Traumatic Brain Injury and Substance Use In A Prison Population: Lifetime Prevalence Rates and Neuropsychological Sequelae

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Abstract

The present study investigated the rates of traumatic brain injury (TBI) and substance use in a prison population, and the effect of these on neuropsychological functioning. The study was conducted in two parts. In the first part, responses to a screening questionnaire indicated that 86.4% of the 118 subjects had sustained TBI, 56.7% reported more than one TBI, and Maori subjects sustained 12 % more TBI than non-Maori. Subjects reported higher rates of illicit substance use than the general population, and Maori reported higher substance use than non-Maori. All subjects reported difficulties with general memory and socialisation on a Problem Rating Scale, but no differences were found in the level of difficulties reported due to severity of TBI sustained. Subjects with more severe substance use histories reported experiencing most problems with interpersonal relationships, family, and finances.

In part two, 50 subjects from the original sample with a history of TBI and/or substance use, completed neuropsychological measures of short and long term verbal and visual memory, learning, information processing, motor speed and co-ordination, executive functioning, and malingering. All subjects performed below norms on tests of verbal memory and verbal abstract thinking, but overall, no differences were found due to either severity of TBI or level of substance use. Maori subjects obtained the lowest scores on tests of verbal ability, but also reported higher rates of TBI and substance use, which is presumed to account for this result. In conclusion, prison populations seem to have a disproportionably high TBI rate, recurrent TBI rate, and substance use rate, compared to the general population. Further, there are a group of individuals who have experienced both TBI and substance abuse, and consequently have impairments in verbal memory and learning, abstract thinking, and report problems with general memory and socialisation. These difficulties should be taken into account, since they may affect functioning both in prison and following release.

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Chapter 1

Introduction

Traumatic Brain Injury (TBI) is the term used to describe a sudden injury to the head causing a wide range of neuropsychological changes. TBI has been described as the silent epidemic (Gronwall, Wrightson, & Waddell, 1990) because the effects are often invisible to others but devastating to the brain injured individual, and because the prevalence has reached epidemic proportions, affecting millions of people worldwide.

New Zealand is not immune to this epidemic. The Accident Rehabilitation and Compensation Corporation (ACC) estimates that every year in New Zealand 9,000 people are admitted to hospital with a head injury (ACC, 1993). Gronwall (1990) estimates that a further 20,800 are treated at a hospital for TBI but are not admitted. These figures are an under-representation of the problem as they do not include the many more people who receive minor head injuries or concussions, and choose not to go to a hospital. In 1992 the ACC paid out a total of 15,851 new claims for head injury alone (ACC, 1993). This figure excludes accidents which required one week or less off work, and excludes some injuries sustained by the unwaged, children, the elderly, who do not fit into strict compensation categories (ACC, 1993). This figure may then exclude those who sustain light and mild TBI, and some children, elderly, and unemployed individuals. These may be important oversights, since some groups of individuals may have higher rates of TBI than other, and it is now widely accepted that even mild concussions can result in neuropsychological consequences. Thus, the true prevalence of TBI in New Zealand is likely to be much higher than these estimates.

Research suggests that certain groups are over-represented in the TBI statistics; these include young males under the age of 25, racial minorities, and those from low socioeconomic groups. Over 50% of individuals admitted to hospital with TBI are

under 25 years of age and tend to have been involved in a motor vehicle accident (MVA) (ACC, 1993). Maori rates of hospitalisation for MVA are proportionally greater than European rates, particularly in the under 25 age group. Individuals from a low socioeconomic background feature prominently in the TBI statistics, and assaults in addition to MVA are common causes of TBI in this group.

The idea for a study of a prison population developed from an earlier study of memory loss subsequent to TBI, where a control group had been sought from a local prison. It was found that an unusually high number of inmates had sustained TBI. On reflection, this result may have been expected since many predisposing factors for TBI are present in prison populations, including low socio-economic status, fights, and drug and alcohol use, and a specific study of the nature and extent of head injury within New Zealand prisons seemed worthwhile.

The need for research in this area becomes clear when the literature on the consequences of head injury is reviewed. Head injury can result in cognitive, behavioural, and personality changes. Specifically, changes in mood, memory, concentration, resistance to fatigue, and irritability are common, as are decreases in self-awareness, self-control, and motivation. These symptoms all impact on the ability to function in social situations, sustain employment, and form interpersonal relationships. Such symptoms may not be noticed in a prison, given the strictly controlled environment that allows inmates few opportunities to engage in tasks that may highlight cognitive or personality difficulties. On release, however, neuropsychological difficulties may exacerbate the problems of re-establishing a normal lifestyle, and may increase the likelihood of recidivism. Thus, some inmates with a history of TBI are likely to experience difficulties that may affect functioning both while in prison and following their release. Further, these inmates may require and benefit from carefully designed neuropsychological rehabilitation programmes.

Any study of head injury is complicated by drug and/or alcohol abuse. Research has demonstrated that substance abuse can also lead to cognitive, behavioural,

personality, and physical changes, and when comorbid with head injury, can exacerbate an individual's problems. Prison populations are again over-represented in substance abuse statistics, which suggests that there may be a specific population whiho have sustained head injury(s) as well as abused alcohol and/or drugs. This comorbid group may have different problems and rehabilitative needs than a group with either head injury or drug abuse alone.

The purpose of the present research is to determine the nature and extent of head injury and substance abuse in a New Zealand prison population, and to identify the specific neuropsychological outcomes for this population. Chapter two presents the epidemiology of groups that may be at high risk for sustaining TBI, including substance abusers, the New Zealand prison population and Maori. Chapter three covers the classification of severity of TBI, and the neuropsychological and psychosocial consequences of TBI. The fourth chapter reviews the literature on the neuropsychological and psychosocial consequences of substance abuse. The rationale and hypotheses pertaining to the present research are presented in chapter 5. Methodology, results, and discussion of the research findings with respect to the literature, are presented in chapter six to eight respectively, and chapter eight also presents the conclusions and recommendations arising from this research.

Chapter 2

Risk Factors for TBI: Socio-Economic-Status, Motor Vehicle Accidents, Age, Substance Abuse and Incarceration in New Zealand

The purpose of the present chapter is to examine the epidemiological information pertaining to those populations with a higher risk of sustaining TBI. The risk factors reviewed include age, alcohol use, motor vehicle accidents, and socioeconomic status (SES), with an emphasis on how these factors apply to New Zealand. The epidemiological characteristics of substance abusers, prison inmates, and Maori in New Zealand are presented, since these groups may have higher rates of TBI than the general population.

Factors That Increase the Risk of Sustaining TBI

The most common causes of TBI include MVA's, falls, and assaults (Bond, 1986; Dikmen, Donovan, Loberg, Machamer, & Temkin, 1993; Morse & Montgomery, 1992). In Western countries, including New Zealand, MVA occur more frequently in males aged 15 to 25, and are often associated with alcohol use (ACC, 1993). Alcohol use immediately prior to injury is a significant risk factor for sustaining TBI, and research indicates that it is the most extensively studied and well accepted causal factor (Dikmen et al., 1993). The literature pertaining to alcohol use and TBI will be reviewed later in this chapter, together with the literature concerning alcohol use in New Zealand.

SES also features prominently in TBI mortality and morbidity literature. Individuals on low incomes with lower standards of living are subject to higher risk of sustaining TBI and may also experience more negative outcomes (Lezak, 1983). In a review of the US literature, Morse and Montgomery (1992) concluded that 75% of all TBI victims are from low SES groups with an income under US$10,000 per annum. This corresponds with early epidemiological research which found higher rates of mortality and morbidity from accidents, falls, and fights in low SES groups compared to higher SES groups (Blaxter, 1976). Further, Lezak (1983) suggests individuals

who are bought up without adequate nutrition, housing, medical attention, and education have a higher prevalence of illness and disorders that may result in less effective adaption and recovery following TBI.

Age is another factor that influences both the risk of sustaining TBI and recovery from TBI. The average TBI victim is approximately 20 years old, with most injuries sustained between the ages of 10 and 30 years (Bond, 1986; Morse & Montgomery, 1992). ACC (1993) statistics indicate this is also the trend in New Zealand, particularly for MVA. Further, the rates are high for children and those over 70 years of age, where falls are the most common cause. Younger people tend to have a more positive neuropsychological outcome than older individuals (Lezak, 1983). Specifically, age and severity appear to interact to produce a more negative status following TBI, stroke, tumors, and neurosurgery.

Populations with Comorbid TBI and Alcohol Abuse

There is a growing body of international research indicating the existence of a specific group of people who have a history of problem drinking as well as one or more TBI (Brismar, Engstrom & Rydberg, 1983; Dikmen, et al, 1993; Grant, Adams, Carlin, & Rennick, 1977; Greer, 1986; Jones, 1989; Miller & Welte, 1987). This group of people is overly represented in prisons, as Miller and Welte (1987) found in a group of inmates who abused alcohol and/or other drugs, were young low income males, had lower education levels, and had a history of violence and violent offences.

Overseas research has linked alcohol use and head injuries. Dikmen et al. (1993) state that alcohol use is "*the most commonly cited and best predisposing factor in head trauma*" (p.296). Intoxicated people are more likely to get into fights, have falls, and to perform dangerous activities such as drunk-driving (Tarter & Edwards, 1986; Brismar,et al., 1983; Malloy, Noel, Longabaugh, & Beattie, 1990). The research indicates that the number of TBI victims having both detectable blood alcohol levels and meeting the criteria for alcohol dependence, are increasing over time. In a two year study of hospital admissions for head injury Edna (1981) found

that 52% had a detectable blood alcohol level, while Brismar et al. (1983) in a study of 100 hospital admissions for concussion, reported 58% were intoxicated, of whom 43% met the criteria for a diagnosis of alcohol dependence. In another study, over 40% of Accident and Emergency admissions for head injuries had elevated blood alcohol levels (Jones, 1989). This study estimated that approximately 55% of people who sustain head injuries have a history of alcohol or drug abuse, and that around 40% have moderate to severe substance abuse problems. In a recent review, Miller (1992) concluded that up to 68% of head injured patients have elevated blood alcohol levels at the time of their injury.

Miller (1992) also suggests that up to 50% of all people who sustain TBI had a pattern of pre-injury alcohol abuse. Dikmen et al.'s (1993) estimate is more conservative, with around one-third of all TBI victims estimated to meet the criteria for alcohol dependence. When this is applied to New Zealand head injury figures, it is probable that between 3,000 and 4,500 new individuals will meet the criteria for alcohol dependence or abuse each year. Further, it is likely that alcohol use was a causal factor in sustaining the head injury(s).

Research indicates there are links between TBI, substance abuse, and imprisonment. Specifically, a group within the population may be more likely to both abuse alcohol and sustain TBI, and in turn, may experience severe psychosocial and personality changes as a consequence. Malloy et al. (1990) conducted neuropsychological assessments of individuals in a rehabilitation programme who had both a pre-head injury history of impulsive and dysfunctional behaviour and met the criteria for diagnoses of Antisocial Personality Disorder (ASPD). The ASPD group began both drinking alcohol and having alcohol abuse related problems at an earlier age than controls. Both the ASPD alcoholics and ASPD non-alcoholics had a significantly higher prevalence of serious head injuries than controls, and the ASPD individuals as a group. Further, the types of behaviour engaged in by individuals meeting the diagnosis of ASPD tends to result in convictions and imprisonment (Kaplan & Sadock, 1991). Thus, it seems that prison populations may contain a number of individuals who have both experienced TBI and have a history of substance abuse.

Substance Use in New Zealand

Research on substance use and abuse is subject to a number of methodological biases, many of which will be covered in chapter 4 of the present study. There is a lack of representative research on the epidemiology of substance use in New Zealand, (with the exception of alcohol), due to the methods employed in data collection. The largest and most representative piece of research was a telephone survey of a random sample of 4,088 people between the ages of 15 and 45 in two regions of New Zealand, and was conducted to examine the use of alcohol, tobacco, prescription medications and illicit substances (Black & Casswell, 1993).

Cannabis Use in New Zealand

Cannabis was found to be the most frequently tried of all the illicit drugs, with 43% of the sample having experience with this drug, but only 12% indicating they were current users (Black & Casswell, 1993). Most of those who had tried cannabis did so when they were under the age of 20 years, and about 3% stated they had used cannabis ten or more times in the previous month. This frequent user group were mostly male and 81% were under the age of 30 years. A range of problems associated with frequent use were reported by this group, including trouble with the law, memory difficulties, financial problems and decreased motivation (Black & Casswell, 1993).

Other Illicit Substance Use in New Zealand

The rate of use of illicit substances other than cannabis was low compared to alcohol and tobacco use (Black & Casswell, 1993). Only 8% of the sample reported experience with hallucinogens, 5% had tried stimulants, 3% had tried opioids, 2% had experience with tranquillisers or barbiturates, and 0.9% had ever tried inhalants. The survey indicated that substances used in the US were also available in New Zealand, with reports of cocaine, crack, methamphetamine, heroin, and homebake being used. However, only 3% of the sample stated they taken drugs intravenously, and only one respondent reported using a needle in the previous 12 months. Rates for intravenous drug use in New Zealand are not available, but estimates indicate that 16,000 have used intravenous drugs and around 7,000 are current users (Adams,

Paulin, & George, 1992). During 1990, approximately 240,000 syringes were distributed through the New Zealand needle and syringe exchange programme, indicating that a significant number of users chose to make use of this scheme (Steenhuisen, 1991). Taking these statistics into consideration, the results obtained by Black and Casswell (1993) seem to be lower than might be expected since only a small number reported intravenous use, suggesting that a subset of the drug using population were either missed or declined to provide accurate information about their drug habits. This could have occurred because only those able to afford a telephone were surveyed, the age of the sample was restricted, and only one North Island urban and one rural area were sampled. Thus, the rates of illicit substance use in New Zealand may be higher than the figures obtained by this study.

Alcohol Use In New Zealand

The pattern of alcohol use has been surveyed and monitored by the New Zealand Department of Health and the Alcohol Liquor Advisory Council (Black & Casswell, 1993; Wyllie & Casswell, 1989). Black and Casswell (1993) reported that 43% of males aged between 18 and 24 years consumed 6 or more drinks at any occasion. Around 60% of this age group reported feeling drunk at least once a month, and 25% reported experiencing 2 or more problems associated with alcohol use. Wyllie and Casswell (1989) surveyed alcohol use in a sample of 1,680 people aged 14 to 65 years in 1988. A total of 77% of all alcohol consumed by the sample was used by males, with males aged between 18 to 23 and 35 to 44 years, consuming the most. Forty-four percent of males sampled reported experiencing problems due to alcohol use that were more severe than a hangover. The problems areas most often endorsed were health, energy/vitality, appearance, friendships/social life, outlook on life, and financial position. Seven percent of males in the sample reported being assaulted twice on average by someone who had been drinking in the previous year. Seven percent of women sampled also reported being assaulted by someone who has been drinking, on an average of 4 occasions. These figures represent 81,000 males receiving 168,000 assaults and 79,000 females receiving 283,000 assaultsper year. These statistics from Wyllie and Casswell, along with the list of frequently endorsed problems, provide a clear illustration of the types of problems that result from the misuse or abuse of alcohol.

Polysubstance Use In New Zealand

Polysubstance use is common among individuals who report using illicit drugs. Black and Casswell (1993) found that the most common combination was alcohol, cannabis, and tobacco use, with 33% of the sample reporting this pattern. Alcohol and tobacco in combination were reported by 23%, with only 8% using cannabis and alcohol together and 2% using cannabis and tobacco. As only 34% of the sample reported using any illicit drug at all, the numbers reporting polysubstance use were small. A total of 4% reported trying three or more illicit drugs, and only 2% of these stated they had used these drugs on 5 or more occasions.

In summary, the research indicates that few New Zealanders have ever used any illicit substance with the exception of cannabis, and only a small percentage have tried a range of illicit drugs. However, this epidemiological information is based on the one study that has been conducted in New Zealand, and it probably underestimates the problem due to sampling flaws. In contrast, alcohol use appears to be wide spread throughout the general population, is often used in excess, with a range of negative consequences being reported. It is likely that research with a subset of the general population such as prison inmates would provide different substance use statistics, given that the research on U.S.A. prison populations has demonstrated that inmates are more likely to have abused and experimented with illicit substances (Franklin, Allison, & Sutton, 1992; Harlow, 1991; Maden, Swinton, & Gunn, 1992).

The New Zealand Prison Population

In accordance with overseas trends, both the number of inmates in New Zealand prisons and the seriousness of offences increases with each new census. In November 1991 there were a total of 4,232 people incarcerated in New Zealand's 20 penal institutions, giving an incarceration rate of 121 per 100,000 head of population (Braybrook & Southey, 1992). This is an increase of 49% in the number of inmates at the same time in 1983, and reflects both an increase in the number of cases handled in New Zealand courts and an increase in the length of sentences received by inmates (Spicer & Norris, 1993). The census found that most of the inmates were

persistent offenders, with 61% of the male inmates incarcerated at least once before the current term. The majority of these persistent offenders were imprisoned for serious crimes; approximately half had committed a violent offence, and almost half had a record of at least 20 previous convictions (Braybrook & Southey, 1992).

The 1991 New Zealand prison census found gender, age, and ethnic differences within the prison population, again consistent with research in other Western countries (Harlow, 1989). In New Zealand, females account for only 2.8% of the total prison population, a clearly significant gender difference. At the time of the 1991 census, the majority of inmates were aged 30 or younger. Specifically, 40% were aged 25 years or younger and 62% were under 30 years of age (Braybrook & Southey, 1992). Forty percent of male inmates chose to identify as New Zealand European, 43% identified as New Zealand Maori, and 9% as Pacific Island. Given that Maori and Pacific Island people constitute only a small percentage of the total New Zealand population, these ethnic groups are disproportionably represented in the prison population. (Department of Statistics New Zealand, 1994). Further, Maori male inmates were younger on average than other inmates, indicating that Maori inmates tend to be incarcerated at an earlier age than their European counterparts, a trend evident with ethnic minorities in other Western countries (Braybrook & Southey, 1992).

The number of drug related convictions in New Zealand have increased over the last 10 years. Norris and McPherson (1990) report a 36% increase from 1985 to 1989 in possession and dealing convictions. Most convictions were due to possessing or dealing cannabis, followed by hallucinogenic drugs, heroin, and cocaine (Spicer & Norris, 1993). In fact, the number of convictions for dealing in cannabis have increased 78% from 1983 to 1992, and convictions for dealing in drugs other than cannabis have increased 266% during the same time period. This may reflect either a more aggressive policing policy, or an increase in the availability and use of illicit substances, but these statistics are in line with the conviction rates for other Western countries (Harlow, 1991). Further, alcohol abuse is common amongst prisoners, with one US study finding that a third of inmates had consumed a large amount of alcohol prior to committing offences (U.S. Department of Justice, 1983).

In summary, the New Zealand rates of imprisonment are increasing at approximately the same rate as other Western countries. The profile of an average offender is male, under 30 years of age, more likely a repeat offender, and with a 50% chance of being Maori. Further, the typical prison inmate is twice as likely to have experimented with illicit substances as the general population, and is 7 times more likely to be a current drug user (Harlow, 1991).

Populations at Risk of TBI in New Zealand

There are factors that predispose individuals to sustaining TBI, and groups within a population often share risk factors. Those most at risk of TBI include individuals in low SES groups, alcohol abusers, and those sustaining motor vehicle accidents. Any group within a population who are exposed to these risk factors are likely to be over-represented in TBI statistics. In New Zealand, research indicates that Maori are included in this group.

New Zealand is a multicultural society, with a population consisting mostly of people of European, Maori, Pacific Island, and Asian origin. Maori comprise 13% of the New Zealand population, yet are over-represented in many of the negative social indicators, such as low income, unemployment statistics, crime statistics, and illness and injury figures (Department of Statistics New Zealand, 1994). Pomare and de Boer (1988) state that in 1984, 60 to 70% of Maori could be classified into the two lowest SES groups. Membership in these SES groups is an indication of low income, high rates of unemployment, poor standards of housing and education, lower self esteem, and a higher imprisonment rate than members of higher SES groups. Specifically, the 1991 Census of population in New Zealand found more than half of Maori had no formal qualifications and had a mean annual income of $11,000, which is lower than the mean Pakeha income of $14,800. The mean income for the Pacific Island population, which comprises 3.9% of New Zealand, is even lower than Maori at $10,800, indicating this population may be subject to similar risk factors as Maori (Department of Statistics New Zealand, 1994).

Maori aged 5 to 64 years are admitted to hospital following MVA twice as often on average as non-Maori, and MVA is the leading cause of hospital admissions for Maori males aged 15 to 44 years old (Pomare & de Boer, 1988). Maori also have a high hospital admission rate resulting from non-motor vehicle accidents and falls, both of which are linked epidemiologically to TBI. Alcohol abuse occurs at a higher rate in Maori compared to non-Maori in New Zealand. In 1984 the Maori psychiatric admissions for alcohol dependence/abuse occurred at a rate of 10.5 per 10,000, in contrast to the non-Maori rate of 3.8 per 10,000 (Pomare & de Boer, 1988). The rate of alcohol-related deaths for Maori males is 2.8 times higher than non-Maori, and approximately 50% of all Maori MVA mortalities can be linked to alcohol. Further, 4.5 times more Maori than non-Maori are arrested for drunk-driving (Bailey & Belsham, 1982).

In summary, Maori have high rates of all the well established risk factors of TBI, including low SES, hospital admissions for MVA, accidents and falls, higher rates of psychiatric admissions for alcoholism, and higher rates of drink-driving than non-Maori. Therefore, it seems reasonable to expect Maori to have an inflated rate for TBI when compared to non-Maori, and this hypothesis will be investigated by the present study.

Conclusions

There is evidence to suggest that specific groups may have higher probability of sustaining TBI than the general population. Belonging to a low SES group is an important risk factor for TBI, other injuries, and mortality. There is strong evidence to suggest TBI and substance use/abuse are associated, with high numbers of admissions to hospitals for TBI having positive blood alcohol levels. Further, the link between motor vehicle accidents and assaults and alcohol use is well established. Prison populations contain high numbers of substance users compared to the general population. Prison inmates are more likely to experiment with drugs and to be current users, and alcohol use is associated with committing offenses. Being of Maori origin appears to be a risk factor for a number of negative factors including alcohol use, low SES, imprisonment, and motor vehicle accidents, and given these

factors, Maori may be at higher risk than non-Maori of sustaining TBI. Further, approximately half of all New Zealand prison inmates are Maori and aged under 30 years of age, placing them in risk groups for alcohol abuse and MVA, the two factors most consistently linked with increased rates of TBI. These factors indicate that prison populations may have higher rates of TBI and substance abuse than the general population, and may have measurable levels of neuropsychological deficits associated with these factors, as outlined in the following two chapters.

Chapter 3

Traumatic Brain Injury: Neurophysiological and Neuropsychological Sequelae

Any literature review on the neuropsychological effects of TBI will reveal extensive research, and accordingly, this chapter examines only those aspects pertaining to the present study. The sequelae commonly associated with mild, moderate, and severe TBI will be reviewed, along with the much researched post concussive syndrome. The cognitive, behavioural, and personality changes that can occur will be covered, with respect to the associated cortical areas. The effects of recurrent TBI will be examined, as will the impact of substance use on survival and recovery from TBI. Determining the nature and extent of damage sustained in a TBI is essential to any retrospective research study. Accordingly, this chapter will commence with a review of the issues relating to the classification of severity of TBI.

Classification of Traumatic Brain Injury

TBI is typically classified as mild, moderate, or severe, on the basis of either the Glasgow Coma Scale (GCS) or the duration of Post-Traumatic Amnesia (PTA). The GCS developed by Teasdale and Jennett (1974) was designed to give a global measure of the post-traumatic state of altered consciousness, ranging from deep coma to mild confusion. The severity of coma is assessed on the basis of the best total score for three dimensions; ocular, verbal, and motor responses. A patient receives a total score ranging from a low of 3 to a high of 15, with a score of 8 or less constituting a severe TBI, scores of 9 to 11 or 12 are considered moderate, and scores of 12 or 13 to 15 are considered mild (Morse & Montgomery, 1992; Teasdale & Jennett, 1974).

The GCS is widely used as an indicator of TBI severity in both hospitals and research studies. Stambrook, Moore, Lubusko, Peters, and Blumenschein (1993) assert that the accuracy of the GCS is confounded when TBI victims are intoxicated, since both head trauma and intoxication cause altered levels of consciousness. Teasdale and Jennett (1974) did not intended that the GCS would be capable of

distinguishing between mild and moderate TBI, as it is a brief screening instrument with a restricted range of possible scores. Although subject to the same constraints when applied to intoxicated patients, the duration of PTA may be more useful than the GCS in estimating the severity of outcome (Morse & Montgomery, 1992). PTA refers to the duration of time taken for a patient to regain memory for day-to-day events. It is measured from the time of injury onwards, and includes any time spent in a coma or period of altered consciousness. No PTA or loss of consciousness following TBI is typically classified as light, PTA of one hour or less is considered mild, from 1 to 24 hours is classified as moderate, and PTA of 24 hours or longer as severe TBI. PTA has been found to be more accurate than GCS scores when estimating the neuropsychological consequences of TBI (Morse & Montgomery, 1992).

Another method for classifying the severity of TBI is to make an estimate based on the duration of unconsciousness immediately following the injury. Generally, the greater the period of unconsciousness and confusional state, the more severe the head injury (Morse & Montgomery, 1992). The advantage of this estimate is that very mild TBI can be assessed with the same level of accuracy as severe TBI. Thus, patients who receive a mild concussion and do not attend a hospital or general practitioner, and so do not receive a GCS or PTA score, can still be included in a research study. Patients often do not know their GCS or PTA scores, but are usually aware of any period of unconsciousness, which provides a guide to the severity of TBI sustained.

Physical Sequelae Associated with TBI

Both mortality and morbidity can result from TBI; survival rates depend on many factors including the extent, location, and type of brain injury, the age and premorbid history of the victim, whether drugs and/or alcohol are involved, and the length of time before medical attention is available.

