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**THE EFFECTS OF TRAUMATIC BRAIN
INJURY ON LOGICAL MEMORY.**

A thesis presented in partial fulfilment of
the requirements for the degree of Masters
of Science in Psychology at Massey University.

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ABSTRACT

The Logical Memory subtest of the Wechsler Memory Scale - Revised was administered to 80 subjects with mild to severe traumatic brain-injury (TBI) and 49 Control subjects. Quantitatively TBI subjects scored significantly below Control subjects and forgot more between the immediate and delayed testing. TBI clients also recalled more of Story B than Story A, as did all the male subjects. Female subjects performed better than the male subjects overall, TBI males scored as well as Control males which was unexpected. When the order of presentation was reversed for random Control subjects results show that performance was better for the first story presented. After the LM passages were modifying to eliminate various Americanisms, the Control subjects randomly selected performed better on the NZ version, although these results were not significant. When the demographic variables of the TBI and Control groups were compared the only significant differences were between the 21 - 30 year old subjects and the Pakeha subjects. Qualitative analysis was attempted in order to introduce a new domain of research and suggestions for improved scoring criteria. The evidence suggest that TBI subjects tend to focus on isolated details, have difficulty remembering proper nouns, and have more bizarre intrusion errors than Control subjects. Control subjects were more inclined to translate the stories into their own words and remember more of the overall gist.

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INTRODUCTION

Over the past decade or so there has been growing awareness that head injuries constitute a major health problem and that memory impairment is extremely likely to be a particular problem, both in the short and long term. However research into memory after traumatic brain injury (TBI) is dated, controversial and not always applicable to all populations.

The current study focused on the effect of TBI on the area of verbal memory, particularly memory for logical passages. Such passages reflect commonly occurring everyday life experiences such as hearing and remembering items of news, descriptions from others of important events, and messages from the telephone. Disturbance in the ability to recall such material impacts severely on all facets of everyday life.

In earlier work with persons with TBI, it has been observed that the strategies employed in the attempt to learn, have accounted for much of the variability in individual scores on such tests. Further, some persons scoring the same number of items of material may differ considerably in the quality of those responses. These observations have not been examined formally in TBI or normal subjects. Measures of verbal memory such as the Logical Memory subtest of the Wechsler Memory Scale-R (Wechsler, 1987) are typically scored against a normal standardisation group with regard to the total number of features of a short story read to the subject. There is no scoring for the quality of those responses or of any method for evaluating the usefulness or even presence of strategies used to enhance recall.

Cognitive psychologists have established that verbatim recall is not an adequate indicator of prose memory (Bransford & Franks, 1971; Sachs, 1967; cited Webster, Godlewski, Hanley & Sowa, 1992). People tend to use their own experience and background knowledge to interpret and arrange the relationship between various components of the story to produce a rational understanding of the tale (Webster et al., 1992).

An obvious reason for the substitution of one's own vocabulary, is to replace the dated and stilted grammar and syntax of the Wechsler stories that does not always fit various cultures and socio-economic groups (Sweet & Wysocki, 1984). Although some studies have examined Australian and New Zealand alternatives to various Americanisms throughout the two stories, the results did not significantly alter the difficulty of the subtest to improve the subjects' scores.

The current study also aims to use appropriate alternatives to compare the recall of the passages and examine whether New Zealand populations are disadvantaged. By dividing the Control subjects and administering half the subjects passages with more familiar terminology, i.e. police station instead of central station, an attempt will be made to see if the LM subtest is sensitive to a New Zealand sample.

Another aim of the study is to compare and contrast the recall of the two stories. By relating the subject's demographics with their performance on the two stories, various questions can be answered. For example, are there gender effects? The two stories are about members of the opposite sex, so does one gender recall a particular story more easily than the other? The second story is about an accident involving a vehicle where the driver was injured. Is there a positive correlation for the TBI subjects where they can personally relate to the accident, and this assists their recall? Or, is there a negative correlation where the accident impedes the memory because the incident is blocked from recall?

All of the literature examined uses the quantitative examination of the Logical Memory subtest. The third aim of the present study therefore sought to examine the qualitative aspects, and answer such questions as - Do the subjects remember the facts of the story or do they remember the first few items? Is the recall logical or does it not make sense?

The fourth aim of the study is to compare the strategies used in recall. Previous research has demonstrated that some recall is based on the position of the items in the passage. Depending on the interference, the first few or the last few items are often recalled more successfully than those in the middle. By counterbalancing the passages and contrasting the TBI and Control groups' recall such "serial position effects" as "primacy" and "recency" can be examined.

Lastly the current study aims to compare the results of head injured versus non-head injured subjects on the Logical Memory subtest. Previous results show that head injured subjects do not recall as many items from the passages as the Control subjects. Thus by examining the results of the two groups recall comparisons can be made.

CHAPTER ONE:

HEAD INJURY

INTRODUCTION

Of the 2 million annual head injuries in the U.S. 75,000 - 100,000 result in death and 500,000 are critical enough to need hospital admission. Viewed in another way someone will receive a head injury every 15 seconds in the United States alone (Long & Ross, 1992). In New Zealand there are no formal epidemiological studies on prevalence, but based on overseas studies and the fact that 9,000 people are admitted to New Zealand hospitals every year with head injuries, the probable incidence is 250 - 370 per 100,000 (NZ Head Injury Society, 1992).

Trauma is now the primary cause of death under 45 years of age and has led to growing appreciation over the past two decades that head injuries are a major public health problem (Levin, Eisenberg & Benton, 1989). In order to understand more about traumatic brain injury (TBI) and in an effort to develop preventative measures and suitable treatment, contributing factors of age, sex, and socioeconomic group predominately at risk, common causes of such injury, and the types of outcome have been identified.

EPIDEMIOLOGY

Statistics about head injury come from a variety of sources; statutory returns by health departments, registrars of deaths, reports by clinicians, and the collaborative International Head Injury Study and its data bank. The International Classification of Disease provides a universal terminology and enables united coding of records (Giannotta, Weiner & Karnaze, 1987).

Regardless of their source, the figures are consistent, accidents comes fourth in order of frequency as cause of death, after ischaemic heart disease, cancer and cerebrovascular disease. During the first four decades of life, death by accident is the single most common cause of death (Cartlidge & Shaw, 1981).

