



The relationship between head injury and violent offending in juvenile detainees

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This study reports the incidence of head injury and other risk factors and their association with severe violent offending in 242 juvenile detainees in the custody of the New South Wales Department of Juvenile Justice from January to March 2003. One third of the sample self-reported that they had experienced at least one head injury in the past. The most common causes of head injuries were fights (43.5%) followed by sport (29.4%) then misadventure/other (27.1%). More than half of those reporting a head injury reported cognitive or behavioural problems associated with head injury. A history of head injury was significantly associated with severe violent offending. Other risk factors associated with severe violent offending were harmful and hazardous alcohol use and coming from a culturally and linguistically diverse background. Protective factors against severe violent offending were Aboriginality and severe conduct disorder. The most parsimonious explanation for the relationship between head injury and violent offending is that head injuries increase disinhibition of aggressive impulses, especially in the presence of harmful/hazardous alcohol use, which raises the risk of severe violence within an offence pattern.

INTRODUCTION

Although information is scarce, available data indicate that the frequency of head injuries and other neurological problems in adolescents is very low. One large survey of 13,446 presentations to general medical practitioners by young people aged 12 to 24 years reported that fewer than five per cent of consultations were for neurological problems (including but not confined to head injuries) (ICPC 2001). Similarly, little is known about the incidence and severity of head injuries in young offenders, and accordingly, the association between head injury and violent offending is unclear. Most of the research conducted in this area has focused on adult offenders and shows a high incidence of head injuries and a significant association between head injury and violence (Sarapata et al. 1998;

Leon-Carrion & Ramos 2003; Farrington 2000; Raine, Buchsbaum & Stanley 1994; Lewis, Pincus & Bard 1986). In this paper, we explore the incidence, causes and severity of head injury, the relationship between head injury and violent offending and the influence of other factors such as ethnicity, alcohol use and conduct disorder in violent offending (in a sample of incarcerated young offenders).

Recent research has explored the possible organic substrate of violence and interactions between biological, neurological and social factors that may be associated with violent offending. Various studies have documented abnormalities in the brain function of criminals. For example, following injuries to the frontal lobe (frontal lobe lesions) subjects displayed more frequent aggressive and violent behaviour than non-injured

criminals (Grafman, Schwab & Warden 1996; Pagani & Pinard 2001). Neuro-imaging techniques have revealed pre-frontal dysfunction in murderers and left temporal dysfunction and hypofrontality (an inability to control violent impulses) in aggressive adults and violent patients. Most research has focussed on the relationship between executive functioning deficits and violence (Broomhall 2005). 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, Buchsbaum & Stanley 1994; Brower & Price 2001; Duncan, Kosmidis & Mirsky 2003). In a sample of 71 adolescent homicide offenders, Busch et al. (1990) identified a higher rate of neurological impairments than for a matched non-homicide offender

group. Neurological impairment was assessed via diagnosis of attention deficit disorder and severe educational deficits. However, the overall rate of neurological problems for the homicide group was only seven per cent. In a replication of this study, Zagar et al. (1990) reported higher rates of epilepsy and central nervous system disorders in the early childhoods of 30 young offenders who killed compared to a matched group of 30 non-violent offenders. Hardwick and Rowton-Lee (1996) argued that the relationship between brain damage and homicide in young offenders was mediated through deficits in social problem solving, impulse control and language.

There are a number of explanations of the causal relationship between head injury and violence. The most common assumes that head injury has a direct unitary effect of a biological or social nature on violent behaviour. Other theories posit interacting effects between biological and social factors. For example, the 'threshold effect' theory (Susman & Finkelstein 2001) proposes that head injuries precipitate violent behaviour in those individuals who are already predisposed to violent behaviour due to the presence of other biological or social risk factors; that is, head injuries lower the 'threshold' for violent behaviour in the presence of other activating conditions such as alcohol use and specific crime determinants such as victim resistance (Leon-Carrion & Ramos 2003).

Raine, Brennan, and Farrington (1997) outlined four models that link biological and social factors to violence:

- i) The correlated model proposes that a biological risk (e.g. prefrontal dysfunction) and social risk (e.g. child abuse) might show an additive effect by virtue of their close association.
- ii) The additive model is based on the observation that the presence of both neurological problems and adverse family environments are better predictors of violence than either alone.
- iii) The sequential model proposed that a biological risk factor appears first in the sequence of emerging risk, which

influences a social factor, (or a social factor may influence a biological factor), which in turn makes violence more likely. An example of the latter occurs when an infant suffers physical abuse such as 'shaken baby' syndrome. This may cause damage to the prefrontal cortex, which leads to behavioural disinhibition, thus making violent behaviour more likely.

- iv) The multiplicative model states that the combined impact of risk factors is greater than each of the factors occurring alone. For instance, Raine, Brennan and Mednick (1994) showed that the presence of both maternal rejection and birth complications were three times more likely to lead to violent behaviour than either one alone.

Leon-Carrion and Ramos (2003) compared the educational, behavioural, medical and family background histories of adult violent offenders (serving sentences for offences involving the infliction of physical violence on persons or property) and non-violent offenders (convicted of offences where physical violence was absent i.e. the crimes were 'white collar' in nature). They classified offenders on the following factors: severity of head injury, school problems, learning disabilities, childhood illness and psychological or psychiatric treatment. There was only one significant difference between the two groups: violent offenders reported experiencing significantly more blows to the head than non-violent offenders. Education, learning difficulties, childhood illness and psychological/ psychiatric treatment did not differ between the two groups. These data suggest that a history of discrete neurological damage as a consequence of injury to the head is more indicative of violent behaviour than academic and intellectual problems or medical or family background. In addition, the pattern of responses among the groups suggests that when various factors are combined, the risk of violent offending increases (Susman & Finkelstein 2001). For example, the triad of a past head injury with learning disability and behavioural problems significantly

predicted violent offending (Leon-Carrion & Ramos 2003). Other research supports the finding that cumulative factors additively (or multiplicatively) increase risk in forensic populations (Andrews & Bonta 1994), although the work on criminogenic needs indicates that certain factors are more likely to lead to criminal behaviour than others. Vulnerability to impulsivity and aggression are two such factors, both of which have been shown to be affected by head injury (Blackburn 1993).

