PCS was negatively correlated to age of first conviction ($r=-.25$, $p<0.05$), positively correlated to total number of convictions ($r=.33$, $p<0.01$) and previous violence ($r=.31$, $p<0.01$). However, greater dosage of HI (severity and frequency) was not significantly correlated with any indicators of crime, contrary to predictions.

Alcohol and Drug Usage

Drug use (excluding cannabis) was positively correlated with frequency of HI ($r=.22$, $p<0.05$), PCS ($r=.38$, $p<0.01$), reactive aggression ($r=.33$, $p<0.01$), total convictions ($r=.28$, $p<0.01$), previous violence ($r=.21$, $p<0.0$) and negatively correlated with age of first convictions ($r=-.35$, $p<0.01$). Cannabis use was positively correlated with proactive aggression ($r=.31$, $p<0.01$) and negatively correlated to age of first conviction ($r=-.22$, $p<0.05$). Alcohol use was positively correlated with severity of HI ($r=.29$, $p<0.01$), PCS ($r=.21$, $p<0.0$), total convictions ($r=.32$, $p<0.01$) and negatively correlated to age of first conviction ($r=-.34$, $p<0.01$).

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Table 1.*Bivariate Correlations (Pearson's) n=98*

	Severity of Head Injury	Frequency of Head Injury	Post-Concussion Symptoms	Reactive Aggression	Proactive Aggression	Age of First Conviction	Total Convictions	Previous Violence	Total Drug Use (excl Cannabis)	Cannabis Use	Alcohol Use
Severity of Head Injury	1	.58**	.38**	.23*	.11	-.20	.18	.11	.15	-.07	.29**
Frequency of Head Injury		1	.27**	.25*	.10	-.14	.05	-.00	.22*	-.01	.10
Post-Concussion Symptoms			1	.39**	.23*	-.25*	.33**	.31**	.38**	.11	.21*
Reactive Aggression				1	.65**	-.24*	.20	.08	.33**	.31	.15
Proactive Aggression					1	-.07	.20*	.06	.08	.31**	.09
Age of First Conviction						1	-.55**	-.40**	-.35**	-.22*	-.34**
Total Convictions							1	.58**	.28**	.19	.32**
Previous Violence								1	.21*	.11	.13
Total Drug Use (excl Cannabis)									1	.33**	.39**
Cannabis Use										1	.20*
Alcohol Use											1

*p<.05 **p<.01

Inferential Analysis

Hypothesis 1. Greater dosage of HI (frequency and severity) will be associated with higher levels of PCS.

To explore hypothesis 1 a Univariate Analysis of Variance was used to explore the effect of frequency and severity of HI on PCS whilst entering the total alcohol use, total drug use (excluding cannabis), and total cannabis use variables as covariates to control for their effects.

There was a significant main effect for frequency of HI ($M=.48$, $SD=.50$), $F(1, 93)= 4.10$, $p<0.05$. Those who had experienced two or more HIs scored significantly higher on the PCS compared with those with one or no HIs . There was a significant main effect for severity of HI ($M=1.35$, $SD=1.05$), $F(3, 91)= 5.39$, $P<0.01$. Of all the covariates only drugs (excluding cannabis) ($M=2.68$, $SD=4.23$) had a significant effect on the PCS, $F(1, 93)= 8.09$, $P< 0.01$. When controlling for this, the IVs still had a significant effect on PCS scores (See table 2).

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Table 2

Descriptive Statistics for Each of the Variables used in the ANOVA for Hypothesis 1

Variable	N	Mean	SD
Frequency			
No HI or 1 HI	51	13.04	3.76
2 or more HIs	47	15.34	4.54
Severity			
No HI	26	12.19	3.05
Dazed and confused	28	13.79	3.51
LOC up to 10 minutes	28	14.32	4.51
LOC over 10 minutes	16	17.63	4.98

Hypothesis 2. Greater dosage of HI (frequency and severity) and higher levels of PCS will be associated with higher scores on the measure of reactive aggression; there will be no association with proactive aggression.

To explore H2 a hierarchical linear regression was conducted, with the dependent variable being reactive aggression. The drug and alcohol variables were entered into the first step to control for their effect on the DV. The variables PCS, frequency of HI and severity of HI were entered as the predictors for step 2. Following the correlation analysis, proactive aggression was not significantly correlated with the HI or PCS variables and thus excluded from the regression analysis.

As hypothesised PCS scores were a significant predictor of reactive aggression, However, HI (severity and frequency) were not (see table 3). Total cannabis use was also a significant predictor of reactive aggression.

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Table 3

Summary of Regression Analysis for Hypothesis 2 (reactive aggression)

Variable	B	SE (B)	β
Step 1			
Constant	10.09	1.31	
Total alcohol use	0.01	0.10	.01
Total drug use (excl cannabis)	0.26	0.11	.25*
Total cannabis use	0.67	0.30	.23*
Step 2			
Constant	5.63	1.81	
Total alcohol use	-0.03	0.10	-.03
Total drug use (excl cannabis)	0.13	0.11	.12
Total cannabis use	0.76	0.28	.26**
PCS	0.27	0.11	.27**
Frequency of head injury	1.00	1.00	.11
Severity of head injury	0.31	0.52	.07

Note $R^2 = .16^{**}$, $\Delta R^2 = .11^*$, $F = 5.76^{**}$, $\Delta F = 4.50^*$, Model (F) = 5.45**. * $p < .05$ ** $p < .01$

Although there was no relationship between proactive aggression and HI at the univariate level, there was a relationship between proactive aggression and PCS. Therefore, equivalent analysis was done with proactive aggression as the dependent variable. As hypothesised, PCS scores and HI (frequency and severity) were not significant predictors of proactive aggression (see table 4). However, total cannabis use was a significant predictor of proactive aggression.