Historically, TBI can be split into two general types, acceleration and deceleration injuries (Morse & Montgomery, 1992). Acceleration injuries occur when a

stationary person is struck by a vehicle or missile, causing the brain to both rapidly accelerate and decelerate within the skull. Acceleration injuries can cause contrecoup injuries and general contusions as well as open head wounds, where the skull is cracked and the brain is exposed and damaged. Deceleration injuries are more common and occur, for example, when a moving person strikes a stationary object and result in the motion of the head stopping very suddenly. TBI sustained in car or bicycle accidents are examples of deceleration injuries, which tend to result in closed head injuries with diffuse damage throughout the brain, including axon shearing, stretched nerve fibres, torn arteries and veins (Gronwall et al., 1990; Morse & Montgomery, 1992).

Secondary injuries can occur following the initial damage, further complicating outcome. These fall under two main headings; systemic processes and intracranial processes (Morse & Montgomery, 1992). Systemic processes refer to the systems supplying the body with oxygen and nutrients that are often disturbed following TBI Johnson, Roerthig-Johnston, & Richards, 1993). Hypoxia, arterial hypotension, anaemia, hypoglycaemia, or hypercapnia, can result from respiratory or vascular disturbance, and these are associated with neuropsychological sequelae of their own. The behaviour syndrome of severe hypoxia, for example, consists of exaggerated hysterical symptoms, including non-goal directed manipulativeness, gross exaggerations of deficits, inappropriate responses to reinforcement, as well as extrapyramidal motor disorder (Eames, 1990; Kolb & Whishaw, 1990).

Disturbances to intracranial processes can result in a range of outcomes, including edema, vasospasm, epilepsy, and infection. Edema can be caused by contusions, fluid build up due to dead cells, damage to the ventricular system, or hydrocephalus due to disturbance in the flow or absorption of cerebrospinal fluid. These disturbances cause intracranial pressure to rise, risking further damage to brain tissue. Damage to both systemic processes and intracranial processes result in the brain shifting within the skull, increasing the chance of hypoxia or ischemia. It is important, therefore, for the risk of secondary damage to be identified quickly after TBI, since early treatment can prevent much of the additional damage. Simply

maintaining blood pressure and oxygenation systems can reduce the risk of hypoxia, and brain scans determine whether treatment is necessary (Johnson, et al., 1993; Kolb & Whishaw, 1990; Morse & Montgomery, 1992).

In summary, it is not possible to determine the effects of TBI based upon an assessment of the focal site of injury alone. Secondary damage should be taken into account and careful ongoing assessment is necessary to document the types of impairments received and the recovery of function that occurs over time. The severity of the injury received is another factor influencing the type and extent of sequelae resulting from TBI, and this is presented in the following sections.

Neuropsychological Effects of Light and Mild TBI

Light and mild TBI tend to result in diffuse axonal injuries rather than focal or systemic injuries (Morse & Montgomery, 1992). Recent literature indicates patients are left with cognitive deficits following minor TBI that are evident on neuropsychological testing. Impaired memory and visuo-spatial deficits can occur, and are often independent of both the duration of loss of consciousness and PTA (Barth, Macciocchi, Giordani, Rimel, Jane, et al., 1983). Measurable deficits have been found in reasoning, information processing, and verbal learning (Leninger, Gramling, Farrell, Kreutzer, & Peck, 1990). Further, mild TBI can cause significant disruptions to daily activities due to headaches, fatigue, irritability and memory difficulties (Dikmen, McLean, & Temkin, 1986; Leninger, et al., 1990; Schapiro & Sacchetti, 1993). These symptoms together with dizziness, anxiety, blurred vision, insomnia, and attention problems, comprise the phenomena known as post-concussive syndrome (Binder, 1986; Gronwall, 1989). The prevalence of this syndrome is unclear due to the potentially large number of people who choose not to seek medical assistance for the initial injury or the subsequent cluster of symptoms. The duration of the syndrome is also unknown, but research indicates symptoms may persist for 3 months or longer (Gronwall, 1991).

Neuropsychological Effects of Moderate and Severe TBI

Moderate and severe TBI both tend to result in a combination of diffuse axonal and focal and systemic injuries resulting in a wider range and greater severity of possible injuries (Morse & Montgomery, 1992; Rimel, Giordani, Barth, & Jane, 1982). The mortality and morbidity rates for moderate and severe TBI are proportionally higher than the rates for mild TBI. Again, it is difficult to describe the nature of the impairments associated with either moderate or severe TBI as these depend on factors such as the site of injury, the subsequent systemic damage, and injuries to the rest of the body. However, research indicates that a degree of recovery of function occurs more frequently with moderate than severe TBI, with better levels of social, emotional, interpersonal, and vocational functioning being obtained (Rimel, et al., 1982).

Neuropsychological Outcomes Following TBI

The following review of symptomology associated with TBI is divided into the cognitive and personality disorders that have been documented in the literature. No distinction is made for severity of TBI, but in general, more severe brain damage is associated with more severe and profound impairments (Kolb & Whishaw, 1990).

Cognitive Disorders

Cognitive functioning can be defined as the ability to process, store, retrieve, and manipulate units of information (Prigatano & Fordyce, 1986). Problem solving and general functioning within an environment depend on the cognitive processes that are often damaged as a result of TBI. These processes include attention and concentration, learning and memory, speed of information processing, initiation and planning, judgement and perception, and communication, (Burgess & Wood, 1990; Eames, 1990; Novak, Roth, & Bell, 1988; Prigatano, 1992; Prigatano & Fordyce, 1986). The literature pertaining to these symptoms will be examined, with the most commonly reported outcomes examined first, and the less frequent symptoms reviewed later.

Attention and Concentration

Disorders of attention and concentration frequently follow TBI. Patients report difficulty in maintaining concentration, problems with selective and divided attention, as well as poor shifting of attention, which in turn make it difficult to follow conversations in groups, complete tasks, and perform more than one activity at a time (Kolb & Whishaw, 1990; Prigatano & Fordyce, 1986). Morse and Montgomery (1992) state that changes to attention processes result in people being slower to take in information, which affects both interpersonal relationships and work performance.

Learning and Memory

Learning and memory are two areas of functioning commonly affected following TBI, regardless of the severity of injury sustained (Binder, 1986; Gualtieri & Cox, 1991). Short term memory is typically spared from deficit, and loss of memory for past events is rare (retrograde memory), but problems with other areas of memory occur, especially memory for new material (anterograde memory), resulting in difficulty remembering names, appointments, telephone numbers, and daily activities (Morse & Montgomery, 1992). Ability to rote learn material may be impaired, and declarative memory is more often affected than procedural memory, with problems occurring in encoding, storage, or retrieval of information. This is compounded by impairments in organising and processing information (Prigatano & Fordyce, 1986). The incidence of memory problems increases as the severity of TBI increases, which clearly impacts on the ability to sustain interpersonal relationships and function effectively in an employment context. Comprehensive assessment is required to determine the nature of the memory difficulty.

There is evidence to suggest not only that there is little improvement to the severity of memory deficits over time but that further deterioration may occur (Gualtieri & Cox, 1991; Novak et. al., 1988; Prigatano, 1992). Prigatano's subjects reported no improvement (or deterioration) after 15 years, but Gualtieri and Cox (1991) state the concept of delayed deterioration syndrome is beginning to gain credence with initial research indicating no association with either dementia or depression.

Information Processing

The time taken to complete even simple tasks greatly increases following TBI, resulting in slowed psychomotor activity and reaction time (Prigatano & Fordyce, 1986). Impairments to attention and concentration abilities are associated with slowed information processing ability and increased fatigue, which all impact on the ability to resume normal levels of functioning following TBI (Morse & Montgomery, 1992).

Initiation and Planning

TBI can cause deficits to the executive function of initiation and planning of goal directed activities. Specifically, damage to the lateral convexity of the frontal lobe results in two specific disorders (Eames, 1990). The first involves an inability to execute plans in an organised manner, and the second results in a more general inability to generate new ideas, dream, or be creative. Other deficits include the areas of problem identification, goal formation, self-regulation, concept formation, temporal sequencing, and the non-verbal ordering of new information (Levin, 1990; Eames, 1990; Morse & Montgomery, 1992). Prigatano and Fordyce (1986) include impairment of the abstract attitude, ability to inhibit responses, slowed initiation of responses, difficulty requesting help and learning from mistakes, and the generation of unrealistic problem solving strategies, under the general heading of initiation and planning deficits. These deficits are amongst the most disabling for a patient, since maintaining interpersonal relationships and productive employment are dependent on both problem solving skills and the ability to initiate and plan goal directed abilities.

Judgement and Perception

Impairments to judgement and perception can result from TBI. Misinterpreting the intentions or actions of other people falls under this general heading, along with impairments to self perception and appraisal. Prigatano and Fordyce (1986) state that patients can become confused when presented with more than one piece of information and may respond in a socially inappropriate manner. Connected with this is the notion of general unawareness of one's impact upon others and

unawareness of deficit, which will be discussed further under personality disturbances associated with TBI (Prigatano, 1986; Morse & Montgomery, 1992).

Communication

Ineffective retrieval of words or strict anomia are sometimes reported after TBI, along with tangentiality of both thought and speech. Inappropriate talkativeness can occur and is often associated with an uninhibited choice of words, which can result in social difficulties. Slowed processing of written or auditory material contributes to socialisation difficulties. Speech production disorders such as aphasia or apraxia can also occur (Prigatano & Fordyce, 1986; Morse & Montgomery, 1992).

In summary, a range of cognitive disorders have been associated with TBI, all of which affect the ability to function in interpersonal, social, and vocational relationships. However, the behavioural and personality disorders that have been associated with TBI also have an impact on functioning as a review of the literature demonstrates.

Personality and Behavioural Disorders

Personality can be defined as a general pattern of motivational and emotional responses that develop over time (Prigatano, 1986). As with cognitive disorders, there are a range of disturbances that can be addressed under the heading of personality disorders. Many impairments can result from damage to specific functional areas of the brain, and the associated disorders will be reviewed here, beginning with the more commonly reported disorders.

Psychomotor Agitation

Agitation and general restlessness can occur following TBI , particularly during the acute stages of recovery (Prigatano, 1986). In the early stages, psychomotor agitation and disorientation tend to manifest in association with paranoid ideation, which may be a reflection of generalised cognitive confusion. More chronic psychotic reactions are thought to be associated with left temporal lobe damage, which is believed to stem from cognitive and perceptual disturbances. Irritability has been identified as

the single most common personality and behavioural complaint following a moderate or severe TBI (Prigatano, 1992). As with many disorders, it is likely that irritability is caused by both neurological damage and /or reactions to psychosocial stressors. For example, an inability to complete tasks that were easily manageable before injury, and repeated failures in other areas causes irritability, frustration, and depression.

Frontal Lobe Disturbance

Many of the personality changes that occur are associated with damage to the frontal lobe. The changes are so well documented that the label "*frontal lobe syndrome*" or "*frontal lobe personality*" have been developed (Eames, 1990; Stuss, Gow, & Hetherington, 1992). Stuss et al. (1992), however, suggest that "*frontal personality disturbance*" is more apt, since the damage causes changes to the unique and individual behaviour patterns that embody personality. The fundamental characteristic of the disorder is a lack of self-reflection, or a basic lack of insight. This combines with the other key features of the disorder to result in disturbing changes to drive, mood, affect, and other aspects of personality. These changes include social disinhibition, self-centredness, childishness, unrealistic attitudes and expectations, apathy, indifference, restlessness, and depression. Taken individually, each symptom has a devastating effect on social and interpersonal relationships, so the cluster of symptoms that occur with frontal lobe damage present significant problems.

Socialisation Disorders

Social disinhibition has been associated with the social isolation that follow many TBI (Marsh & Knight, 1991). The reduced concern for social propriety leads TBI victims to behave inappropriately and to discuss issues publicly that are more suitably discussed in private. In many cases the person knows how to behave appropriately, but is unable to make the transition from knowledge to behaviour (Stuss et.al. 1992). This causes profound embarrassment to both the TBI victim and their family and friends.

Disorders of Initiation and Motivation

Other disorders associated with damage to the frontal lobes can be as disruptive as the frontal personality disturbance. Damage to the medial surface of the frontal lobes can produce a passive behaviour disorder. People with this disorder have profound difficulties in generating spontaneous activity, and present with symptoms of depression that do not include sad affect (Eames, 1990). Apathy, indifference, and disordered emotional expression result from dorsolateral frontal damage. Bifrontal lesions cause impulsiveness, inappropriate behaviour, and antisocial activity (Stuss, et.al., 1992).

Aggression Disorders

Serious aggressive disorders have been correlated with damage to the frontal lobe. Anger and aggression tends to be episodic in nature, rather than chronic (Cassidy, 1990). It has been variously labelled as "frontal aggression" and "organic personality disorder, explosive type" (Cassidy, 1990). Yet, Prigatano (1990) states there is little evidence that frontal lobe damage actually causes aggression specifically, but suggests damage results in having a reduced range of alterative behaviours to deal with conflict. Frontal lobe damage causes impairments such as behavioural rigidity, stereotyped responses, and reduced self-awareness, which together make dealing with conflict and frustration difficult.

Depressive Disorders

Depression is a common outcome of TBI, but research has demonstrated that it is not related to either the severity of the injury sustained, or the level of impairment (Cassidy, 1990; Godfrey, Marsh, & Partridge, 1987; Prigatano, 1992). The onset of depression is typically 3-18 months after TBI, and is believed to occur as a reaction to the consequences of the injury. People report feelings of worthlessness, helplessness, a loss of interest in work and social activities, increased dependence on others, and significantly, a sense of catastrophic loss of their former abilities (Cassidy, 1990; Prigatano, 1992). Depression is often linked to the social withdrawal that often occurs with TBI. Social skill deficits lead to a failure to maintain satisfactory social interactions, and past failures and embarrassment cause patients to

avoid social situations. This results in social isolation and loneliness, both of which are common problems for brain-injured people and are often associated with reports of anxiety.

Anxiety Disorders

Postmorbid anxiety and the behavioural phenomena known as the "catastrophic reaction" refer to the overt behaviour exhibited following failure to complete a desired task. Prigatano (1986) describes this state as having similar behavioural manifestations as anxiety, but in reality, the reaction occurs due to cognitive confusion, emotional lability, and a lack of social skills to cope appropriately with the situation. Behaviourally, patients appear confused and dazed, have poor tolerance for frustration, may become agitated and aggressive, bad tempered and uncoordinated. Adding to the confusion are observers negative reactions to the behaviour found rewarding by the patient, which can add to the feelings of hopelessness.

Disorders of Self-Awareness

Anosagnosia or denial of deficit refers to a general disturbance to self-awareness after TBI that can contribute to poor psychosocial outcome following recovery (Crosson, 1987; Prigatano, 1991). Patients that are not fully aware of their cognitive, emotional, and behavioural limitations, often choose to return to work too soon, and can perform poorly with interpersonal and social relationships. Through being unaware of the social inappropriateness of their behaviour, patients unwittingly lose friendships and end relationships. When confronted with the extent of the deficits or the inappropriate behaviour patients tend to react badly and become angry or withdrawn (Prigatano, 1986).

Psychological denial and genuine unawareness of deficit have different causes but similar presentations. It is important to differentiate the causal factors for the purpose of rehabilitation, as patients cannot work towards improving impairments they are either unaware of, or deny (Prigatano, 1991). Psychological denial is thought to be motivated by a need to suppress the actual extent of the deficits from

conscious awareness to prevent severe depression and catastrophic reactions, whereas "genuine" denial is thought to have an organic basis. Neuropsychological evidence suggests the disorder develops due to decreased responsiveness of the nervous systems to stimuli. Changes in arousal and attention mechanisms lead to decreased self-awareness, which suggests that deficits are denied because the person is unaware of them. Prigatano (1986) concluded from a literature review that unawareness of deficit occurs frequently with nondominant hemispheric lesions and has been consistently associated with disorientation to time and place and non-aphasic naming errors, which may assist in differential diagnosis.

Disorders Associated with Pre-Frontal Damage

There are three rare clinical syndromes associated with prefrontal damage, confabulation, reduplicative paramnesia, and capgras syndrome. These syndromes are delusional disorders that demonstrate failures to perceive and test reality. Confabulation is a disorder where imaginative and untrue answers are given to questions. Reduplicative paramnesia refers to the belief that two or more locations exist simultaneously, and have identical features. Capgras syndrome is similar to reduplicative paramnesia, but it is the belief that a person has been duplicated and then replaced by the substitute (Stuss et.al., 1992). All of these syndromes cause profound difficulties in social and interpersonal functioning.

Disorders Associated with Temporal Lobe Damage

Research suggests that temporal lobe damage is associated with a number of disorders. Damage to the amygdala and related structures lead to problems in conditioned learning, the production and control of aggression, and also the subjective experience of emotions. Patterns of irritability that include verbal aggression and destroying inanimate objects have been linked with damage to the medial temporal lobe or to the connected diencephalic limbic structures (Eames, 1990). TBI has occasionally been associated with temporal lobe epilepsy, which occurs only very rarely. People with temporal lobe epilepsy experience seizures that consist of repetitive bizarre behaviour and post-seizure amnesia. Temporal lobe damage can also cause an alteration in mood and affect that can be misdiagnosed as

a major depressive episode (Eames, 1990). Other affective symptoms include paranoia, psychomotor agitation, and disorientation, and are typically associated with left temporal lobe damage (Prigatano, 1992).

Post-Traumatic Psychotic Disorders

There is evidence that damage to the limbic system and other frontal-temporal structures may affect the development of post-traumatic psychotic disorders (Eames, 1990). Disorders such as schizophreniform psychosis of epilepsy have been documented as developing gradually after injury, and researchers have suggested that chronic disturbances of limbic function cause this (Eames, 1990). Fortunately, the development of such psychotic disorders are rare, but research suggests that TBI may increase the likelihood of developing such disorders postmorbidly. Gualtieri and Cox (1991) report that having experienced TBI increases the incidence rate for psychosis by a factor of between 2 and 5, the rates for seizures also by 2 to 5, and the rates for dementia by a factor of 4 or 5. Further, the incidence rates for depression may be increased by a factor of 5 to 10, and there is evidence to suggest that these risk rates increase as the severity of TBI increases.

Disorders Associated with Brainstem Damage

Damage to the lower brainstem is associated with physical disability and communication disorders. People with lesions to this site are easily fatigued, and suffer from low levels of both arousal and drive. Communication is affected because of the combination of disruption to cognitive functions and alterations in attention and motivation. Damage to the midbrain areas result in altered emotional expression, specifically with instabilities in physical expression, so that there is often a mismatch between the subjective emotions reported, and the actual outward expression of these emotions (Eames, 1990). A patient may report feeling depressed, but be demonstrating euphoria whilst doing so.

Diencephalic Disorders

Damage to diencephalic structures results in extrapyramidal disorders (Eames, 1990). Symptoms include bradykinesia, lack of expressiveness, a lack of spontaneity and

activity. Eames (1990) states that many of the symptoms are similar to those developed as a result of frontal cingulate lesions, but that the presence of extrapyramidal motor symptoms differentiates the two lesion sites.

Factors Complicating the Neuropsychological Sequelae Associated with TBI

In addition to the primary and secondary effects of TBI discussed earlier in this chapter, there are a number of factors that complicate the outcome of TBI, in terms of survival and associated deficits. First, the research on the effects of multiple TBI which will be briefly reviewed, as will literature on the effect of substance use and head injury. The impact of premorbid and postmorbid alcohol use is examined for three reasons; (1) alcohol is the substance most reliably associated with neuropsychological deficits that may impact upon impairments resulting from TBI (reviewed in chapter 4), (2) alcohol use has been demonstrated to be a causal factor in sustaining TBI, and (3), a literature search for the purposes of this review failed to uncover any research on the use and/or abuse of other substances associated with TBI. Thus, the research on the implications of alcohol use at the time of injury, the neuropsychological effects of comorbid alcohol abuse and TBI, and the postmorbid use of alcohol are examined following a review of recurrent TBI.

Recurrent TBI

Little is known about the epidemiology, causes or neuropsychological effects of recurrent TBI, as the vast majority of the research has been conducted with non-English speaking populations, with only a few US based studies available (Salcido & Costich,1992). In summarising the non-English literature, Salcido and Costich reported incidence rates varying between 4.3% and 40%, with differences in the populations sampled and in the criteria employed to select samples making generalisation inappropriate. Similar difficulties exist in the available US research, although there is limited evidence to suggest that age may be associated with recurrent TBI, with the risk increasing proportional with age (Salcido & Costich, 1992). Another recent literature review concluded that sustaining one TBI increases the risk of a second TBI by a factor of 2, and a second TBI increases the risk of further TBI by a factor of 8 (Gualtieri & Cox, 1991). Thus, although accurate

incidence and prevalence figures are yet to be established, evidence indicates that recurrent TBI may be a frequent phenomena.

Research on the effects of recurrent TBI tends to indicate that a cumulative effect occurs producing progressive deterioration of function, even when loss of consciousness does not occur (Gronwall, 1991; Salcido & Costich, 1992). This has implications for populations that regularly experience recurrent light or mild TBI, such as boxers, those who play contact sports, and those who indulge in gang or street fights. There is also evidence that drug or alcohol use can increase the risk of sustaining recurrent TBI, which is consistent with the literature documenting the association between alcohol use and TBI (Zielinski, Theroux-Fichera, Rayls, Tremont, & Mittenberg, in press).

Alcohol Use and TBI

Acute Alcohol Intoxication and TBI

Patients with positive Blood Alcohol Content (BAC) are at risk of negative and serious consequences immediately after sustaining a head injury. Alcohol reduces the movement of neutrophils into infected or damaged areas of the body, and reduces the bactericidal activity within blood cells (Elmer & Lim, 1985). Such fluid and electrolyte abnormalities can increase the severity of a cerebral edema (Miller, 1992). Alcohol also decreases tolerance to blood loss by impairing the bodys primary homeostatic response to the loss of blood. This can have a significant impact on the likelihood of recovery from trauma.

Patients who consumed alcohol before their head injury enter hospital with a lower level of consciousness. They tend to remain in a coma longer, and they spend a longer period in hospital compared to those without positive BAC (Brismar, et al., 1983; Dikmen, et al., 1993; Miller, 1992). In a two year study of head injured patients, for example, Edna (1981) found that patients admitted with positive BAC spent an average of 20 days in hospital, while those with comparable injuries but no detectable BAC spent an average of only 9 days. In support of this, more recent research found that having a positive BAC at the time of TBI results in longer

periods spent recovering in hospital before being admitted to rehabilitation programmes (Kaplan & Corrigan, 1992).

Chronic Alcohol Intoxication and TBI

Chronic alcoholics who have some degree of cerebral atrophy are at greater risk of haematoma if they sustain head injuries than non-alcoholics. Chronic alcohol abuse is associated with blood capillaries becoming fragile, which along with decreased brain counter-pressure to low-pressure venous leaks, and possible impairments to blood clotting mechanisms, substantially increases the risk of haematoma. Further, there is a risk of brain hypoxia due to lowered blood pressure and blood loss tolerance, and an alcohol linked dilation of peripheral blood vessels (Freund, 1985; Miller, 1992).

Long-term alcohol use also increases the risk of suffering multiple infarctions. Multi-infarct dementia is a disorder typically associated with old age, but the rates among alcoholics under forty years of age are steadily growing. Alcohol intoxication and the associated neurophysiological changes are thought to contribute to the increased risk of sustaining multiple infarctions (Freund, 1985). There is also research suggesting an association between lifetime alcohol consumption and the length of PTA experienced following TBI (Zielinski, et al., in press).

The Consequences of Comorbid Alcohol Abuse and Traumatic Brain Injury

The neuropsychological deficits of alcohol abuse and TBI tend to be very similar, and it can be difficult to separate the effects of each in any one individual. In a study examining alcohol use and its effects on neuropsychological outcome following TBI, Dikmen et al. (1993) hypothesised that pre-injury alcohol use would exacerbate the neuropsychological effects of TBI. This seemed a reasonable theory, given that alcohol abuse can effect neuropsychological functioning, and the effects of TBI can be similar to alcohol abuse. They found that neuropsychological performance was related to both TBI severity and the degree of alcohol problems at one month and one year after injury. As expected, they found performance levels on psychometric tests decreased as the severity of TBI increased. When the effects of age, education,

and gender were controlled for, however, the relationship between neuropsychological performance and alcohol abuse decreased, indicating that the impact of head injury may be independent of the effect of alcohol abuse, and that other factors mediate this relationship.

Research also indicates that more neuropsychological deficits occur as levels of alcohol abuse increase (Dikmen et al., 1993). Specifically, impairments in performance intelligence, verbal intelligence, psychomotor coordination and speed, abstraction and problem solving skills have been found. Jones (1989) cites 1986 research by Hillbom and Holm demonstrating that the psychometric performance of head injured alcoholics is significantly lower then the performance of non-head injured alcoholics, and the performance of both groups is substantially lower than normal controls. These results are consistent with the theory that comorbid alcohol abuse and head injury can lead to more severe neuropsychological consequences than either event alone.

There is also evidence to suggest that alcohol use can impact on the progression through the stages of recovery from head injury. Dunlop, Udvarhelyi, Stedem, O'Connor, Isaacs, et al. (1991) found that patients who experienced emotional and/or behavioural deterioration during the first year after a brain injury experienced emotional and affective impairments which deviated from the usual pattern of slow recovery, and in some cases, deteriorated later. The symptoms most likely to deteriorate were levels of agitation, hostility, social withdrawal, lability of mood, depression, loss of insight, and disinhibition. Significantly, the patients who deteriorated were significantly more likely to have a history of pre-injury alcohol abuse than non-deteriorators. They were also more likely to have sustained their TBI through an assault, have fractured their skull, and were more likely to have sustained a left parietal lobe injury.

Alcohol Use Following Traumatic Brain Injury

Given that the head injured population as a whole have a high rate of premorbid alcohol abuse, it is reasonable to assume that alcohol abuse will continue after a head

injury. Jones (1989) cites work by Sparedo and Gill in 1988 that suggests as many as 54% of people who used alcohol before a head injury continue to use or abuse alcohol after recovery. This statistic indicates that a significant number of people who have sustained head injuries may require substance abuse intervention.