Not every head injury predicts violent behaviour. Most individuals who suffer head injuries do not become violent (Raine, Buchsbaum & Stanley 1994). If head injury is associated with violence and violent crime, what are the mechanisms that mediate or moderate this association? Some potential mediating or moderating factors are: (a) substance abuse; (b) poor coping skills; (c) reduced inhibition or restraint; (d) past physical abuse and (e) social and cultural factors. Head injury increases sensitivity to the effects of alcohol, so a head injury may exacerbate the criminogenic effects of alcohol abuse (Raine, Buchsbaum & Stanley 1994). Alcohol and substance use are important factors to consider in offending populations and especially in juvenile populations who have been shown to be heavy users of these substances (Allerton et al. 2003). A direct effect between alcohol abuse and involvement in violent offending among young people has been frequently observed (for a review see Lennings, Copeland & Howard 2003). Both substance abuse and head injury are known to diminish coping skills, judgment and restraint or inhibition (Miller 1990). Sustained head injuries may precipitate violence in individuals who already have deficits in those areas (Raine, Brennan & Mednick 1994). Physical abuse has been implicated as a cause of 95 per cent of serious head injuries in children (Miller 1990). Blackburn (1993) has noted that the incidence of neglect is high among young offenders, and recent research in the neurological and endocrine interactions between abuse, neglect and development have suggested that early and chronic abuse and neglect

cause considerable disruption to both behavioural and neurological self-regulation (Fonaghy 2004).

Research from the United States has consistently revealed a relationship between offending and ethnicity (primarily African-American and Hispanic), a relationship that is possibly mediated by social factors such as low socioeconomic status (Cornell, Benedek & Benedel 1987). A more recent study that investigated the relationship between indicators of interracial and intraracial economic inequality and violent crime rates showed that interracial inequality was a strong predictor of the overall violent crime rate and on crimes committed against one's own race (Stolzenberg, Eitle & D'Alessio 2006). The findings supported the relative deprivation hypothesis (i.e. economic inequality between racial groups is a better predictor of crime rates than the absolute level of socioeconomic conditions for a given racial group).

The relationship between Aboriginality and violence is complex. Studies with non-offending populations and adult offenders have indicated that a heightened risk of violence may co-occur with Aboriginality (Weatherburn, Fitzgerald & Hua 2003). Adult Aboriginal offenders had a ten times greater risk of arrest for violence than non-Aboriginal offenders when arrest rates were compared with available statistics taking into account proportions of Aborigines in the general population (Weatherburn et al. 2003). Higher rates of both official and self-reported violence and general criminality among school attending Aboriginal juveniles compared with non-Aboriginals have also been reported (Weatherburn et al. 2003).

Other research on incarcerated juvenile justice samples in Australia comparing Indigenous and non-Indigenous offenders has found that Indigenous status was protective against violent offending (Kenny & Press 2006; Lennings et al. 2003). It is difficult to draw conclusions on the basis of the studies available other than to note that the link between violence and social disadvantage is well

known. However, the relationship between Aboriginality, policing practices, violence and social disadvantage have not yet been clearly explicated or controlled in much of the available research (Cunneen 1997). The evidence to date supports the conclusion that rates of violence are generally higher among Indigenous people than among non-Indigenous people, except perhaps among incarcerated samples.

Recent research has identified serious problems in the way in which violence is classified in the literature and demonstrated that violence classification can have a profound impact on the significance of observed relationships between a number of purported putative factors frequently reported to be associated with violent offending (Kenny & Press 2006). Accordingly, Kenny and Press (2006) developed a violence-coding framework that distinguishes between four levels of violence (none, low, moderate and severe) based on international classifications (e.g. Dodd et al. 2004), legal definitions and statistical classifications adopted by the Australian Bureau of Statistics.

This paper examines the relationship between head injury and different levels of violent offending. It also explores the association between self-reported history of head injury and other factors frequently associated with violence to determine their relationship with violent offending. These factors were substance abuse; physical abuse and neglect; intellectual functioning and learning disability; and cultural factors. These issues are explored by reference to the results of a survey of young offenders in juvenile detention in 2003.

METHOD

PARTICIPANTS

In 2003, the New South Wales (NSW) Department of Juvenile Justice (DJJ) in collaboration with the University of Sydney and NSW Justice Health undertook a comprehensive population survey of young people in juvenile detention in NSW. The survey, titled Young People

in Custody Health Survey, gathered information on the physical and mental health of participants. All consenting young people in custody in NSW, either on remand or serving a control order during the study period (January to March 2003), were eligible to participate. NSW has nine juvenile detention centres, of which five are in urban regions and four are in rural regions. Within these centres, there were 319 incarcerated young people eligible to participate in the survey.

DATA COLLECTION PROCEDURE

Ethics approval for the study was obtained from the Collaborative Research Unit Ethics Committee (CRU) of DJJ and from the Aboriginal Health and Medical Research Council (AHMRC).

After completing intensive training in the administration of the survey protocol, psychologists employed by DJJ administered the psychological and educational assessment protocol in each of the nine juvenile justice detention centres.

MEASURES

Biological factors

(i) The measurement of head injuries

A head injury describes a wide range of injuries that can occur to the scalp, skull, brain and underlying tissue and blood vessels in the head. When medical and hospital records are available, EEGs, CT scans, the Glasgow Coma Scale or the Westmead PTA scale are employed to provide checklists and threshold points that determine whether the head injury is mild, moderate or severe. When the injury data are self-reported in response to a survey questionnaire, as they are in the current study, the classification must be developed by matching markers, derived from the literature on head injury, to participants' responses.

In this study, we relied on detailed retrospective self-report of head injuries as the outcome variable of interest. Participants were asked if they had ever had a head injury and, if so, to provide details on the three worst head injuries

suffered including cause of the injury, length of time unconscious, and how long ago the injury occurred. Participants were also asked if they had any behavioural or cognitive difficulties as a result of the injury such as mild dysphasia, memory loss or poor concentration, dizziness or changes in behavioural and emotional regulation. The severity of the head injury was calculated by considering a number of factors including the period of unconsciousness and the number of head injuries.

(ii) Substance Use

The alcohol section of the survey asked questions about the frequency of alcohol consumption, quantities (in standard drinks), what the participants typically drank and how often they got drunk. The drug use questions asked about type of drugs used and how often they were used.

There are no recommended drinking levels for people under 18 years of age. For this survey, hazardous/harmful levels were based on the Australian Alcohol Guidelines (National Health and Medical Research Council 2001) for adults. For men, drinking more than four standard drinks (one standard drink = 12gm alcohol) a day on average, drinking more than six standard drinks on any one day or drinking every day was classified as unsafe. For women, drinking more than two standard drinks a day on average, drinking more than four standard drinks on any one day or drinking every day was classified as unsafe.

Psychological and educational tests

(i) Wechsler Abbreviated Scale of Intelligence (WASI)

The WASI is a standard, brief and reliable test of verbal and non-verbal intelligence for individuals aged 6-89 years. The WASI contains four subtests: vocabulary, block design, matrix reasoning and similarities. These four subtests yield three intelligence quotients, verbal intelligence (VIQ), performance intelligence (PIQ) and full-scale intelligence (FSIQ). The WASI scores are measured against a normative sample

with a mean of 100 and SD of 15 (The Psychological Corporation, 1999).

(ii) Wechsler Individual Achievement Test II – Abbreviated (WIAT-II-A)

The WIAT-II-A is used to assess basic literacy and numeracy skills. The test involves three subtests: word reading, numerical ability and spelling. These subtests yield a composite standard score, which is an estimate of overall academic achievement in reading, spelling and mathematics. The WIAT-II-A is based on a normative sample with a mean of 100 and a SD of 15 (The Psychological Corporation 2001). The WASI and WIAT-II-A together provide a brief, reliable assessment of achievement and cognitive functioning.