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Table 4

Summary of Regression Analysis for Hypothesis 2 (proactive aggression)

Variable	B	SE (B)	β
Step 1			
Constant	3.59	1.39	
Total alcohol use	0.05	0.11	.05
Total drug use (excl cannabis)	-0.05	0.13	-.05
Total cannabis use	0.93	0.31	.31**
Step 2			
Constant	0.26	1.99	
Total alcohol use	0.01	0.11	.01
Total drug use (excl cannabis)	-0.14	0.13	-.13
Total cannabis use	0.97	0.31	.33**
PCS	0.23	0.12	.21
Frequency of head injury	0.32	1.10	.04
Severity of head injury	0.21	0.57	.05

Note $R^2 = .10^*$, $\Delta R^2 = .05^{***}$, $F = 3.30^*$, $\Delta F = 1.91^{***}$, Model (F) = 2.65*. * $p < .05$ ** $p < .01$

*** $p > .05$

Hypothesis 3. Greater dosage of HI (frequency and severity) and higher levels of PCS will be associated with earlier age of first offence, higher total number of convictions and a higher number of previous violent convictions.

To explore hypothesis 3 a hierarchical linear regression was conducted, with the dependent variable being total number of convictions. The drug and alcohol variables were

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entered into the first step to control for their effect on the DV. The variables PCS, Frequency of HI and Severity of HI were entered as the predictors for step 2.

As hypothesised PCS scores were a significant predictor of total number of convictions.

However, HI (severity and frequency) were not (see table 5).

Table 5

Summary of Regression Analysis for Hypothesis 3 (total number of convictions)

Variable	B	SE (B)	β
Step 1			
Constant	1.71	0.33	
Total alcohol use	0.06	0.03	.24*
Total drug use (excl cannabis)	0.04	0.03	.15
Total cannabis use	0.06	0.07	.08
Step 2			
Constant	0.09	0.47	
Total alcohol use	0.05	0.03	.20
Total drug use (excl cannabis)	0.02	0.03	.09
Total cannabis use	0.07	0.07	.09
PCS	0.06	0.03	.23*
Frequency of head injury	-0.24	0.26	-0.11
Severity of head injury	0.10	0.13	.09

Note $R^2 = .14^*$, $\Delta R^2 = .06^{**}$. $F = 4.97^*$, $\Delta F = 2.22^{**}$. Model $F = 3.69^*$. * $p < .05$, ** $p > .05$

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Equivalent analysis was done with previous violent convictions as the dependent variable. As hypothesised PCS scores were a significant predictor of previous violent convictions.

However, HI (severity and frequency) were not (see table 6).

Table 6

Summary of Regression Analysis for Hypothesis 3 (previous violent convictions)

Variable	B	SE (B)	β
Step 1			
Constant	0.34	0.16	
Total alcohol use	0.01	0.01	.05
Total drug use (excl cannabis)	0.02	0.01	.18
Total cannabis use	0.01	0.04	.04
Step 2			
Constant	-0.04	0.23	
Total alcohol use	0.00	0.01	0.01
Total drug use (excl cannabis)	0.01	0.01	.11
Total cannabis use	0.02	0.04	.04
PCS	0.03	0.01	.27*
Frequency of head injury	-0.14	0.12	-.14
Severity of head injury	0.03	0.06	.07

Note $R^2 = .05^{**}$, $\Delta R^2 = .07^{**}$. $F = 1.62^{**}$, $\Delta F = 2.44^{**}$, Model (F) = 2.07^{**}. * $p < .05$, ** $p > .05$

Equivalent analysis was done with age of first convictions as the dependent variable. PCS scores and HI (frequency and severity) were not significant predictors of age of first conviction (see table 7).

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Table 7

Summary of Regression Analysis for Hypothesis 3 (age of first conviction)

Variable	B	SE (B)	β
Step 1			
Constant	14.55	0.66	
Total alcohol use	-0.11	0.05	-.22*
Total drug use (excl cannabis)	-0.12	0.06	-.23*
Total cannabis use	-0.13	0.15	-0.09
Step 2			
Constant	15.33	0.97	
Total alcohol use	-0.09	0.06	-.19
Total drug use (excl cannabis)	-0.10	0.06	-.19
Total cannabis use	-0.15	0.15	-.10
PCS	-0.05	0.06	-0.09
Frequency of head injury	0.03	0.53	0.01
Severity of head injury	-0.18	0.28	-0.08

Note $R^2 = .18^{**}$, $\Delta R^2 = .02^{***}$. $F = 6.33^{**}$, $\Delta F = 0.58^{***}$. Model (F) = 3.41^{**}. * $p < .05$, ** $p < .01$.

To further control for alcohol and drug use in the relationship with age of first conviction, a hierarchical stepwise regression was also run with total drug use (excluding cannabis) entered into the first step, total alcohol use entered into the second step and the remaining variables (PCS, frequency and severity of HI) entered in the third step. There was no real difference in this analysis therefore only the hierarchical linear regression is reported here²⁶.

²⁶ See appendix 8

Discussion

In line with previous research, the current study found that 73.5% of YO's reported suffering a HI, which is considerably higher than the general population (Williams et al., 2010; Schofield et al, 2006 and Slaughter, Fann & Ehde, 2003). Half of the participants' reported a LOC from their worst HI and 47.9 % reported suffering more than one HI. As hypothesised, there was a significant main effect for dosage of HI (frequency and severity) on PCS: those with more severe and frequent HIs scored higher on the PCS scale. The results showed significant predictors were as hypothesised, PCS was a significant predictor of reactive aggression, total number of convictions and number of previous violent convictions. However, a number of anticipated predictors were not found to be significant (dosage of HI was not found to be a significant predictor of reactive aggression or any of the criminal profiles measured and PCS was not a significant predictor of age of first conviction).