Hospital surveys suggest that the very young, the uneducated, and the poor are disproportionately represented in injury on the roads (Selecki, 1979). The young adult male and adolescent population with a peak at 15 - 24 years are most at risk of motor vehicle accidents (MVAs), with a male-to-female ratio of 2 or 3 to 1 usually reported (Burton & Volpe, 1988; Kraus, 1987; Rimel, Jane & Bond, 1990). A secondary peak incidence includes infants, children and the elderly (Kraus, 1987). Rimel et al. (1990) report that the bulk of the head injured patients (75%) earned less than U.S. \$10,000 a year, where "students" (24% of the population) and the "unemployed" sustained head trauma almost three times that of the normal population. Of those injured 25% had less than 8 years of education, 50% had between 8 - 12 years, and 25% had more than 12 years. Further 59% were single, 29% of the patients were married, and the remainder were either widowed or divorced.

The victims of head injury are not a random sample of the population and include a disproportionate number of those with some kind of social deviancy. Often the victims present with prior disturbance in their family life, a history of antisocial behaviour, risk-taking conduct in cars / motorcycles, or are drinkers / alcoholics (Bond & Brooks, 1976; Jennett, 1990). Kraus (1987) notes that blacks (non-whites) have a higher incidence by race compared to non-blacks in three of five U.S. studies. Epidemiological studies show that lower socioeconomic groups are overly represented among the head injured population and that MVAs, drinking and assaults are the common causes. Sports - related injuries occur more often in upper income groups (Levin, Benton & Grossman, 1982).

The use of alcohol shortly before injury (whether MVA, domestic accident / assault) is the most established predisposing cause. Alcohol was implicated in 29% of head injuries in males 15 years and older and 10% of females (Levin et al., 1982).

According to Levin et al. (1989) MVAs are the cause of 42% of TBIs. (In 64% of these cases the victim was an occupant of the vehicle, a motorcyclist 20%, a pedestrian 10%, and a bicyclist 6%). The remaining 58% of TBI can be accounted for by falls at 23%, assaults at 14% (3 injured by firearms), bicycle collisions not involving a motor vehicle at 6%, sports and recreation activities at 6%, and all other causes at 8%.

However these figures are not accepted by all researchers. In a critical review, Kraus (1989; cited Wood, 1990) highlighted a number of methodological flaws common to these studies; which included

- (1) The inconsistency in the definition and classification of severity of TBI.
- (2) The terms 'head injury' and 'brain injury' are often used interchangeably despite their very different conditions.
- (3) Some studies include congenital conditions in their analysis which further misconstrues the definitions.
- (4) Even in cases when International Classification of Disease (ICD) codes are applied, there is still some dispute as to which codes are appropriate to use.
- (5) Problems arise with motor vehicle accidents, when the visiting physician may be essentially concerned with stabilizing the patient and the primary diagnosis may be internal injuries or broken bones not TBI.
- (6) When a patient is attended to and discharged, if in the same year they are later readmitted or relocated in another hospital for problems from the initial injury, then he / she may be recorded and counted twice.

CLASSIFICATION

There are a number of systems for classification of TBI, which include Primary / Secondary, Open / Closed, Minor / Severe. Traumatic brain injury is an internationally accepted term referring to any of the injury subsets described below. These classifications systems, which are based on initial neurological findings, allow supervision of care to be devised for patients with varying degrees of head injury severity (Dacey & Dikmen, 1987).

Primary Brain Damage / Secondary Brain Damage

Primary brain damage occurs at the time of injury, and may include contusions which are commonly found under the site of impact, and / or diffuse axonal injuries which are found scattered throughout the brain (Teasdale & Mendelow, 1986). Secondary brain damage occurs later and can be caused by many factors, such as brain swelling or infection, respiratory failure or hypotension (Teasdale & Mendelow, 1986).

Open Head Injury / Closed Head Injury

An open head injury refers to an injury where the skull is perforated and the skull fragments may then penetrate the brain substance. The extent of brain damage depends on the speed and angle of the object, as well as the site and the strength of the skull at point of entry. In these cases consciousness may not even be lost, and other symptoms tend to undergo speedy and spontaneous recovery.

Closed head injury (CHI) is a blow to the head where damage at the site ("coup") moulds the bone inwards producing pressure that may force the brain to the opposite side of the skull producing other damage ("countercoup"). Such damage is frequently caused by a sudden change in motion of the head by acceleration, deceleration or rotation. The abrupt impact causes the brain to shift in the skull, twisting, stretching or shearing the nerve fibres in the brain. This could result in the "disconnection syndrome" where the damage is to the leading fibre tracts like the corpus callosum or the anterior commissure. Impact may also cause a haematoma - bleeding trapped in the skull, or edema - swelling around the wound which also creates pressure (Lezak, 1983; Kolb & Whishaw, 1990).

Damage resulting from CHI can be discrete, and alter the functions mediated by the cortex at the site (more commonly the frontal and temporal lobes), or more generalized, causing general loss of complex cognitive functioning, decreased mental speed, and an inability to concentrate. Generalised damage is usually from extensive tiny lesions and lacerations distributed throughout the brain (Kolb & Whishaw, 1990).

Minor Head Injury

A "Minor Head Injury (MHI) is classically defined as an injury that results in a period of "Posttraumatic Amnesia" (PTA) of less than 1 hour (Russell & Smith, 1961)" (p. 253, Gronwall, 1991). PTA is the time between the injury and the full recall of events afterwards. The bulk of MHI result from assaults, sports injuries, falls, or a blow to the head when it strikes a fixed medium such as a wall (Gronwall, 1991). MHIs can include scalp contusions, lacerations, or haematomas (Long & Ross, 1992), and produce disturbances in mental and social life which may be permanent (Bond, 1986).

Minor head injured patients comprise the bulk of head injury victims. They have the best prospect for recuperation, yet often receive the least therapy, and are the least understood (Whitaker, 1988). This can occur because they are commonly seen by a variety of health professionals or may not come to medical attention at all. Levin, Mattis, Ruff, Eisenberg, Marshall et al. (1987) propose that if a MHI patient is (a) assessed for neurobehavioural deficits, (b) given information on the gradual resumption of activities after discharge, and (c) followed up after 1 month, there would be less secondary emotional distress and excessive time away from work.

Major Head Injury

Major head injuries involve the brain, and / or blood vessels of the brain, and often the skull. Injuries may consist of cerebral concussion, cerebral contusion, or cerebral lacerations to the brain, and linear, depressed, or basilar fractures to the skull (Long & Ross, 1992). The posttraumatic amnesia (PTA) period is greater than 24 hours, and the period of unconsciousness 20 minutes or more for the head injury to be considered severe.