(iii) Adolescent Psychopathology Scale (APS)

The APS assesses a range of psychological and psychiatric symptoms warranting possible referral or intervention. It is not a diagnostic tool, but the scales in the APS are based on DSM-IV criteria. The APS generates 40 scales, which are organised according to clinical disorders (20 scales), personality disorders (5 scales), psychosocial problems (11 scales) and response style indicators (4 scales). In addition, three broad indicator scores (internalising, externalising and personality) can be obtained by combining various scales. The APS mean score is 50 [with a SD of 10]. Scores above sixty-five are considered an indication of possible disorder, but not a formal diagnosis. The APS has been extensively standardised on a USA population (Reynolds 1998).

(iv) Childhood Trauma Questionnaire (CTQ)

The CTQ (Bernstein & Fink 1998) is a 28-item retrospective self-report measure of childhood abuse and neglect experiences. The CTQ generates classification scales relating to five areas of maltreatment: emotional, physical and sexual abuse, and emotional and physical neglect. Each scale contains five items that are summed to produce the Scale Total Score which ranges from 5 to 25. The higher the score, the greater the severity of maltreatment. There are four levels of maltreatment for

each type of trauma: None (minimal); Low (to moderate); Moderate (to severe); and Severe (to extreme). The CTQ also generates a minimisation/denial scale (three items) for the detection of false-negative reports regarding trauma. The standardisation sample of the CTQ included male inpatient substance abusers and adolescent inpatients. For each sample, norms are offered separately for males and females. Internal consistency falls within the satisfactory to excellent range (0.66 to 0.92), with the total scale achieving a Cronbach's alpha of 0.95.

Criminal history variables

Offending history records from the Department of Juvenile Justice were accessed for all juvenile detainees who took part in the survey. Information was gathered on the following variables: age at first offence, total number of court dates attended, total number of offences committed and most severe sentence that they had received. Sentences varied from fines, dismissal without penalty, suspended detention, community supervision orders and detention.

Cultural Background

Each respondent was asked to indicate whether they identified as an Aboriginal or Torres Strait Islander (Indigenous), their country of birth, their parents' country of birth and the main language spoken at home.

Offence classification

The classification system for determining the level of violence in the criminal offence history was based on the method for violence classification developed by Kenny and Press (2006). This categorisation standardises the severity of violence code by capturing both the 'true' nature of the violent offence as well as its legal classification. For example, common assault is violent but can, in practice, involve a minor altercation with minimal or no physical violence involved. Thus, according to our classification, a young person needed at least two convictions for common assault to receive a (low) violent rating. Other offences

receiving a low violence rating include assault, robbery and the offence of two or more people threatening violence and causing fear. Juvenile detainees with a conviction for assault occasioning actual bodily harm, aggravated sexual assault, robbery with an offensive weapon, or aggravated assault were rated as having a moderately violent offending history. If the juvenile detainee had a conviction for any of the following offences he or she was considered to have a history of severe violent offending: homicide; attempted homicide; discharge firearm with intent to murder; malicious infliction of grievous bodily harm or aggravated robbery with wounding.

Using information on the index offence from the survey (i.e. the offence that resulted in the present incarceration) and criminal history data from the Department of Juvenile Justice database, we were able to classify all young offenders with respect to their offence history. The level of violence in the index offence and offence history was coded as absent, low, moderate or severe. Detainees were then coded on the most severe offence documented from either source.

Using this classification, 12.8 per cent ($n=31$) of participating juvenile detainees were categorised as non-violent offenders, 30.6 per cent ($n=74$) as low, 43.8 per cent ($n=106$) moderate, and 12.8 per cent ($n=31$) as severe violent offenders. A second classification was developed in which absent, low and moderate violence were combined and compared with serious violence to test the hypothesis that the relationship between head injury and violence was only significant for the most severe violent offences.

Statistical methods

The measurements of head injury (no head injury, mild, moderate or severe head injury) and violent offending (none/low, moderate or severe violence) were categorical. Associations between these measurements and co-morbidities or possible predictive factors were explored using continuity correction for 2x2 tables and Pearson's chi-square for larger

tables. When there were cells with a small number of cases, adjacent categories were combined. Associations with p values less than 0.2 were considered for inclusion in logistic regression models to measure adjusted effects. Variables were reduced to binary form except for cultural background, which was transformed into two dummy variables.

Unadjusted odds ratios were calculated from 2x2 contingency tables. Variables were then entered into logistic regression models in ascending order of p values for the unadjusted association and tested using a sequential approach, that is, variables were added one at a time and their effect on the model was examined. Variables were retained in the model if the p value was less than 0.1 or if the adjusted odds ratio was greater than 1.5, which was considered a clinically important effect size. This p value was chosen in order that any potential effects of confounding were not overlooked as a result of type II errors because the sample size was not large.

For explanatory variables that were continuously distributed, ROC curves were used to estimate the predictive value. ROC curves display the rate of true positive values plotted against the rate of false positive values that are calculated for each value of the continuous explanatory variable. In this way, the most optimal cut-off point for a continuous variable in predicting a binary variable can be estimated. An area under the ROC curve of 0.5 indicates that the value of the continuous variable in predicting the outcome is no better than chance. For factors with an area under the curve less than 0.4 (indicating a protective variable) or greater than 0.6 (indicating a predictive variable), the coordinates of the ROC curve were examined and Pythagoras' theorem used to estimate the cut-off value for the curve that was closest to the top of the y-axis for area under the curve greater than 0.6, i.e. where the rate of true positives was maximised and the rate of false positives was minimised, or to the right hand side of the x-axis for area under the curve less than 0.4, i.e. where the rate

of true negatives was maximised and the rate of false negatives was minimised. These cut-off points were used to convert continuous variables to a binary form for testing as predictive variables in logistic regression models.

RESULTS

DEMOGRAPHICS

A total of 242 incarcerated young offenders participated in the NSW Juvenile Justice Health survey; this represented 76 per cent of all available juvenile detainees. The sample consisted of 223 (92.1%) males and 19 (7.9%) females. The mean age of the male participants was 17 years 2 months (range: 14-21 years); the mean age of the female participants was 16 years 11 months (range: 15-18 years).

Of the 242 participants, 102 (42.1%) were Indigenous. Of the remaining 140 juvenile detainees, 105 (43.4% of the total sample) were classified as being from an English speaking background.¹ Only 14.4 per cent of the sample was from a culturally and linguistically diverse background. This comprised participants who identified with a culture that is not English speaking and did not identify as an Indigenous Australian. In most cases, either the young person and/or one or both parents were born overseas and/or spoke a language other than English in the home. This included juvenile detainees from the Pacific Islands, Asia, the Middle East and Africa.