PCS as an Indicator of HI

Previous research has shown that injuries involving a LOC and repeat HIs can result in long term negative consequences (Williams et al, 2010). Consistent with previous work by Kenny et al (2007), the severity of PCS increased with greater frequency and severity of HIs. This is suggestive of a dose-response effect of HI on PCS (modified from the RPSQ, King et al, 1995).

Previous studies have suggested that PCS cannot be used as a reliable replacement measure of HI (Smith-Seemiller et al, 2003). However, the findings from this study suggest that measures of PCS can provide a useful tool in distinguishing HI sufferers from controls. The

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positive linear relationship between increasing frequency and severity of HI with severity of PCS suggests the modified RPSQ differentiates between degrees of HI and is sensitive to picking up the on-going subtle symptoms of HI.

It has been suggested that particular subsets of PCS have better discriminatory power in determining severity of HI; namely items measuring somatic and cognitive symptoms (Moran et al, 2011 and Ayr et al, 2009). The short form RPSQ (Herrmann et al, 2009) used in this study was a good indicator of on-going symptoms of HI, lending further support to this.

However, the internal reliability of the scale could be greater ($\alpha = 0.69$), it would be wise therefore to attempt to replicate the findings in future.

Drug use (excluding cannabis) had a significant effect on PCS. Research suggests substance use and HI are highly co-morbid (Schofield et al, 2006; Peron and Howard, 2008). This study found a relationship between substance use and the on-going symptoms of HI, but causality cannot be established. Lubman, Yucci and Hall (2007) suggested drug use can serve as a risk factor for acquiring a HI, yet could also be used to cope with the on-going PCS post HI. It is worth emphasising in this study the relationship between HI and PCS remained significant after controlling for the effects of drug and alcohol use. Consequently, the PCS reported were unlikely to be the result of alcohol or drug usage.

PCS, HI and Aggression

PCS was a significant predictor of reactive aggression. Previous literature has highlighted individuals with HI have an increased risk of aggression, diminished ability to regulate behaviour and impulsivity (Hux et al., 1998, Tateno, 2003 & Leon-Carrion and Ramos,

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2003), all of which are features of reactive aggression (Raine et al., 1998)²⁷. The current results extend previous literature by linking PCS scores with reactive aggression offering a possible indicator for future difficulties in functioning.

PCS scores could be associated with reactive aggression in a number of ways. Evidence exists to support the presence of neural damage leading to brain dysfunction in PCS, which can cause cognitive and behavioral maladjustment (Yeates and Taylor, 2005). It is also worth noting there is some debate as to whether PCS are related to a psychological response to the HI, i.e. depression, anxiety, chronic pain, and PTSD (Suhr & Gunstad, 2002, Less-Haley et al., 2001 and Mittenberg et al., 1997). These difficulties may have an impact on mood and behaviour, manifesting reactive aggression. A bio-psycho-social approach may offer a better understanding of the on-going difficulties faced by HI sufferers (Williams, Potter & Ryland, 2010). Future studies could combine the measurement of PCS, neuro-cognition, mental health and reactive aggression in YOs to explore potential relationships further.

An influential theory for understanding the relationship between cognition and emotion was developed by Damasio (1994, 1999). According to this theory, cognitive representations interact with internal representations of relevant emotional state. Emotional states, termed ‘somatic markers’, serve the purpose of allocating and maintaining the limited resources of attention in working memory (Damasio, 1994). Following pre-frontal cortex injury, a person may fail to recognise emotional significance in the actions of others, or take account of such significance in planning their responses. Damasio (1999) suggests that deficits in decision making and planning relative to social knowledge, which are commonly observed in pre-

²⁷ Reactive aggression is derived from the frustration-aggression hypothesis (Berkowitz, 1993, as cited in, Hubbard et al, 2002) whereby high emotional arousal (threat, vulnerability for example) is experienced as a result of perceived frustration or provocation, culminating in an aggressive response.

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frontal injury, are caused by an inability to respond emotionally to thoughts. This provides further understanding into the link found in the current study between reactive aggression and the on-going symptoms of HI. Turkstra (2003) proposed that those who have suffered a HI may misperceive elements of a situation (such as not reading the emotions of others effectively and perceiving threat where there was none), make poor social judgements which can lead to behaving inappropriately and lack communication skills to negotiate conflict. This could manifest itself as reactive aggression towards others.

This study found reactive aggression was significantly correlated with frequency of HI. However, further analysis using multiple linear regression showed the predictive power of the PCS on reactive aggression to be strong, resulting in the frequency of HI and reactive aggression relationship becoming insignificant. This provides further support for the use of PCS in predicting outcomes.

HI variables were not found to be significant predictors of reactive aggression. This could be seen a result of the significant positive correlation between frequency of HI and drug use (excluding cannabis) and severity of HI with alcohol use. Kenny et al (2007) offered an explanation for the relationship between HI and violent offending such that HIs increase dishinhibition of aggressive impulses, especially in the presence of harmful/ hazardous alcohol use, which raises the risk of severe violence within the offence pattern. It may be possible that HI is not a significant marker in the context of the drug and alcohol variables and perhaps PCS are more sensitive to the overall deficits related to HI and aggressive behavior; clearly further research is needed to clarify these relationships. In short, the current study supports a multi-factor model, whereby alcohol/ drug use and HI combine to influence outcomes in YO.