The effect that alcohol use has on people who have sustained TBI can be more rapid and severe than the effect achieved by premorbid use (Langley, Lindsay, Lam, & Priddy, 1990). Alcohol consumption in non-head injured individuals very quickly affects the central nervous system, disinhibits higher cortical functions, and alters mental functions in general. This effect is intensified in TBI victims because disinhibition is already a common consequence of head injury. The excitatory and the depressing effect of ethanol consumption occurs more rapidly, more severely, and requires a smaller dose after a TBI. Further, alcohol can interact with prescription medications, which can exacerbate disinhibited social and psychological functioning. Rosenbaum and Hoge (1989) suggest that the combination of alcohol use and head injury increases the likelihood of an individual becoming aggressive and getting into fights. Alcohol use and head injury each have strong associations with increased aggressive behaviour; when combined, the effects are additive.

An individual with intellectual, behavioural, or physical disabilities in addition to an alcohol abuse problem is referred to as a "*multi-disabled alcoholic*" (Greer, 1986, p.34). Such an individual usually has severe difficulties adjusting to the changes that resulted from the TBI, and experiences increased levels of stress, frustration, failure, and a reduced sense of control over the environment. Alcohol abuse may represent their attempt to escape from or to distort the unpleasant reality that faces them. Many of those who have abused alcohol prior to TBI had problems with low self-esteem which continue or become worse after the injury, increasing the likelihood of continued alcohol abuse.

Research indicates that many people hold the belief that alcohol both enhances social functioning and releases tension, so it is not surprising that many head injured people turn to alcohol to assist their social skills (Langley, et al., 1990). Unfortunately,

many TBI victims have a decreased ability to accurately perceive their social behaviour and continue behaving dysfunctionally, under the impression they are functioning they same as they did pre-morbidly. Lack of self-awareness is a characteristic of TBI, and makes an individual vulnerable to continued alcohol abuse, and to the negative social and personal consequences of problem drinking.

Alcohol and other substance use can be a part of the culture that surrounds people with head injuries and other disabilities. Greer (1986) points out that this population have easy access to prescription drugs to relieve pain, control seizures, and ease other medical conditions. This can lead to the abuse of analgesics, sedatives, and other prescription medications. People self-medicate with alcohol or illicit drugs in the belief that alcohol will relieve the stress, frustration, and emotional pain of the changes caused by the injury. When the individual has been severely injured, s/he may have to come to terms with now belonging to the group in society labelled as disabled, a major adjustment in itself.

Personality changes are a common consequence of TBI, especially when damage is sustained by the frontal lobe. Many TBI victims find themselves becoming increasingly more socially isolated and alienated from their friends, as a result of their socially disinhibited behaviour. Greer (1986) points out that hotels and bars are the centre of many small communities, and provide avenues for meeting new people in larger cities. He states that disabled people often gain acceptance in bars more readily than other social groups, because all people are similar when they are drunk, so the head injured "*are just like everyone else*" (p.36). This reinforces problem drinking behaviour as a means to fit into social situations, yet may increase socially inappropriate behaviour, given the increased dose-effect response alcohol has on TBI victims.

There are a range of practical factors that impact on alcohol abuse following a head injury (Jones, 1989). Alcohol is widely available in the community, and individuals have easy access to this and other drugs after being released form hospital or a rehabilitation programme. TBI victims tend to have increased discretionary time on

their hands after they leave hospital, and are likely to suffer from boredom. Alcohol can provide an escape from this situation, particularly if it was regularly consumed before the head injury. As recovery progresses, individuals have increasing independence from health professionals, family, and friends, and have the opportunity to attempt to return to their premorbid levels of social and occupational functioning. Failure to cope with returning to work or to function successfully socially can result in increased alcohol use if the individual does not have adequate means of dealing with frustration and disappointments. Further, post-traumatic mood changes also impact on self-medication with ethanol, given that many TBI victims had alcohol abuse histories before their head injury.

Comorbid alcohol abuse and head injury can compromise an individuals progress in a rehabilitation programme, as Meek, Clark, and Solana (1989) found in following TBI participants in a substance abuse treatment programme. Neuropsychological impairments were found to be the main cause of failure to benefit from the programme. Meek et al. (1989) found that approximately two-thirds of their sample had neuropsychological impairments which affected their ability to participate effectively in the programme. These were most commonly deficits in attention and memory, calculation, abstraction, the ability to follow instructions, and visuo-spatial skills. Although the authors did not investigate the etiology of the neuropsychological deficits, given the research on the neuropsychological consequences of TBI and the association between alcohol and TBI, it is reasonable to assume that both alcohol abuse and head injuries contributed to the impairments. These deficits have implications for rehabilitation programmes for both head injury and substance abuse. For example, noncompliance with the programme may be misinterpreted as resistance or denial if cognitive impairments go undetected.

Following a literature review, Greer (1986) proposed that individuals who abuse alcohol after TBI tend to hold the belief that drinking large quantities of alcohol is an acceptable and effective manner of adapting to the stress of the head injury Greer states post-TBI alcohol abusers can be divided into two types; type A drinkers abused alcohol prior to TBI, and had never had adequate coping mechanisms, so present a

greater challenge to rehabilitation programmes. Type B drinkers began problem drinking after the TBI, and respond better to rehabilitation, in terms of learning new strategies, skills, and attitudes.

Conclusions

A wide range of information has been presented in this chapter, including the general mechanisms of injury, the types of injury associated with mild, moderate, and severe TBI, cognitive and personality disorders resulting from TBI, and factors complicating the outcomes of TBI, with particular reference to the literature associated with alcohol use. It is clear the neuropsychological effects of TBI depend on a range of factors including severity of the injury, the primary and secondary neurological damage sustained, the nature of injuries previously sustained, and whether alcohol was involved premorbidly and/or postmorbidly. The resulting cognitive, behavioural, and personality disturbances can have a profound effect on all aspects of human functioning, including employment, interpersonal, and social relationships, with perhaps the greatest impacts caused by impairments to memory, concentration, executive and affective functioning, emotional regulation, social interactions, and impulsivity. Inspite of appearing healthy and physically fit, individuals can still experience these serious problems, earning the label of the "*silent epidemic*" (Gronwall, et al.,1990). The neuropsychological outcome is complicated by substance abuse, which is also associated with cognitive consequences, and is reviewed in the following chapter.

Chapter 4

The Neuropsychological Sequelae of Substance Abuse

The Fourth Edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM IV) (American Psychiatric Association, [APA], 1994) contains a section detailing substance-related disorders and provides clear criteria for diagnosing the intoxication, dependence, abuse, tolerance, and withdrawal symptoms of 11 classes of drugs of abuse, prescribed medications, and toxins. The substances of abuse are divided into categories according to their mechanism of action on the central nervous system. Not all of the classes of substances in the DSM-IV will be reviewed here, however, as a literature review failed to uncover relevant research on the neuropsychological effects of caffeine or nicotine abuse. The literature concerning alcohol, cannabis, hallucinogen, opioid, cocaine, sedative-hypnotic, inhalant, and amphetamine abuse, are reviewed with respect to the associated neuropsychological sequelae. Since many individuals abuse many substances, the literature covering the neuropsychological effects of polysubstance abuse will also be discussed.

Specific DSM IV (APA, 1994) definitions were adopted for the purposes of the present review. The term *abuse*, for example, is used to describe "*a maladaptive pattern of substance use manifested by recurrent and significant adverse consequences related to the repeated use of substances* " (APA, 1994, p.182). The term *dependence* is defined as "*a cluster of cognitive, behavioral, and physiological symptoms indicating that the individual continues use of the substance despite significant substance-related problems*" (APA, 1994, p.176).

Research in the area of drug abuse is complicated by many factors. First, the vast majority of studies on chronic substance abuse rely on subjects self report. Substance dependent or abusing subjects, however, tend to be poor historians in terms of relating their past experience with substances. This may be due to a number of factors including an unwillingness to admit to indulging in illegal activities, a contrasting tendency to exaggerate their experience with illicit substances, or poor

recall due to ensuing memory difficulties. For example, a questionnaire administered to a prison population found 10.5% of subjects claimed they had used a phoney drug (Miller & Cappiell, 1983; cited in van Hoeven, Stoneburner, & Rooney, 1991, p. 1104). Whatever the motivation or causal factor, retrospective research is subject to confounds based on the reliability of self-reported recall (Adams, Rennick, Schoof, & Keegan, 1975).

A further complication in the research on substance abuse is the tendency for abusers to use a range of other substances in addition to their primary drug of abuse (Carlin, 1991; DSM IV; 1994; Fishbein & Pease, 1990). This issue will be referred to throughout the literature review as a confound affecting specific studies, and will be further examined under the section on polysubstance abusers. The review of each substance will begin with a brief summary of the diagnostic categories provided by the DSM IV (APA, 1994), followed by the confounds and issues specific to the research on the substance. Research on the physical and neuropsychological sequelae associated with chronic abuse will be presented, and a summary of the main findings will conclude each section.

Alcohol

Alcohol is one of the most well researched drugs in the substance abuse literature since it can be purchased legally and it is widely used by the adult population. Although a comprehensive literature exists, a summary of the only well documented impairments associated with chronic abuse will be presented. In accordance with the well-documented nature on the effects of alcohol use, the DSM IV (APA, 1994) lists diagnostic criteria for alcohol intoxication, abuse, tolerance and withdrawal amongst the alcohol-related disorders.

Research on the effects of prolonged alcohol abuse is subject to different issues and potential confounds to those associated with illicit substances. Although chronic alcohol abuse has been associated with neuropsychological and neurophysiological consequences, a relationship between the amount and duration of alcohol use and impairment has been demonstrated only in animal studies, and a direct dose-effect

relationship between human alcohol consumption and neuropsychological performance has yet to be established (Grant, 1987; Parsons & Leber, 1981). Not every alcohol abuser will develop alcohol-related disorders. For example, only ten percent of chronic alcoholics develop cirrhosis of the liver (Freund, 1985). Another limitation of research in this area is that ethical considerations prevent all but correlational studies being performed on human subjects.

Of the conditions caused by chronic alcohol abuse, Wernicke-Korsakoff Syndrome is the most serious (Browning, Hoffer, & Dunwiddie, 1992). The syndrome consists of a period of alcoholic encephalopathy (Wernicke's encephalopathy) which can progress into Alcohol Amnesic Disorder (Korsakoff's syndrome). Wernicke's encephalopathy is a neurological disease that is manifest by lesions, typically in the mamilliary bodies and the dorso-medial nucleus of the thalamus which results in a state of ataxia, cranial-nerve palsy, nystagmus, and confusion (Freund, 1985). This state may clear after a few weeks with treatment, or may progress into Korsakoff's Syndrome, resulting in irreversible damage to short-term memory and chronic anterograde amnesia. This is thought to be due to diencephalic lesions caused by thiamine deficiency, which in turn is caused by malnutrition or malabsorption after ingestion of large quantities of alcohol (Kaplan & Sadock, 1991).

Once, Wernicke-Korsakoff Syndrome was thought to only occur rarely, but recent research suggests that as many as one in five chronic alcoholics will develop Wernicke's encephalopathy, and if not treated with thiamine, will progress into Korsakoff's Syndrome. With the incidence of alcoholism in Western countries estimated as being 5-10% of population, it is clear that this devastating syndrome has been under-rated (Bowden, 1994).

As mentioned earlier, studies on the neuropsychological effects of alcohol abuse are plentiful. Research on alcohol abusers hospitalised for their first detoxification found 68% or more had measurable cognitive deficits (Franceschi, Truci, Comi, Lozza, Marchettini, et al., 1984; Hasin & Grant, 1987; Loberg, 1986; Miller, 1992). Franceschi et. al. (1984) found that younger alcoholics had a greater prevalence of

brain damage than liver damage. Peripheral neuronal damage was found in 74% of their sample and autonomic neuronal damage in 24%, and this was associated with impaired attention, concentration, visuo-spatial and perceptuo-motor functioning, difficulties in learning and memory, verbal reasoning, abstraction and conceptualisation, judgement and behavioural control.

Although most chronic alcohol abusers have intelligence quotient scores that are within the normal ranges, as measured by the Wechsler Adult Intelligence Scale-Revised (WAIS-R), they may have more difficulty on the block design and the picture arrangement subtests due to visuo-spatial and sequential arrangement deficits (Tarter & Edwards, 1986). Deficits in abstraction and problem solving, finger dexterity and perceptual motor skills, learning, short-term memory, verbal and non-verbal memory, and some language skill problems, have been commonly reported in studies of alcohol abusers (Carlin, 1991; Schafer, Birchler, & Fals-Stewart, 1994; Tarter & Edwards 1986). These researchers all agree that long periods of abstinence from alcohol is associated with some improvement in the cognitive deficits, but that a complete return to normal functioning does not occur.

A recent study of the differential rates of neuropsychological recovery in groups of substance abusing prison inmates found that the chronic alcohol abusing group were impaired on 11 of the 16 tests in their battery, indicating deficits in short and long-term verbal memory, visual memory, and information processing speed (Selby, Azrin, Ireland, Quiroga, & Malow, in press). When the length of abstinence from alcohol was examined, the subjects who had been abstinent longer performed better than those who had been abstinent for shorter periods, but full recovery to the level of controls did not occur. This suggests that while deficits improve over time, chronic alcohol abusers may be left with long-lasting or permanent residual deficits.

In summary, chronic alcohol abuse has been reliably and consistently associated with neuropsychological deficits particularly in the areas of auditory and visual memory, and perceptual motor skills. While improvements in neuropsychological functioning

can occur with prolonged abstinence, further research is required to investigate the specific nature and extent of improvement that may occur.

Substances Other Than Alcohol

Cannabis

Research conducted in the United States has found cannabis to be the most frequently used illicit drug (Azorlosa, Heishman, Stitzer, & Mahaffey, 1992; Heishman, Stitzer, & Yingling, 1989). There is some evidence to suggest this also applies in New Zealand, given that the majority of convictions for drug offenses involve cannabis use or dealing (Spicer & Norris, 1993). According to the DSM IV (APA, 1994) cannabis use can result in intoxication, dependence and abuse, in addition to other cannabis-induced disorders.

Comprehensive research has emerged on both the acute and chronic effects of cannabis use, which has been subject to the same methodological confounds as mentioned earlier. In addition, the constant alteration in concentration of the principal hallucinogenic compound used has caused researchers to question the validity of past research. Each study reports different levels of frequency and amount of cannabis used, and has different definitions for mild, moderate, and severe levels of use. Complicating matters further, delta -9-tetrahydrocannabinol levels (Δ^9 THC) in cannabis plants have been increasing over the past 10 years as a result of different strains of plants being developed (Carlin, 1991), and the chronic neuropsychological effects of the newer and stronger strains of cannabis have not been adequately investigated, although a substantial literature exists on the acute effects (Belmore & Miller, 1980; Block, Farinpour, & Braverman, 1992; Block & Wittenborn, 1984; Heishman, et al. 1989; Hooker & Jones, 1987; Wetzel, Janowsky, & Clopton, 1982). It is likely, therefore, that past research will only provide a guideline to the frequency and severity of sequelae associated with chronic cannabis abuse. Nonetheless, ann examination of this literature to identify the nature of the deficits uncovered by this research, is worthwhile.

In a review on the chronic effects of cannabis abuse, Carlin (1991) concluded that most studies failed to find a clear and consistent association between cannabis use and neuropsychological impairment. Amongst the research demonstrating impairments, two studies are noteworthy because they report small but important differences between chronic users and controls, and they are longitudinal. In a 10 year follow-up study of chronic cannabis and hashish users and controls, Mendhiratta, Varma, Dang, Malhotra, Das, et al. (1988) successfully re-contacted 45 of the original 75 subjects. All subjects in both the cannabis and hashish groups reported still using relatively high amounts of their respective drug on a daily basis. Measures were readministered, and results were compared to the original scores and to those of a matched control group not using either cannabis or hashish. The drug-user group was found to have deteriorated significantly on tests of digit span (backwards), speed and accuracy tests, reaction time tests, and tests of visuo-motor co-ordination. The deterioration was significantly greater in users than controls, even when the effects of aging were controlled for. This study, although confounded by the subjects probable comorbid use/abuse of other substances, provides an indication of the types of neuropsychological sequelae that may occur from chronic cannabis use.

The second longitudinal study was described as "psychosociocultural" research by Page, Fletcher, and True (1988), and was intended to reflect a multidisciplinary approach to information gathering. Fifty-seven of 82 subjects who had participated in a Costa Rican study in 1975 were successfully re-contacted and agreed to participate in the research (Rubin & Comitas, 1975; cited in Page et al., 1988). The original sample of 41 matched pairs of chronic heavy cannabis smokers and controls had not been significantly different in neuropsychological functioning, although the user group tended to have lower scores on tests of learning and memory. The authors hypothesised that these differences would have increased, over the interceding 30 years of exposure to cannabis. The original neuropsychological test battery was re-administered, along with new measures that were designed to further evaluate attention, memory, and organisational skills. Three significant differences between users and controls were found on the new measures, but not on any of the original battery. The differences indicated slowed rates of processing information,

impaired ability to learn lists of unrelated words, and impaired performance on tests requiring sustained attention. It was considered that differences in age, alcohol consumption, education, or other confounding variables did not account for these differences. The results of the neuropsychological tests indicate that the effects typically associated with acute cannabis intoxication may become permanent with chronic use, due to permanent changes to neurotransmitters (Page, et al., 1988).

Psychosocial research findings suggests that chronic cannabis abuse may impact on more than neuropsychological functioning. Page et al. (1988) found that cannabis users were more likely to live alone than controls, were significantly more likely to have been arrested and imprisoned, and generally spent less time engaged in productive mental effort at work than controls. These findings provide an interesting insight into the lives chronic cannabis users in a country where cannabis smoking is considered to be socially undesirable.

Although the literature is far from conclusive in demonstrating an association between chronic cannabis use and neuropsychological impairments, the studies that have found impairments in memory, difficulty sustaining attention and slowed information processing, have cast doubt on the theory that long term cannabis use has no adverse effects. Caution should be taken in drawing any comprehensive conclusions from this research, however, given the ever increasing levels of Δ^9 THC levels in cannabis plants, along with the tendency for cannabis users to use and/or abuse other substances, thus complicating the findings.

Hallucinogens

There are a wide range of substances with hallucinogenic effects, with Lysergic acid diethylamide (LSD), morning glory seeds, and psilocybin ("magic mushrooms") amongst the more commonly known drugs in this class, but also included are phenlyalkylamine compounds such as mescaline, and 3,4-methylenedioxymethamphetamine (MDMA, "Ecstasy"). The DSM IV (APA, 1994) includes criteria for hallucinogen-related abuse, dependence, intoxication, and Hallucinogen Persisting Perception Disorder (flashbacks) amongst the Hallucinogen-

related disorders. Although both cannabis and phencyclidine (PCP) have hallucinogenic effects on users, they are excluded from the hallucinogen category due to accepted differences in the mechanisms of action for these substances. Much of the early research on the neuropsychological effects of hallucinogenic substances have included both PCP and LSD users amongst their subject groups, and accordingly, PCP use will be included in the following review of the hallucinogen literature.

Unlike the literature for cannabis abuse, there are strong theoretical indications that the chronic use of LSD is associated with either long term or permanent changes to the central nervous system (Brun & Maage, 1975). LSD use has been demonstrated to result in what is termed "flashbacks" by users and Hallucinogen Persisting Perception Disorder by the DSM IV (APA, 1994). These terms both refer to a perceptual disturbance similar to an incident experienced during an earlier LSD intoxication, but these occur when an individual has not used LSD. The DSM IV (APA, 1994) states that these experiences can occur for as long as five years and do not require the re-administration of LSD. This suggests that relatively long lasting changes occur, but research has had mixed success in demonstrating consistent and significant neuropsychological impairments in chronic users of hallucinogenic substances. Again, the research is subject to the confounds of polysubstance use and/or abuse, and this is especially true of individuals who use LSD as a recreational drug (Carlin, 1991).

For many years LSD was considered to be a relatively safe drug that did not lead neuropsychological deficits. This view originated from the failure of many of the early studies to find support for their hypotheses on the types of deficits LSD use could cause. Wright and Hogan (1972), for example, examined a group of 20 chronic LSD users and found no differences between the user group and controls on any of their 20 measures, except one which they attributed to chance. Similarly, Grant, Adams, Carlin, and Rennick (1977) concluded in a study of polysubstance abusers, that hallucinogen use did not contribute to any neuropsychological impairments.

More recent literature with larger groups has revealed that a few but persistent deficits may occur. In a review on the neuropsychological effects of chronic LSD use, Carlin (1991) concluded there is some evidence for an association between mild spatial difficulties and chronic use, especially deficits in map reading. The sparse literature on chronic PCP use suggests that neuropsychological impairments may result, but as with other studies, polysubstance use by the subjects has resulted in serious confounds.

Reduction in the use of PCP has been associated with improvements in neuropsychological functioning. Cosgrove and Newell (1991) conducted research with chronic PCP users in an outpatient drug treatment programme, who were tested at entry to the programme and after a four week period. At initial testing significant differences were found between the users and a matched control group on measures of immediate and short-term memory, motor ataxia, and speech. After the four week period during which the users reduced the amount of PCP used, their impairments on the neuropsychological battery decreased. Improvement was most significant in tests of verbal memory, and least significant in tests of motor co-ordination and reaction time, and tests of verbal fluency. Although improvements occurred with reduced PCP use, scores tended to remain below the level of normal performance suggesting chronic use may result in residual deficits.

Fishbein and Pease (1990) reviewed the effects of PCP use with respect to neuropsychological impairments and examined the link to violent crimes. They state that chronic use, while not reliably linked to irreversible cognitive impairments, has been associated with unpredictable and extreme episodes of violence to self and others. Further, results of studies such as conducted by Cosgrove and Newell (1991), indicate chronic PCP use may result in a temporary organic brain syndrome that recovers with continued abstention from PCP. Further research is required to investigate this hypothesis, since factors such as a dose-response relationship may complicate findings. Fishbein and Pease comment that the effect PCP has on the user very much depends on the dose ingested, but in general the limbic system has been implicated in its action, thus affecting emotional behaviour and higher

intellectual functions. The full implications of PCP's effect on emotional behaviour has yet to be adequately investigated.

Again, the literature is sparse on the neuropsychological implications of the chronic use/abuse of the other hallucinogenic substances such as psilocybin and MDMA. The lack of literature on psilocybin use can be attributed to the seasonal restrictions on the availability of "magic mushrooms", which subsequently tend to be treated as recreational drugs rather than strict drugs of abuse. MDMA or ecstasy is considered to be a designer drug that has gained some popularity in the US, but details on the availability in New Zealand are not included in Justice Department Statistics (Spicer & Norris, 1993). In one American study on the neuropsychological effects of chronic MDMA use, mild to moderate impairments were found for all current users on immediate and delayed recall of a paragraph of meaningful prose, and on at least one other test on the neuropsychological battery administered, but no consistent pattern emerged (Krystal, Price, Opsahl, Ricaurte, & Heninger, 1992). These results indicate that diffuse impairments may result from chronic MDMA use, with particular implications for auditory memory.

In general, the evidence for an association between neuropsychological deficits and chronic hallucinogen use is not consistent, and again confounds exist in the research methodology, particularly with selection of subjects who co-use other substances. Further, hallucinogens tend to be used less often than other substances, and the criteria for dependence in the DSM IV (APA, 1994) requires only a few occasions of use each week. Thus, the development of neuropsychological sequelae may require a much longer period of use than drugs that are used on a daily basis. Nonetheless, sufficient studies exist to suggest that chronic LSD, PCP, and MDMA use is associated with subtle neuropsychological impairments that tend to improve with reduced drug use.

Opioids

The opioids are a category of drugs that include both naturally occurring substances and synthetic and semi-synthetically produced compounds. The DSM IV (APA,

1994) includes heroin, morphine, codeine, and methadone amongst a long list of opioid substances and includes criteria for opioid dependence, abuse, intoxication, and withdrawal amongst the opioid-related disorders. Opioids are amongst the more commonly abused intravenous drugs in the United States and the associated conviction rate is high. In a study of 2,500 inmates convicted for a wide range of crimes, a total of 43% admitted to a history of intravenous drug use and stated heroin as the drug of preference (van Hoeven, et al., 1991). No corresponding New Zealand data exists, but in 1992 only 30 convictions occurred for the use or sale of heroin, perhaps indicating the drug is less well established here (Spicer & Norris, 1993).

Yet again controversy exists in the research on the neuropsychological implications of opioid abuse. And again, complicated issues affect the design and validity of research efforts, as outlined by Fishbein and Pease (1990). As with other illicit substances, there can be a degree of reluctance for potential subjects to admit to using opioids, and recruitment of subjects from any source apart from rehabilitation clinics can be difficult. Opioid use carries heavier legal penalties than cannabis, for instance, and tends to be viewed as a "hard" drug by users. Further, because opioid drugs are usually administered intravenously, the consequences of sharing needles (such as contracting Human Immunodeficiency Virus (HIV) or Hepatitis B) have to be considered, because research suggests neuropsychological consequences and central nervous system abnormalities may be associated with HIV infection (Royal, Updike, Selnes, Proctor, Nance-Sproson, et al., 1991). Therefore, including HIV positive subjects in research may seriously confound results. Further complications include the unhygienic conditions under which the drugs are prepared for sale and used. Individuals who manufacture and distribute the drugs for sale typically dilute the pure drug with other similar substances in order to have more merchandise to sell. The unknown quality of the substance mixed with the pure opioid can cause problems for the users since almost any powder can be used, including talcum powder and cleaning agents. The physiological consequence resulting from injecting foreign matter into the bloodstream depend on what the opioid was mixed with, but the effect is generally damaging (Carlin, 1991).

In a study investigating the neuropsychological performance of parenteral drug users which included a group on a methadone programme, Richards, Sano, Goldstein, Mindry, Todak, et al. (1992) found that those maintained on the methadone programme achieved significantly better performances on neuropsychological tests. This result supports an earlier observation by Fishbein and Pease (1990) that chronic addiction to opioids tend to be relatively harmless providing the drug is obtained in a pure form and the amount taken is strictly controlled. Difficulties occur when the user does not know the purity of the substance and so cannot control the dose correctly, thus increasing the probability of accidental overdosing.

But there are doubts concerning the purported harmlessness of chronic opioid abuse. Brun and Maage (1975) suggest damage to the central nervous system occurs with repeated administration, as hypersensitivity or tolerance to the drug develops, and greater quantities of the drug are necessary to achieve the same effect. Cosgrove and Newell (1991) cited research that examined the neuropsychological functioning of drug abusers and found impaired memory for lists of unrelated words and deficits in sentence recall in subjects identifying as predominantly opioid abusers (Fischman, 1984; cited in Cosgrove & Newell, 1991, p.161).