OFFENCE CLASSIFICATION

The sample was coded according to the classifications presented above. The classifications were either dichotomous (classification 2 - none/low/moderate vs. severe violence) or coded according to a four level classificatory system (classification 1). Table 1 shows the frequencies with which young offenders were coded into violence categories based on these coding systems.

HEAD INJURIES

Of the 242 juvenile detainees who took part in the survey, 85 (35.1%) reported having had at least one head injury in which they 'blacked out' or became unconscious. This group of 85 reported a total of 161 head injuries.

The cultural backgrounds of those with head injuries were as follows: 34 (40.0%) identified as Indigenous; 41 (48.2%) were from an English speaking background; and ten (11.8%) were from a culturally and linguistically diverse background including eight (9.4%) from a Pacific Islander background and two (2.4%) from an Asian background.

The average age was 17.33 years (s.d. = 1.29; range = 14.2 to 20.5), with the average age at first offence 14.48 years (s.d. = 1.82; range = 10 to 18). These 85 detainees had each committed on average 14.22 offences and had on average 8.72 court dates. They had been placed in custody on average 5.84 times (s.d. = 9.06; range = 1 to 70).

There was no difference between juvenile detainees who self-reported a head injury and those who did not on age, number of court dates, age at first offence, body mass index, age at which they left school, grade at which they left school, number of times they were suspended or number of times they were placed in care.

Table 2 presents data examining whether head injury was related to gender, age or cultural background. The results show a significantly higher rate of head injuries in males than in females, but there was no relationship between head injury and age or cultural background.

Table 2 also shows whether moderately or severely violent offences were related to gender, age or cultural background. A slightly higher proportion of females had committed a moderate/severe violent offence but the difference was not statistically significant. There was no relation between violent offending and age. However, there was a significantly higher proportion of juvenile detainees with a history of violent offences from culturally and linguistically diverse

Table 1: The level of violent offending among juvenile detainees (n=242)

<i>Violent offending</i>	<i>Classification 1</i>	<i>Classification 2</i>
None	31 (12.8%)	} 211 (87.2%)
Low violence	74 (30.6%)	
Moderate violence	106 (43.8%)	
Severe violence	31 (12.8%)	31 (12.8%)

Table 2: Head injury and violent offending among juvenile detainees by gender, age and cultural background

<i>Characteristic</i>	<i>Number</i>	<i>Percent of group with head injury</i>	<i>Percent of group with moderate/severe violent offence</i>
Gender			
Male	223	37.7%	53.8%
Female	19	5.3%	68.4%
<i>Chi-square test: p-value</i>		0.01	0.32
Current age			
Under 16 years	44	27.3%	43.2%
16 to 17 years	143	36.4%	58.0%
18 years or over	55	38.2%	56.4%
<i>Chi-square test: p-value</i>		0.47	0.22
Cultural background			
Indigenous	102	33.3%	46.1%
English speaking	105	39.0%	56.3%
Culturally and linguistically diverse	35	28.6%	75.7%
<i>Chi-square test: p-value</i>		0.54	<0.01
Total	242	35.1%	55.0%

backgrounds and a significantly lower proportion from an Indigenous background. The fact that there were similar proportions of Indigenous detainees and detainees from an English speaking background with a history of violent offending in this sample does not necessarily indicate that they have the same general proclivity for violent behaviour. A study designed to assess the population attributable risk would be needed to address this issue.

Of those detainees who reported suffering one head injury in which they 'blacked out' or became unconscious, 30.6 per cent (10.7% of the total sample) reported a second head injury. Of those who reported

a second head injury, 57.7 per cent (6.2% of the total sample) reported a third head injury. Of those who reported suffering at least one head injury, 11.8 per cent (4.1% of the total sample) reported more than three head injuries where they 'blacked out' or became unconscious.

Being involved in fights, riots or quarrels where the young person reported being struck by either a person or an object was the largest cause of unconsciousness (43.5%). This was followed by sporting injuries (29.4%) and then misadventure/other (27.1%). 'Misadventure' included incidents where the young person fell from a height, motor vehicle accidents in which the young person was either a

driver or passenger and, to lesser degree, pedestrian accidents. ‘Other’ reported causes of head injury were injuries sustained in the course of offending or when being arrested and self-harm through the use of firearms or poison.

Probability of having had a head injury: Multivariate comparisons

It was considered important to know the causes and extent of morbidity associated with head injuries. Accordingly, multiple logistic regression analysis was used to identify significant predictors of head injury. Only one female had experienced a head injury and it was therefore impossible to include gender as a factor in the model even though the bi-variate analyses showed that males were at much higher risk of having a head injury than females. The results show that there were only two independent risk factors for head injury. Offenders who had a history of gambling (odds ratio = 2.72, 95% CI = 1.04, 7.12, $p = 0.04$) and offenders who had a history of moderate to severe anger (from APS) (odds ratio = 2.03, 95% CI = 0.98, 4.21, $p = 0.05$) were at a significantly increased risk of having had a head injury. The adjusted odds ratio for harmful/hazardous drinking was 1.6 (95% CI = 0.8, 3.4) but this fell short of significance ($p = 0.18$).

Table 3 shows the factors that were examined to assess whether they were more often associated with mild head injury or moderate/severe head injury. The severity of head injury experienced was not associated with how the head injury occurred (i.e. fights, quarrels, sport or misadventure as a precipitating factor) or with the number of unconscious episodes that had been experienced. For those who experienced symptoms there was no association between the number of symptoms and the severity of the head injury. Similarly, for those who had persisting symptoms, there was no relationship between the number of persisting symptoms and the severity of the head injury. A significant relationship was found between severe head injury and a period of unconsciousness of over 10 minutes.

Table 3: Factors associated with mild head injury and moderate/severe head injury among juvenile detainees

<i>Characteristic</i>	<i>Number</i>	<i>Mild head injury</i>	<i>Moderate/severe head injury</i>
Precipitating factor			
Fight or quarrel	37	67.6%	32.4%
Sport	25	84.0%	16.0%
Misadventure/other	23	87.0%	13.0%
<i>Chi square test: p value</i>			0.14
Number of unconscious episodes			
One	58	82.8%	17.2%
Two or more	27	66.7%	33.3%
<i>Chi square test: p value</i>			0.17
Number of symptoms			
One	13	76.9%	23.1%
Two or more	16	62.5%	37.5%
<i>Chi square test: p value</i>			0.25
Persisting symptoms			
One	11	81.8%	18.2%
Two or more	14	64.3%	35.7%
<i>Chi square test: p value</i>			0.42
Time unconscious			
Briefly	42	100.0%	-
More than 10 minutes	29	34.5%	65.5%
<i>Chi square test: p value</i>			<0.0001
Total		66	19

Conditions co-morbid with head injuries

Of those detainees who reported a head injury, 54.7 per cent reported suffering problems immediately following their

head injury (45.3 per cent reported no subsequent problems). Table 4 shows the reported problems and the frequency with which they occurred both immediately following the head injury and for those with persisting problems.