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Further analysis found cannabis use was predictive of reactive aggression, which was not hypothesised due to cannabis generally being reported as having a pacifying effect (e.g. Green et al., 2004). Williams et al (2010) found frequent cannabis use in a sample of YO with HI, but reactive aggression was not measured in this study. The current study also found high rates of cannabis use with only 9% of the sample claiming they have never used cannabis. This suggests that cannabis use is almost normative within the YO sample used in the current study and cannot be used to reliably distinguish between offenders with and without HI or to predict reactive aggression, given that nearly all participants are using cannabis.

As hypothesised, proactive aggression was not predictive of HI. However, proactive aggression was related to PCS at a univariate level, but further analysis found there was no significant relationship between PCS, proactive aggression and HI. This supports the literature that suggests those with HIs are more likely to engage in reactive aggressive behaviour (Dooley, Anderson et al, 2008). Furthermore, when controlling for drug and alcohol use in the analysis, cannabis use was found to be predictive of proactive aggression. There are difficulties in offering an explanation for this relationship when considering the apparent lack of literature covering this issue. Given causal direction is not known and levels of cannabis use are relatively high in this population perhaps people high on proactive aggression use cannabis to 'calm' them down? This is an unexpected relationship and further research is needed to explore it, using a sample with greater variation in cannabis use.

PCS, HI and Offending

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Previous work has found a relationship between HI and worse offending profiles (Perron & Howard, 2008 & Williams et al., 2010). Although, frequency and severity of HI were not found to be significant predictors of worse offending profiles in this study, PCS were found to be a significant predictor of total number of convictions and previous violent convictions. It is possible; PCS is a more sensitive indicator of on-going symptoms post HI and offending.

Age of first conviction was not predicted by PCS or HI, however, drug use (not including cannabis) and alcohol use were almost significant predictors of age of first conviction and alcohol use was almost a significant predictor of total number of convictions: a larger sample size may have led to significant findings. Alcohol and substance use are thought to influence offending behavior: Lubman, Yucci and Hall, (2007) suggested HI and substance misuse may reduce inhibition of inappropriate responses, leading to an increase in aggressive offences.

Previous studies have suggested a link between reactive and proactive aggression and criminal behaviour (Brower and Price, 2001; Raine et al, 2006; Pulkkinen, 1996). However, although there was a significant positive correlation between proactive aggression and total number of convictions and a significant negative correlation between reactive aggression and age of first offence at a univariate level, in the current study, they were not predictive of offending at a multivariate level. It is possible that reactive and proactive aggression are better able to distinguish offenders from non-offenders rather than within offender groups. Unfortunately the lack of a control group using a community sample prevented further exploration of this. It is also possible the measures of offending used in this study lacked specificity and sensitivity to detect subtle differences in violent offending. Cornell et al, (1996) developed a coding system to categorise offences as instrumental (proactive) or

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reactive. The use of such a tool may have been better at revealing relationships between each aggression subtype and violent offending.

Additional Limitations

A common limitation of research in this area is the cross-sectional nature of this study which prevents causal links from being drawn. The study appears to indicate that PCS are significantly associated with HI (Yeates and Taylor, 2005). PCS was a strong predictor of reactive aggression; as such the direction of causality could be seen to flow from on-going impacts of HI to reactive aggression. However, it is impossible to rule out alternative explanations for the observed associations. An additional suggestion proposes this group of young people may already be vulnerable to a number of precipitating factors such as trauma, attachment issues and substance use (e.g. Turkstra, Jones & Toler, 2003 & Fazel, Bains & Doll, 2006). These may impair recovery from HI and account for some of the on-going symptoms they experience. However, drugs and alcohol use were controlled for in this study as one of the possible influencing factors and the observed associations remained. Further research is needed to explore the impact of co-variables.

Accounts were retrospective self-reports, which risk report biases. The inclusion of other sources of information to corroborate the reports was not possible due to the limited resources and time constraints. However, there is a body of evidence to support the usefulness of self-report: Schofield, Butler, Hollis and D'Este (2011) found self-report of HI was similar in accuracy to hospital records in a group of prisoners. Furthermore, Jolliffe et al. (2003) demonstrated that the validity of self-reports of offending was high when they undertook a prospective longitudinal survey of 808 youths comparing annual court referral

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data to self-reported data. Future research would do well to collect collateral information to address weaknesses inherent in self-reports.

An additional limitation of the study that often plagues research in this area is it lacks a control group for comparison for rates of HI in non-offenders. However, Farrer & Hedges (2011)²⁸ recently conducted a meta-analysis of HI in YO, mostly males. In the studies they identified as having control groups, they calculated YO were significantly more likely to have a HI than controls, suggesting this may be a robust finding.

Implications

This study found high rates of PCS could offer markers for reactive aggression and offending behaviour. If longitudinal research was to replicate these findings, interventions to address the on-going sequelae post HI, would be well placed. Assessment of PCS after HI may become an integral part of decision making regarding further assessment and intervention for young people. These symptoms may offer indicators of the subtle signs of HI that could be missed when compared with those who may have moderate to severe HIs typically associated with more obvious neuropsychological deficits (Stamrook et al., 1990). The ability to classify severity of HI, particularly mHI, from PCS presentation may be beneficial to clinical care and research. Neuroimaging or neuropsychological evaluation is uncommon following mHI unless complications are indicated. Improved monitoring and management of HI and related symptoms in the immediate period following the incident could dramatically influence development in adolescence (Williams et al., 2010).

²⁸ Farrer & Hedges (2011) found the majority of studies related to males only. They identified four studies without control groups and five with.