One study examined the neuropsychological functioning of a group of heroin addicts before and after a rapid detoxification treatment (Guerra, Solé, Camí, & Tobeña, 1987). The performance of the user group was compared to a group of matched controls and at the first administration of the battery, significant between group differences were obtained. The greatest differences occurred on tests of attention, verbal fluency and memory. After the week long detoxification period the battery was re-administered and the user groups performance improved to the level obtained by the controls for all measures except the test of verbal fluency. The results indicate that impairments can be associated with chronic opioid abuse but that significant improvements in the level of functioning are associated with cessation of use. Yet again potential confounds exist with the research, for while the subjects were primarily opiate dependent, they also used barbiturates, other sedatives, and alcohol.

It is difficult to summarise the research on the neuropsychological effects of chronic opioid abuse given the conflicting nature of the research and the special issues that tend to confound research on intravenous drug abuse. However, some studies indicate that mild impairments in verbal fluency and verbal memory are associated with abuse, and there are indications that significant improvements may occur on detoxification. These results make it difficult to conclusively state that any particular impairment is linked to chronic use, and consequently difficult to state that no impairment will occur (Carlin, 1991).

Cocaine

The DSM IV (APA, 1994) includes criteria for cocaine dependence, abuse, intoxication, and withdrawal, in addition to a range of other cocaine-related disorders. Research suggests cocaine use is widespread in countries such as the US, with over 23 million Americans reporting some cocaine use (NIDA, 1991; cited in Selby, et al., in press). The extent of cocaine use and/or abuse is reflected in the United States Department of Justice report on drug use and crime for 1990, which reported that cocaine was the drug tried by the majority of new arrestees (Harlow, 1991). New Zealand Department of Justice statistics indicate that cocaine use is less popular but still available, as four individuals were convicted of using cocaine in 1992 (Spicer & Norris, 1993).

Given the reported prevalence of cocaine use in the US, the lack of research on the neuropsychological effects of chronic cocaine abuse is surprising. Berry, van Gorp, Herzberg, Hinkin, Boone, et al., (1993) in a comprehensive literature search found only five studies reporting short-term cognitive deficits in cocaine dependent individuals. Following their review, Berry et al. (1993) then examined the cognitive functioning of 16 cocaine addicts who had been abstinent for two weeks, to a group of matched controls. All subjects were administered a neuropsychological battery within 72 hours of last using cocaine, and the battery was re-administered two weeks later. Initial testing revealed impairments in tests of memory, visuo-spatial abilities, and concentration, when compared to controls. Improvements occurred at the second testing, but the cocaine-using group still did not reach the performance level of

controls. Specific impairments were evident on tests of psychomotor speed, memory, concentration and divided attention, indicating that chronic cocaine use is associated with a range of neuropsychological impairments that remain for two weeks following last use and may be evident for even longer periods.

One of the five studies identified by Berry et al. (1993) was conducted by Ardila, Rosselli, and Strumwasser (1991) who examined the neuropsychological deficits associated with chronic freebase cocaine ("crack") use. Subjects were recruited from a rehabilitation centre and had abstained from crack for at least 30 days. Crack is a form of cocaine that is ready to be smoked and is particularly associated with psychotic symptoms (Fishbein & Pease, 1990). Evidence of impairments in short-term verbal memory and difficulty in tasks requiring sustained attention were found, with test scores negatively correlated with the lifetime amount of cocaine used. These findings suggest relatively long lasting cognitive impairments may result from chronic cocaine use, and the extent of impairments sustained may be associated with the amount of cocaine consumed.

A more recent study replicating the Ardila, et al. (1991) findings found impairments in concentration, memory, non-verbal problem solving, and abstracting ability in 50% of recently abstinent users and 15% of matched controls (O'Malley, Adamse, Heaton, & Garwin, 1992). Further, neuropsychological performance in the cocaine dependent sample was correlated with both the recency and amount of cocaine used. But other research is contrary to the findings of Ardila et al (1991) and O'Malley et al (1992). Selby et al. (in press) in a literature review found reports of deficits in visual and verbal memory, recognition, learning, shifting and maintaining set, anomia, concept formation and visuo-spatial processing speed, associated with chronic cocaine abuse. They point out, however, that the lack of consistency between the deficits and the fact that a number of well designed studies had failed to demonstrate any impairments, implies a lack of convincing evidence that neuropsychological deficits are associated with chronic cocaine use. Further, their own research failed to find any neuropsychological deficits in cocaine dependent subjects, although impairments were demonstrated in alcohol and polysubstance abusers.

Other researchers have found the evidence from the small research pool more compelling. Cosgrove and Newell (1991) conclude that there is sufficient research to suggest that long term cocaine use is associated with impairments to learning, poor memory for unrelated words and impaired sentence recall. Fishbein and Pease (1990) state that the pharmacological properties of cocaine increase the likelihood of violent behaviour occurring ,and that chronic use has been associated with depression and tendencies towards aggression and violence.

Again, it is difficult to summarise the neuropsychological effects of chronic cocaine abuse given the differences between the research findings and methodologies. However, the weight of evidence suggests that chronic cocaine use is associated with impairments to concentration and memory.

Sedative-Hypnotics

Sedative-hypnotic drugs are not often selected as the predominant drug of abuse by the typical addict population, but tend to be used as adjuncts to other substances. The DSM IV (APA, 1994) states that individuals who are prescribed sedative-hypnotic medications only occasionally meet the criteria for abuse of these drugs, and individuals who obtain these drugs illegally may not meet the criteria for dependence or abuse. The manual contains criteria for diagnoses of abuse, dependence, intoxication, and withdrawal amongst other sedative-hypnotic-related disorders. A brief literature review reveals that there have been neuropsychological consequences associated with chronic abuse of sedative-hypnotics.

A group of subjects were followed up four to six years after hospitalisation for abusing sedative-hypnotic medications by Bergman, Borg, Engelbrekston, and Vikander (1989). All subjects had been administered a neuropsychological battery of tests after detoxification at the time of the first study. At follow-up, 17 of the patients were still abusing sedative-hypnotics and 17 were abusing both sedative-hypnotics and alcohol. Although there were significant improvements since first testing in the abstinent subjects, almost half the group were considered to show signs of cognitive impairment, particularly in the area of verbal learning. These results

were confounded by the high number of subjects abusing alcohol, but indicates improvements in cognitive functioning can occur with abstinence and continued abuse may result in impairments.

There is evidence to suggest that the comorbid abuse of sedative-hypnotics with other substances is associated with an increased likelihood of neuropsychological impairments, particularly when alcohol is amongst the substances abused (Carlin, 1991). Therefore it is reasonable to conclude that abuse of sedative-hypnotics may be expected to result in neuropsychological consequences, the exact nature of which have not yet been adequately studied.

Inhalants

The chronic abuse of the category of substances known as inhalants have been associated with physical consequences which include liver disease, central and peripheral nervous system damage (APA, 1994). The DSM IV includes criteria for inhalant intoxication, abuse, and dependence amongst a wide range of other inhalant-induced disorders. Chronic inhalant abuse has been reliably associated with both neuropsychological and neurological sequelae, as outlined below.

Twenty subjects who had been abusing toluene-based solvents for two or more years were administered a brief neuropsychological battery and were evaluated neurologically, following a four week abstinence period (Hormes, Filley, & Rosenberg, 1986). Evidence of mild to moderate cognitive impairments occurred in five subjects and severe impairments were found in seven. Most had attention deficits, memory impairments, and abnormalities of visuo-spatial function and complex cognitive functions. Evidence of apathy and flattening of affect were relatively consistent outcomes. There were evidence of neurological abnormalities in 13 of the subjects, with CT scans indicating diffuse atrophy in cerebral hemispheres, cerebellum, and brainstem.

The non-verbal memory area of cognitive functioning was also implicated in research by Cosgrove and Newell (1991). Carlin (1991) concludes that the research indicates

clearly and consistently that chronic abuse is associated with both neuropsychological and neurological consequences. Taken together, these reviews provides strong evidence to suggest that inhalant abuse has a negative impact on the cognitive functioning of chronic abusers.

Amphetamines

Amphetamines are substances that have a stimulant effect on the central nervous system and include amphetamine, dextroamphetamine, methamphetamine (speed), and various types of appetite suppressants. The DSM IV (1994) includes criteria for the diagnoses of amphetamine intoxication, withdrawal, dependence and abuse as well as other amphetamine-induced disorders, and states that many of the effects of stimulants resemble cocaine but that the psychoactive effects may be longer and stronger than those elicited by cocaine.

Few studies on the neuropsychological effects of chronic amphetamine abuse were uncovered by a literature search for the purposes of this review. Brun and Maage (1975) included amphetamine abusing subjects in their study but failed to find any significant differences between the user groups and the control group. Schafer, Birchler, and Fals-Stewart (1994) examined cognitive impairments in a group of polysubstance abusers, 29 of whom stated amphetamines amongst the substances they used. The results revealed impairments but the effects associated with amphetamine abuse could not be differentiated from the effects of other substances. Fishbein and Pease (1991) claim that chronic amphetamine use has been associated with paranoia that increases the chances of violent behaviour. Finally, Carlin (1991) stated that he was unable to find any convincing research to suggest an association between neuropsychological effects and chronic amphetamine use.

Altogether, there is a lack of research on the neuropsychological effects of chronic amphetamine abuse, except as part of a polysubstance abuse study, thus making it difficult to reach any conclusions about possible neuropsychological impacts. There is clearly a need for well designed investigations into the effects of chronic abuse.

Polysubstance abuse

It is important to examine the literature on the effects of polysubstance abuse on cognitive functioning, given that the bulk of the literature on drug abuse indicates that most individuals use a range of different substances concurrently (Carlin, 1991; Fishbein & Pease, 1990; Selby et al., in press). The DSM IV (APA, 1994) also recognises polysubstance use and provides a list of criteria for polysubstance abuse and dependence. A diagnosis requires that three or more groups of substances are used by the individual with no particular substance predominating. In research, this group of individuals are beginning to be recognised as a separate population, but many past studies failed to adequately acknowledge the impact that including polysubstance abusers in their specific drug use samples may have had.

The present review of the literature on the neuropsychological effects of chronic specific substance use uncovered confounds in the choice of the research population selected. Individuals who are dependent on one substance tend to use and/or abuse other substances making it difficult to separate the effects of one drug from another (Carlin, 1991). There is a growing literature on the effects of polysubstance abuse on cognitive functioning which will be presented from a historical perspective.

The neuropsychological functioning of 51 polysubstance abusers recruited from an inpatient treatment centre was investigated in an early study by Adams, Rennick, Schoof, and Keegan (1975). The subjects were primarily abusing substances other than alcohol, although most used alcohol to a lesser extent. All subjects were administered a test battery within three days of admission, and tests that could be re-administered without practice effects were repeated a total of four times. The results obtained indicated significant deficits in the areas of word fluency, categorising information, information processing and decision making, visual scanning, and general motor co-ordination and speed. The researchers found that improvements occurred over time but most subjects remained at the level of mild impairment, indicating that some of the neuropsychological effects of chronic polysubstance abuse may be relatively long lasting.

In another early study on the neuropsychological effects of polysubstance abuse, Grant, et al. (1977) administered a neuropsychological battery to 151 subjects enrolled in polysubstance treatment centres and to a normal and a psychiatric patient control group. Thirty-seven percent of the user group were found to have neuropsychological impairments, but insufficient details were provided by the authors to allow identification of particular deficits. While greater levels of impairment were obtained by subjects who abused sedatives and/or opioid drugs, the strength of the association between drug use and deficit was reduced by the finding that deficits were partially related to increased age, low levels of education, and some premorbid medical conditions. Further, the criteria by which the normal control group were selected may have resulted in confounds. This group were able to have significant experience with a range of substances before reaching the criteria for exclusion, including up to 70g of ethanol per day, two cannabis cigarettes per week, up to 50 experiences with hallucinogenic drugs, up to 20 experiences with stimulants, and as many as 10 experiences with inhalants. It seems reasonable to assume that some of the normal control group may have had some deficits associated with their own experience with various substances. Nonetheless, this research did find an association between neuropsychological deficits and polysubstance abuse.

More recently, Sweeney, Meisel, Walsh, and Castrovinci (1989) examined the verbal abstraction abilities in groups of polysubstance abusers. Two samples of 100 subjects were recruited from a detoxification and rehabilitation programme. The typical subject had been abusing alcohol, benzodiazapines, cocaine, and /or cannabis for several years. All subjects were administered either the Wechsler Adult Intelligence Scale (WAIS) vocabulary and similarities subtests or the Wechsler Adult Intelligence Scale Revised (WAIS-R) vocabulary and similarities subscales. The second sample were administered a more extensive battery designed to examine memory in addition to verbal abilities. All subjects performed better on the similarities subtests indicating that verbal concept formation is not affected by polysubstance abuse. The second subject sample performed consistently below the levels of normal performance for the other tests in the brief battery, indicating impairments in verbal and visual memory and information processing speed. These

impairments were not related to achievement on the similarities subtests of the WAIS and WAIS-R. The results of this research indicates that deficits associated with chronic polysubstance abuse are not necessarily diffuse but may impact differentially on separate areas of cognitive functioning.

A study examining three areas of general functioning of polysubstance abusing males was conducted by Schafer, Birchler, and Fals-Stewart (1994). They recruited a sample of 31 couples in which the husband was an abstinent polysubstance abuser, and examined his cognitive, affective, and marital functioning. This complex piece of research involved neuropsychological assessments, detailed assessments of mood and marital functioning , and videotaped assessments of each couples marital communication skills. The neuropsychological results were only reported in terms of their association to affective or marital communication. However, the researchers conclude that the overall cognitive functioning of the subjects, rather than the affective functioning, was significantly related to the quality of marital communication, with poorer cognitive performances being associated with poorer communication. This research suggests that the neuropsychological functioning of chronic polysubstance abusers may have an impact upon areas of interpersonal functioning, such as communication within a close interpersonal relationship.

The most recent study examining the differential recovery of neuropsychological functioning in groups of alcohol, cocaine and polysubstance abusing subjects was conducted by Selby, et al., (in press). The subjects were recruited from a prison population and were divided into groups based upon their substance abuse history and their length of abstinence (short or long-term). These researchers also found an association between the type of substance abused and performance on neuropsychological tests. The lowest performances were obtained by subjects in the polysubstance abusing and alcohol abusing groups. Impairments were found in delayed memory for word lists, memory for complex information, mental processing speed, and general visual and verbal memory, and improvements over time occurred in select visual-spatial tasks. The results indicated that subjects who had been abstinent longer had significantly better levels of achievement on neuropsychological

tests compared to those abstinent for shorter periods. This research provides an indication of the types of deficits that may result from chronic polysubstance abuse, and suggests some impairments may be relatively long-lasting.

Other research has concentrated on the association between polysubstance use and crime. Gandossy, Williams, Cohen, and Harwood (1980) examined the literature on patterns of drug use and criminal behaviour. They conclude there is evidence to suggest polysubstance abusers begin committing crimes at an earlier age and commit crimes more frequently than single substance abusers. They also suggest that polydrug users may commit crimes that are more serious in terms of both length of sentences and violent behaviour, than other substance using offenders. Gandossy et al. report that US statistics demonstrate drug addicts tend to commit income-generating crimes rather than overtly violent crimes per se, but that non-addicted offenders commit more crimes of a violent nature. This research, in addition to the study by Schafer et al (1994) indicates that polysubstance use may impact on more than just neuropsychological functioning.

The research on the neuropsychological effects of chronic polysubstance use is consistent in finding associations between impairments and chronic use, as well as evidence to suggest a relationship between level of impairment and length of abstinence for at least some areas of functioning. Other areas, however, may not demonstrate the same recovery of functioning and chronic users may be left with residual deficits. The types of deficits observed depend on the predominant substances abused, and further research is required to investigate this matter.

Summary and Conclusions

There are methodological issues and difficulties affecting research on the neuropsychological effects of chronic substance abuse that make it precarious to draw conclusions. However, the overall research suggests that there are neuropsychological consequences associated with the chronic abuse of most substances.

The literature on chronic alcohol use is relatively consistent in identifying deficits in areas of memory and perceptual motor skills that may improve with abstinence. Chronic cannabis abuse research demonstrates little consistency between findings, but deficits in memory, attention, and information processing have resulted in a select group of studies. The literature on chronic hallucinogen abuse reveals conflicts between studies, but overall, subtle impairments have been associated with chronic abuse. Again, the literature concerning chronic opioid abuse is inconsistent in terms of identifying deficits, however, some research indicates impairments to verbal fluency and verbal memory that may improve with abstinence. The research on chronic cocaine abuse is also inconsistent, but there are suggestions of impairments to concentration and memory. Research on chronic sedative-hypnotic and amphetamine abuse suggests that both substances are similarly difficult to review, given that they tend to be researched as part of polysubstance abuse, thus making the exact nature of impairments, if any, difficult to determine. Chronic inhalant abuse, in contrast is consistently associated with neuropsychological impairments and it appears that non-verbal memory is particularly susceptible to deficits. Finally, the literature on polysubstance abuse is relatively consistent in finding associated impairments that may be related to both the length of time the substances have been abused and the category of substances abused by the individual.

Chapter 5

The Present Study

The previous chapters have established that TBI is a frequent occurrence affecting at least 9,000 individuals in New Zealand each year, although the exact prevalence is difficult to determine since those sustaining light or mild TBI often choose not to seek medical attention (A.C.C., 1993). Severity of TBI can be assessed by a number of different measures, but retrospective research often has to rely on self-report of length of unconsciousness, since subjects who sustained light, mild, and often moderate injuries tend to be unaware of either their GCS score or the length of their PTA. Using length of unconsciousness as an estimate of severity allows the inclusion of individuals who sustain light and mild TBI but did not attend hospital.

The nature and severity of neuropsychological impairments associated with TBI depend on a range of factors including the site and type of injury (open, closed, acceleration, deceleration, etc), the resulting systemic processes and intracranial processes, the presence of alcohol, and any previous TBI sustained. However, research has found that deficits in memory, attention, concentration, planning, perception, learning, information processing and communication, are common cognitive outcomes following TBI. Personality and behavioural disorders include increased anxiety, depression, poor impulse control, increased irritability, lack of self-awareness, social disinhibition, fatigue, and denial of deficit.

Further complicating the nature and severity of deficits associated with TBI is the issue of recurrent TBI. Research suggests that sustaining one TBI leads to an increased risk for sustaining further TBI, and the neuropsychological effects of recurrent TBI may be cumulative. Continued use of alcohol increases the likelihood of sustaining further TBI, thus, the rates of recurrent TBI may be higher in a population that has a history of comorbid TBI and alcohol abuse. The present study also investigates the rate of recurrent TBI in the prison population.

Although the number of inmates in New Zealand penal institutions increases every year, it is possible to present a profile of the typical inmate based on research and census information. The typical inmate is male and under 30 years old; has a 50% chance of being Maori, and has approximately a 50% chance of having committed a violent offence. In 33% of cases, he will have been intoxicated before committing the offence he is imprisoned for, and is twice as likely to have experimented with illicit drugs in the past and seven times as likely to be a current drug user than a member of the general public. Given these risk factors, this population seems to be at an increased risk of sustaining TBI. Thus, it is hypothesised in the present study that the rates of TBI sustained by the prison population will be higher than within the general population.

Alcohol use by itself is a serious risk factor that increases the likelihood of TBI. Alcohol use and intoxication are associated with falls, fights, assaults, and motor vehicle accidents, and the presence of alcohol in the blood at the time of TBI affect the likelihood of survival. Patients with positive BAC spend longer in hospital, are unconsciousness for longer periods, and take longer to enter rehabilitation units than patients who were not intoxicated at the point of injury. Continued use and/or abuse of alcohol following TBI may exacerbate impairments following from the head injury, resulting in further social, behavioural, and often financial problems.

The chronic use of alcohol and illicit substances, in general, tend to result in measurable neuropsychological impairments. The effects of chronic alcohol abuse have been comprehensively researched, are well established, and typically result in memory problems, perceptual difficulties, and impairments to motor skills. Chronic cannabis use is also well researched but is more controversial, in terms of the methodological issues affecting research on illicit substances. However, there is sufficient evidence to conclude that deficits in memory, attention, and information processing can occur. Research on other substances is mixed in terms of associating specific deficits with chronic use, but findings typically indicate mild impairments. A survey of drug use in New Zealand found few people had tried substances other than alcohol and cannabis, although sampling flaws may have affected these results.

Polysubstance use appears to be limited in the general population, but research indicates this to be very common amongst substance abusers. In summary, neuropsychological impairments tend to result from chronic substance abuse and these impairments can be similar to those associated with TBI. The present study expects to find that subjects with a history of substance abuse will achieve lower scores on neuropsychological measures than those without such a history.

It seems reasonable that individuals who have a history of TBI and drug and/or alcohol abuse will have a greater number and more severe neuropsychological deficits than individuals with an equivalent TBI(and no such abuse history) or substance abuse history alone, given that both can result in deficits independently. The present study expects to find that subjects with a comorbid history would achieve lower scores on psychometric testing, rather than show any pattern of deficit.

There is evidence to suggest that Maori may have a higher rate of TBI than the non-Maori population. Maori are disproportionably represented in the statistics pertaining to other risk factors that are associated with TBI, including low income, accident and injury figures, alcohol-related disorders, and crime. Given these factors, it seems reasonable to expect Maori to have proportionally higher rates of TBI, and this was a hypothesis in the present study.

In summary, the purpose of the present study was to examine the rates of TBI and substance abuse in a prison population and to subsequently examine the neuropsychological functioning of a sample of this population. The nature of impairments associated with both comorbid TBI and substance abuse and recurrent TBI would be investigated, along with subjects self-reported problems with aspects of daily functioning.

Participation was sought from inmates of Kaitoke Prison and City Prison in Wanganui, New Zealand. The inmates were initially asked to complete a screening questionnaire which included questions on TBI history, and drug and alcohol use in the past and present. From this information, fifty subjects were selected to

participate in a brief neuropsychological assessment, which examined the major aspects of cognitive functioning. The assessment provided information on short and long term memory for visual and verbal stimuli, motor speed, hand-eye coordination, problem solving, ability for abstract thought, visuo-spatial processing, capacity for learning. A test for malingering was included in the brief test battery as a guide to evaluate the test-behaviour of each subject. Selection for participation in the neuropsychological assessment was based on the severity of TBI sustained and/or severity of substance abuse identified in the screening questionnaire, as outlined more specifically in the method section.

The following hypotheses were based on an examination of the relevant literature and population statistics:

Hypotheses: Part One

(1) TBI Rates

(a) A higher rate of TBI will have been experienced in the prison population than in the general population.

(b) Of those who have sustained a TBI, a greater proportion will have experienced more than one TBI.

(2) Maori TBI

(a) A higher rate of TBI will be reported by subjects who identify as Maori than by the non-Maori population.

(3) Problem Rating Scale (PRS)

The number and severity of problems endorsed on the PRS will increase in proportion with the severity of TBI: More severe TBI will be associated with a greater number and more severe symptoms than less severe TBI.

(4) Substance Use

(a) A higher proportion of the prison population will report the using alcohol and illicit substances than is reported by the general population.

(b) Subjects with a history of severe substance abuse will endorse both a greater number and more severe problems on the Substance Use Problem Rating Scale than those with a history of mild substance abuse.

Hypotheses: Part Two

(5) Psychometric Assessment

(a) The scores of subjects with a history of TBI on psychometric measures will be proportional to the severity of TBI sustained: Subjects with more severe TBI will obtain significantly lower scores than those with less severe TBI.

(b) The scores of subjects with a history of recurrent TBI on psychometric measures will be lower than those with a history of single episode TBI.

(c) Subjects with a history of severe substance abuse will score lower on psychometric measures than those with a history of mild substance abuse.

Chapter 6

Method

Overview of the Present Study

This study was conducted in two parts. Part one examined the prevalence of TBI and substance abuse, cognitive, social, and personal problems within a prison population via a self-report survey. A screening questionnaire requesting information on personal experience with TBI, alcohol, illicit drugs, and containing symptom checklists, was distributed to 118 inmates of a New Zealand prison. In part two, a sample of 50 subjects were selected from within the larger group of 118 on the basis of reported experience with TBI and/or substance use. These subjects were administered a brief neuropsychological assessment battery to investigate the neuropsychological sequelae that may be associated with TBI and chronic substance use.

Aspects of the methodology common to both parts of this study will be presented initially, followed by information on the subjects, measures and procedures for each of the two parts.

Ethical Issues

Permission to conduct the present study was obtained from the Massey University Human Ethics Committee, from the Senior Psychologist of the Palmerston North Justice Department, and from the General Manager of the Wanganui Prisons.

The principle issues included informed consent, confidentiality, and the personal safety of the researcher. To ensure that all participants were aware of their rights as research subjects, information and informed consent sheets were provided to all prospective participants. The information sheet was designed to inform subjects of the purpose of the study, and to provide details on the method to allow each subject to decide if they wished to participate (see Appendix I). The informed consent form was designed in accordance to the requirements of the Massey University Human

Ethics Committee, and each subject signed and dated this form to indicate they were aware of, and understood their rights as a research subject (see Appendix II). Voluntary participation was emphasised, and no reward or privileges were offered contingent on participation. Since prison inmates are a research population with few rights and choices, all care was taken to ensure that participation was voluntary.

Each participants right to confidentiality was strictly enforced, and no member of the Prison staff had access to questionnaires, individual results of the neuropsychological battery, or any results containing identifying information. Further, the questionnaires and the neuropsychological batteries were not administered in the presence of any member of the Prison staff. To maintain the safety of the researcher, however, staff remained close at hand, and the researcher was provided with an inconspicuous personal alarm, which was never required.

Research Setting

The Wanganui prisons were selected for the present study due to their convenient location and because of the permission and support obtained from the general manager and the activities officer. The Wanganui Prisons are a conglomerate of blocks with different security ratings. City Prison is located within Wanganui city and is a minimum security unit with facilities for 60 inmates. Kaitoke Prison is located 10 kilometres from Wanganui city and is a high-medium security unit. Kaitoke consists of East wing, West one and West two blocks, each of which have facilities for 60 inmates. Kaitoke also has a special purpose block called Te Moinga, which can contain 30 inmates.