Table 4: Relative frequency of problems following a head injury among juvenile detainees

<i>Problem</i>	<i>Immediate Problems Frequency</i>	<i>Persisting Problems Frequency</i>
Weakness	2 (3.1%)	2 (7.1%)
Poor Concentration	12 (18.8%)	11 (39.3%)
Memory Loss	15 (23.4%)	12 (42.9%)
Problems Speaking	7 (10.9%)	6 (21.4%)
Coordination & Balance	4 (6.3%)	2 (7.1%)
Personality/ Behavioural	9 (14.1%)	6 (21.4%)
Anxiety or Depression	5 (7.8%)	5 (17.9%)
Headaches	21 (32.8%)	16 (57.1%)
Blackouts	1 (1.6%)	1 (3.6%)

Association between head injuries and violent offending: Bivariate comparisons

Table 5 shows the relationship between various head injury characteristics and detainees' history of violent offending. Two sets of comparisons were made for each head injury factor. Comparison one shows the relationship between involvement in non or mild violent offences versus involvement in moderate or severe violent offences. Comparison two compares involvement in non, mild and moderate violent offences against involvement in severe violent offences.

There was no significant difference in moderate or severe violent offending compared to non-violent or mildly violent offending between groups with head injuries present or absent, or between groups defined by morbidity associated with head injuries. However, when the group who had committed a severe violent offence was compared with the combined groups who had committed less violent offences, a significantly higher percentage of offenders who had been involved in severe violence had a head injury (20.0% vs. 9.5%, $p = 0.04$). The unadjusted odds ratio for involvement in a severe violent crime where the young offender had a head injury was 2.37 (95% CI = 1.12, 4.93) and if the young offender had been unconscious, the unadjusted odds ratio was 2.82 (95% CI = 1.33, 5.92).

Figure 1 shows juvenile detainees' past involvement in violent offending (none/mild, moderate and severe) by whether they had ever been unconscious. Inspection of Figure 1 suggests that having been unconscious one or more times has no effect on whether or not an individual has been involved in mild or non-violent offending but does have an effect on the likelihood of involvement in severe (as opposed to moderate) violent offending. It should be noted, however, that the differences are not statistically significant. It is difficult to tell, therefore, whether this is a real effect or simply a result of sampling variation.

Figure 2 shows the proportion of juvenile detainees who had been involved

Table 5: Association between head injuries and violent offending among juvenile detainees

<i>Characteristic</i>	<i>Number</i>	<i>Non/mild-violence</i>	<i>Moderate violence</i>	<i>Severe violence</i>
Head injury				
Absent	157	44.6%	45.9%	9.5%
Present	85	45.9%	34.1%	20.0%
<i>Chi-square test: p value</i>			<i>0.95¹</i>	<i>0.04²</i>
Severity of head injury				
No head injury	157	44.6%	45.9%	9.5%
Mild	66	47.0%	34.8%	18.2%
Moderate/severe	19	42.1%	31.6%	26.3%
<i>Chi-square test: p value</i>			<i>0.92¹</i>	<i>0.05²</i>
Precipitating factor				
No head injury	157	44.6%	45.9%	9.5%
Fight or quarrel	37	45.9%	35.1%	19.0%
Sport	25	44.0%	28.0%	28.0%
Misadventure/other	23	47.9%	39.1%	13.0%
<i>Chi-square test: p value</i>			<i>0.99¹</i>	<i>0.05²</i>
Number of unconscious episodes				
No head injury	157	44.6%	45.9%	9.5%
One	58	43.1%	36.2%	20.7%
Two or more	27	51.9%	29.6%	18.5%
<i>Chi-square test: p value</i>			<i>0.74¹</i>	<i>0.07²</i>
Time unconscious				
No head injury	157	44.6%	45.9%	9.5%
Briefly	42	54.8%	21.4%	23.8%
More than 10 minutes	29	34.5%	44.8%	20.7%
<i>Chi-square test: p value</i>			<i>0.23¹</i>	<i>0.02²</i>
Total number		109	101	32

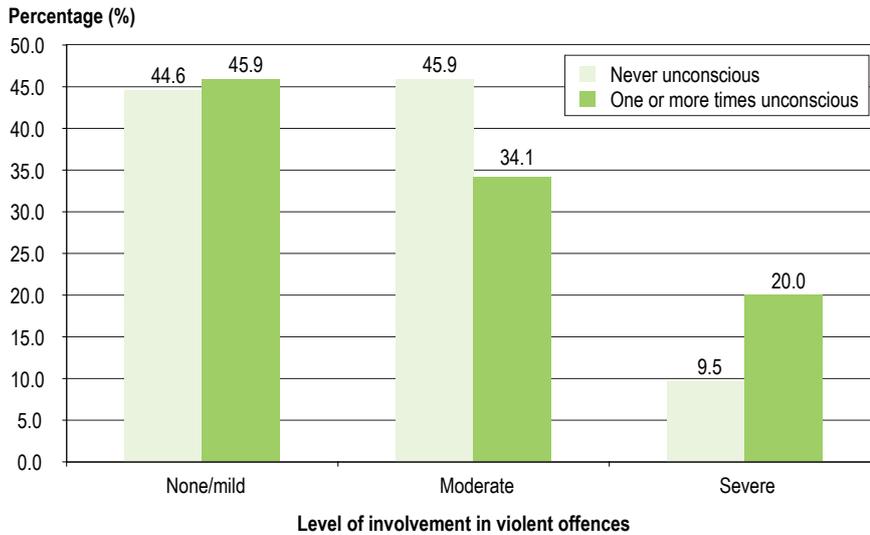
1. *p value for the comparison between non/mild violence and moderate/severe violent offence*
 2. *p value for the comparison between non/mild/moderate violence and severe violent offence*

in severe violent offences by cultural background and whether the detainee had experienced a head injury. The figure shows that Indigenous detainees had the lowest rate of severe violent offending and detainees from culturally and linguistically diverse backgrounds had the highest rate.

In addition, the figure shows that among detainees from English speaking

backgrounds and culturally and linguistically diverse backgrounds participation in a severely violent offence was higher in offenders with a head injury. Among Indigenous detainees, the rate of having committed a severely violent offence was low, at less than 10 per cent in both of the groups with or without a previous head injury.