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At present PCS have a growing evidence base, but are still classed as a crude tool to differentiate injury severity (Ponsford et al., 2000). Many young people with mHI with LOC would be misclassified as low-severity mHI or not identified at all, failing to be followed up. Classification accuracy needs to be increased before PCS can be used clinically to diagnose mHI and identify markers for poor outcomes, such as reactive aggression: it is an important area for development, (Moran et al, 2011)²⁹.

The current study supports previous research findings of high rates of HI within adult and adolescent prison populations (Schofield et al., 2006). It had long been recognised there was a lack of standardised HI screening for YO (e.g. Williams et al., 2010). It is encouraging to see the recent introduction of the Comprehensive Health Assessment Tool (2012) for YO includes HI. However, in light of the current findings; the inclusion of a PCS measure (such as the modified RPSQ scale used in the current study, Herrmann et al., 2009) could be indicated. This could offer further improvements in identifying individuals who could benefit from interventions targeting the impact of their on-going symptoms of HI³⁰.

Adolescents are recognised to engage in more risky behaviours than children and adults (Steinberg, 2008). A dual systems model which provides some insight into this proposes that risky behaviour in adolescents is the product of the lack of synchrony in the development of two of the critical brain systems that enable fully adaptive behavior (Steinberg, 2008).

Adolescent risk-taking is hypothesized to be stimulated by a rapid development of the socio-

²⁹ See Appendix 9 point 1

³⁰ See Appendix 9 point 2

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emotional system around the time of puberty, which is presumed to lead to increases in reward seeking. This system develops rapidly compared to the other systems that regulate and control behaviour. The teenage brain, therefore, has an adult-like ability to reason, but with a heightened need for basic reward, and a lowered capacity to buffer immediate influences and potential short-term rewards for greater, longer-term gains. This creates a period of heightened vulnerability to risk-taking during middle adolescence (Steinberg, 2008). This offers insight into understanding some of the possible explanations for why adolescents are at risk of HIs and aggressive/ offending behavior. There are potential benefits to raising awareness and addressing these neuro-developmental changes in young people in relation to prevention and rehabilitation strategies.

Evidence here supports previous findings of increased drug and alcohol use in YOs and higher usage in those with a history of HI (Schofield et al., 2006). This highlights the need for targeted interventions to address the substance use within YOs. YOIs may present a good setting to introduce these interventions as it offers a structured environment for those who may not have received or sought such support in the community. Deficits with attention or memory related to HI would need to be considered when delivering such interventions (Alderman & Knight, 1997). Furthermore, the current findings suggest interventions need to consider the specific function substance use has played in relation to HI and offending: i.e. has it served as a risk factor in acquiring a HI and/or was it used as a means of self-medicating the undesirable PCS, this consideration may increase success of the interventions (for example, offering psycho-education on alternative coping strategies to problems such as chronic pain).

Conclusions (for dissemination statement, see Appendix 10)

In summary, the findings of this study suggest HI leads to PCS which is a significant predictor of reactive aggression and worse offending profiles (total number of convictions and previous violent crime), in a sample of YOs. These findings indicate a number of areas for intervention before, during and after a young person has been imprisoned. A combination of further exploration of the use of PCS as a measure to differentiate levels of impairment and serve as a marker for continuing problems as well as introducing more thorough assessment, screening and monitoring of HI symptoms throughout health and criminal justice systems would be beneficial. Such action could highlight appropriate interventions, which could act to reduce crime and improve levels of functioning.

Conflict of Interest

None of the authors have conflict of interests or financial disclosures.

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Appendices

Word count: 5393

Appendix 1 – Extended Method**Point 1**

This study was part of a larger study using the same participants, but further exclusion criteria were required. Those with neurodevelopmental difficulties were also excluded from the study. Neurocognitive and social cognitive data was collected to explore the links between executive functioning, emotional recognition skills, HI and crime

Point 2

All staff from the YOI involved in data collection agreed to abide by the ethical requirements of the project, for example: maintaining confidentiality; storing consent forms separately from response sheets in locked facilities; and reassuring participants that specific information regarding their criminal pasts was not required and they could not therefore be further reprimanded for offences previously undeclared.

Point 3

A participant information sheet³¹ was provided for participants who expressed an interest in the study. Written consent to participate was obtained via completion of a consent form³². Owing to difficulties in obtaining consent from individuals aged below 16 years of age it was decided to limit the age of participants to 16 years and over. Participants were given the option to indicate if they wished to receive a summary of the findings by letter. Participants who completed the self-report measures for this study were asked if they would be willing to complete part two of the research programme. A presentation of findings to the YOI staff involved in data collection was planned as part of the dissemination process.

³¹ See Appendix 5

³² See Appendix 6

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Appendix 2

Rivermead Post-concussions Symptoms Questionnaire- Adapted Version (Herrmann et al, 2009).

Please rate the extent to which you experience the following symptoms in everyday life, and how much they are a problem for you.

	I do not experience it	Not much of a problem	A mild Problem	A moderate problem	A severe problem
Headaches	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Feelings of dizziness	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Nausea and/or vomiting	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Forgetfulness, poor memory	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Poor concentration	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Confusion	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Fogginess (groggy feeling)	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Difficulty recalling everyday events	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>

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Appendix 3

The Reactive-Proactive Aggression Questionnaire (Raine et al., 2006)

Instructions: There are times when most of us feel angry, or have done things we should not have done. Rate each of the items below by putting a circle around 0 (never), 1 (sometimes), or 2 (often). Do not spend a lot of time thinking about the items – just give your first response. Make sure you answer all the questions.

How often have you...