Part One: Administration of the Screening Questionnaire

Subjects

The initial subject pool consisted of 360 inmates at the Wanganui prisons, but approximately half of these were unavailable due to work party commitments, parole or court hearings, security reasons, and during staff meetings when the inmates were confined to cells. A total of 118 consented to fill in the screening questionnaire.

The demographic characteristics of the sample are presented in Table 1. The subjects ages ranged between 20 and 69 years, with an overall mean of 31 years. A total of 59.3% identified as Maori, 28.8% identified as European, 5.9% as Pacific Island, and 5.9% identified with other ethnic origins. In part two subjects were asked about their educational history, and the results are also presented in Table 1. Most of the sample left school either during or at the completion of the third form year. Only 24% of the sample completed some time in the fifth form year, and 10% progressed into the sixth form year.

Table 1.

Demographic Characteristics of the 118 Subjects who Completed the Screening Questionnaire and of the 50 Subjects who Completed the Neuropsychological Battery

Part 1 (n = 118)			
Ethnicity	*Percentage*	*Mean Age*	*n*
European	28.8	36	34
Maori	59.3	28	70
Pacific Island	5.9	37	7
Other	5.9	37	4
Part 2 (n = 50)			
Ethnicity	*Percentage*	*Mean Age*	*n*
European	22	31	11
Maori	35	29	35
Pacific Island	2	28	2
Other	2	35	2
Education[a]	*Percentage*		*n*[b]
No High School	10		5
Form 3	32		16
Form 4	16		8
Form 5	24		12
Form 6	10		5

[a] Includes subjects completing the full year and those dropping out at some time within the year

[b] Excludes 8 % missing data

Measures

The screening questionnaire was developed specifically for this study (see Appendix III), and surveyed five topic areas; (1) basic demographics, (2) TBI history, (3) the Problem Rating Scale, (4) experience with alcohol and drugs, and (5) the Substance Use Problem Rating Scale.

(1) Basic Demographics

Information on age and ethnic identity was gathered to examine the hypothesis concerning head injury rates and ethnicity, and to accurately compare each subjects performance on the neuropsychological tests to the correct age norms.

(2) Experience with TBI

Subjects were asked to estimate how many head injuries they had sustained, how each had occurred, and the duration of loss of consciousness for each injury. The length of loss of consciousness was selected as a method of estimating TBI severity, given the expectation that few subjects would be aware of the notion of PTA or their GCS scores. The estimated length of loss of consciousness gives a crude measure of severity that would be sufficiently accurate for the purposes of the present study, since the study is subject to the same biases and inaccuracies experienced by any self-report retrospective research.

(3) Problem Rating Scale (PRS)

The third topic area consisted of selected items from the Patient Competency Rating Scale (PCRS; Prigatano, Fordyce, Zeiner, Roueche, Pepping, et al., 1986) and the Cognitive Failures Questionnaire (CFQ; Broadbent, Cooper, Fitzgerald, & Parkes, 1982). Both of these instruments are useful in eliciting the nature of everyday difficulties people rate themselves as experiencing after sustaining TBI. However, many of the items are unsuitable for administration to a prison population as they include situations presently unavailable to inmates. For instance, inmates do not have the opportunity to prepare their own meals (item 1, PCRS), wash dishes (item 4, PCRS), or do laundry (item 5, PCRS). Nor do they have the opportunity to shop at a supermarket (item 13, CFQ), turn off lights or lock doors (item 6, CFQ).

Accordingly, these items were excluded, and the remaining items were reworded to simplify the vocabulary used without altering the meaning of the item. The rationale for the rephrasing of items was to enable as many inmates as possible to read the questionnaire unassisted, given that many New Zealand prison inmates leave school at an early age, and have a lower than average reading age (Braybrook & Southey, 1992). The combined PCRS - CFQ consisted of 26 items; 16 originating from the PCRS (items c,d,e,f,g,h,i,j,k,l,m,n,o,p,q,r), 5 from the CFQ (items a,u,v,x,z), and the remaining 5 were developed from research on symptoms commonly reported by people who sustain TBI (items b,s,t,w,y). These items were problems with following the story of a T.V programme, with headaches, remembering phone numbers, with blurring vision, and ringing noises in ears. All items were paired with a five point Likert scale which was anchored with the labels "*Always*", "*Often*", "*Sometimes*", "*Hardly Ever*", and "*Never*".

(4) Substance Use

This section obtained information on the frequency of current and past use of alcohol and drugs, and an estimate of how often alcohol and drugs were/are used, and was again paired with a four point frequency scale. The scale was anchored with the labels "*Never*", "*Hardly Ever*", "*Weekly*", and "*Daily*". The 13 substances were selected on the basis of their abuse potential and their availability within New Zealand (Braybrook & Southey, 1992; Kaplan & Sadock, 1991).

(5) Substance Use Problem Rating Scale

A list of seven items covered the areas of health, interpersonal relationships, family, finances, school, employment, and social relationships, and were paired with a five point Likert scale anchored with the labels "*Always*", "*Often*", "*Sometimes*", "*Hardly Ever*", and "*Never*". These areas were selected to give a general overview of the impact substance use or abuse may have on an individual's functioning (Black & Casswell, 1993).

Procedure

Recruitment was designed to cause minimum disruption to prison routines and to ensure that all subjects were informed of their rights as a research subject. All subjects were informed of the general purpose of the research either by the researcher or by the activities officer. Subjects that indicated they would be interested in hearing more about the research were bought in groups of 6-10 to either a school room or a visitors area. The researcher outlined the purpose of the study and subjects indicated a willingness to participate in the study or left. Those who remained were provided with an information sheet outlining the purpose of the study (see Appendix I), a consent form (see Appendix II), and a copy of the questionnaire (See Appendix III). The information sheet and consent form were read aloud to any inmate requiring individual assistance with reading the questionnaire. On completion of the questionnaire the subjects were thanked for their assistance.

Criteria for Categorisation of Severity of TBI

Information from the questionnaire was then extracted and analysed. Each subject's self-reported experience with TBI was categorised according to the following criteria;

* Head trauma not resulting in loss of consciousness was categorised as light TBI.
* Multiple incidence of head trauma not resulting in loss of consciousness was grouped as multiple light TBI.
* Head trauma resulting in loss of consciousness for 30 minutes or less was categorised as mild TBI.
* Multiple incidence of head trauma resulting in loss of consciousness for 30 minutes or less was grouped as multiple mild TBI.
* Head trauma resulting in loss of consciousness for greater than 30 minutes but less than 24 hours was categorised as moderate TBI.
* Multiple incidence of head trauma resulting in loss of consciousness for greater than 30 minutes but less than 24 hours was categorised as multiple moderate TBI.

* Head trauma resulting in loss of consciousness of 24 hours or greater was categorised as severe TBI.
* Multiple incidence of head trauma resulting in loss of consciousness of 24 hours or greater was categorised as multiple severe TBI.
* If any subject met two or more of the above categories, the more severe classification was selected as the primary TBI.

Criteria for Classification of Severity of Substance Use

Subjects self-reported experience with drug and alcohol use were allocated to more and less severe substance use groups based on the following criteria;

* Those who reported using one or more substances on a daily basis for 5 or more years were allocated to the more severe substance use group;
* Subjects reporting use of one or more substances weekly or less often for less than years were allocated to the less severe substance use group.

It is acknowledged that this classification system is a conservative estimate of substance use, and may have resulted in instances of both under and over estimation in either group. This classification system, however, was only intended as a guide to the substance use level of subjects.

Part Two: Administration of the Neuropsychological Battery

Subjects

Fifty subjects were selected to complete the second part of the study, based on the information obtained from the screening questionnaire. Strict selection criteria were employed, and only subjects who indicated on the informed consent form that they were willing to participate in the second part were available for selection.

Subject Selection Criteria

Subjects were selected according to the following criteria;

* Any subject who indicated he was unconscious for 30 minutes or longer,
* Any subject with multiple mild or light head injuries who indicated experiencing a range of problems typically associated with TBI by endorsing 10 or more problems on the symptom rating scale in the questionnaire,
* Any subject in the more severe substance use group who indicated experiencing two or more problems on the Substance Use Problem Rating Scale.

These criteria were applied until a sample of 50 subjects were obtained. Subject selection was performed in this manner as it was often difficult to gain access to subjects, since many were transferred or committed to work parties.

Measures

A brief neuropsychological battery examining areas of functioning that can be impaired by TBI was comprised of;

* Rey Auditory Verbal Learning Test (AVLT; Lezak, 1983; Rey, 1964),
* Rey-Osterrieth Complex Figure Test (CFT; Rey, 1941; Osterrieth, 1944),
* Rey 15 Item Malingering Test (Rey, 1964),
* Finger Tapping test from the Halstead-Reitan Neuropsychological Battery (Lezak, 1983),
* Subtests from the Wechsler Adult Intelligence Scale Revised (WAIS-R):
  Digit Span (Wechsler, 1981),
  Digit Symbol (Wechsler, 1981),
  Similarities (Wechsler, 1981).

Rey Auditory Verbal Learning Test

The AVLT was selected to provide information on short term auditory memory, long term auditory memory, recognition memory, and learning (Anderson, 1994). The AVLT provides a guide to rates of learning, reveals learning strategies, demonstrates

the effect of proactive and retroactive interference, measures retention following an interference activity and after a delay of 30 minutes, and reveals tendencies to confabulate (Lezak, 1983).

The AVLT consists of two lists of 15 different words which are read slowly to subjects (see Appendix IVa). The first list is presented five times and the second list is presented once as an interference trial. Recall for words is tested after each presentation of the two lists, and recall for the first list is tested again without presentation after the interference trial and after a period of 30 minutes. The AVLT is a widely used test with well established norms for different age groups and education levels (Lezak, 1983; Shapiro & Harrison, 1990; Geffen, Moar, O'Hanlon, Clark, & Geffen, 1990), and was administered according to the standardised instructions. The specific procedure is presented in Appendix IV (a).

Rey-Osterrieth Complex Figure Test

The CFT measures short term visual memory, long term visual memory, organisation and integration of visuo-spatial constructional functions (Tombaugh, Faulkner, & Hubley, 1992). The CFT consists of three trials; a copy trial, three minute delayed recall, and a 30 minute delayed recall trial. The test yields scores for each trial and percentage forgetting and percentage recall scores. The CFT is also a widely used test with well established quantitative and qualitative norms (Lezak, 1983; Tombaugh. et al., 1992). Qualitative norms suggest that individuals with TBI tend not to perceive the large rectangle, may repeat elements, and lose details easily, which results in poor performance and high percentage forgetting (Lezak, 1983). The CFT scoring form and the standardised administration procedure appear in Appendix IV(b).

Finger Tapping Test

The Finger Tapping test from the Halstead - Reitan Neuropsychological Test Battery provides information on general motor speed and co-ordination as well as information on understanding and conforming to test instructions. The test consists of a lever connected to a counter mechanism and the task is to depress the lever with an index

finger as many times as possible in a 10 second time period. The test requires 5 counter balanced trials with each hand. Lezak (1983) notes that TBI tends to have a slowing effect on the finger tapping rate. The Finger Tapping score sheet and the administration procedure are presented in Appendix IV(c).

Similarities Subtest of the WAIS-R

The Similarities subtest measures the higher order executive functions of verbal abstract thinking, ability to categorise concepts, and associative thinking (Anderson, 1994). The test consists of 14 word pairs which both belong to a general category and requires the subject to make abstract connections between seemingly increasing unrelated concepts. As part of the WAIS-R, it has been subject to rigorous examinations of the psychometric properties, and the manual states it has an overall split-half reliability coefficient of .84, with a standard error of measurement of 1.24 (Wechsler, 1981). The sheet of word pairs and the standardised administration procedure from the WAIS-R manual appear in Appendix IV(d).

Digit Symbol Subtest of the WAIS-R

The Digit Symbol subtest was selected to measure short-term figural memory, motor and information processing speed, and ability to learn new information (Anderson, 1994). This test consists of a worksheet printed with divided boxes that have numbers randomly ordered on top, and an empty box underneath (see Appendix IV). The worksheet has a key with the numbers from one to nine and printed below each number is an individual symbol. The test requires subjects to fill in the correct symbol beneath each number. Lezak (1983) reports that this test is sensitive to the effects of TBI and poor performance can result form even minor damage. The WAIS -R manual states that the test-retest reliability coefficient is .82, and the standard error of measurement score is 1.24 (Wechsler, 1981). The standardised administration procedure from the WAIS-R manual was followed in the present study, and this is presented in Appendix IV(e).

Digit Span Subtest of the WAIS-R

The Digit Span subtest was selected to measure short term memory for digits forward, and the ability to hold information in memory and manipulate it for the digits backwards trials. The Digits Forward test consists of presenting a series of seven pairs of randomised numbers for a subject to repeat back in the same order. A three-digit item is presented first and the number of digits is increased until both trials of any item are failed, or nine digits are successfully recalled. Digits Backwards trials require digits to be recalled in the reverse order they were presented in. Again, the test is terminated after both trials of any item are failed or eight digits are successfully recalled backwards. The Digits Backwards trials are sensitive to problems with sustaining attention and TBI. The WAIS-R manual states this test has a test-retest reliability co-efficient of .83, with a standard error of measurement score of 1.23 (Wechsler, 1981). Again, the standardised procedure from the WAIS-R manual was used, and these instructions and the Digit Span trials are presented in Appendix IV(f).

Rey 15 Item Test

The 15 Item Test (Rey, 1964) was included an indicator of simulated cognitive impairment. This test is based on the rationale that people who simulate cognitive impairment tend to overestimate the degree to which TBI affects performance on a simple short term memory task, and so achieve scores below patients with severe TBI or below chance performance. Although Lezak (1983) states that failure to recall nine or more items is indicative of simulation, research suggests this cutoff point may be too high, particularly if ineffective learning strategies are employed (Rawling, 1990). Therefore, this test was used only as an indicator of simulated cognitive impairment and was used as a more qualitative measure of learning strategies. The administration procedure and the test stimuli are presented in Appendix IV(g).

Procedure

The second part of the present study involved administering the brief neuropsychological battery to the 50 subjects selected on the basis of the screening questionnaires. Administration of the battery took approximately 45 minutes per subject, and testing was conducted in a quiet room. The subtests were administered in the following order:

(1) Trials 1 to 6 of the AVLT
(2) Copy and 3 minute delay trials of the CFT
(3) Forward and Backwards trials of the Digit Span test
(4) Finger Tapping test
(5) Digit Symbol test
(6) Similarities test
(7) Delayed recall trial and Recognition trial of the AVLT
(8) 30 minute delay trial of the CFT

Each subject was tested individually and was thanked for their participation following completion of the final task. Subjects were requested not to divulge details of the testing to other subjects.

The data was then collated and analysed using the SPSS statistical analysis package, and the results appear in chapter seven.

Chapter 7

Results

Part 1: Information Obtained from the Screening Questionnaire

TBI Rates

Hypothesis 1.

(a) A higher rate of TBI will have been experienced in the prison population than in the general population.

Research on TBI is usually conducted with subjects who have come to medical attention through sustaining mild, and particularly moderate and severe TBI. Subjects with light TBI are rarely included in such research, but were included in this study because research suggests that the effects of recurrent TBI are cumulative.

It was found that 86.4% of the sample had sustained a TBI, at some time in their lives. With light TBI excluded, 78.8% of the sample had sustained mild, moderate, or severe TBI. These figures are lifetime prevalence rates, making it difficult to compare directly with either New Zealand or international figures, which report only annual incidence rates. An annual incidence rate could not be calculated because many subjects were only able to estimate the year(s) in which they had sustained TBI, especially if it was 5 or more years ago. Further, asking about the current or past year was inappropriate since most of the sample had been incarcerated during that time thus reducing their exposure to the main risk factors for TBI.

1 (b) Of those who have sustained a TBI, a greater proportion will have experienced more than one TBI.

Results presented in Table 2 support this hypothesis, with 27.9% of the sample experiencing only one TBI and the remaining 56.7% sustaining two or more. With light TBI excluded, 32% of the sample sustained more than one TBI.

Table 2.

Percentage of 118[a] Subjects Sustaining One or More TBI

Number of TBI	N	%	% (Cumulative)
1	33	27.9	
2	22	18.6	
3	11	9.3	27.9
4	7	5.9	33.8
5+	27	22.9	56.7

[a] 102 reported sustaining TBI, but only 100 gave sufficient details on the number and severity of TBI sustained. The total N was reduced to 118 for this calculation.

Although some epidemiological information on the frequency of moderate and severe TBI exists for the general population, these rates typically exclude light and mild TBI, and are based on hospital populations using well standardised measures such as the GCS and length of PTA. The present study, however, was conducted with a very different population for whom there was no access to GCS scores or PTA (even if this data had existed). Accordingly, duration of unconsciousness was used as the estimate of severity.

Data on the severity of TBI is presented in Table 3. This table shows that 153 TBI of varying severity were sustained by 100 of the 118 subjects. Since research suggests the effects of recurrent TBI may be cumulative, rating severity by the length of unconsciousness may not provide an reliable estimate of the true impact that sustaining a number of TBI could have. For example, any one individual could sustain light, mild, moderate, and/or severe TBI, and therefore be eligible for all of these categories. TBI is typically classified by the most severe or the most recent sustained, and this clearly is not an accurate reflection of the true experience of head injury.

Table 3.

Frequency & Severity of TBI Sustained by 100 Prison Inmates

Number of TBI	Light	Mild	Mod.	Severe
1	25	34	17	9
2	15	12	1	
3	3	9	2	
4	6	2	2	
5+	12	4		
Total	61	61	22	9

The research literature gives no guidelines for classifying TBI that takes both the number and severity of TBI sustained into account, in spite of clear evidence that both are important (Salcido & Costich, 1992). Accordingly, in the present study, an attempt was made at reclassification, and the criteria are presented in Table 4.

Table 4.

Criteria for Reclassifying Subjects Experience with TBI

Severity	Criteria for Each Classification of Severity
Light:	Up to and including 3 light TBI,
Mild:	4 or more light TBI and/or 2 or less mild TBI,
Moderate:	4 or more mild TBI and/or 2 or less moderate TBI,
Severe:	3 or more moderate TBI and/or any severe TBI.

Percentages of subjects in each of the new and old severity classifications are shown in Table 5. As a result of the reclassification, the number of subjects in the moderate (29.4%) and severe (10.8%) categories increased (no individual was included in more than one category).

Table 5.

Percentage of Light, Mild, Moderate and Severe TBI Sustained by 102[a] Subjects with TBI, Before and After Reclassification

TBI	Light	Mild	Mod.	Severe
Before[b]	59.8	59.8	19.6	8.8
New Rationale[a]	16.6	41.2	29.4	10.8

[a] 102 subjects reported sustaining TBI, but data of 2 subjects was missing due to insufficient information.
[b] Does not total 100% due to recurrent TBI.

When the reclassified TBI subjects were further subdivided on the basis of substance abuse, as shown in Table 6, some groups had very few subjects. There were uneven numbers of subjects across the groups and insufficient numbers in cells to conduct certain statistical techniques such as Analysis of Variance.

Table 6.

The Number of Subjects in Each Group as a Result of Reclassification of TBI and Substance Use

		TBI			
	No	Light	Mild	Mod.	Severe
Substance Use (n=118)					
Mild	11	11	18	17	6
Severe	7	6	24	13	5

Maori TBI

Hypothesis 2.

A higher rate of TBI will be reported in subjects who identify as Maori than in the non-Maori population.

Of the 59.3% of subjects who identified as Maori, 91.4% reported sustaining TBI, compared to 79.4% of the 28.8% of non-Maori subjects, providing support for the hypothesis. These percentages do not add to 100% because subjects who identified as "other" ethnic groups are missing from these statistics.

Problem Rating Scale

Hypothesis 3.

The number and severity of problems endorsed on the Problem Rating Scale will increase in proportion with the severity of TBI; more severe TBI will be associated with a greater number and more severe symptoms than less severe TBI.

The internal consistency of this outcome measure was tested using Cronbach's Alpha, and the obtained overall alpha coefficient of r = .9337 indicated that the items provide a stable and consistent measure of the overall construct of outcome following TBI. The 26 item Problem Rating Scale (PRS) was completed by all 118 subjects but some subjects chose to omit some questions. Those who answered fewer than 3 items were dropped from the analyses, resulting in the data of two subjects being dropped.

Oneway Analysis of Variance (ANOVA) was computed between severity of TBI and the overall mean score on the PRS. This analysis revealed no difference between groups on self-reported problems due to the severity of TBI sustained, $F(4,11) = .97$, $p = .42$. The four groups were then further collapsed to determine whether there was a difference between those sustaining minor TBI and those sustaining serious TBI. A t-test was conducted between subjects sustaining either no, light, and/or mild TBI, and those sustaining moderate and/or severe TBI for the overall means on the

problem rating scale. Again, no significant differences were found, t (114) = .667, p = .15. The means and standard deviations for each item rated by the 118 subjects is presented in Appendix V. This appendix shows that the subjects generally reported a mild level of difficulty with items.

Substance Use

Hypothesis 4.

(a) A higher proportion of the prison population will report using alcohol and illicit substances than is reported by the general population.

Comparisons between this prison population and the New Zealand general population are shown on Table 7. Unexpectedly, alcohol use was lower for the prison population (89%) than for the New Zealand male general population (96%). This may have been partly due to the wording of the screening questionnaire which asked whether subjects had ever "*used*" rather than whether they had ever "*drunk*" alcohol. While the term "*use*" was appropriate for the illicit substances, it may have confused subjects when applied to alcohol.

The prison population reported more use of illicit substances than the New Zealand general population. Specifically, cannabis, LSD, psilocybin, and amphetamines had been used by over 40% prison inmates. Use of PCP was reported by the fewest subjects (8.4%). Currently, no data is available on rates of substance use in other New Zealand prison populations. Further, comparison with studies of prison populations overseas is inappropriate because availability and popularity of substances differs from country to country.

Since some unanticipated differences occurred between non-Maori and Maori, and these results are also presented in Table 7. Maori reported using more cannabis, LSD, psilocybin, and barbiturates than non-Maori. A higher use of sleeping pills, sedative hypnotics, opioids, and cocaine were reported by non-Maori, with little difference occurring between the two groups on the use of the remaining substances.

Table 7.

Percentage of the New Zealand General Population, Subjects in the Prison Population, and Non-Maori and Maori Subjects Who Reported Use of Alcohol and Illicit Substances

Substance	NZ General Population[a]	Entire Sample[b]	Non-Maori	Maori
alcohol	96.0[c]	89.0	91.2	92.8
cannabis	56.0	78.9	67.6	88.5
LSD	8.0[d]	44.1	38.2	49.9
psilocybin	8.0[d]	43.2	38.3	52.9
amphetamines	5.0	42.3	44.9	44.3
cocaine	5.0	27.9	29.4	25.7
opioids	3.0	22.8	26.5	21.5
sleeping pills	2.0	34.7	50.0	31.4
sedative hypnotics	2.0[e]	39.9	50.1	40.1
inhalants	1.0	18.6	14.7	22.9
barbiturates	--	27.9	20.5	34.3
PCP	--	8.4	8.8	8.6
morning glory seeds	--	11.0	11.8	11.4

[a] Black & Casswell (1993).
[b] Includes other ethnic groups
[c] Refers to adult males in New Zealand
[d] Refers to all hallucinogens, not LSD or psilocybin specifically
[e] Refers to all sedative hypnotics, not sleeping pills specifically.

Another perspective on substance use is presented in Table 8, which provides further support for Hypothesis 4 (a). This Table again shows the percentage of the sample who have ever used each substance, and shows the percentage of current users, and the percentage of these individuals who continued to use each substance for 5 or more years. The mean length of use is also presented, but it should be noted that this statistic represents a general measurement rather than the mean number of years, since this was measured in categories of time, rather than years per se. Thus, the closer the mean is to 5.00, the higher the length of time the substance was used.

Table 8.

Percentage of Sample Ever Trying Substances, Compared to Those who Continued to Use Substances for 5 or More Years, Mean Time Used and Percentage of Current Users

Substance	Entire Sample	Use 5> years	Mean use[a]	Current Use
alcohol	89.0	73.1	4.5	36.4
cannabis	78.0	65.3	4.7	56.8
LSD	44.1	88.4	4.1	19.5
psilocybin	43.2	100.0	4.4	17.8
amphetamines	42.3	75.0	4.5	16.1
sleeping pills	34.7	81.8	4.4	13.5
sedative hypnotics	39.9	68.2	4.4	20.3
barbiturates	27.9	92.3	4.7	9.2
opioids	22.8	88.9	3.9	11.9
inhalants	18.6	59.4	4.9	2.5
cocaine	27.9	53.3	3.7	8.4
PCP	8.4	66.7	5.0	5.8
morning glory seeds	11.0	100.0	5.0	4.2

[a] These figures do not represent actual years but refer to categories of time as appear in the screening questionnaire:

(1) 1 month or less
(2) from 1-6 months
(3) from 6-12 months
(4) from 1-5 years
(5) more than 5 years

Of those reporting ever using alcohol, 73.1% continued drinking for 5 or more years, and a total of 65.3% who had ever used cannabis continuing using it for 5 or more years. LSD, amphetamines, psilocybin, sleeping pills, other sedative hypnotics, and barbiturates were less widely used, but high percentages of those ever trying these substances continued using them for a long period of time. Subjects were more likely to continue using certain substances. Psilocybin and Morning Glory seeds were reported by 43.2% and 11.0% of subjects respectively, yet everyone who ever tried this substance continued using it for 5 or more years. Overall, these results suggest that most substances were used for one year or longer. Not surprisingly,

fewer subjects reported currently using substances. However, 36.4% reported having access to alcohol, and 56.8% reported using cannabis. These were unexpected results, given that all subjects were in prison with supposedly no access to alcohol or illicit substances. Other substances with high rates of current use included sedative hypnotics, LSD, and psilocybin, all of which also had high rates of past use.

Substance Use Problem Rating Scale

4 (b) Subjects with a history of severe substance abuse will endorse both a greater number and more severe problems on the substance use problem rating scale than those without a history of substance abuse.

The internal consistency of the Substance Use Problem Rating Scale (SPRS) was assessed by calculation of the Cronbach's Alpha reliability coefficient, which indicated that the items all measured the same underlying construct, r = .86. A Student's t-test was conducted between the two levels of substance abuse groups for the mean ratings of problems on the substance use problem rating scale, which are shown in Table 9. It was found that subjects in the less severe substance abuse group endorsed more problems overall than those in the more severe substance abuse group, t (90) = 2.41, p = .018. Thus, the hypothesis was not supported.