Figure 1: Juvenile detainees' involvement in violent offending by whether they have had an unconscious episode



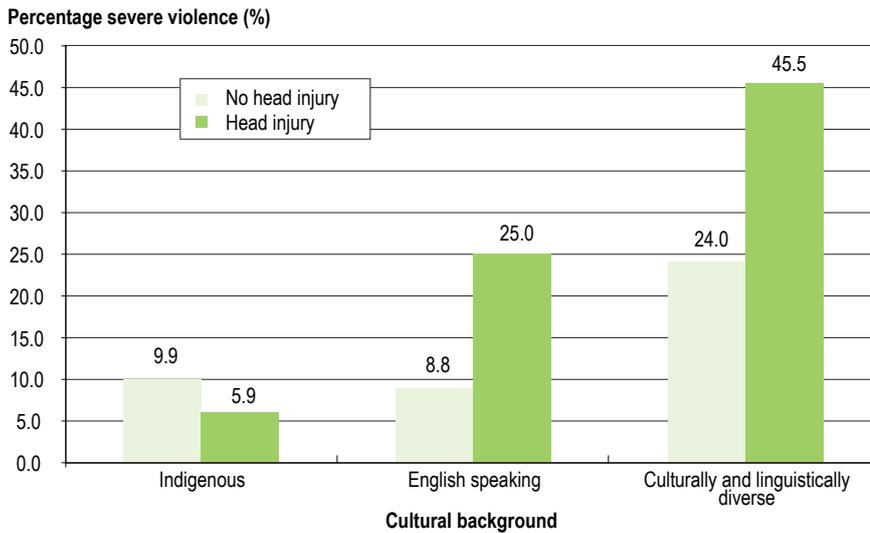
offences only. The only factor predictive of moderate/severe violent offending was cultural background with culturally and linguistically diverse offenders being at increased risk and offenders of Indigenous background showing reduced risk of having committed a moderate/severe violent offence.

More factors were significantly predictive of involvement in severe violent offences. Juvenile detainees from a culturally and linguistically diverse background were at a significantly increased risk of having been involved in a severe violent offence and detainees of Indigenous background were at a significantly reduced risk. Having had a history of head injury or a history of hazardous or harmful drinking also increased the risk of having committed a severely violent offence. Having severe conduct disorder reduced the risk of committing a severely violent offence. None of the subscales or full scales of the WASI, WIAT or CTQ were significant independent predictors of severe violent offending.

Odds ratios cannot be interpreted directly as measures of differences in risk. To examine the impact of our independent variables on the risk of involvement in violent crime we exponentiate the parameter estimates in the logistic regression models and plot the resulting differences in risk (Figures 3 and 4 below). The figures can be interpreted as the average probability that an individual will commit a violent crime in the absence or presence of the risk factors shown. Figure 3 shows the relationship between cultural background, hazardous drinking and head injury in juvenile detainees who had severe conduct disorder as assessed by the Adolescent Psychopathology Scale. Figure 4 shows the relationship between these three factors for those with no, mild or moderate conduct disorder.

The figures show that the nature of the relationship between cultural background, head injury and hazardous drinking follow the same trajectories for the groups with and without severe conduct disorder. However, the probability of those with

Figure 2: Juvenile detainees' involvement in severe violent offences by cultural background and head injury



Probability of having committed a severely violent offence: Multivariate comparisons

The significance of between-group comparisons of categorical outcomes identified in the logistic regression was estimated using a continuity-corrected chi-square test. P values less than 0.05 were considered statistically significant. To estimate independent

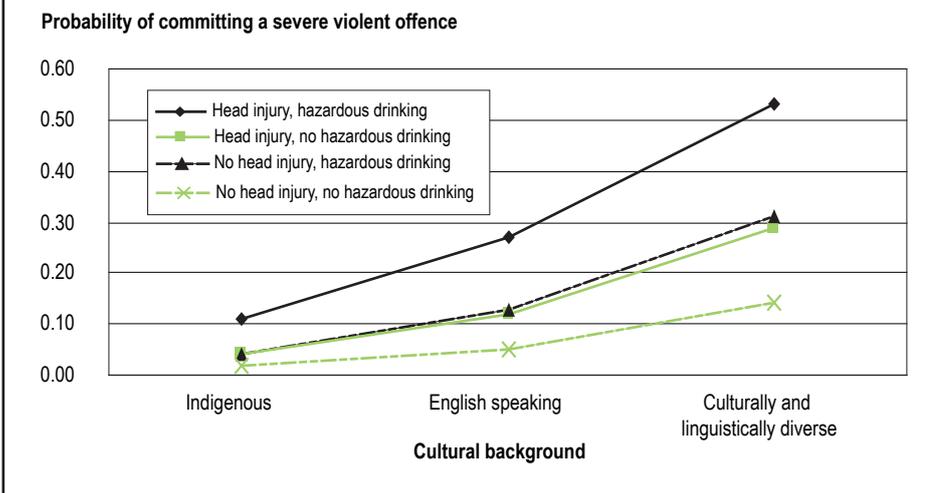
effects of risk factors on the outcomes, logistic regression was used. Variables were entered in a sequential manner and retained in the model if $p < 0.1$ and if they were free of colinearity with other variables in the model.

Table 6 shows the results of the logistic regression analyses conducted to identify factors that were significant predictors of involvement in either moderate or severe violent offences or severe violent

Table 6: Logistic regression models for the probability of a juvenile detainee having committed an offence of moderate/severe violence and severe violence

Characteristic	Odds ratio	Beta	SE	95% confidence interval		Significance
				Lower	Upper	
Predicting moderate/severe violence						
Culturally and linguistically diverse v. English speaking background	2.41	0.88	0.43	1.04	5.63	0.041
Indigenous v. English speaking background	0.66	-0.41	0.28	0.38	1.15	0.144
Predicting severe violence						
Culturally and linguistically diverse v. English speaking background	3.15	1.15	0.50	1.19	8.33	0.021
Indigenous v. English speaking background	0.33	-1.12	0.55	0.11	0.97	0.043
Head injury v. no head injury	2.52	0.93	0.42	1.11	5.72	0.027
Hazardous/harmful drinking v. non-harmful or no drinking	2.72	1.00	0.51	1.00	7.36	0.049
Severe conduct disorder v. no, mild or moderate conduct disorder	0.38	-0.96	0.45	0.16	0.92	0.031

Figure 3: Probability that a juvenile detainee with a severe conduct disorder will have committed a severely violent offence by head injury, hazardous alcohol consumption and cultural background



a severe conduct disorder committing a severe violent offence is lower than for those without a severe conduct disorder. Juvenile detainees most at risk of committing a severely violent offence are from culturally and linguistically diverse backgrounds, have sustained a

head injury, engage in hazardous/harmful drinking and do not have a severe conduct disorder. The juvenile detainees least likely to commit a severely violent offence are Indigenous, with no history of head injury or hazardous/harmful drinking and have a severe conduct disorder.