	Never	Sometimes	Often
1. Yelled at others when they have annoyed you	0	1	2
2. Had fights with others to show who was on top	0	1	2
3. Reacted angrily when provoked by others	0	1	2
4. Taken things from other people	0	1	2
5. Gotten angry when frustrated	0	1	2
6. Vandalised something for fun	0	1	2
7. Had temper tantrums	0	1	2
8. Damaged things because you felt mad	0	1	2
9. Had a gang fight to be cool	0	1	2
10. Hurt others to win a game	0	1	2
11. Become angry or mad when you don't get your way	0	1	2
12. Used physical force to get others to do what you want	0	1	2
13. Gotten angry or mad when you lost a game	0	1	2
14. Gotten angry when others threatened you	0	1	2
15. Used force to obtain money or things from people	0	1	2
16. Felt better after hitting or yelling at someone	0	1	2
17. Threatened and bullied someone	0	1	2
18. Made obscene phone calls for fun	0	1	2
19. Hit others to defend yourself	0	1	2
20. Gotten others to gang up on someone else	0	1	2
21. Carried a weapon to use in a fight	0	1	2
22. Gotten angry or mad or hit others when teased	0	1	2
23. Yelled at others so they would do things for you	0	1	2

Appendix 4 - Ethical Approval

Psychology Research Ethics
Committee

Psychology, College of Life
& Environmental Sciences

Washington Singer Laboratories
Perry Road
Exeter
EX4 4QG

Telephone +44 (0)1392 264626
Fax +44 (0)1392 264623
Email Marilyn.evans@exeter.ac.uk

To: Emma Hodges & Hannah Meadham
From: Cris Burgess
CC: Huw Williams & Avril Mewse
Re: Application 2010/165 Ethics Committee
Date: May 3rd 2011

The School of Psychology Ethics Committee has now discussed your application, **2010/165 – *The association between TBI, social cognition and violent offending in young offenders.*** The project has been approved in principle for the duration of your study.

The agreement of the Committee is subject to your compliance with the British Psychological Society Code of Conduct and the University of Exeter procedures for data protection (<http://www.ex.ac.uk/admin/academic/datapro/>). In any correspondence with the Ethics Committee about this application, please quote the reference number above.

I wish you every success with your research.

A handwritten signature in black ink, appearing to read 'Cris Burgess', with a horizontal line underneath.

Cris Burgess
Chair of Psychology Research Ethics Committee

Appendix 5 – Participant Information Sheet**What is the relationship between head injury, social cognition and offending behaviour?**

You are being invited to take part in a research study, whether you have or have not experienced a head injury (HI) in the past. The research will investigate the impact that HI has on social processes, offending behaviour and general wellbeing. As part of this we will also look at the effect of HI on other brain functions, such as attention, and explore whether there is a link between these functions and the social processes we will measure. We will also explore the effect of HI on conviction rates and whether a HI affects the severity of violence of the convictions (for more detail read below).

This research is being conducted as part of our Clinical Psychology degree, which we are studying at the University of Exeter.

Taking part in this study is completely voluntary. Please could we ask you to take some time to read the following information to help you decide whether or not you would like to take part. You may want to talk to other people before making a decision. Please feel free to ask if you have any questions or would like to know more. You can also contact us by email at any time to ask more questions: [appropriate email to be inserted]. Our address is [appropriate address to be inserted].

Thank you for taking time to read this.

What is the research about?

Research suggests that a HI may make it difficult to understand what other people are thinking or feeling (this is what we mean by social processes). A HI may also affect other brain functions such as memory and attention. We are interested in whether problems in these areas are linked with committing crime and potentially more violent crimes. We will also be exploring whether HI is related to general wellbeing and family background.

Why have I been chosen?

You have been chosen because you are in custody for committing a crime. You may or may not have had HI. We are particularly interested in this topic in young males which is why you are a suitable candidate.

Do I have to take part?

No, you do not have to take part. This is entirely your choice.

If you do decide to take part, you will be given this information sheet to keep and will be asked to sign a consent form. You can contact us if you have further questions. You will still be able to stop taking part in the research at any time without having to give a reason. This

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will not affect the care you receive.

What will happen to me if I do take part?

One part of the study will involve filling in some questionnaires, which should take about 30 minutes. Another part of the study will involve some paper based tasks to explore the functions mentioned earlier in this information sheet. These will take about 40 minutes, but you will be able to take breaks if you need to. We will also need to access your Asset records for information about where you have lived before X, you can let us know if this is ok if you agree to take part in the study.

What are the possible disadvantages and risks of taking part?

There is a small risk that some people may become upset if they find it hard to complete some of the tasks or answer some of the questions. However, let us assure you that you will not be judged on how well you perform, and all results will be kept anonymous and confidential. You can withdraw from the study at any time and if you would like to talk things through either during or after the study, we would be happy to arrange this. We have conducted many studies like this before and have found that few people become upset in the process. Rather, the main disadvantage of taking part is the time involved.

Will I have to travel a long way to take part?

If you want to take part the staff from X will help you to get involved.

What are the potential benefits in taking part?

We hope that the information gathered in this research may be used in the future to inform the rehabilitation of people who have had a HI and may be at risk of committing a crime for the first time or re-offending. It will also inform us about young people's general wellbeing after a HI and having been convicted of a crime, which could help provide better care for people in your situation.

Will my taking part in the study be confidential?

We will follow ethical and legal practice and all information about you will be handled in confidence. Your name will be removed from any information collected from you during the sessions and all records will be given a code to maintain confidentiality. Any documents that do contain identifying information (e.g. names) will be securely stored separately from your responses. Your name will not be used in the writing up of the results. When your responses are entered onto a laptop at X they will be anonymous. When this laptop is taken away from X back to University of Exeter your responses will still be anonymous.

What will happen to the results of the research study?