Table 9.

Mean Ratings on the Substance Use Problem Rating Scale for the Mild and Severe Substance Use Groups

Item	*Mild Group* Mean (sd)	*Severe Group* Mean (sd)
(a) Health	1.1 (1.1)	1.4 (1.3)
(b) Wife/partner	2.0 (1.4)	1.8 (1.4)
(c) Family/children	1.9 (1.3)	1.6 (1.6)
(d) Money	2.4 (1.4)	2.1 (1.4)
(e) School	1.8 (1.4)	1.1 (1.5)
(f) Work	1.9 (1.4)	1.4 (1.4)
(g) Social life/friends	1.6 (1.4)	1.9 (1.4)

Part 2: Selection of a Sample Group of 50 Subjects

Subjects were selected for Part 2 based on the information obtained in the screening questionnaire and selection criteria developed for the present study. Subjects who had sustained moderate or severe TBI or who reported a history of substance abuse were preferentially selected, along with those reporting significant problems on the PRS. This sample of 50 did not differ significantly in mean age or ethnicity from the part 1. The frequency and severity of the TBI sustained by this sample is presented in Appendix VI(a), and shows than a higher percentage of the sample sustained moderate and severe TBI compared to the group of 118. Appendix VI(b) contains the samples reclassified experience with TBI, again indicating the importance of taking recurrent TBI into account, since the proportion of subjects in the mild, moderate, and severe TBI categories increased after reclassification, reflecting the impact of multiple injuries of differing severity. Table 10 shows the number of subjects in different combinations of TBI severity and substance use groups. As with the large sample, some groups have small numbers, restricting the range of statistical analyses available to test hypotheses.

Table 10.

The Number of Subjects in Each Group as a Result of Reclassification of TBI and Substance Use

	TBI				
	No	Light	Mild	Mod	Severe
Substance Use (n=50)					
Mild	2	4	5	8	3
Severe	2	2	15	8	3

Appendix VI(c) contains data on the substance use reported by the sample, and shows that the sample reported more illicit substance use than the general population, and again Maori subjects tended to report more use than non-Maori. Appendix VI(d)

contains data on the length of time each substance was used by the sample, and there were few differences from the entire group, indicating that the sample were representative of the subjects as a whole. This Appendix also shows the percentage of current substance users among the sample of 50 subjects. As with the larger group, a higher than expected percentage of subjects reported having access to alcohol and illicit substances, particularly cannabis, alcohol. LSD, and sedative hypnotics. The rates of current use tended to be higher than the larger group, but since subjects were selected on the basis of greater substance use, this was expected.

Results Compared to Norms

During neuropsychological assessment, it was observed that all subjects were performing at lower levels on certain tasks, and no differences between subjects on the basis of TBI history or substance abuse were evident. Accordingly, it was decided to assess the overall level of performance of subjects compared to selected norms, and these comparisons are shown on Table 11. Norms for unskilled males of the appropriate age group were available for the AVLT, and Figure 1 shows performance of this groups compared to norms (Geffen et al., 1990). Performance of this group was below the norms on all trials.

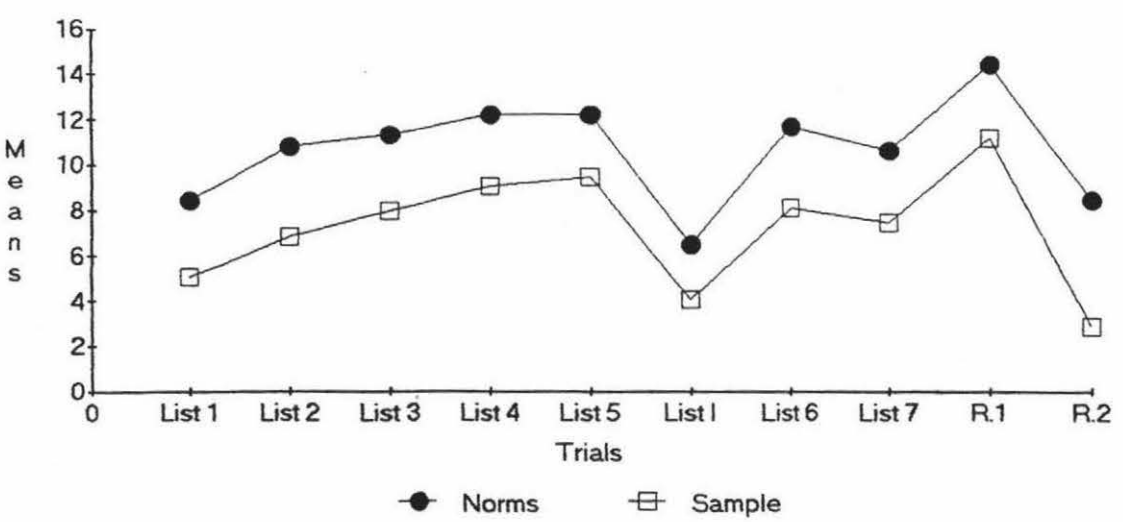

Figure 1.

Performance of the Sample of 50 Subjects on the AVLT Compared to Norms From Geffen, et al. (1990).

Student's t-tests were conducted between the present subjects and the norms for the AVLT provided by Geffen et al (1990), as shown in Table 11. Significant differences in the level of performance were found for all trials except the Interference List. Differences in the level of performance between norms and subjects scores were found on the Similarities subtest, with subjects performing 1.33 standard deviations below the mean (Wechsler, 1981). As only small differences were found between the norms and subjects performance on other measures, statistical analyses were not conducted.

Table 11.

Comparison of Means of the Sample of 50 and Norms for the Neuropsychological Measures

	Means			
	Norms	This Study	*t*	*p*
AVLT[a]				
List 1	8.4	5.1	6.4	.001
List 2	10.8	6.8	6.6	.001
List 2	11.3	7.9	48	.001
List 4	12.2	9.0	4.6	.001
List 5	12.2	9.4	3.5	.001
Interf.	6.5	4.1	1.9	n.s
List 6	11.1	8.1	3.2	.010
Delay	10.6	7.4	3.4	.010
Recog.1	14.2	11.2	2.8	.010
Recog.2	8.2	2.8	5.9	.001
WAIS-R Subtests[b]			sd from mean	
Similarities	10	6	1.3	
Digit Span	10	8	0.7	
Digit Symbol	10	8	0.7	
CFT[c]				
Copy	35.1	34.5		
Delay	22.7	23.9		
Finger Tapping[d]				
Left	50	50.6		
Right	50	53.9		
Rey 15 Item Test[e]	9.1	12.0		

[a] From Geffen et al (1990)
[b] From Wechsler (1981)
[c] From Spreen & Strauss (1991)
[d] From Lezak (1983)
[e] From Guilmette, Hart, Giuliano, & Leninger (1994)

Hypothesis 5.

TBI Severity and Neuropsychological Scores

(a) The scores of subjects on psychometric measures will be proportional to the severity of TBI sustained: subjects with more severe TBI will obtain significantly lower scores than those with less severe TBI.

The most appropriate statistic to test this hypothesis would have been Analysis of Variance, but the characteristics of the sample (small numbers in each cell and the uneven groups) did not meet the requirements for performing this analysis and Students t-tests were used instead. Based on the reclassification of their TBI history subjects were divided into groups. Those who had sustained single TBI or combinations of mild, light, or no TBI (severe substance users) were allocated to one group, and those sustaining moderate and/or severe TBI to the other. The results of the t-tests presented in Table 12 show that the only significant difference between the two groups of severity of TBI on any measure occurred on List 7, (the delayed recall trial of the AVLT). On this trial the more severe TBI group performed at a significantly lower level than the less severe TBI group, $t\ (48) = 2.25$, $p = .03$. However, all subjects performed below the norms on the AVLT and Similarities subtest from the WAIS-R.

Table 12.

Comparison of Means of Mild and Severe TBI groups on Neuropsychological Measures

	Mild	Severe	t	*p*
AVLT Trial				
1	5.2	4.9	0.6	0.5
2	6.8	6.8	0.0	1.0
3	8.0	7.8	0.7	0.7
4	9.0	8.9	0.1	0.9
5	9.4	9.4	0.0	1.0
Interf.	4.0	4.1	0.1	0.9
6	8.5	7.6	1.1	0.3
7	8.1	6.5	2.3	0.03*
Recog.1	11.7	10.5	1.3	0.2
Recog.2	2.9	2.7	0.8	0.8
CFT				
Copy	34.4	34.7	0.6	0.6
Recall	25.0	23.8	0.8	0.5
Delay	24.6	22.9	1.0	0.3
Digit Span				
Forward	6.5	7.1	1.1	0.3
Backward	5.3	5.6	0.4	0.7
Finger Tapping				
Left	49.6	50.7	0.7	0.5
Right	53.0	55.2	1.1	0.3
Similarities	13.0	13.7	0.5	0.7
Digit Symbol	49.2	47.9	0.5	0.6
Rey 15 Item Test	11.9	12.1	0.2	0.8

* Denotes statistically significant result

5 (b) The scores of subjects with a history of recurrent TBI on psychometric measures will be lower than those with a history of single episode TBI.

Since 13 subjects sustained a single TBI in the sample, and because the severity of TBI sustained differed, it seemed inappropriate to treat the single TBI group as homogenous for the purpose of statistical analysis. Thus it was not possible to test this hypothesis.

5 (c) Subjects with a history of severe substance abuse will obtain lower scores on psychometric measures than those without a history of substance abuse.

The subjects who indicated they had used alcohol and illicit substances were allocated to one of two groups, based on the information obtained from the screening questionnaire. Subjects who reported using one or more substances daily for 5 years or longer were categorised as substance abusers, and the remaining subjects were allocated to the non-substance abuser group. This system may have resulted in a number of false positive and false negatives, but provided a rough guide to the level of substance abuse. For example, since the amount of substance consumed was not surveyed, those consuming one glass of wine each night for more than 5 years would be incorrectly allocated to the severe substance use group. At the same time, it has already been stated that compared to New Zealand norms, this group rated lower levels of alcohol use, so the figures are probably accurate. Similarly, those using cocaine several times a day for less than 5 years would be missed from the severe use group.

Again, it was considered inappropriate to perform Analysis of Variance, given the small sample size and the uneven allocation to groups. Instead, Student's t-tests were conducted and the results are shown on Table 13. No significant differences occurred between the two levels of substance abuse and the mean outcome on any measure, but again, all subjects were below the norms on the AVLT and Similarities subtest of the WAIS-R.

Table 13.

Comparison of Means of Mild and Severe Substance Abuse groups on Neuropsychological Measures

	Mild	Severe	*t*	*p*
AVLT Trial				
1	5.4	4.9	1.1	0.3
2	7.3	6.5	1.5	0.2
3	8.0	7.9	0.2	0.9
4	8.9	9.1	0.3	0.3
5	9.6	9.3	0.4	0.7
Interf.	4.0	4.1	0.2	0.8
6	8.5	7.8	0.9	0.4
7	7.4	7.5	0.1	0.9
Recog.1	10.2	11.8	1.8	0.1
Recog.2	2.8	2.9	0.1	0.9
CFT				
Copy	34.1	34.8	1.4	0.2
Recall	24.4	24.5	0.1	0.9
Delay	23.5	24.1	0.4	0.7
Digit Span				
Forward	6.5	6.9	0.8	0.4
Backward	5.3	5.5	0.5	0.6
Finger Tapping				
Left	51.7	49.0	1.6	0.1
Right	54.1	53.9	0.1	0.9
Similarities	13.9	12.9	0.7	0.5
Digit Symbol	46.9	49.8	1.1	0.3
Rey 15 Item Test	11.4	12.4	1.1	0.3

Although the two levels of substance use groups did not perform significantly differently from each other on any measure, they achieved scores lower than the norms for the AVLT. The substance use groups obtained lower levels of

performance on every trial compared to the norms from Geffen et al. (1990), as shown in Figure 2.

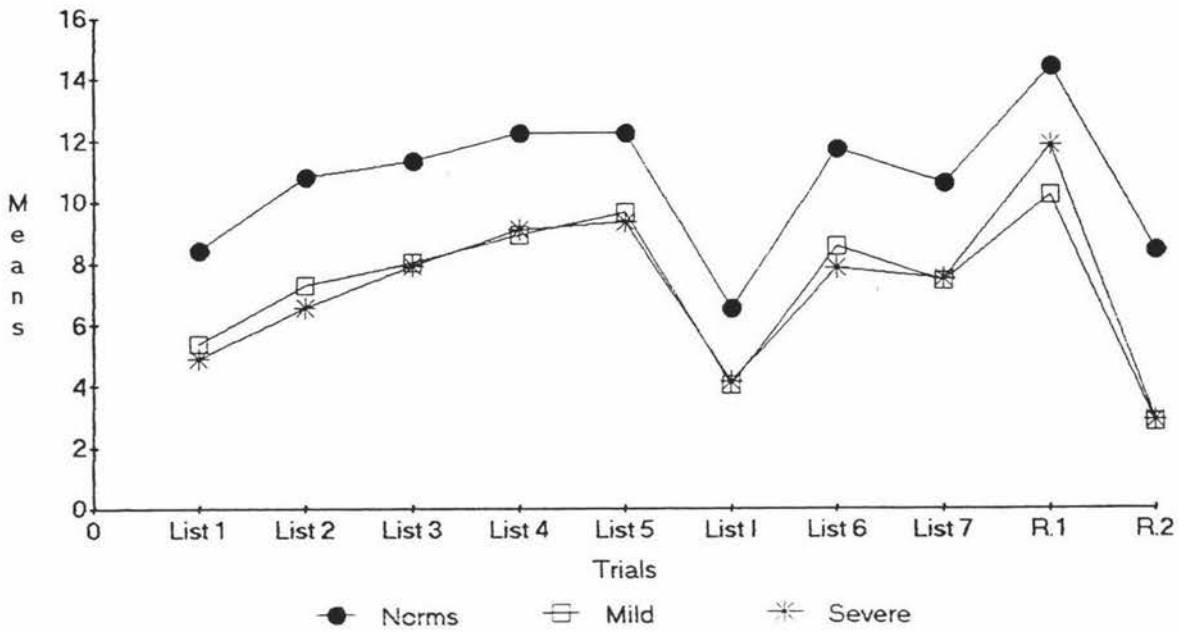

Figure 2.

Mean Performance of Mild and Severe Substance Use Groups on the AVLT Compared to Norms From Geffen et al. (1990).

Post-Hoc Findings

Ethnicity and Performance on the Neuropsychological Battery

An impression was formed whilst conducting this study that Maori subjects were performing at lower levels than non-Maori subjects. Accordingly, performance of these two groups on the neuropsychological measures were compared using Student's t-tests. Subjects of Pacific Island, Asian, or other ethnic origin were not included in either group, since the numbers of these subjects were small and the epidemiological characteristics are different to either the Maori or non-Maori groups in the present sample. The results are shown in Table 14.

Table 14.

Comparison of Means of Maori and non-Maori groups on Neuropsychological Measures (N=44)

	Non-Maori means	Maori means	*t*	*p*
AVLT Trial				
1	6.3	4.7	3.3	0.002*
2	8.1	6.4	2.9	0.005*
3	9.4	7.5	2.6	0.1*
4	10.0	8.7	1.8	0.1
5	10.9	8.9	2.3	0.024*
Interf.	4.6	4.0	1.0	0.3
6	9.9	7.5	2.7	0.009*
7	8.5	7.0	1.7	0.1
Recog.1	12.9	10.6	2.1	0.050*
Recog.2	4.2	2.5	1.1	0.1
CFT				
Copy	34.6	34.5	0.1	1.0
Recall	25.0	24.0	0.5	0.6
Delay	24.1	23.5	0.3	0.8
Digit Span				
Forward	7.4	6.7	1.0	0.4
Backward	5.6	5.6	0.1	1.0
Finger Tapping				
Left	48.5	50.6	1.0	0.3
Right	51.4	54.1	1.2	0.3
Similarities	16.3	12.9	2.3[a]	0.03*
Digit Symbol	50.7	47.4	1.1	0.3
Rey 15 Item Test	13.6	11.8	1.9	0.1

* Denotes statistically significant result

[a] Levene's test of equality of means indicated that the means were not equal, thus the unequal means t-value, degrees of freedom, and p-value were used

Differences between non-Maori and Maori on the AVLT, compared to norms from Geffen et al. (1990) are shown in Figure 3. Although both Maori and non-Maori groups achieved scored lower than the normative group, Maori scores were lower than those obtained by non-Maori on all trials.

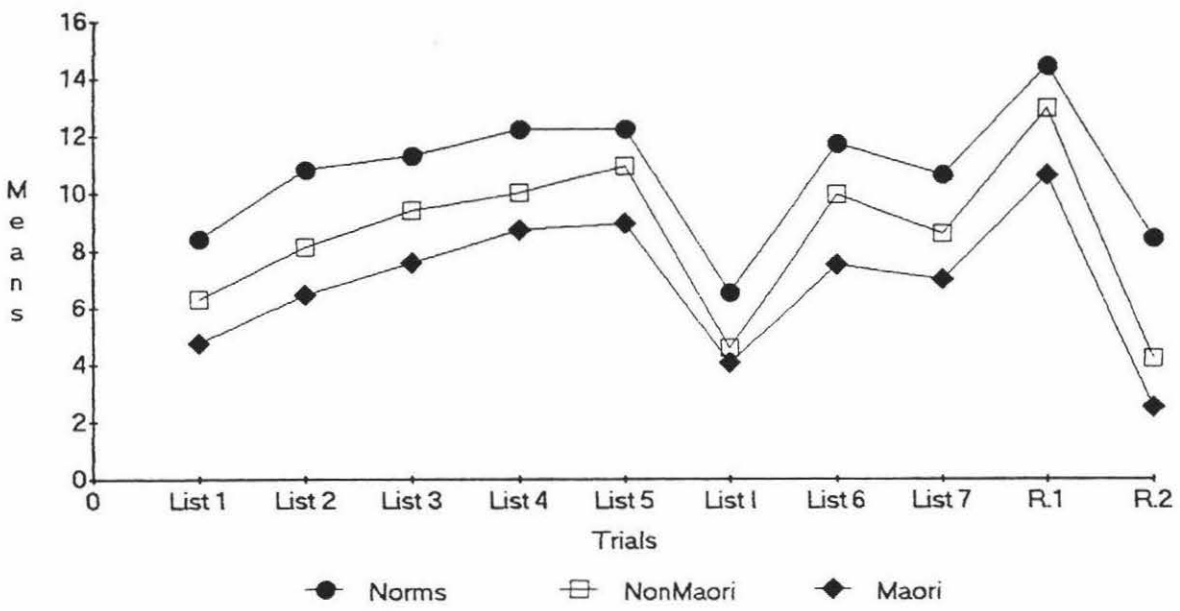

Figure 3.

Mean Performance of Maori and Non-Maori Subjects on the AVLT Compared to the Norms From Geffen et al. (1990).

Qualitative Results

The Causes of TBI Sustained by 102 Prison Inmates

It became apparent that the prison population was not only subject to different rates of TBI than the general population, but differed in the causes of TBI. Fights, and especially gang fights accounted for the majority of the light and mild TBI reported by subjects, while motor vehicle accidents accounted for most of the moderate and severe TBI. The causes of TBI reported by the present sample, (roughly in order of frequency), are presented in Table 15, and shows that fights, MVA's, and other accidents account for most of the TBI reported. Sports injuries also feature prominently, as do injuries sustained as a result of being beaten as children. Interestingly, a small number of subjects reported sustaining TBI while under Police custody.

Table 15.

The Causes of TBI Reported by 102 Prison Inmates in Order of Frequency Reported

Causal Factor	
Fights:	includes gang fights and assaults
MVA:	includes motor cycle and bicycle accidents
Other Accidents:	includes falls, accidents at work, etc
Sports:	includes rugby, league, soccer, water sports
Child Abuse:	includes beatings and other assaults
Police Baton:	includes injuries sustained while being arrested, transferred, etc

It was difficult to categorise the subjects responses to the question on how each injury was sustained, since a wide variety of situations were recorded. Further, many of the subjects did not provide sufficient detail to allow the response to be categorised. For example, "got the bash" was a frequent response which was impossible to categorise, since this could have happened during a fight, an assault, or

as a punishment from childhood. Thus, frequencies are unavailable and this information is presented for interest value rather than to investigate a specific hypothesis.

Chapter 8

Discussion

Part 1: The Screening Questionnaire

Prevalence of TBI in the Prison Population

Information obtained from the Screening Questionnaire indicated that most of the sample had experienced TBI. Although data on lifetime prevalence rates were not available for comparison, at 86.4%, this prison population appear to have experienced a disproportionably high rate of TBI compared to the general population, and possibly compared to their non-incarcerated counterparts. This could be a result of their exposure to all of the leading risk factors TBI; the subjects were all male, an average of 30 years old, and almost all reported some experience with alcohol and/or illicit drugs. Further, subjects were sentenced to a high medium security prison, presumably for committing serious crimes, and may have been exposed to more assaults than other prison populations. Gang fights, assaults, and motor vehicle accidents accounted for most of the TBI reported by the inmates. It could be suggested that some subjects may have exaggerated their experience with TBI, but since subjects completed the forms independently, without the opportunity to compare results with other inmates, and since no incentives were offered for completing the questionnaires, this suggestion is weakened.

Recurrent TBI

A high rate of recurrent TBI was found, with 56.7% of those reporting TBI experiencing more than one. While this rate is substantially higher than is reported in the literature, where estimates vary from 4 to 40% (Salcido & Costich, 1992), this study included light TBI, which inflated the recurrent TBI rate. When the light TBI are removed, the rate becomes 32% , which is still high, and may indicate that rates of recurrent TBI are especially elevated in populations that are subject to the risk factors for TBI.

Classification of Severity of TBI

The unexpectedly high number of subjects reporting recurrent TBI raised the issue of classifying experience with TBI. Using either the most recent or the most severe TBI sustained did not always provide an accurate account of an individuals experience with TBI, since the most recent TBI may not have been the most severe. Accordingly, an attempt was made to create a classification system taking into account both the number and severity of TBI. The system was based on research suggesting that recurrent TBI have a cumulative effect neuropsychologically, with the more TBI sustained, the more severe the resulting damage (Gronwall, 1991; Salcido & Costich, 1992). Since the research literature does not provide guidelines as to how many mild TBI must be sustained before the equivalent effect of moderate or severe TBI has been reached, arbitrary cutoff points were used. This new system was developed in response to the results obtained and appeared to provide a more accurate measure of each subjects TBI history. Since it was not the focus of the present study, analysis to assess the validity of the system was not conducted.

Further complicating the allocation of subjects to groups was the cross-over between TBI and substance use. Most subjects reported both sustaining TBI and using alcohol and/or illicit substances, and very few subjects reported either history alone. Thus, separate TBI and substance use groups could not be formed, complicating both the analysis and the interpretation of results. These results replicate research reporting high rates of substance abuse following TBI are high (Greer, 1986; Jones, 1989). The present results also indicate that both experience of recurrent TBI and past and current substance use need to be taken into account when conducting research, or assessing the neuropsychological functioning of an individual.

Problem Rating Scale

Developed specifically for this study but based on the Patient Competency Rating Scale (Prigatano, et al., 1986) and the Cognitive Failures Questionnaire (Broadbent, et al., 1982), this instrument sampled a range of problem areas that would still pertain to prison inmates. The internal consistency of the scale was found to be high, and nearly all of the subjects reported mild difficulties. This result was expected,

given that over 86% of the sample had sustained one or more TBI. However, the results obtained did not support the hypotheses that subjects with more severe TBI would report a higher number and greater severity of problems.

Subjects did report greater difficulties with certain items, irrespective of their experience with TBI and substance abuse. The items with the highest overall problem rating involved memory, including "*forgetting where things are put*", "*forgetting words on the tip of the tongue*", "*remembering instructions*", and "*forgetting names*". Other items frequently endorsed by subjects concern socialisation and impulse control. For example, subjects reported difficulty with "*handling arguments*", "*controlling anger*", "*accepting criticism*", and "*coping with sudden changes*". Inability to cope with these situations indicates more generalised social problems, and often little awareness of the difficulties, which often results in loss of relationships, social failures, and ultimately, social isolation (Marsh & Knight, 1991; Stuss et, al., 1992). Awareness and accuracy could have been investigated if the subjects had been exposed to normal social and employment situations, and had relatives and employers willing to rate their performance. This was not possible with the prison population.

While these difficulties might affect everyone occasionally, they are reported more often following TBI, and the levels reported here may have been elevated in comparison to the general public, given that the items rated most difficult received ratings between "*sometimes*" and "*often*" being a problem. However, norms are unavailable for the patient Competency Rating Scale non-head injured populations, although research has found adequate internal consistency and test-retest reliability (Heilbronner, Millsaps, Azrin, & Mittenberg, 1993). It should be noted that the purpose of this measure is to assess the level of awareness of deficit, rather than a measure of daily living problems, per se. Certain items have been found to be frequently underrated by patients, compared to relatives perceptions of problem severity. These include coping with changes, handling arguments, controlling anger, and keeping from being depressed (Prigatano, Altman, & O'Brien, 1990; Prigatano &

Leathem, 1993). In the present study, these were also amongst the items rated most difficult by subjects.

Maori and Non-Maori Results

In part one, a higher rate of TBI was found in subjects who identified as Maori. While this was hypothesised to occur, the size of the difference was surprising (12%). The rationale for this particular hypothesis was based on the fact that Maori are over-represented in many of the risk factors for TBI, and as with any group subject to higher risk factors, were expected to report more TBI. Indeed, Maori in the present sample appeared to be in the high risk group; they were all male, with a mean age of 30 years, and most endorsed alcohol and illicit drug use. While information on SES was not obtained in the present study, due to the constraints of the population sampled (e.g. inmates in a high-medium security prison do not hold regular jobs and may not have had a taxable income for many years), it is reasonable to assume, based on research, that most inmates families of origin were in the lower SES groups. It is already known that up to 75% of those sustaining TBI are from low SES groups, and that low SES is associated with increased rates of accidents, injury, and death (Blaxter, 1976; Lezak, 1983; Morse & Montgomery, 1992). Since Maori in general are overly represented in the lower SES group and other risk factors, this may partly account for the high TBI rate.