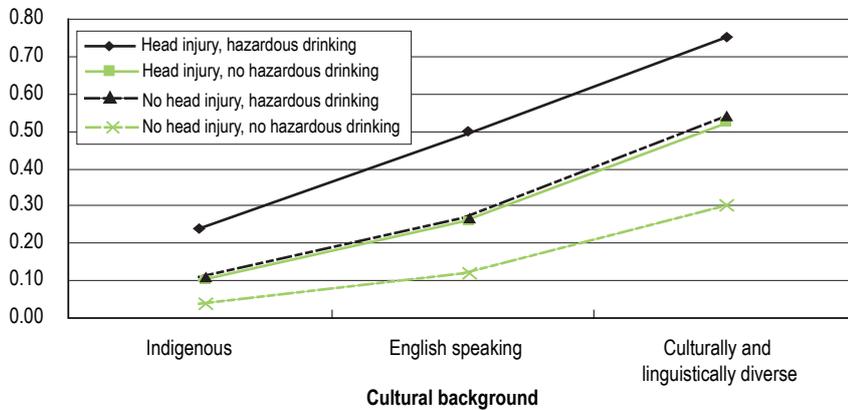
DISCUSSION

Our findings have highlighted some important relationships between head injury and violent crime among juvenile detainees. However, the conclusions that can be drawn about these relationships are not clear. Of the 85 juvenile detainees who had experienced a head injury, 46 per cent had committed either no violent offences or only mildly violent offences, 34 per cent had committed a moderately violent offence and 20 per cent had committed a severely violent offence. Among the 157 juvenile detainees who had never had a head injury, 45 per cent had committed either no violent offences or only mildly violent offences, 46 per cent had committed a moderately violent offence and 10 per cent had committed a severely violent offence.

Our analysis found that the presence of a head injury was not related to whether the juvenile detainee had ever been involved in moderate/severe violent offences as opposed to only non-violent or mildly violent offences. However, when involvement in a severe violent offence was compared against involvement

Figure 4: Probability that a juvenile detainee with no, mild or moderate conduct disorder will have committed a severely violent offence by head injury, hazardous alcohol consumption and cultural background

Probability of committing a severe violent offence



in less violent offences (none, mild, moderate) the presence of head injury was found to have a significant impact. Twenty per cent of juvenile detainees with a head injury had committed a severe violent offence compared to ten per cent of juvenile detainees without a head injury.

The severity of the head injury (related to the period of time unconscious) was also found to be significantly related to participation in serious violent offences.

The finding of a significant association between self-reported head injury and severe violent offending among juvenile detainees is consistent with findings for adult violent offenders. This association is consistent with the hypotheses that head injury may have an effect on violent offending through increasing the vulnerability of a young person. The increased vulnerability can result either, putatively, through impairing cortical control and lowering the threshold for violence (Blackburn 1993) or through adding to the burden of multiple stressors, weakening restraints that prevent violence (Susman & Finkelstein 2001). The observation that head injuries are associated with violent crime in both young people and adults indicates the important aetiological role such trauma

may play in serious violent offending. The significant relationship between the number of unconscious episodes and the persistence of symptoms of head injury suggests a 'dose-response' effect; the accumulation of stressors specific to head injury (i.e. the number of post-head injury symptoms) that accompany each period of unconsciousness may increase the risk of severe violent behaviour.

It is probably the case that no single factor can explain why young people become involved with violent crime, but the comorbid presentation of head injuries, alcohol use and possibly cultural background best explain such involvement in our study. Research on adult populations has indicated very high percentages of head injury, and even higher rates of substance abuse in adult offenders. The link between head injury, substance use, developmental vicissitudes and impaired executive functioning as a feature of violent crime is also well known, without direct causal pathways yet established (Broomhall 2005). At least one explanation that might provide some understanding of how severe head injury and violent crime intersect is through drawing a distinction between instrumental and expressive violence. Serious violent crime such as juvenile homicide is thought to be an outcome of another offence

'gone wrong' (Carcach 1997) implying a lack of inhibition in the commission of the offence. Moderate and mild levels of violence are probably instrumental, part of a planned offence, in which the amount of violence used is proportionate to the offence goal and not enacted randomly or impulsively. Although we could not directly test the hypothesis in this study, our results are supportive of the hypothesis that severe violent offending may be a product of disinhibition of expressive violence and probably reflects disinhibition of control processes when faced with opposition or frustration. It is probable that the risk of disinhibition is greater when other factors as well as a history of head injury are present, such as cultural factors predisposing a person to the use of violence, substance abuse or victim resistance. If this were the case, it would be reasonable to expect head injuries (a marker for disinhibition) to be associated with expressive but not instrumental violence. These findings support the hypothesis that a history of head injury lowers the threshold for violent behaviour in affected young offenders (Pagani & Pinard 2001).

There was no relationship between head injury, violent crime and serious conduct disorder. Externalising disorders such as conduct disorder and oppositional defiant disorder increase the risk of criminal behaviour (i.e. engagement in crime and hence possible violent crime) and expose a person to risk taking and unsafe situations. The absence of conduct disorder in the severely violent young offenders in this sample is consistent with the disinhibition hypothesis. Head injuries are acquired and much of our sample revealed multiple markers of behavioural problems (school expulsion, bullying etc). Externalising disorders are usually associated with negative developmental experiences that increase the likelihood of instrumental aggression, but these developmental markers were not more prevalent in this sample of severely violent young offenders. Externalising disorders are related to a general deviance orientation, while severe violence is characterised by disinhibition. In our view, severe violent crime can

be explained, at least in part, by head injuries and not generalised deviancy. Head injuries are associated with a certain kind of crime (severe violence), and this association can be explained by both a reduction in restraint as well as the interaction of cumulative stressors such as alcohol use with head injury. The possibility that the negative relationship between severe conduct disorder and severe violent offending might be a product of severe conduct disorder acting as a triage variable, identifying a young person with significant problems and hence diverting them out of the juvenile justice system and into the mental health system, has to be considered. However, such a possibility is unlikely. In most cases severe conduct disorder is an exclusion criterion for treatment. We are unaware of any major treatment initiative that selectively identifies and treats the severely conduct disordered young person in NSW and doubt that the ad hoc treatments available could explain the effect found in our analysis. It is more likely, in fact, that if treatment effects were to be observed it would be with the milder conduct disorders.

Alcohol has an important role to play in augmenting the impact of head injuries on violent crime. Alcohol acts as a central nervous system depressant and reduces the inhibition of behaviour. If head injuries increase the risk of disinhibition, and alcohol also increases the risk of disinhibition, the two together should show synergistic effects, and this is clearly evident in our results. A disinhibition hypothesis would posit that alcohol use and head injury together would have a stronger relationship with violent crime than either alone; that is, they would act as cumulative stressors. The relationship between disinhibition and severe head injury is further strengthened by the finding that gambling and the experience of anger were strongly predictive of head injury in this sample.

Our study found evidence that biological (head injury and alcohol) and social (cultural) factors acted in concert, thus

supporting the biosocial hypothesis proposed by Raine et al. (1997). We have insufficient information to understand precisely what characteristics of our aggregated culturally and linguistically diverse group contributed to serious violent offending. It may be that aggravated assault is more common in some culturally and linguistically diverse groups or that some culturally and linguistically diverse groups are more likely to operate in gangs. Further research on the contribution of these factors to serious violent crime is needed. Factors that had a direct effect through biological dysregulation (head injury and alcohol) were associated with the most serious levels of violence.