The results will be written up by us as part of our degree research. It may be published in academic journals or presented at conferences for psychology professionals. Your identity will not be revealed in any report, publication or presentation.

If you would like to know the outcome of the research we would be happy to send you this in

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written form when the study is complete.

What if something goes wrong?

If you have a concern about any aspect of this study, you can talk to the staff from the psychology department who will do their best to answer your questions (see email address above). If you are still unhappy and wish to complain formally, you can do this through the Serco Complaints Procedure. Details can be obtained from Sian Murphy, Forensic Psychologist in Training.

Who is organising or funding the research?

The research is being sponsored by the University of Exeter.

Who has reviewed the study?

This research project has been reviewed and approved by the University of Exeter. All research conducted by Clinical Psychology students is looked at by an independent group of people, called a Research Ethics Committee, to protect your safety, rights, wellbeing and dignity. This study has been reviewed and given favorable opinion by the University of Exeter Research Ethics Committee and cleared by X's Research Ethics Committee (pending).

We will be leading the research under the supervision of Dr Williams and Dr. Mewse at the University of Exeter.

Thank you for taking the time to read this information sheet.

Emma Hodges and Hannah Meadham

Contact details: W.H.Williams@exeter.ac.uk. or A.J.Mewse@exeter.ac.uk

All of the above can be contacted by post at:

School of Psychology, Washington Singer Laboratories, Streatham Campus, University of Exeter, Exeter, EX4 4QG

Appendix 6**Consent Form**

Taking part in this study will involve completing a short questionnaire beforehand and a number of computerized and paper tasks with the researchers. The assessment should take around 90 minutes. If you are happy to participate please read the statements below:

- I agree to allow the data collected during my participation in this research project to be used, understanding that I am doing so voluntarily and that confidentiality will be maintained.
- I agree for the researchers to gain access to my ASSET records at Ashfield regarding my background information.
- I agree to the researchers providing a brief summary of my results during this assessment to the Psychology Department within Ashfield.
- By completing the assessment, I give my informed consent to participate in this study. I have read and understood the information sheet and consent form.

Signature

Print Name

Date

Questions or concerns about the study can be addressed to:

Dr. Huw Williams (Research Supervisor), phone Number: 01392 724661, email: W.H.Williams@exeter.ac.uk

Dr. Avril Mewse (Research Supervisor), phone Number: 01392 724596, email: A.J.Mewse@exeter.ac.uk

Dr Lousie Pendry (Chair of Ethics Committee)

All of the above can be contacted by post at:

School of Psychology, Washington Singer Laboratories, Streatham Campus, University of Exeter, Exeter, EX4 4QG

Note: Participants' should be asked to sign two copies of this form, one for their own records and one for those of the researcher.

Appendix 7**Debriefing Form**

[Date]

Thank you for participating in this study. Your time and effort are much appreciated. This experiment investigated the impact head injuries may have on social cognition, offending behaviour and general well-being. The procedure included a first phase during which participants completed a short questionnaire and a second phase where participants met with the researchers and undertook a number of different paper and computerised tasks. The tests aimed to record:

- Information about whether the participant has experienced a head injury
- Number and type of convictions
- Nature and level of violence in offending behaviour
- Socioeconomic status
- Drug and alcohol use
- The ability to recognise and understand other peoples' emotions
- The ability to show compassion towards another person (Empathy)
- Family background
- Brain functioning i.e. memory and attention
- General well being

We predict that young offenders with head injuries may have more problems in their ability to recognise and understand emotions of others than those who haven't experienced a head injury. We also predict that young offenders with head injuries may have difficulties in how they process information compared to those who have not experienced a head injury such as memory and attention. Also, in comparison to those who have not experienced a head injury, young offenders with head injuries may report more convictions, more violent convictions and more problems with their general well-being.

Further Information:

This study has received ethics clearance through the Psychology Department Research Ethics Committee. If you have any questions or concerns about your participation in this study, you can contact Dr. Huw Williams at 01392 724661 or W.H.Williams@exeter.ac.uk.

If taking part in this research has raised any issues that you would like to address, please contact the HEADWAY UK Helpline on free phone: 0808 800 2244 or by email: helpline@headway.org.uk

Appendix 8- Extended results

To further control for alcohol and drug use a hierarchical stepwise regression was also run with total drug use (excluding cannabis) entered into the first step, total alcohol use entered into the second step and the remaining variables (PCS, frequency and severity of HI) entered in the third step. The predictors did not alter in this analysis.

PCS scores and severity and frequency of HI were not significant predictors of age of first conviction.

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Table 8

Summary of Regression Analysis for Hypothesis 3 (age of first conviction- hierarchical stepwise)

Variable	B	SE (B)	β
Step 1			
Constant	13.48	0.26	
Total drug use (excl cannabis)	-0.18	0.05	-.35*
Step 2			
Constant	14.06	0.37	
Total drug use (excl cannabis)	-0.13	0.05	-.26**
Total alcohol use	-0.11	0.05	-0.23**
Step 3			
Constant	14.76	0.79	
Total drug use (excl cannabis)	-0.11	0.06	-.22
Total alcohol use	-0.10	0.06	-.21
PCS	-0.05	0.06	-.09
Severity of head injury	-0.14	0.28	-.07
Frequency of head injury	0.02	0.53	.01

Note $R^2 = .12^*$, $\Delta R^2 = .15^*$ (step 2), $\Delta R^2 = .14^{**}$ (step 3). $F = 13.00^{**}$, $\Delta F = 9.13^{**}$, $\Delta F = 3.90^{**}$.