Another factor which may be related to the high Maori TBI rate is membership of predominantly Maori gangs that seem to engage in a high number of fights. Gang rivalry both in and out of prison is commonly reported through the media, and reports typically involve some act of violence such as assaults or gang fights. Kaitoke prison typically contains approximately equal numbers of Mongrel Mob and Black Power gang members and associates, according to the 1991 Census of prisons (Spicer & Norris, 1993). It seems reasonable to assume that members of this gang may be exposed to situations where the risk of sustaining TBI is increased, and thus may have sustained more TBI than the general population. Further, loyalty and dedication to the respective gangs is apparently strong, as shown by many subjects in

this study who endorsed both the Maori and "other" ethnicity option, writing either "Mongrel Mob" or "Black Power" in the "other" space provided.

Alcohol and Illicit Substance Use

Differences in the use of alcohol and illicit drugs occurred between the prison sample and the general population and also between Maori and non-Maori subjects. Unexpectedly, the figure for alcohol use in the New Zealand male general population was slightly higher than for the prison sample. This may have been due partly to the wording of the screening questionnaire which asked whether the subject "*ever used*" rather than "*ever drunk*" alcohol. The inmates may have interpreted "use" as meaning "*misuse*", or may not have understood what was being asked of them.

A contrast was also found between the New Zealand general populations reported use of illicit substances and that reported by the prison sample. Without exception, a far higher percentage of inmates reported using each illicit substance than did the general population. The highest differences occurred with the use of cannabis, hallucinogens (LSD, psilocybin), amphetamines, and sedative hypnotics. Cannabis was the most widely used illicit drug by both populations. The contrast between the two populations may be partly explained by research that suggests prison inmates may be more amenable to risk-taking in general, and experimentation with illicit substances (Harlow, 1991). Prison inmates may have more "contacts", in terms of knowing people who have access to illicit substances, and may be less concerned about the legal consequences of the use and possession of illicit substances.

In contrast, research suggests that inmates may over exaggerate their experience with substances (Miller & Cappiell, 1983; cited in van Hoeven, et al., 1991). In Miller and Cappiell's research, however, only 10.5% reported using a phoney drug, and even taking this into account, subjects in the present study would still have reported significantly higher rates of substance use than the general population. Further, subjects were not able to compare their substance use with others, and no rewards were given for participation, minimising the likelihood of exaggeration.

Classification of Substance Use/Abuse

A system to classify the substance use/abuse experience was developed for the purpose of the prison study, since the conventional guides to the classification of substance abuse were not appropriate to the present population, as they were not expected to be current users. An estimate of use was obtained by asking about the most frequent use of any substance and the length of time each substance was used. The amount used was not measured, since there are different measurement systems for each substance and the amount required to gain an effect depends largely on the substance used, the individuals experience or tolerance to the drug, and how much can be financially afforded, which may differ from the amount that the individual would like to use. Measures of substance use were made on the basis of past use, since subjects are not supposed to be able to gain access to illicit substances while in prison. It is interesting to note that subjects reported still having access to their choice of substances, and reported being restricted only by the financial resources available to them.

Substance Use Problem Rating Scale

Overall, subjects indicated experiencing problems between "*hardly ever*" and "*often*" with items. Subjects who reported lower frequencies of alcohol and illicit substance use reported more problems on the SPRS with finances, close interpersonal relationships, and family relationships. This was unexpected, since it was assumed that higher levels of substance use would be associated with higher levels of problems (Wyllie & Casswell, 1989). It is likely that TBI affected these results, since there were more subjects who had sustained moderate and severe TBI in the mild substance use group than in the severe group, and these problems are also associated with TBI.

Research has found other factors that may account for subjects with lower rates of use reporting more problems. Substance abusers may be less likely to form close interpersonal relationships, and so may be less aware of the impact their abuse is having on other people (Page et al., 1988). Subjects in the severe substance use group may have been unaware of any problems, due to psychological or neurological

denial, which are common to both alcohol addiction and TBI (Greer, 1986; Prigatano, 1991). Subjects may have been using substances as a means of coping with their unpleasant reality, particularly if they had also sustained TBI, and may perceive substance use is improving their social functioning and relieving tension, rather than causing any problems (Jones, 1989; Langley et al, 1990).

Research with other groups within the population have found that health, appearance, and social problems were the most frequently reported outcomes of alcohol abuse (Wyllie & Casswell, 1989). The present sample consisted mostly of polysubstance users, and it is acknowledged that the types of problems reported may depend on the population sampled and the primary substances of abuse. For example, difficulties related to work were not endorsed by most of the sample. Many of the subjects, however, reported that substance use did not cause problems with work because they were unemployed, or selling drugs provided them with employment and using was a perk of the job. This was not likely to apply to alcohol abusers in the general population.

Studies have found chronic polysubstance abuse affects functioning within interpersonal relationships, particularly with communication (Schafer et al, 1994). Since all subjects reported problems between "*sometimes*" and "*often*" with their wife/partner due to drug and/or alcohol use, the present study replicated the findings of Schafer et al.(1994). Further, Schafer et al. found that more severe cognitive impairments were associated with a higher level of problems within interpersonal relationships, and the effect of TBI may have masked the degree of impairment due to polysubstance use found in the present study.

The nature of the problems reported in the present study indicate a degree of insight into the issues concerned with substance abuse. The mild users acknowledged that their actions were causing problems for their families and significant others, both financially and on a personal level. It is interesting to note that the respondents in Wyllie and Casswell's (1989) research primarily endorsed problems relating

specifically to themselves. It may be that the prison environment allows mild users the time and distance for accurate self-reflection.

Part Two: Neuropsychological Assessment of a Sample of 50 Subjects

Results of the Present Study Compared to Norms

The performance of subjects on neuropsychological measures were compared to selected norms. Differences were obtained on two measures, the AVLT and the Similarities subtest from the WAIS-R, which are both tests of verbal ability.

Increasingly significant differences between the present sample and norms from Geffen et al. (1990) were found across all trials of the AVLT, except the Interference List. Subjects were able to recall fewer words on the initial list, and learning was consistently slower for the remaining trials. Fewer words were recalled following the interference list, indicating subjects were more affected by the distracter task than controls. Further, subjects were able to recognise fewer words than controls, indicating that difficulties with encoding or storing the information may account for some of these differences.

It is interesting to note that only one subject reported using a sophisticated strategy to assist recall of the word list. This subject constructed a story based on the words on the list, an effective strategy, since he successfully recalled 14 or 15 words from List 3 onwards. The remaining subjects reported repeating words to themselves, memorising words on each end of the list, or trying to recall words that were meaningful for them. Almost the entire group recalled "gun" and "ranger" from List 2. One subject explained this by reporting that guns are associated with the reason many of the subjects were incarcerated, and that a ranger is just another name for the police, again, familiar to all subjects. Aside from consistently recalling these words, the strategies selected by subjects were generally not successful, indicating that subjects may be ineffective in compensating for memory deficits. Research has found that ineffective strategy selection is common following TBI (Lezak, 1983).

The mean performance on the Similarities subtest was 1.66 standard deviations below the norms provided by the WAIS-R manual (Wechsler, 1981). It is unlikely that lowered performance on the Similarities subtest was due to differences in the level of education reported by the present subjects, since the WAIS-R norms have been designed to reflect the average level of performance, and as such, should not be significantly affected by lower levels of education. Thus, the results indicate subjects had difficulty with verbal abstract thinking, and forming connections between abstract concepts. Concrete interpretations of abstract material is common to subjects with lowered scores on this measure, which may have implications for functioning across a number of different areas, including social skills, self-awareness, and performance in the work place (Crosson, 1987; Prigatano, 1991). Deficits to executive functioning are common sequelae associated with TBI (Eames, 1990; Levin, 1990; Prigatano & Fordyce, 1986).

It is difficult to explain why subjects experienced difficulties only with verbal measures. Performance on the CFT was within the norms, and it was observed that subjects who achieved average scores or better had a more logical and organised approach to copying the figure. Conversely, lower scores were obtained by subjects who appeared not to perceive the large rectangle, side triangle, and other elements, as units within the figure, and so took a more disorganised approach to drawing the CFT. This was expected since research has found that organisation of visuo-spatial features facilitates encoding and recall of the stimulus (Shorr, Delis, & Massman, 1992).

As expected, most subjects recalled fewer digits in the Digit Backwards trials than in the Digits Forward, and the overall mean was within the limits of normal performance, as defined by the WAIS-R manual (Wechsler, 1981). This indicates that most subjects had an average short term memory for digits and were able to maintain an average level of concentration. Short term memory for digits is generally unaffected by TBI, but may be impaired by chronic abuse of illicit substances such as cannabis (Prigatano & Fordyce, 1986). Given the level of cannabis use reported by subjects, some deficits in this measure were expected.

Mean scores on the Finger Tapping test again were within the limits for normal performance, indicating no overt impairments to motor speed or coordination. In fact, many subjects scored significantly above the norms for both the dominant and non-dominant hands, and largely attributed their superior performance to boxing or martial arts training.

Mean scores on the Digit Symbol subtest fell within the limits of normal performance, indicating few overall impairments with short-term figural memory or information processing speed. This result is contrary to research which indicates the Digit Symbol is the most sensitive of all the WAIS-R subscales for indicating organic impairments (Lezak, 1983). Again, it is difficult to comment on this result, except to reiterate that subjects seemed only to have difficulties on tests of verbal abilities.

Overall, on the Rey 15 Item Test most subjects performed within the limits of normal performance suggested by Guilmette et al. (1994), which suggested that few of the sample were intentionally performing at a level below their true capabilities. However, it was observed that many of the subjects who did obtain low scores adopted a poor strategy to learn the 15 items. These subjects tried to learn the items by columns rather than by rows, resulting in fewer items being recalled and false positives being obtained. It is not clear why subjects chose the most difficult method of learning the items, whether they failed to notice the obvious pattern, or had difficulties processing the information. It is clear, however, that attempting to learn the items as separate and unrelated pieces of information placed strain on an already impaired system, and fewer than expected items were recalled. According to Lezak (1983), many of this group of subjects met the criteria for diagnoses of malingering, but the results of the present study suggest that the strategies used by subjects should be taken into account, and new norms developed for subjects obviously selecting an inferior strategy.

Severity of TBI and Performance on Neuropsychological Measures

The results of the present study revealed only one statistically significant difference between subjects with differing levels of severity of TBI. This occurred on the delayed recall trial of the AVLT, indicating impairment in long-term recall of learned information (Lezak, 1983). However, differences were found between norms and the present subjects performance on tests of verbal ability, and appeared to be independent of the severity of TBI reported. It is possible that a more indepth neuropsychological assessment, rather than the brief battery administered for the purposes of the present study, may be more sensitive to the deficits typically resulting from TBI of different severity.

Although there were no significant differences in the neuropsychological performances between groups of different severity, this does not necessarily reflect any flaw in the classification system, for all groups performed poorly compared to the accepted group norms. Further, no significant differences were found when analysis was conducted before reclassification, with recurrent TBI unaccounted for. It is likely that the nature of the population sampled affected the results, since it was not possible to control for the effects of alcohol, illicit drug use, or SES.

It was not possible to comprehensively assess the neuropsychological consequences of recurrent TBI in the present study, due to a number of factors. A higher percent of subjects reported sustaining recurrent TBI than single episode TBI, and different combinations of TBI frequency and severity were sustained. Thus, subjects could not be assigned to homogenous groups for statistical analysis, nor were there sufficient numbers in the sample group. It is anticipated that future research will encounter the same issues, even if large numbers of subjects are sampled.

Substance Use and Performance on Neuropsychological Measures

The hypothesis concerning the effects of substance abuse on the neuropsychological assessment measures was not supported. No significant differences in level of performance were found due to severity of substance abuse, although again subjects achieved scores below the norms on tests of verbal functioning. Few subjects

reported using only a single substance, with most reporting using a range of substances on a regular basis and trying others. Thus, most subjects could be classified as polysubstance users/abusers, which, in turn, indicates a range of neuropsychological impairments that may be associated with their substance use, depending on the drugs that are predominantly used.

Polysubstance abusers have been found to be impaired on delayed memory trials for lists of unrelated words (Selby et al., in press). In the present study, all subjects performed below norms from Geffen et al. (1990) on the AVLT, providing support for the Selby et al. findings. Bergman et al. (1989) found impairments to verbal learning in chronic sedative hypnotic users, and improvements following abstinence. The results of the present study support this research, since high numbers of subjects reported past use of sedative hypnotics and sleeping pills, and up to 20% reported current use. It is likely that subjects were not abstinent long enough to replicate the improvement in verbal memory found by Bergman et al. (1989).

Research on polysubstance users has found that verbal concept formation, as measured by the Similarities subtest of the WAIS-R (Wechsler, 1981), is unaffected by chronic abuse (Sweeney et al., 1989). These findings were not replicated by the present study, since subjects in general performed at a level below the mean. However, the subjects in the Sweeney et al. study had all undergone detoxification and rehabilitation, whereas the present sample reported current use of alcohol and illicit substances, which may partly account for differences in the results. Research has also found impairments in non-verbal functioning associated with chronic inhalant abuse (Hormes et al., 1986), but no such impairments were evident in the present research, in accordance with the small number of inhalant users.

The general screen of neuropsychological functioning provided by the battery used in the present study may not have been sensitive enough to find specific deficits, and there were too few subjects to allocate to groups based on the specific substances used. There is evidence to support this explanation, given that the performance was lowered overall compared to norms. It is anticipated that future research will

encounter similar difficulties, given that the prison population reports using a wider variety of illicit substances more frequently than the general population.

Maori and Non-Maori Results

Unexpected differences were found between Maori and non-Maori subjects on the neuropsychological battery. Maori performed at a significantly lower level than non-Maori on AVLT trials except the Interference List, and on the Similarities subtest of the WAIS-R. Maori were found to be particularly impaired at verbal tasks, although it is important to note that all subjects performed in the impaired range compared to norms (as shown by Figure 3), and these differences were not due solely to the lowered performance of Maori subjects.

Research has been performed on how other cultures perform with comparison to norms. In a review of the literature on the WAIS-R, Anderson (1994) concludes that African-Americans tend to perform at a lower level than white Americans, but there are few differences between subjects with 0 to 8 years of education. Since this is approximately the level of education reported by the present subjects, few differences should be expected due to cultural biases. However, this research refers to the African-American culture, and may not be accurate or appropriate in New Zealand.

Cultural factors must be considered, since all of the tests in the neuropsychological battery were constructed and norms developed in the US, and may be subject to biases when used with the New Zealand population. Further, Maori have a well documented history of achieving lower scores in the New Zealand education system, due to culturally biased syllabuses, resources, and assessment measures (Benton, 1988; Ennis, 1987). Research suggests that Maori have a different style of approaching learning and testing situations due to differences in their philosophical and spiritual beliefs regarding ownership of knowledge (Sachdev, 1989). The process of the assessment procedure may also have influenced the outcomes, since research suggests that Maori may communicate differently, both verbally and non-verbally. Measures such as the Similarities subtest from the WAIS-R require direct verbal replies, and no credit is given for non-verbal or circular responses (Waldergrave,

1985). Further, the assessment measures and interview situation may have been inappropriate for accurately assessing the functioning of Maori subjects. Neuropsychological measures have not yet been specifically developed for Maori to overcome any such disadvantages.

Variations between the TBI rate and level of substance use reported by Maori and non-Maori subjects may account for some of the differences. Over 91% of Maori subjects reported sustaining TBI, which was 12% higher than the non-Maori rate. Further, more Maori reported using alcohol and all illicit substances. Thus, some combination of TBI and substance abuse most likely contributed to the lowered performance of the Maori subjects.

Research suggests that differences in the levels of SES account for differences in scholastic achievement levels between Maori and non-Maori children. Fergusson, Lloyd, and Horwood (1991) performed an 11 year longitudinal study on the scholastic achievement of children in Christchurch, New Zealand. Significant differences in test scores between Maori and non-Maori were found but were no longer apparent after adjustments for SES. However, the authors point out that the study was conducted in the South Island where there is a relatively small Maori population, and that cultural factors may have contributed to the results, even though most of the variation was accounted for by SES level.

Recommendations for Future Research

The present study encountered a range of difficulties due to the nature of the population sampled. The results obtained have raised a number of issues that may be addressed by future research.

Research on lifetime prevalence rates for the general population would not only allow direct comparison with special groups such as prison inmates, but would obtain information on the rates of recurrent TBI, which were also found to be high in the present study.

There appears to be a need for research on alternative classification systems that take the number and severity of TBI sustained into account. Neither the GCS nor the length of PTA incorporate both these factors, and while they may provide appropriate information for a medical setting, they do not provide sufficient information for research purposes, since categorising by the most recent or the most severe TBI does not provide an accurate account of recurrent TBI. The neuropsychological effect of sustaining multiple TBI may be cumulative, at least in some cases, and a classification system to reflect this is required.

A need for research on a classification system for polysubstance abuse was identified by the present study. Almost all subjects who reported abusing an illicit substance reported concurrently using other substances, and it was often difficult to determine the primary substances of abuse. Since research suggests that the neuropsychological effects of substance abuse depend upon the substances used the most, further research on the nature and extent of neuropsychological impairments associated with different combinations of polysubstance abuse would be beneficial. It is anticipated that research of this nature is required before an accurate classification system can be developed.

The present study found that Maori achieved lower scores on tests of verbal ability compared to non-Maori. This may have been due to the higher rate of both TBI and substance abuse in Maori, but may also have been due to culturally biased measures or the process of the assessment. Developing Maori norms for the standard neuropsychological measures, particularly for tests assessing verbal functioning, is recommended, along with further research on how the process of assessment may be altered to accommodate Maori needs. Research in these areas is required to fully investigate the differences obtained in the present study.

Finally, subjects reported difficulty with aspects of general memory functioning and socialisation. Further research is required to investigate the level of awareness of the prison population, since obtaining independent ratings was not possible in the present study. Prison inmates who have sustained TBI may experience different problems to

the general population, in terms of impulse control and anger management in particular. Future research is required to investigate this, since there may be a group of head injured inmates who require sensitive rehabilitation programmes to assist with these difficulties.

Summary and Conclusions

The purpose of the present study was to investigate the incidence of TBI and substance abuse within a prison population, and to examine the subsequent neuropsychological functioning of a sample of subjects in these groups. It was found that over 86% of the 118 participating subjects reported sustaining one or more TBI. The rate of recurrent TBI was also higher than expected, with over 56% of those who had sustained any TBI including light reporting more than one, and 32% excluding light. There were differences in the rates reported by Maori and non-Maori subjects, with 12% more Maori reporting sustaining TBI.

Differences were found between the rates of use of alcohol and illicit substances between the prison inmates and the general population. Fewer of the prison sample reported using alcohol then the general population, but as expected, a higher percentage of prison inmates reported using all illicit substances. The highest rates of use occurred with cannabis, hallucinogens, amphetamines, and sedative hypnotics. Maori subjects reported higher rates of use of alcohol and illicit substances overall.

The high rate of TBI caused difficulties, since neither the most recent nor the most severe TBI provided an accurate reflection of the true experience with head injury. Thus, a classification system was developed to take account of these factors, based on the recurrent TBI literature and clinical judgement.

Lower levels of performance on measures of verbal functioning were found, with Maori obtaining lower scores than non-Maori. Specifically, impaired memory and learning of lists of unrelated words and deficits in abstract and associative thinking were found. These tests may have been the most sensitive measures of the types of difficulties experienced by the present population.

The results indicate that there may be higher rates of TBI and recurrent TBI in prison populations, and this is likely to be complicated by substance abuse, which may also be more prevalent in this population. Assaults and fights reportedly caused the highest percentage of TBI, and seemed to cause a high proportion of the recurrent TBI.

The present study has found evidence to suggest that TBI may be especially high in a prison population, and assessing the associated neuropsychological sequelae is complicated by the level of alcohol and illicit substance use reported by inmates. Prison populations are likely to benefit from further research to investigate the extent of the problem across other prisons, with the aim of identifying the rehabilitation requirements of head injures inmates.

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Appendix I

Information Sheet

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FACULTY OF
SOCIAL SCIENCES

DEPARTMENT OF
PSYCHOLOGY

Information About The Head Injury Study

You are being asked if you would be willing to take part in a study that is looking at head injury in New Zealand. Every year 9,000 people end up in hospital because of a head injury. Many more people injure their heads and don't go to hospital at all. This means that the rate of head injury is probably much higher than the hospital figures. We want to find out exactly how many people have ever had a head injury, how it happened, and if anything has changed because of the head injury. We will also ask questions about drug and alcohol use to see if this complicates matters.

There are two parts to this study, (1) a short questionnaire and (2) a part where we ask some people for more information. Today you are being asked if you are willing to fill in a questionnaire about your experience with head injury. If you haven't had one, we would still like you to fill in a questionnaire. This is so we can get information from people who have and haven't had head injuries.

This will take up only 15 minutes of your time, and is not compulsory. Your answers will be completely confidential. This is so you will feel comfortable telling us the truth about your experiences.

If you decide to take part in this study you have the right to fill in only some of the questions, or you can stop filling the questionnaire in halfway through. And you have the right to ask questions about the study. The University requires you to sign a consent form to show that you agreed to do the study, but you don't have to put your name on your questionnaire, unless you want to.

You will see that there is a matching number on each consent form and questionnaire. This is so we can match up the two forms if you take part in the second half of the study. The consent forms will be kept separate from the questionnaires. The researchers are the only ones who will ever be able to match up the forms. Your name and the information you give us will not be matched up *unless* you are willing to do the second part. If you don't want to do the second part of the study then just cross out the numbers on the forms and no one will be able to identify what your answers were.

In the second part of this study we will ask some people extra questions and to do some short tasks. This will take about 30 minutes. We won't be asking everyone to do the second part. Don't forget, if you are willing to take part in the second half, leave the number on the top of your questionnaire so we can contact you. Remember that your name and any information you give us will be kept completely confidential.

This study is being conducted by Tracey Barnfield and Dr. Janet Leathem from the Psychology Department at Massey University. The information you give us will help us to understand more about head injuries, and tell us how best to help people after they have a head injury. Thanks for your cooperation.

T. J Barnfield

Tracey Barnfield
Researcher

Janet Leathem, Ph.D.
Senior Lecturer
Clinic Director

Appendix II

Informed Consent Form

MASSEY
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FACULTY OF
SOCIAL SCIENCES

DEPARTMENT OF
PSYCHOLOGY

Consent Form

I have read the information sheet and have had the details of the study explained to me. My questions about the study have been answered to my satisfaction, and I understand that I may ask further questions at any time.

I also understand that I am free to withdraw from the study at any time, or to decline to answer any particular questions in the study. I agree to provide information to the researchers on the understanding that it is completely confidential.

I wish to participate in this study under the conditions set out on the information sheet.

Signed: _____

Name: _____

Date: _____

If asked, I wish to participate in the second part of this study YES / NO
(cross out one)

I wish to receive a copy of the results of this study YES / NO
(cross out one)

Please send the results to the following address:

_____

_____

_____

Appendix III

The Screening Questionnaire

Head Injury Study Questionnaire

(1) Name: _____
(not compulsory)

(2) Age: _____

(3) Are you: (PLEASE TICK)
European _____
Maori _____
Pacific Island _____
Other _____ (PLEASE SPECIFY)

(4) Have you ever had a head injury? Yes _____ No _____
(IF NO, GO TO QUESTION 6 ON PAGE 2)

(5) Please list your head injury(s):

First head injury: Year? _____
How did it happen? _____
Were you knocked out? No ____ Yes ____
If Yes, how long were you out? _____

Second head injury: Year? _____
How did it happen? _____
Were you knocked out? No ___ Yes ___
If Yes, how long were you out? _____

Third head injury: Year? _____
How did it happen? _____
Were you knocked out? No ____ Yes ____
If Yes, how long were you out? _____

Fourth head injury: Year? _____
How did it happen? _____
Were you knocked out? No ____ Yes ____
If Yes, how long were you out? _____

Fifth head injury: Year? _____
How did it happen? _____
Were you knocked out? No ____ Yes ____
If Yes, how long were you out? _____

Other head injuries:

_____
_____
_____

PLEASE TURN THE PAGE

2

(6) In the last 6 months, I have had a problem with..... (PLEASE CIRCLE)

	Always	Often	Sometimes	Hardly Ever	Never
(a) *remembering peoples names*	4	3	2	1	0
(b) *following the story of a T.V. programme*	4	3	2	1	0
(c) *getting to where I am supposed to be on time*	4	3	2	1	0
(d) *starting conversations in a group*	4	3	2	1	0
(e) *remembering important things I must do*	4	3	2	1	0
(f) *getting help when I am confused*	4	3	2	1	0
(g) *coping with sudden changes*	4	3	2	1	0
(h) *handling arguments*	4	3	2	1	0
(i) *accepting criticism from other people*	4	3	2	1	0
(j) *controlling crying*	4	3	2	1	0
(k) *knowing when I have upset somebody*	4	3	2	1	0
(l) *understanding instructions*	4	3	2	1	0
(m) *controlling my temper when I am angry*	4	3	2	1	0
(n) *keeping from being depressed*	4	3	2	1	0
(o) *controlling my laughter*	4	3	2	1	0
(p) *stopping emotions from affecting daily activities*	4	3	2	1	0
(q) *acting normally around other people*	4	3	2	1	0
(r) *showing people that I like them*	4	3	2	1	0
(s) *with headaches*	4	3	2	1	0
(t) *remembering phone numbers*	4	3	2	1	0
(u) *forgetting where I put things*	4	3	2	1	0
(v) *confusing left and right*	4	3	2	1	0
(w) *stopping my eyes from blurring*	4	3	2	1	0
(x) *bumping into things*	4	3	2	1	0
(y) *ringing noises in my ears*	4	3	2	1	0
(z) *not remembering words although they are on the tip of my tongue*	4	3	2	1	0

PLEASE TURN THE PAGE

Question 7 asks you about your use of drugs and alcohol in the past and now. You do not have to answer the next questions if you don't want to. But remember, everything you tell us will be kept completely confidential.