Classification can be by type of injury (sharp / blunt), extent of the damage (localized or general), and whether the brain is exposed or not (open / closed). Further lesions can be divided into macroscopic lesions, which are contusions (or bruising) underlying the site of impact, or microscopic lesions, such as the shearing or stretching of nerve fibres. Secondary lesions result from indirect damage, such

as swelling and damage by haemorrhage. Localized or focal damage refers to damage at a particular point in the brain, whereas generalized or diffuse damage is more widespread involving a few areas or all areas of the brain, sometimes due to shock waves or pressure effects.

A sharp object, like a missile, usually causes localized damage. A blunt injury is caused by either acceleration (being stationary and being hit by something moving) or more commonly deceleration (moving then suddenly stopping) which creates more generalized damage. Compression injury, when both sides of the head have been pressed together, occurs only rarely.

MEASUREMENT OF SEVERITY

Regardless of the type of injury, evaluation of the severity of the lesion is critical. PTA and length of coma, are the main measures of severity.

While coma relates essentially to damage of the brain stem, PTA relates primarily to damage of the diencephalon, therefore it has been recommended that PTA is a better predictor of mild and moderate injuries, whereas coma is a better predictor of severe injury (Long & Ross, 1992).

Jennett (1976) concludes that, while there is no one procedure for appraising severity that is relevant for all types of head trauma, reference should always be made to both coma and PTA to distinguish severity from complications.

Posttraumatic Amnesia

One difficulty with using PTA, is that there is no agreeable method of evaluating it across separate studies (Kolb & Whishaw, 1990). There have been various approaches to solving this dilemma. Gronwall (1989, p. 23) has suggested redefining PTA, "as the period of disorientation in time, place and person. This point in time after injury when the patient can correctly give the day, date, month,

and year, as well as correctly say where they are and what has happened to them is taken as the end of PTA. This has the advantage that it can be objectively assessed, and that it does not need sophisticated techniques or skilled testers to obtain that information".

There is a direct correlation between the severity of head injury and the duration of posttraumatic amnesia and Selhorst (1989) emphasises the following scale: mild head injury, 0 to 1 hour PTA; moderate injury, 1 to 24 hours PTA; severe injury, 1 to 7 days PTA; very severe injury, 7 days PTA or longer.

Gronwall & Wrightson (1980) maintain that it is not feasible to record short durations of PTA with more precision than "less than 5 minutes", "5 to 30 minutes", or "30 to 60 minutes" and say that the validity of studies which attempt to be more specific should be questioned.

While PTA is probably the best available clinical indicator of head injury severity some consider that the duration of PTA is unsuitable as a quantitative measure, because it is decided upon retrospectively, and relies on the subject's own estimate of the point when memory reappeared, and their recall of the connected happenings which allow it to be timed (Gronwall and Wrightson, 1980). Further sometimes subjects are kept sedated, thus increasing PTA artificially.

Another problem surrounding PTA as a measure of severity is that the association is not as strong in either penetrating or crushing injuries. Here damage may be severe without impaired consciousness or a identifiable period of post-traumatic amnesia (Cartlidge & Shaw, 1981). Finally, it has been suggested that sometimes posttraumatic amnesia may be due to a conscious wish not to recall, suggesting that some memories of the accident may be intentionally forgotten.

Glascow Coma Scale

In 1974 the Glasgow Coma Scale (GCS) was created to standardize evaluation of impaired consciousness and coma (Bailey & Gudeman, 1989). Today it is the most frequently used measure available for an impartial and quantitative appraisal of the extent of the coma (Gronwall, 1989). The scale assesses three aspects of behaviour; the best degree of eye opening, the best motor response and the best verbal response, which are rated numerically on a scale from 3 (no response

of any kind) to 15 (no impairment). The total of the numerical rankings is the overall score which indicates the depth of the patient's coma. Usually the recordings are made hourly and produce an impartial account of the patient's progress through this phase (Gronwall, 1989).

Normally on admission, or 6 hours after injury, a head injured patient with a GCS score of 8 or less is considered to be severely impaired. While patients with GCS scores of 9 - 12 are moderately impaired, and 13 - 15 have a minor impairment (Dacey & Dikmen, 1987).

Sometimes patient's reactions alternate during the examination. It has been suggested that a record of both the highest and the lowest scores, plus the left and the right motor responses are useful in following trends in patient improvement (Selhorst, 1989).

The GCS promotes a dependable and reproducible explanation of impaired consciousness, which enables health professionals to obtain reliable evaluations of the injury, rate of severity and to assist with the management of the patient (Bailey & Gudeman, 1989). But there are some drawbacks with the GCS, for example eye opening may be difficult with facial swelling, and verbal reactions may be obstructed by an endotracheal tube. Also the use of drugs to lessen intracranial pressure, like the effects of alcohol, can lower the patient's response. Finally the reliability of the scale has been questioned in young children, those who do not understand English, or in chronic conditions which affect motor, verbal, or eye response (Kraus, 1987).

Other criticisms are that it is not a useful alternative for grading less severely head injured patients, for example a patient who recovers consciousness at the scene of the accident (Gronwall & Wrightson, 1980); and that a lack of consciousness is associated with the brain stem reticular formation, the GCS in fact fails to consider brain stem reflexes as indices of severity of injury (Lezak, 1983; Davis & Cunningham, 1984).

Glascow Outcome Scale

The Glasgow Outcome Scale (GOS) is a measure of neurological complications or residual effects after discharge from primary medical care. The scale includes four levels of recovery (1) Persistent Vegetative State (PVS) - no cerebral cortical function; (2) Severe Disability (SD) - conscious but dependent on 24 - hour care; (3) Moderate Disability (MD) - disabled but independent; and (4) Good Recovery (GR) - unaltered or mild impairment with recurring sequelae but able to take part in a normal social life. Each category of outcome is a composite of cognitive, physical and social functioning (Levin et al., 1982; Kraus, 1987; Rimel et al., 1990).

Numerous questions have also arisen concerning the GOS. A great deal of subjectivity is required of the observer, and it does not associate the perceived sequelae to the brain injury or to other non-neurological injuries (Kraus, 1987).