$P < .01^{**}$, $p < .05$

Appendix 9- Extended Discussion**Point 1**

Interventions that target the link between HI and reactive aggression could be beneficial. Work by Kenny et al. (2007) suggested HIs increase disinhibition of aggressive impulses, especially in the presence of harmful/ hazardous alcohol use, which raises the risk of severe violence within the offence pattern. They proposed that appropriate preventative strategies may need to involve impulse control programmes for young offenders and treatment leading to abstinence from alcohol. Furthermore, intervention programs that work on the young person's ability to tolerate frustration, inhibit inappropriate responses and plan alternative pro-social behaviours could reduce the levels of reactive aggression they display (Kempes et al., 2005). Previous examples of such interventions have included intensive cognitive behavioural and skills based therapies, with an emphasis on violence prevention (Fabiano, Robinson & Porporino, 1991).

Point 2

Given that previous research has highlighted that PCS can be related to reactive aggression through neural damage (e.g., Yeates & Taylor, 2005) and psychological responses to HI (e.g., Suhr & Gunstad, 2002) consideration should be given to the possible impact of bio-psycho-social factors in the future. There is a need to consider the individual's personal history and circumstances in addition to the neurological factors throughout assessment and interventions with YOs. Ideally, treatment would be predicated upon a neuropsychiatric evaluation, assessment of the presence of comorbid mental health problems, or substance use, whether or not these are regarded as etiologically related to the HI. Treatment addressing the specific residual PCS, psychiatric, neurological, and physical health needs would be highly beneficial.

Appendix 10 - Dissemination Statement

Participants who asked to receive a summary of the results will be provided with this following the completion of the project. Furthermore, the results of this study will also be presented to the staff team at the Young Offender Institute who assisted with the collection of data in this study. This will be done through a presentation conducted by the researcher and there will opportunities to answer questions. It is proposed that an article will be written for the Journal of Head Trauma Rehabilitations³³ for publication. An abstract of the study has already been accepted to be presented at the World Congress on Brain Injury (San Francisco March 2014) by Prof. Huw Williams (research supervisor).

³³ See Appendix 11 for instructions for authors

Appendix 11- Instructions for Authors³⁴**Journal of Head Trauma Rehabilitations****SCOPE**

The *Journal of Head Trauma Rehabilitation (JHTR)* is a bimonthly journal devoted to clinical management and rehabilitation of persons with traumatic brain injury. It is interdisciplinary, and designed to provide the most current and relevant information for the practicing professional and researchers in the field. Three or four issues each year are devoted to single topics recommended to or solicited by the editors. The remaining issues consist primarily of unsolicited, empirical research reports. All articles, whether in a topical issue or not, receive masked peer review.

Authors are encouraged to submit to *JHTR* original manuscripts based on observations or experimentation that add new knowledge to the field of brain injury rehabilitation. Analytical reviews that codify existing knowledge or illuminate the present and future issues in the field are welcomed. In addition to topical articles, *JHTR* seeks manuscripts dealing with a variety of subjects that have current or future importance to all areas of brain injury rehabilitation, from acute medical management and clinical interventions to problems with reintegration into the community and long-term quality of life.

MANUSCRIPT SUBMISSION

Article types: Manuscripts reporting original research and systematic reviews are welcomed. Case studies may be published if they address a seminal clinical condition or procedure that has not been previously reported in the published literature. (Unless you have been invited by a topical issue editor to submit a manuscript for a topical issue, all manuscripts should be submitted as “Unsolicited (Focus on Clinical Research)”. *JHTR* emphasizes research on *traumatic* brain injury. If participants included in a research manuscript are not exclusively individuals with traumatic brain injury, the proportion of each etiology must be described. Generally, to be published in *JHTR*, a majority of the participants must have incurred traumatic brain injury, or data analysis allows evaluation of the specific effect on those with a traumatic etiology.

Article length: Manuscripts should generally not exceed 4,500 words excluding abstract, references, tables and figures. Authors are encouraged to use Supplemental Digital Content (SDC) for manuscript details that supplement but are not central to the comprehension of the paper. SDC is linked to the article indefinitely via the *JHTR* website (for more information, see below)

³⁴ Accessed from <http://edmgr.ovid.com/jhtr/accounts/ifaauth.htm> on 05.09.13

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Authors must state all possible conflicts of interest in the **Title Page of the manuscript**, including financial, consultant, institutional and other relationships that might lead to bias or a conflict of interest. If there is no conflict of interest, this should also be explicitly stated as none declared. All sources of funding should be acknowledged in the **Title Page of the manuscript**. All relevant conflicts of interest and sources of funding should be included on the title page of the manuscript with the heading "Conflicts of Interest and Source of Funding:".

For example:

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- JHTR requires authors to use person-first language—avoid phrasing such as "the brain-injured participant" or the "TBI patient" and replace with "participant with a brain injury" or "patient with a TBI".
- Manuscripts should be line numbered in their original format (e.g., Microsoft Word line numbering).
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- Title page including (1) title of the article; (2) author names (with highest academic degrees) and affiliations (including titles, departments, and name and location of institutions of primary employment); (3) all possible conflicts of interest including financial, consultant, institutional and other relationships that might lead to bias or a conflict of interest; (4) disclosure of funding received for this work including from any of the following organizations with public or open access policies: National Institutes of Health, Wellcome Trust, and the Howard Hughes Medical Institute; and (5) any acknowledgments credits, or disclaimers.
- A structured abstract of no more than 200 words should be prepared. Authors should use telegraphic language where possible, including omission of introductory clauses. Headings should typically include the following: Objective, Setting, Participants, Design, Main Measures, Results, Conclusion. The Conclusion section should encapsulate the clinical implications of the results, not merely restate the findings.
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- The author is responsible for obtaining written permission for any borrowed text, tables, or figures.

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