There was no relationship between a history of child abuse, in particular physical abuse, and head injury and violent crime. There was sufficient range in the CTQ scores to indicate that the failure to find a relationship was not the result of a ceiling effect. A possible explanation for the lack of association in CTQ scores and severe violent crime was offered by Menninger, Rosen and Mayman (1960). In an examination of offenders who had committed homicide, they found a pattern of severe lapses in ego control that permitted the expression of primitive violence, which they hypothesised originated in early (but now unconscious) traumatic experiences of abuse or neglect; that is, they suggested that some experiences of child abuse and/or neglect are so traumatic they are repressed. If this were the case, young offenders in this study would not be capable of reporting abuse on standardised psychological self-report measures. In fact there was evidence on the minimisation and denial scales of the CTQ that some of our subjects were under-reporting their experiences of abuse.

No cognitive variable (IQ or educational attainment) was related to head injury or violent crime. Previous research has suggested that low IQ and a history of special education are related to violent offending and juvenile offending in general

(Lennings et al. 2003). Despite the apparent counter-intuitive nature of the lack of significance for cognitive variables, this finding has also been observed in previous research on the relationship between head injury and violent crime. Low IQ and educational difficulties tend to be associated more directly with social disadvantage and developmental deprivation and hence have generalised effects on offending behaviour. It is likely that the discrete neurological dysfunction brought about by head injury, particularly the disinhibition of aggressive impulses and impaired executive function, is more closely related to severely violent crime than the more diffuse effects of developmental deprivation (Susman & Finkelstein 2001). It is also the case that the restriction in range of our cognitive variables due to the extreme negative skew towards the very low range of IQs observed in our study and the general low level of cognitive competence exhibited by our participants might have obscured potentially significant relationships between cognitive factors, head injury and violent crime in our sample.

Cultural background was important in predicting the relationship between head injury and severely violent crime. Indigenous young people were significantly less likely to have engaged in severe violent crime than non-Indigenous young offenders, a finding observed in other studies. Lennings et al. (2003) found that Indigenous status was less likely to be associated with violent crime when drug use was controlled for. This finding appears inconsistent with the fact that Indigenous young people are over-represented in detention (Allerton et al. 2003). It is a somewhat counter-intuitive finding that Aboriginality should be 'protective' of violence given the findings in studies of adult prisoners indicating the opposite association. Aboriginal youth offend more often, come into the justice system at a younger age and are more often incarcerated for non-violent crimes than young non-Indigenous offenders (Cunneen 1997). It is possible that the over-representation of Aboriginal

young people in the juvenile justice system means that, as a proportion, more non-violent Aboriginal offenders are institutionalised compared to non-Aboriginal offenders. Further, given the likelihood that the over-representation of young Aboriginal people results from a mix of factors including more assiduous policing of Aboriginals, it is not possible to test whether a 'real' difference exists (Cunneen 1997). The purported systemic bias in the justice system with respect to Aboriginal people makes it possible that a greater percentage of non-Aboriginal offenders are dealt with by alternate means to indictment, or are simply not apprehended; hence, the base rates for discovered crime in Aboriginal and non-Aboriginal groups may be different, preventing genuine population comparisons. A non-random selection factor may be operating, with many more Indigenous young offenders incarcerated for non-violent crime compared to other offender groups.

There was a significant over-representation of violent offending within the culturally and linguistically diverse group. We are unaware of any current research on the relationship between culturally and linguistically diverse group status and juvenile offending in Australia, although inspection of the NSW Department of Juvenile Justice annual reports over the last few years have consistently revealed higher levels of committals among culturally and linguistically diverse people than expected for their percentage in the population. Research into migrant status and youth crime in Australia has largely failed to support the view that certain populations have higher crime rates than others. However, such research does indicate that specific stressors such as refugee status and being unaccompanied as a minor increase the likelihood of involvement in the criminal justice system (Easteal 1997). The relationship between head injury and violent crime for this group is one that needs more research. Not only did the culturally and linguistically diverse group have the

lowest relative rate of head injury, their general over representation in violent crime suggests other as yet unknown causal factors are operating.

LIMITATIONS AND FUTURE RESEARCH

A non-offending control population would have been extremely helpful in further illuminating the relationships observed in this offender sample, particularly since there were no substantial differences between the violent and non-violent groups on most of the factors assessed.

Reliance on self-report of head-injuries is always problematic; however, it is unrealistic and not economically viable to submit each young offender to expensive neurological investigation. The structured nature of the questionnaire ensured some reliability in the self-report, but it is probably the case that some under-reporting of head injuries occurred. Clinical experience indicates that people may hurt themselves when drunk or intoxicated without realising that they have done so, or attribute the period of unconsciousness to simply falling asleep or being 'zonked'.

We were also unable to provide direct measures of frontal lobe function, or coping, factors thought to be important in explicating the role between head injury and violent crime. We relied on proxy judgments based on IQ and educational measures. A future study using responses to social dilemmas might elicit qualitative information to further explore the role of cognitive factors and executive function such as problem solving ability, attributions and attitudes in the relationship between head injury and violent crime.

An important issue the study could not address was the sequencing of violence and head injury. It is possible that engagement in violent behaviour raises the risk of acquiring a head injury, just as having a head injury may raise the risk of engagement in violent behaviour. Longitudinal studies are required to assess these kinds of questions

although research reported by Fonaghy (2004) supports the view that however acquired, head injuries that result in alterations of frontal lobe and executive function increase the risk of aggressive behaviours.

A limitation of this method of violence classification is that homicide is not necessarily associated with a high degree of aggression. A person may be more violent if he engages in several acts of extreme but non-fatal physical assault than a person who fires a gun once and meets his target. The first person is more violent; the second person has a more violent outcome. If privacy laws had not proscribed it, obtaining the police statements of the crime may have assisted in rating the actual degree of violence used by the offender. Plea-bargaining, for instance, may have meant that some young people were sentenced for crimes of lesser violence than actually committed.

CONCLUSION

Consistent with research on adult offenders, this study has found a significant relationship between head injury and participation in severe violent crime in incarcerated juvenile offenders. It is an important finding that has implications with respect to how the court might deal with such offenders and how the criminal justice system addresses the issues of incarceration, treatment and protection of the community. Our research suggests that the relationship between head injury and violent crime is driven by the disinhibition of impulse that severe head injury is likely to cause and that this disinhibition is exacerbated by alcohol use. Subsequent research should follow up violent young offenders with a history of head injury to assess recidivism of violent offending and other offending to determine the level of risk these young offenders pose to the community. The development of impulse control programs for such young offenders and treatment leading to abstinence from alcohol are suggested preventive strategies.

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NOTES

1. In this research subjects were classified into one of three cultural backgrounds: Aboriginal or Torres Strait Islander, English speaking, or Culturally and linguistically diverse. Indigenous identification was given primacy in the classification so if a person identified as an Aboriginal or Torres Strait Islander they were classified as such, regardless of whether their background was English speaking or not.

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