FACTORS AFFECTING AND TYPES OF OUTCOME

Outcome can be influenced by pretraumatic factors over which there is no power. Patient age is a crucial factor because of the ability of a younger brain to rejuvenate and to accommodate to a greater extent than that of an older brain. Generally older people suffer more severe cognitive impairment, and have more difficulty in adjusting to the head injury than younger subjects. Another important pretraumatic factor is psychosocial status of the patient before the injury. As mentioned earlier it is quite commonly accepted that the victims of severe head injury do not represent a random collection of the population. Instead an unjustified percentage of patients, before their injury, were psychosocially maladjusted; many of them abused alcohol, or were antisocial in behaviour (Jennett, 1979). Research indicates that pre-injury factors such as genetic predisposition, age, early experience, educational and occupational background, socioeconomic status (SES), previous

head injury (which acts as a cumulative effect, impairing more severely and taking longer to recover), stress, personality, psychiatric disorders, and alcohol or substance abuse are directly related to the rate of recovery from a head injury (Whitaker, 1988; Long & Ross, 1992).

Another group of factors affecting outcome concern the degree and type of brain damage, and a third group of factors relate to the level of medical attention and management (Jennett, 1979).

The consequences of head injury can be grouped into four main sets - physical, communicative, cognitive and behavioral. When the person regains full consciousness the extent of such disorders can be assessed. However, the full extent of the damage is often not known until many months after the accident.

Physical

The most frequent post-concussional complaint is headache, followed by dizziness, impaired memory and mental ability. These outcomes increase proportionally in the later age-groups and have a longer duration (Russell, 1934).

Postconcussive syndrome (PCS) is a term applied to patients who have recurring subjective symptomatology such as headaches, dizziness, irritability, anxiety, blurred vision, insomnia, easy fatigability, concentration and memory difficulty (Strauss & Savitsky, 1934; Bailey & Gudeman, 1989).

Cognitive

It is difficult to make generalizations about the neuropsychological consequences of head trauma. However the most obvious and constant complaint is of impaired memory. Brooks (1976) tested 82 subjects with severe head injury on the Wechsler Memory Scale. Results indicated that Mental Control was most poorly performed, followed by Digits Reversed, Information, Orientation, and

Visual Reproduction. The two tests with long-term recall elements, namely Logical Memory and Associate Learning, also proved very demanding for the head injured patients. Overall the subjects had difficulties with speed and attention, complaining about "slowness" and being unable to hold information while considering the new incoming information.

The location of the lesion has often been associated with cognitive changes that occur. For example, patients with left hemisphere lesions often experience more difficulty on verbal tests, whereas, those with right hemisphere lesions are more prone to visuospatial and perceptual problems. Also, the frequency of memory disorders may be an indication of how often there is damage to both temporal lobes (Teasdale & Mendelow, 1986).

Behavioural

There is no precise categorisation for global personality changes or general behaviour disturbance, although descriptions of "Frontal Syndrome", "Temporal Lobe Syndrome", "Postconcussional Syndrome" and "Psychotraumatic Psychosis" do occur. Frontal Syndrome is characterised by apathy, inertia, purposeless drive, and loss of initiative and judgement, where in most cases the individual has no control over sudden shifts in mood or behaviour. The description of "Temporal Lobe Syndrome" applies more to irritable and hostile characteristics (Kolb & Whishaw, 1990).

The two psychiatric syndromes associated with head injuries are the "Postconcussional Syndrome" and "Psychotraumatic Psychosis". Symptoms of the postconcussional syndrome include headaches, dizziness, fatigue, reduced concentration, memory difficulties, anxiety, insomnia, hypochondriacal concern and sensitivity to noise and light, whereas psychotraumatic psychosis is a more liberal expression that may refer to depressive or manic responses, or other psychotic behaviours such as hallucinations or delusions (Kolb & Whishaw, 1990).

Return to work is the dominant theme in "social recovery" studies where results show that many of those back in their original employment have not yet returned to their past level of proficiency (Oddy, 1986). Other aspects of social recovery show leisure activities and contact with friends were also drastically

affected. Studies by Oddy, Humphrey & Uttley (1978) confirm a pattern of disrupted social performance and diminished leisure activities, and a follow-up study in 1979 by Oddy & Humphrey (cited Levin et al., 1982), showed a drop in the number of close friends and social outings, and an increase in loneliness.

RECOVERY

Although it is commonly stated that recovery from head injury may continue for 2 to 3 years, there is little doubt that the bulk of cognitive recovery occurs in the first 6 to 9 months. Lezak (1983) points out that some specific impairments and general deficits (such as language and construction disorders) tend to improve at a faster rate, while others (such as visual blind spots and reduced tactile sensitivity) remain essentially unchanged over the years.

During the process of recovery, the systems with the least damage evidently recuperate first (Ommaya & Gennarelli, 1974). The brain stem is generally involved to a lesser extent and is the first to recover, leading to consciousness, whereas higher order systems may remain impaired. Therefore while a patient may be unable to consolidate new information for a time they may recognize significant others and retain remote memory until the diencephalon, and thus consolidation, recovers.

Prognosis is low for adults over 60 years of age which could be due to the increased possibility of preexisting neurological damage, or to cell loss with age (Long & Ross, 1992) and there is increasing consensus that recovery during childhood also differs from that in adolescence or adulthood. Expressive language and motor functions for example are particularly vulnerable under 6 years of age, because of the immature neuroanatomy and lack of empirically based treatment strategies. Some go as far to suggest that children with head injuries may "grow into" deficits as development necessitates verbal encoding, articulate dialect and higher-level logic (Waaland & Kreutzer, 1988).

ASSESSMENT

Assessment of residual behavioral disturbance after head injury usually include: self-report; information obtained from relatives (through interviews and rating scales); and ratings by a clinician (Levin, 1987).

In order to determine a patient's prognosis it is necessary to measure their level of impairment. For example the follow up assessment should include an interview with a family member to characterize the patient's performance of daily activities, psychosocial adjustment, and capacity for planning and organizing a daily schedule (Levin, 1987).

Awareness of a patient's premorbid level of functioning is often used in initiating a reference point with which present accomplishments can be compared. This typically estimates the amount of damage and can be used to determine the usual levels in recovery (Long & Ross, 1992). For example, it has been shown that persons with above-average IQs, higher SES, and higher levels of education tend to have a greater recovery (Long & Ross, 1992).

Assessment both identifies weaknesses in patients, as well as highlighting their cognitive strengths. These descriptions of ability can help in the development of a cognitive rehabilitation treatment plan, formulate a prognosis, and also act as a baseline to monitor the patient's progress over the course of the programme.