I do / do not wish to complete this section (CROSS OUT ONE)

(7) How often have you *ever* used..... (PLEASE CIRCLE)

(a) *Alcohol*	NEVER	HARDLY EVER	WEEKLY	DAILY
(b) *Marijuana*	NEVER	HARDLY EVER	WEEKLY	DAILY
(c) *LSD (acid etc)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(d) *Inhalants (glue etc)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(e) *Opiates (morphine methadone)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(f) *Phencyclidine (PCP)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(g) *Psilocybin (mushrooms)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(h) *Amphetamines (uppers)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(i) *Sleeping pills*	NEVER	HARDLY EVER	WEEKLY	DAILY
(j) *Sedatives (valium diazepam)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(k) *Morning Glory seeds*	NEVER	HARDLY EVER	WEEKLY	DAILY
(l) *Barbiturates (downers)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(m) *Cocaine (crack)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(n) *Other (please state)*	NEVER	HARDLY EVER	WEEKLY	DAILY
_____	NEVER	HARDLY EVER	WEEKLY	DAILY
_____	NEVER	HARDLY EVER	WEEKLY	DAILY

(8) How often do you *now* use..... (PLEASE CIRCLE)

(a) *Alcohol*	NEVER	HARDLY EVER	WEEKLY	DAILY
(b) *Marijuana*	NEVER	HARDLY EVER	WEEKLY	DAILY
(c) *LSD (acid etc)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(d) *Inhalants (glue etc)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(e) *Opiates (morphine methadone)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(f) *Phencyclidine (PCP)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(g) *Psilocybin (mushrooms)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(h) *Amphetamines (uppers)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(i) *Sleeping pills*	NEVER	HARDLY EVER	WEEKLY	DAILY
(j) *Sedatives (valium diazepam)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(k) *Morning Glory seeds*	NEVER	HARDLY EVER	WEEKLY	DAILY
(l) *Barbiturates (downers)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(m) *Cocaine (crack)*	NEVER	HARDLY EVER	WEEKLY	DAILY
(n) *Other (please state)*	NEVER	HARDLY EVER	WEEKLY	DAILY
_____	NEVER	HARDLY EVER	WEEKLY	DAILY
_____	NEVER	HARDLY EVER	WEEKLY	DAILY

PLEASE TURN THE PAGE

(8) If you said that you used alcohol, how long did you use it for?
(PLEASE CIRCLE ONE)

(a) 1 month or less
(b) from 1-6 months
(c) from 6-12 months
(d) from 1-5 years
(e) more than 5 years

(9) If you said that you used other drugs, how long did you use them for?
Please write the name of each drug you have used beside the right time period.

(a) 1 month or less _____

(b) from 1-6 months _____

(c) from 6-12 months _____

(d) from 1-5 years _____

(e) more than 5 years _____

(10) How often has drug/alcohol use been a problem in these areas....
(PLEASE CIRCLE)

	Always	Often	Sometimes	Hardly Ever	Never
(a) *health*	4	3	2	1	0
(b) *wife/partner*	4	3	2	1	0
(c) *family/children*	4	3	2	1	0
(d) *money*	4	3	2	1	0
(e) *school*	4	3	2	1	0
(f) *work*	4	3	2	1	0
(g) *social life/friends*	4	3	2	1	0

THANK YOU FOR FILLING OUT THIS QUESTIONNAIRE

Appendix IV

The Neuropsychological Measures and their Administration Procedures

(a) Auditory Verbal Learning Test

Rey Auditory-Verbal Learning

A	B	C
Drum	Desk	Book
Curtain	Ranger	Flower
Bell	Bird	Train
Coffee	Shoe	Rug
School	Stove	Meadow
Parent	Mountain	Harp
Moon	Glasses	Salt
Garden	Towel	Finger
Hat	Cloud	Apple
Farmer	Boat	Chimney
Nose	Lamb	Button
Turkey	Gun	Key
Colour	Pencil	Dog
House	Church	Glass
River	Fish	Rattle

	1	2	3	4	5	I	6	7 (Delayed)
1.	____	____	____	____	____	____	____	____
2.	____	____	____	____	____	____	____	____
3.	____	____	____	____	____	____	____	____
4.	____	____	____	____	____	____	____	____
5.	____	____	____	____	____	____	____	____
6.	____	____	____	____	____	____	____	____
7.	____	____	____	____	____	____	____	____
8.	____	____	____	____	____	____	____	____
9.	____	____	____	____	____	____	____	____
10.	____	____	____	____	____	____	____	____
11.	____	____	____	____	____	____	____	____
12.	____	____	____	____	____	____	____	____
13.	____	____	____	____	____	____	____	____
14.	____	____	____	____	____	____	____	____
15.	____	____	____	____	____	____	____	____

Adapted from Lezak (1983).

Procedure for Trials 1 to 7

In accordance with experimental convention, the procedure was standardised for each subject. The researcher first read the following to each subject:

"I am going to read a list of words. Listen carefully, for when I stop you are to say back as many words as you can remember. It doesn't matter in what order you repeat them. Just try to remember as many as you can." (Lezak, 1983, p.423)

The researcher then read the 15 word list at the rate of one word per second and wrote down the words in the order the subject recalled them. Confabulations and repeated words were also recorded. When no further words could be recalled, the second set of instructions was read aloud:

"Now I am going to read the same list again, and once again when I stop I want you to tell me as many words as you can remember, including words you said the first time. It doesn't matter in what order you say them. Just say as many words as you can remember whether or not you said them before" (Lezak, 1983, p.423).

Again, the researcher recorded the words in the order recalled by each subject. List one was read a total of five times, always preceded by the second set of instructions. The sixth trial consisted of a new list of 15 words, and each subject received the following instructions:

"Now I'm going to read a second list of words. This time, again, you are to say back as many words of this second list as you can remember. Again, the order in which you say these words does not matter. Just try to remember as many as you can " (Lezak, 1983, p.424).

As with the first word list, the words recalled from the second list were recorded along with any confabulations, repeats, or intrusions from list one. Each subject was then asked to recall list one without it being read first. Again, all words recalled by each subject were recorded.

Appendix IV

Recognition Trials

INSTRUCTIONS: PLEASE CIRCLE ALL THE WORDS YOU REMEMBER FROM THE FIRST LIST THAT WAS READ TO YOU

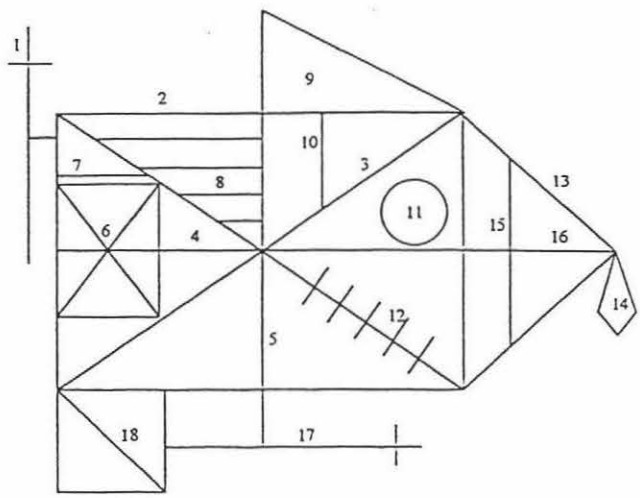
BELL	HOME	TOWEL	BOAT	GLASSES
WINDOW	FISH	CURTAIN	HOT	STOCKING
HAT	MOON	FLOWER	PARENT	SHOE
BARN	TREE	COLOR	WATER	TEACHER
RANGER	BALLOON	DESK	FARMER	STOVE
NOSE	BIRD	GUN	ROSE	NEST
WEATHER	MOUNTAIN	CRAYON	CLOUD	CHILDREN
SCHOOL	COFFEE	CHURCH	HOUSE	DRUM
HAND	MOUSE	TURKEY	STRANGER	TOFFEE
PENCIL	RIVER	FOUNTAIN	GARDEN	LAMB

Procedure for Delayed Recall and Recognition Trials

Each subject was first asked to recall as many of the words from the first list as they could. All words were recorded in the order they were recalled in, including words from the second list and confabulated or error words. The recognition trial was then presented to each subject. A list of 50 words on a single sheet of paper was presented. This list contained all the words form list one and list two and a list of phonetically and semantically similar words to those on lists one and two. Subjects are instructed to indicate all the words they recognise to be from list one. Finally, subjects were asked to indicate all of the words they recognised from the interference list.

Appendix IV

(b) Rey-Osterrieth Complex Figure Test



	Copy	3" Delayed Recall	30" Delayed Recall
1. Cross upper left corner, outside rectangle	.....	.....	.....
2. Large rectangle	.....	.....	.....
3. Diagonal cross	.....	.....	.....
4. Horizontal midline of 2	.....	.....	.....
5. Vertical midline of 2	.....	.....	.....
6. Small rectangle in 2 to left	.....	.....	.....
7. Small line above 6	.....	.....	.....
8. Four parallel lines in 2, upper left	.....	.....	.....
9. Triangle above 2, upper right	.....	.....	.....
10. Small vertical line in 2, below 9	.....	.....	.....
11. Circle with 3 dots, in 2	.....	.....	.....
12. Five parallel lines in 2, crossing 3, lower right	.....	.....	.....
13. Sides of triangle attatched to 2, on right	.....	.....	.....
14. Diamond attatched to 13	.....	.....	.....
15. Vertical line in 13, parallel to right side of 2	.....	.....	.....
16. Horizontal line in 13, continuing 4	.....	.....	.....
17. Lower cross, attatched to 5	.....	.....	.....
18. Square attatched to 2, lower left, with diagonal line	.....	.....	.....

	Placed properly	Placed Poorly
Correct	2	1
Distorted or incomplete but recognizable	1	.5
Absent, not recognizable	0	0

Adapted from Rey (1941) and Osterrieth (1944).

Procedure for Copy and 3 minute Delay Trials

Each subject was presented with a sheet of blank paper and a ball-point pen for each trial of the CFT. The examiner first placed the complex figure diagram in front of the subject and instructed him to copy the figure. The test figure and the subject's reproduction were removed at completion of the copy trial. The examiner unobtrusively recorded the time taken by each subject to complete each trial. The examiner also reproduced the performance of each subject as a qualitative measure of the subject's approach to the complex task.

After three minutes elapsed following completion of the copy trial, the subject was asked to redraw the figure from memory. Again, the trial was timed and the subject's drawing was tracked and reproduced by the examiner, and the drawing was removed at completion of the trial. The delayed recall trial began 30 minutes following completion of the 3 minute recall trial, and was also timed. The test was scored in accordance with the accepted criteria (Lezak, 1983; Rey, 1964).

Appendix IV

(c) Finger Tapping Test

MANUAL FINGER TAPPING TEST

Name _____ Date _____ Examiner _____

Preferred Hand: Right _____ or Left _____

LEFT HAND	RIGHT HAND
1.	1.
2.	2.
3.	3.
4.	4.
5.	5.

Adapted from Lezak (1983).

Procedure for Finger Tapping Test

The Finger Tapping apparatus was placed on a table in front of a seated subject, and activation of the device demonstrated. Each subject was instructed to place the index finger of his right hand on the lever and to depress the lever as quickly as possible. The rules were explained; having to keep the remaining fingers and heel of the hand on the table while depressing the lever, and having to press the lever all the way down and letting it come all the way up again to ensure the counter clicks over with each tap. Each subject was given 10 seconds to perform as many taps as possible, and left and right index finger trials were alternated. Five trials with each index finger were completed, and the mean calculated for the left and right hands for each subject (Lezak, 1983).

Appendix IV

(d) Similarities Subtest from the WAIS-R

11. SIMILARITIES Discontinue after 4 consecutive failures.	Score 2, 1, or 0
1. Orange—banana	
2. Dog—lion	
3. Coat—suit	
4. Boat—car	
5. Eye—ear	
6. Button—zip	
7. North—west	
8. Egg—seed	
9. Table—chair.	
10. Air—water	
11. Poem—statue	
12. Work—play	
13. Fly—tree	
14. Praise—punishment	
Total	Max=28

Adapted from Wechsler (1981).

Procedure for Similarities Subtest

This test consists of 14 word pairs. Instructions were given as per the WAIS-R manual. The test began with item one, and each subject was asked:

"*In what way are an ORANGE and a BANANA alike ?*" (Wechsler, 1983, p.86).

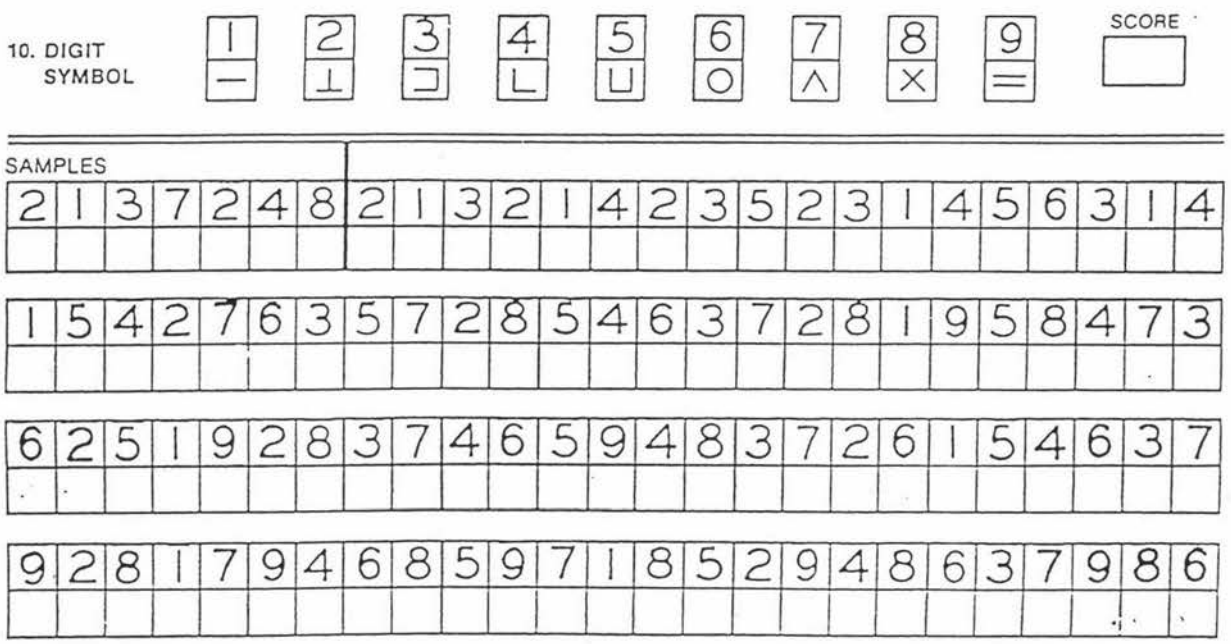
If the subject stated that they are both fruit, an answer receiving two points, then the test proceeded, and no further clues were given. If a one-point answer was given, such as that they can both be eaten, then the following reply was made:

"*That's right, you do eat them both. Also, they are both fruit* " (Wechsler, 1983, p.86).

If an incorrect reply was given, then the examiner gave both the one and two point answers, and then proceeded to item two with no further clues. The examiner recorded each subject's replies, and scoring was performed as per the WAIS-R manual specifications. The test was discontinued following failure on four consecutive items.

Appendix IV

(e) Digit Symbol Subtest from the WAIS-R



Adapted from Wechsler (1981).

Procedure for the Digit Symbol

Each subject was provided with the Digit Symbol worksheet and a ball-point pen. The following instructions were read aloud as per the WAIS-R manual and the relevant features pointed out to each subject by the researcher, who also demonstrated the process:

"*Look at these boxes. Notice that each has a number in the upper part and a special mark in the lower part. Each number has its own mark. Now look down here where the boxes have numbers in the top part but the squares at the bottom are empty. You are to put in each of the empty squares the mark that should go there, like this. Here is a 2; the 2 has this mark. So I put it in this square, like this. Here is a 1; the 1 has this mark. So I put it in this square. This number is 3; the 3 has this mark. So I put it in this square. Now you fill in the squares up to this heavy line*" (Wechsler, 1983, p.84).

The researcher corrected any errors made by the subject while filling in the examples and then further instructions were read aloud:

"*When I tell you to start, you do the rest of them. Begin here and fill in as many squares as you can, one after the other, without skipping any. Keep working until I tell you to stop. Work as quickly as you can without making any mistakes. When you finish this line go on to this one*" (Wechsler, 1983, p.85).

Each subject was given 90 seconds to fill as many squares as possible. Left handed subjects were provided with an extra coding key, as they tend to block the key with their hands while filling in the squares. One point was allocated for each square correctly filled.

Appendix IV

(f) Digit Span Subtest from the WAIS-R

3. DIGIT SPAN — Discontinue after failure on BOTH TRIALS of any item. Administer BOTH TRIALS of each item, even if subject passes first trial.

DIGITS FORWARD		Pass-Fail	Score 2, 1, or 0
1.	5 - 0 - 2		
	6 - 9 - 4		
2.	6 - 4 - 3 - 9		
	7 - 2 - 8 - 6		
3.	4 - 2 - 7 - 3 - 1		
	7 - 5 - 8 - 3 - 6		
4.	6 - 1 - 9 - 4 - 7 - 3		
	3 - 9 - 2 - 4 - 8 - 7		
5.	5 - 9 - 1 - 7 - 4 - 2 - 8		
	4 - 1 - 7 - 9 - 3 - 8 - 6		
6.	5 - 8 - 1 - 9 - 2 - 6 - 4 - 7		
	3 - 8 - 2 - 9 - 5 - 1 - 7 - 4		
7.	2 - 7 - 5 - 8 - 6 - 2 - 5 - 8 - 4		
	7 - 1 - 3 - 9 - 4 - 2 - 5 - 6 - 8		
	Total Forward		Max=14

DIGITS BACKWARD*		Pass-Fail	Score 2, 1, or 0
1.	2 - 4		
	5 - 8		
2.	6 - 2 - 9		
	4 - 1 - 5		
3.	3 - 2 - 7 - 9		
	4 - 9 - 6 - 8		
4.	1 - 5 - 2 - 8 - 6		
	6 - 1 - 8 - 4 - 3		
5.	5 - 3 - 9 - 4 - 1 - 8		
	7 - 2 - 4 - 8 - 5 - 6		
6.	8 - 1 - 2 - 9 - 3 - 6 - 5		
	4 - 7 - 3 - 9 - 1 - 2 - 8		
7.	9 - 4 - 3 - 7 - 6 - 2 - 5 - 8		
	7 - 2 - 8 - 1 - 9 - 6 - 5 - 3		
	Total Backward		Max=14

*Administer DIGITS BACKWARD even if subject scores 0 on DIGITS FORWARD.

Forward	÷	Backward	=	Max=28 Total

Adapted from Wechsler (1981).

Procedure for Forward and Backward Trials of the Digit Span

The Digits Forwards trials were administered first. The following instructions were read to each subject:

"*I am going to say some numbers. Listen carefully, and when I am through say them right back after me*" (Wechsler, 1983, p. 65).

The digits were read at the rate of one per second and the test was discontinued after a subject failed both trials of any one item. Immediately following completion of the Digits Forwards trials, the Digits Backward trials were administered. The following instructions preceded administration:

"*Now I am going to say some more numbers, but this time when I stop I want you to say them backwards. For example, if I say 7-1-9, what would you say?*" (Wechsler, 1983, p.66).

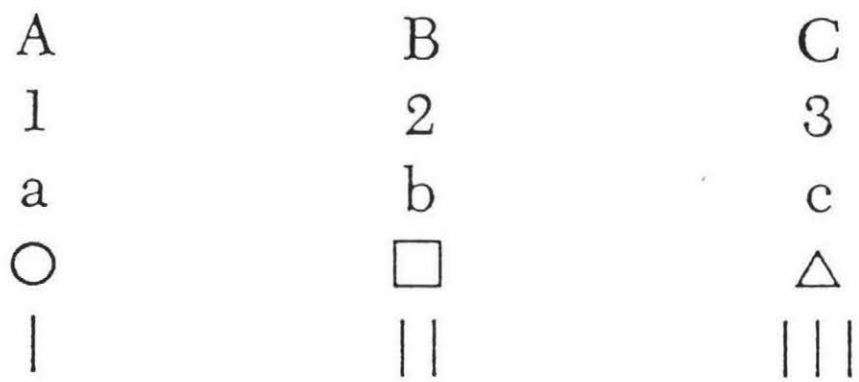
If the subject responded correctly he was informed of his success and the trials began. If the example was failed the following instructions were read aloud:

"*No, you would say 9-1-7. I said 7-1-9, so to say it backwards you would say 9-1-7. Now try these numbers. Remember, you are to say them backwards. 3-4-8*" (Wechsler, 1983, p.66).

The trials began regardless of the subjects performance on the second example. All digits were read at the rate of one per second, and the test was discontinued after a subject failed both trials of any item. One mark was allocated for each trial completed correctly.

Appendix IV

(g) Rey 15 Item Test



Adapted from Rey (1964).

Procedure for Rey 15 Item Test

Each subject was informed that the purpose of this exercise was to try to memorise 15 items of information. It was emphasised that there were 15 items and only a short time available for memorising, in an effort to encourage subjects to view this as a difficult task. Subjects were presented with the 15 items on a card for 10 seconds. The card was then removed and immediately replaced with blank paper and a pencil, and each subject was asked to write down all they could remember. Each item correctly recalled was allocated 1 point, and the points received were totalled (Lezak, 1983; Rawling, 1990).

Appendix V

Mean Overall Ratings on the Problem Rating Scale by 118 Subjects

Mean Overall Ratings on the Problem Rating Scale by 118 Subjects

Item	Mean	s.d.
(a) remembering peoples names	2.26	1.01
(b) following the story of a T.V. programme	1.67	1.25
(c) getting to where I am supposed to be on time	1.69	1.38
(d) starting conversations in a group	1.73	1.16
(e) remembering important things I must do	2.06	1.13
(f) getting help when I am confused	1.86	1.40
(g) coping with sudden changes	2.01	1.27
(h) handling arguments	2.14	1.28
(i) accepting criticism from other people	1.94	1.32
(j) controlling crying	1.25	1.37
(k) knowing when I have upset somebody	1.90	1.26
(l) understanding instructions	1.94	1.22
(m) controlling my temper when I am angry	2.29	1.29
(n) keeping from being depressed	1.87	1.23
(o) controlling my laughter	1.41	1.22
(p) stopping emotions from affecting daily activities	1.52	1.09
(q) acting normally around other people	1.38	1.24
(r) showing people that I like them	1.58	1.31
(s) with headaches	2.07	1.37
(t) remembering phone numbers	2.05	1.25
(u) forgetting where I put things	2.13	1.23
(v) confusing left and right	0.96	1.13
(w) stopping my eyes from blurring	1.50	1.25
(x) bumping into things	1.18	1.13
(y) ringing noises in my ears	1.61	1.29
(z) not remembering words although they are on the tip of my tongue	2.20	1.20

Appendix VI

Characteristics of the Sample of 50 Subjects

(a) The Frequency and Severity of TBI Sustained by a Sample of 50 Subjects

Frequency & Severity of TBI Sustained by a Sample of 50[a] Subjects

Number of TBI[b]	Light	Mild	Mod.	Severe
1	8	16	9	5
2	2	6		
4	3	1	1	
5+	7	2		
Total %	28	31	10	5

[a] 2 subjects did not sustain TBI and are missing from this Table.

[b] The total is more than 48 because some subjects sustained more than 1 TBI.

Appendix VI

(b) Percentage of Different Severity of TBI Sustained by a Sample of 50 Subjects Before and After Reclassification

Percentage of Light, Mild, Moderate and Severe in 74 TBI Sustained by 48[a] Subjects with TBI when Reclassified

TBI	Light	Mild	Mod.	Severe
Before	37.8	41.9	13.5	6.8
New Rationale	12.0	44.0	26.0	14.0

[a] 2 subjects did not sustain TBI and are missing from this table.

Appendix VI

(c) Substance Use of a Sample of 50 Non-Maori and Maori Subjects Compared to The New Zealand General Population

Percentage of a Sample of 50 Subjects Reporting Substance Use compared with the New Zealand General Population, and Maori and Non-Maori Substance Use within the Sample

Substance	NZ General Population[a] (n =5126)	Sample[b] Group (n=50)	Maori (n = 11)	Non-Maori (n = 35)
alcohol	96.0[c]	92.0	91.0	91.4
cannabis	56.0	90.0	27.3	91.4
LSD	8.0[d]	62.0	55.0	65.7
psilocybin	8.0[d]	56.0	54.5	60.0
amphetamines	5.0	60.0	54.6	62.9
cocaine	5.0	34.0	27.3	35.3
opioids	3.0	32.0	27.3	34.3
sleeping pills	2.0	40.0	45.5	40.0
sedative hypnotics	2.0[e]	46.0	36.4	51.4
inhalants	1.0	22.0	18.2	22.9
PCP	--	16.0	9.1	17.2
morning glory seeds	--	12.0	0.00	14.3
barbiturates	--	34.0	0.00	45.6

[a] Black & Casswell (1993).
[b] Includes Pacific Island and Asian subjects.
[c] Refers to adult males in New Zealand.
[d] Refers to all hallucinogens, not LSD or psilocybin specifically.
[e] Refers to all sedative hypnotics, not sleeping pills specifically.

Appendix VI

(d) Percentage of the Sample of 50 Subjects who Used Each Substance for 5 Years or Longer, Mean Length of Time Each Substance was Used. and the Percentage who are Currently Using

Substance use of a sample of 50 subjects: Percentage of sample ever trying substances and percentage using 5 years or more, and mean time used

Substance	% Sample	% Users	Mean Use[a]	Current Use %
alcohol	92.0	70.8	4.31	34.0
cannabis	90.0	92.1	4.79	66.0
LSD	62.0	92.1	4.56	26.0
amphetamines	60.0	85.7	4.64	2.0
psilocybin	56.0	72.7	4.55	18.0
sedative hypnotics	46.0	84.6	4.85	10.0
sleeping pills	40.0	90.9	4.63	20.0
barbiturates	34.0	100.0	5.00	20.0
cocaine	34.0	87.5	4.75	20.0
opioids	32.0	100.0	5.00	24.0
inhalants	22.0	100.0	5.00	6.0
PCP	16.0	100.0	5.00	12.0
morning glory seeds	12.0	100.0	5.00	12.0

[a] These figures do not represent actual years but refer to categories of time as they appear in the screening questionnaire:

(1) 1 month or less
(2) from 1-6 months
(3) from 6-12 months
(4) from 1-5 years
(5) more than 5 years