REHABILITATION

Prior to the 1970s head injured individuals were treated in traditional rehabilitation facilities in a similar fashion to aged stroke victims. Today, however specialised head trauma rehabilitation facilities have been established and comprehensive services are offered for the severely impaired (Whitaker, 1988). Nevertheless many patients with serious deficits affecting their daily lives are being turned away or sent home without the assistance of rehabilitation because of the scarcity of suitable facilities compared to the large numbers of head injured patients seen each year (Rimel et al., 1990).

Successful intervention has noted that the family is becoming more and more the focal point in rehabilitation of the individual with traumatic brain injury. 'The head injured family' philosophy recognizes that group or individual psychotherapy is often essential for spouses, parents, siblings, friends or other caregivers as well as the patients themselves (Bond, 1986; Waaland & Kreutzer, 1988; Whitaker, 1988).

SUMMARY

This chapter had provided a basic overview of traumatic brain injury (TBI) and touched on relevant demographics, aspects of classification, degree of severity, outcome, recovery, assessment and rehabilitation. This provides a basic background for the present study on memory dysfunction after TBI.

Although the study was primarily focused on clarifying performance on a verbal learning task, it also provided epidemiological information on the male-female ratio, age, ethnic affiliation and educational groups most affected, and the proportions of clients with varying assessment intervals who were experiencing some degree of memory difficulty. The main points to be taken from this chapter in relation to the present study are;

- (a) Males are more vulnerable to head injuries than females.
- (b) While head injuries are more common in the younger age groups (11 - 20 and 21 - 30 years) memory is more impaired in the older age groups.
- (c) Recall varies with different ethnic affiliations because of distinctive backgrounds.
- (d) Persons with above-average IQs, and higher levels of education have greater recovery and perform better on memory tests than persons with lower levels of education and IQ.
- (e) The effects of memory recovery have been studied using patients with varying time intervals between the injury and neuropsychological assessment. Although the bulk of cognitive recovery occurs in the first 6 to 9 months more spontaneous recovery can occur over longer periods of time.

Severity of injury was based on length of retrograde and post-traumatic amnesia, and Glasgow Coma Scale as were available. Since some of the clients had not presented for medical help at the time of the accident it was expected that PTA would be the main guide to severity and that most would experience closed head injury.

The following chapter introduces memory, particularly providing a background for verbal memory and its relationship with TBI.

CHAPTER TWO:

MEMORY

INTRODUCTION

Human memory has been seriously studied by psychologists since the mid-19th century, when Hermann Ebbinghaus (cited Tulving, 1987) published a monograph, describing his cautiously controlled examination of learning and recollection of verbal memory.

The association between neuropsychology and memory dates back to 1915, when Karl Lashley (cited Carlson, 1986; Kolb & Whishaw, 1990) began his pursuit of the neural locations of learned habits by studying the effects on memory of a variety of surgical lesions. By 1950 he concluded that it was impossible to isolate memory traces. He demonstrated that a deficit caused by the surgery was proportional to the quantity of cerebral cortex he removed, and that the site of the damage was less significant than the amount of tissue destroyed. Although confined regions might be crucial for learning or retention, he considered that the engram was represented throughout the region (Carlson, 1986).

Another powerful discovery in neuropsychology relating to memory occurred in 1953, when William Scoville (cited Baddeley, 1986; Kolb & Whishaw, 1990) operated on the now reknown H.M. Bilateral removal of the hippocampus for control of his epileptic seizures made H.M. amnesic for almost all occurrences after the operation due to severe interference with the process of storing or retrieving events. This revelation defied Lashley's work and moved modern day neurological studies in a new controversial direction.

Most of the arising research concentrated on theoretical questions about the underlying mechanisms of memory with little focus on the practical questions about how memory functions in daily life. In the 1960s the new school of cognitive psychology, adopted a much more open-minded and speculative approach, with researchers exploring commonplace memory strategies, such as the use of imagery, mnemonics and categorical organization. They also embarked on challenges such as clarifying the tip-of-the-tongue phenomenon (Cohen, 1989).

While understanding of the operation of human memory has multiplied substantially in recent years, there remain problems which plague research in this domain. These include; the tendency for generalizations to be founded only on findings from single experiments; assuming that the performance is one of two mutually exclusive procedures; the overlapping of concepts; and the assumption that experiments should endeavour to segregate memory from other cognitive systems (Eysenck, 1977).

Notwithstanding these reservations, it is generally accepted that there are three principle storage structures; sensory memory, short term memory and long term memory (Klatzky, 1980).

Sensory Memory

Information initially received by modality-specific stores is commonly called the "sensory register" or "sensory memory". Material is held here for a second or two, while a small portion is selected for more processing in the short-term and the remainder deteriorates. The selected material is then forwarded to the various sensory areas of the brain (Filskov & Boll, 1981; Eysenck, 1986).

Short Term Memory

Short term memory (STM) (also known as "primary memory", or more commonly "working memory") is thought to be a conscious process that continues for 20 to 30 seconds, with a limited capacity of seven, plus or minus two, items (Filskov & Boll, 1981; Baddeley, Harris, Sunderland, Watts & Wilson, 1987).

Working memory consists of four separate components: a modality-free central executive, an articulatory loop, a visuospatial scratch pad, and more recently an acoustic loop. The central executive is the most significant because it directs attention to inputs, and operates the other components. The articulatory loop can be considered as a verbal rehearsal loop. The visuospatial loop deals with visual and / or spatial information where the primary acoustic store deals with auditory input (Eysenck, 1986).

Long Term Memory

"Long term memory" (LTM), or "delayed memory", refers to more lasting memory and is of unlimited capacity. LTM begins after the first half-second in which the stimulus enters the realm of attention. Consequently there is a 20 - 30 second crossover between short and long term memory, which should be taken into account in assessment (MacInnes & Robbins, 1987).

Material reaching the LTM has been consolidated from the STM after various information processing techniques, such as repetition or rehearsal, where information is re-circulated in an attempt to minimize forgetting. Alternatively essential information can be substituted or summarized with "reduction coding", or added to and made more memorable by "elaboration coding" (Baddeley & Patterson, 1971). Often the continuation into long term memory involves categorization, or organization by joining the elements into meaningful "chunks" in the working memory, or by using such methods as mnemonics or imagery (Hasher & Zacks, 1979).

LTM has been divided into a number of different types of learning. The main two are "declarative learning" (which can be further divided into "semantic memory" which is stored knowledge, or "episodic memory" which is the store of personal experiences or events) and "procedural learning" (which is the acquisition of perceptual, motor and intellectual skills). Other types include "autobiographical memory", which is the recollection of personally experienced events from ones past, and "prospective memory", which is the ability to do a particular thing at a particular time. The later two overlap with the declarative / procedural dichotomy (Baddeley et al., 1987).

FORGETTING

Generally, there is an increasing, quantitative decay in the ability to remember as the retention period extends. A graph of the amount remembered as a function of progressive retention intervals is known as a forgetting curve, a term first introduced by Hermann Ebbinghaus in 1885 (cited Baddeley, 1984; Squire, Byrne, Nadel, Roediger, Schacter & Thompson, 1992). The curve is exponential and the slope describes the overall rate of forgetting, with forgetting rapid initially, becoming more and more gradual as time passes. In general, rate of forgetting appears to be unusually constant across various groups of people.

There are a number of theories about why forgetting occurs. The earliest was trace decay theory which suggests the trace diminishes naturally over time if it is not renewed by some reacquaintance with the learned material. Today however the trace decay theory has been mostly discarded (Squire et al., 1992).

Interference theory has generated the greatest amount of experimental exertion over the last few decades. Interference occurs when the learning of a set of information interferes with what comes later (proactive) and / or retroactive interference where what is learned later interferes with what was learnt previously (Squire et al., 1992).

Cue-dependency theory is the more novel alternative approach. Here it is asserted that retrieval cues that are lost or absent prevent access to material. The successful blend of stored information and retrieval information provides the integrated experience and if suitable retrieval cues are not available, they will be forgotten. It subsequently suggested that the only effective memory aids are those which were part of the original encoding or the perceptual background being studied (Squire et al., 1992).

Finally the level of processing theory proposed by Craik and Lockhart (1972; in Craik & Tulving, 1975) suggests that shallow encoding is less likely to result in high levels of recall than deeper levels of encoding (such as organization into categories).

DISORDERS OF MEMORY

"Amnesia refers to a failure of some part of the memory system... The causes of amnesia are various, ranging from a blow to the head, through brain damage due to alcohol or infection, to the effects of ageing" (p. 135, Baddeley, 1986). The type of memory loss depends on the nature of the pathology and the degree and locus of injury. Traumatic brain injury (TBI) accounts for most complaints of memory, and can produce any or all of three types of amnesia, retrograde, posttraumatic and anterograde amnesia. Retrograde amnesia (RA) refers to loss of memory for events prior to the injury, it is usually temporary and gradually shrinks leaving a variable period immediately before the accident which is permanent. The duration of PTA (as previously discussed) is the interval between the injury and the time taken to attain continuous memories, and it is often used as a measure of severity. Anterograde amnesia refers to problems associated with new learning found since the injury. PTA is included in anterograde amnesia, but anterograde amnesia extends beyond PTA (Baddeley et al., 1987).

Studies of memory disorders after TBI have been along various dimensions such as verbal / visual memory; declarative (either semantic or episodic) / procedural; and discrepancies between lesions in various brain locations.

In earlier work with individuals with TBI, it has been observed that the strategies employed in the attempt to learn, have accounted for much of the variability in individual scores on tests. The spontaneous use of any memory aids by a patient with severe head injury is rather rare. CHI patient's deficits can limit their concentration, slow their thinking, and affect their ability to attend selectively, discriminate, combine and evaluate information.

Brooks, McKinlay, Simington, Beattie & Campsie (1987; cited Levin, 1989) who studied verbal memory difficulties in particular, found these and slowed information - processing rate to be most clearly correlated to unemployment seven years after severe head injury. Further Brooks (1975; cited Levin, 1989) in a comparison of the verbal memory of TBI patients and Controls in both immediate and 20 second delay trials, found no significant difference in the digit span trials, but the delayed trials recorded the head injured patients to be significantly slower.

Brooks interpreted these findings as indicating a normal STM and a defect in LTM. Similar results were obtained by Lezak in 1979, who added that the improvement on the immediate (short-term) memory span was steady and approached normal performance levels three years after injury.

Gardner, Brownell, Wapner & Michelow (1983) highlighted variations in recall depending on the location of the lesion. Subjects with right hemisphere deficits had a tendency to focus on isolated details of the story, because of their difficulties in the organising and combining of certain information. Further problems arose with extracting morals, inferring logic, and assessing the suitability of various facts, situations and characteristics, because the subjects could not inhibit confabulatory responses and had a inclination to justify the bizarre while being tangentially aware it did not fit. Similar studies have shown that the right hemisphere is influential in "understanding the connotations of common words, for translating figures of speech, and for solving verbal syllogisms" (p. 43, Delis, Wapner, Gardner & Moses, 1983).

Finally, Wechsler (1973) looked at the affects of hemispheric lesions on emotionally charged versus neutral texts. Results showed that those with left cerebral lesions performed lower on both neutral and emotional stories, as well as showing less symbolic misrepresentation of the emotionally charged story than did the right cerebral lesioned patients.

Brooks (1975; cited Levin, 1989) compared the intrusion errors the head injured subjects made and found that it was predominantly semantic confusion (i.e. having a semantic relationship to the test word) rather than acoustic errors (i.e. sounding similar to a test word) that occurred. Levin & Goldstein (1986) looked into the strategies adopted to assist recall and found that head injured patients differed significantly from the Control group in the types of spontaneous strategies, such as the clustering and subjective organization, they used to facilitate their recall.

The studies referred to above are but a few of those covered in the literature on memory dysfunction after head injury. Because of the assorted causes, locations and treatments available, along with the effects of age, sex, education, handedness, previous injuries, and individual differences, the scope is too spacious and the possibilities too countless to be mentioned here.

ASSESSMENT

Measurement of memory is a critical part of any neuropsychological assessment, where the purpose is to assist in the understanding of the pattern of damage; diagnosis of a distinctive organic condition; and in rehabilitation and supervision (Filskov & Boll, 1981). However, because human memory is so complex a number of tests are used for thorough examination.

These may be standardized tests (for which there is some indication of how a person of any given age or intelligence level would be likely to perform), rating scales or questionnaires. The measures can be repeated in order to show the degree of which the patient has improved as a result of treatment, spontaneous recovery or increased familiarity with the test materials.

Assessment techniques need to consider the consequences of daily life, employment and interpersonal relationships. At the same time, cognitive functions can be affected by a variety of factors such as damage of different aetiologies, velocities, and at assorted sites, as well as the influence of different ages groups (Brooks & Lincoln, 1984).

Batteries

The first clinical memory battery developed by Wells and Martin in 1923 (cited Erickson & Scott, 1977), was laborious and poorly assembled, yet correlated highly (.81) with the Stanford-Binet Intelligence Scale. This, and other such tests, were the forerunners of the Wechsler Memory Scale (WMS), published in 1945 as a "rapid, simple, and practical" memory test (p. 184, Randt, Brown & Osborne, 1980).

The Wechsler Memory Scale has been criticised as have others for its heavy reliance on verbal memory performance (all but two of the seven subtests measure verbal memory). Despite criticism of the scale, the WMS and its successor the WMS-R have dominated the clinical assessment of memory ever since (Randt et al., 1980; Erickson & Scott, 1977).

The criticism surrounding the various memory assessment batteries currently available, has led to various speculations about what the 'ideal' battery entails. It is generally accepted that a thorough evaluation of memory should include tests that: (1) are based on a unified theory of brain functioning; (2) are modality specific and represent all areas of the brain; (3) should be independent tests of memory and not associated so closely with tests of intelligence; and (4) should supply separately standardized subtests for each field of mnemonic workings (MacInnes & Robbins, 1987).

Although some would still seek a comprehensive 'battery' it is generally accepted now that independent assessment of separate aspects of a person's memory, through combinations of single tests, is more important than a single 'score' (Williams, 1968). Any assessment of memory should; (a) measure both verbal and nonverbal memory on a variety of memory functions such as STM (immediate recall), LTM (recall after a delay of 10 minutes or more), consolidation, and episodic memory; (b) include a test of learning (preferably more than just one trial); and (c) assess both recall and recognition of verbal and nonverbal materials (MacInnes & Robbins, 1987).

Specific Tests

Everyday memory: To be able to measure the outcome of memory problems in daily life, rating scales, questionnaires and behavioural observations are useful. Research indicates that questionnaires completed by the subjects could be contingent on how they wish to project themselves. Therefore it is often helpful to include observational assessments or checklists performed by someone in daily contact with the patient. Such measures are often given to both the patient and a relative /

caregiver to fill in independently. These measures could be based on a list of memory problems from pilot studies or by asking the patient to keep a diary for a week of all the occasions when he / she was aware of forgetting things (Brooks & Lincoln, 1984).

Overall, the best method of obtaining information regarding memory performance is to utilize both interview or questionnaires, and laboratory testing. A test that can be recognized as an attempt to bridge the gap between laboratory based measures of memory, and assessments obtained by observation and questionnaire is the Rivermead Behavioural Memory Test (RBMT). This measure was designed to detect impairment of everyday memory functioning, and to monitor change following treatment for memory difficulties. The RBMT evaluates prospective memory ability and attention by asking the subject to either remember to carry out some everyday task, or to retain the type of information needed for adequate everyday functioning. It is a short test, easy to understand, use and interpret and is applicable to a wide range of environmental settings (Baddeley et al., 1987; Levin, 1989).

Short term memory: Short term verbal memory can be tested using immediate recall of digits, word lists, or paragraphs. STM is subject to the "serial position effect", "primacy" and "recency". Subjects presented with a list of words, usually recall items from the start (primacy effect) and the end (recency effect) of the list, with recall balancing out in the centre of the list (the asymptote) (Eysenck, 1977). Numerous variables influence the asymptote, - more items or faster rate, lower the asymptote. However such variables have not been found to change the recency effect implying that separate structures are committed to various parts of the list. It has been assumed that recall from the opening and middle segments of the list is from LTM, whereas recall from the last portion is essentially from STM (Eysenck, 1977).

Short term nonverbal memory can be tested by such tests as the immediate recall of the Rey Complex Figure, or the Benton Visual Retention Test, and / or visual digit span from the WMS-R, which involves the subject copying a sequence tapped out by an examiner.

Long term memory: The majority of patients treated for memory problems are probably suffering a deficit relating to long term memory (Baddeley, 1984). Long term memory is often measured after an interval of minutes to hours or even days. Long term verbal memory can be measured by a large number of tests, such as the delayed recall of the Logical Memory or Paired Associates subtests of the WMS-R, the Auditory Verbal Learning Test, or the California Verbal Learning Test. Long term nonverbal memory can be measured by the delayed recall of the Rey Complex Figure, or the Visual Reproduction of the WMS-R. Typically these tests require the subjects to recall material learnt 30 minutes before (Brooks, 1972; Kolb & Whishaw, 1990; Squire et al., 1992).

Verbal Memory

As mentioned previously the majority of memory tests examine verbal memory as opposed to nonverbal or visual memory. Measurement of verbal memory has primarily been on nonsense syllables, words or prose text. The present study aims to examine prose recall, which trails behind memory research for word lists despite the great interest in the principles governing the learning of textual narrative (Johnson, 1970; Kintsch, Kozminsky, Streby, McKoon & Keenan, 1975).

Prose Memory: Memory for prose is complex and influenced by various factors, such as; the category of prose that is being recalled; the type of events which intercede the reading and recall; and the type of assessment used (for example multiple choice, true / false tests, short answer, or recall) (Squire et al., 1992).

Initially to many researchers sentence memory was a means for studying memory in a more naturalistic way. However, even though verbatim recall of sentences indicates that people can retain the exact words in a sentence, it is highly unlikely that they do so in natural circumstances (Eysenck, 1977). Generally it is the message the author is trying to convey that is important, and the same message can usually be sent using different words (Kintsch & Bates, 1977; Smyth, Morris, Levy & Ellis, 1990).

Anderson & Paulson (1977) have explored verbatim versus gist recall and suggest that verbatim memory encoding is like learning meaningless strings of words, and that gist information about the meaning of a sentence, is much more permanent.

However in discourse, sentences follow each other too immediately thus impeding semantic interpretation. Therefore, a discourse processing system is essential to selectively refine the input. This selectivity can be accomplished in response to stress or intonation, or it may be achieved by erasing all that is not essential. If a subject does not have procedures for selectively processing an input text, then he / she would attempt to semantically interpret and store every input sentence in its entirety (Frederiksen, 1975).

Longer text must be organized into a sequence of subunits, called the macrostructure of a text. Kintsch, Mandel & Kozminsky (1977) suggest that macrostructure formation is a necessary part of the learning process.

As in all text comprehension, the reader must use his or her general knowledge about the world to be able to understand the story. Cognitive psychologists suggest that people organize knowledge around units called "frames" or "schema". This framework allows the reader to understand, or interpret these stories in terms of a setting, characters, episodes, reactions, events and goals (Bower, 1976; Gentner, 1976; Kintsch et al., 1977). Recent studies for texts and stories have emphasised the role of schemas. It is important to distinguish between the two different kinds of schemas. Event schemas consist of knowledge about the subject matter of the story, and story schemas use knowledge about the structure of a typical story (Kintsch et al., 1977; Cohen, 1989).

The recall of a story involves the subject picking out the highlights, events that are not main-line or goal-directed will be forgotten with either the summarization or overgeneralization of other portions of the text (Bower, 1976). Often some conclusions are made that are not part of the text, especially in long texts where the subject remembers only the gist or selected details and fills in the gaps with plausible reconstructions (Kintsch, 1977).

Controversy exists between prose researchers as to whether recall is productive, constructive or reconstructive (Kintsch, 1977). In 1932 the late Sir Frederick Bartlett (cited Glass & Holyoak, 1986) presented Oxford University students with a tale based on a Pacific Northwestern Indian culture then recorded their recall at varying intervals. He found that recall was extremely inaccurate where often only the outline of the story was remembered. It was not uncommon for the students to remember nothing more than a vague impression or an isolated detail, yet proceeded to invent a plausible story (Kintsch, 1977; Glass & Holyoak, 1986).

When recall was repeated Bartlett found that names, places and titles were changed; single features were missing; and the stories were inclined to become condensed and more tangible (Kintsch, 1977). The three main schema-inducing processes were: sharpening by adding elaborative inferences, levelling out or omitting, and rationalising. The recall protocols were quite logical stories, and in some cases more logical than the original legend based on an entirely different culture (Glass & Holyoak, 1986).

However, later research failed to replicate Bartlett's findings. Kintsch (1977) cites studies using less exotic material which found recall to be quite precise with the occasional reconstruction or embellishment. Furthermore, when numerous trials were given, there was substantial consistency between what was recalled on one examination and the next.

Recently, another verbal memory test, the TV news test, has been designed to simulate real-world memory tasks in the laboratory. Although it is strongly correlated to the Logical Memory (LM) subtest of the WMS-R, it differs from it in the fact that it is more age sensitive, displays the opposite gender effects than those recorded in the literature by recording males verbal performance to be superior than females, and it is a test of recognition not like the recall from the LM subtest. However the researchers have remarked that to increase the association of the TV news test to measures of recall, they should change to the gist format of everyday life situations (Crook, Youngjohn & Larrabee, 1990).

REHABILITATION OF MEMORY

Treatment approaches are based on whether the rehabilitation is aimed at regeneration or compensation. Regeneration or restoration involves the use of exercises, repetitive practice, or mnemonic aids that aim to restore memory, while compensatory or alleviating techniques usually employ domain specific learning through the use of internal or external memory aids (Sohlberg & Mateer, 1989; Squire et al., 1992).

The notion of repetitive drills is based on the view that memory is like a muscle which will get better with practice. This view is no longer widely held in current rehabilitation programmes, because of a lack of generalization. Remembering one set of words may not increase the probability of later recalling that specific set but it will not enhance one's ability to learn other unrelated materials (Squire et al., 1992).

Domain - specific learning is based on priming effects. A compensation technique called vanishing cues acts by systematically reducing "letter fragments of to-be-learned words across trials...all patients acquired a substantial amount of vocabulary and eventually were able to produce the target words in absence of the fragmented cues" (p. 154, Sohlberg & Mateer, 1989).

Other, internal memory aids focus on enhancing organization, rehearsal, or the use of specific mnemonic devices such as peg words or visual imagery. There are problems which lie with this type of technique in that they place demand on the already loaded cognitive systems, plus teaching of such imagery is often difficult and tricky to measure. Such internal aids have only proven useful for small specific bodies of information (Sohlberg & Mateer, 1989).

On the other hand external memory aids are such things like notebooks, alarms or posted reminders reminding the subject to do something. The problems found with using such external aids is that patients complaining of memory deficits often have difficulty learning this new memory technique.

A procedure that has proven useful in the rehabilitation of memory is the formation of memory groups. These are organised groups of six to eight patients with several stages of impairment. Precise behaviours and goals are set after the first evaluation of the patients and treatments are based on their numerous deficits. The cognitive capability of the group is taken into account and certain techniques are decided upon. These methods usually include the introduction of various memory aids on a daily basis to better their memory impairment.

Regular meetings by all the members of the rehabilitation team means that all information can be pooled together and used to structure and plan each patient's programme. This enables an individually tailored programme for each patient with short- and long- term goals, which are known to both the patient and staff (Brooks & Lincoln, 1984).

Generally, memory training is stalled until a secure baseline has been attained and the various memory deficits are established. Based on the patients cognitive strengths and weaknesses, treatment strategies are selected to suit specific problem (Wilson & Moffat, 1984).

SUMMARY

The focus of this chapter has been on verbal memory. This and the background on memory provides a context from which performance on the Logical Memory subtest of the Wechsler Memory Scale - Revised, can be examined for both Control and TBI subjects.

The main points to be taken from this chapter in relation to the present study are;

(a) Normal persons faced with more words than can be accommodated in immediate span show a very characteristic pattern of recall - words at the beginning of the list (the primacy effect) and at the end (the recency effect) are learned first. The recency effect represents words that are still in a transient short - term store and the primacy effects reflect words from a more permanent memory store.

(b) TBI patients do not necessarily perform differently from Control subjects in immediate trials, but delayed trials record head injured patients to be significantly slower in learning. Brooks interpreted these findings as indicating a normal STM and a defect in LTM.

(c) Recall depends on the location of the lesion. Subjects with right hemisphere deficits tend to focus on isolated details of the story, and have problems abstracting morals, inferring logic, and assessing the appropriateness of various facts. Further TBI patients demonstrate more semantic than acoustic errors, in a study reported by Brooks (1975).

(d) Prose recall is an extremely complex procedure requiring; (1) a discourse processing system to selectively refine the text; (2) a macrostructure to organize events into a sequence; and (3) schema from which to base background knowledge; therefore it was predicted that the TBI recall and rate of forgetting will replicate previous results which are significantly less than those of Control subjects.

The following chapter focuses on the Wechsler Memory Scales, particularly the revised edition (WMS-R), and provides background data about the development and relevant research findings about the Logical Memory Subtest.

CHAPTER THREE:

THE WECHSLER MEMORY SCALES

INTRODUCTION

"A rigid test battery format takes advantage of the uniform procedure of administration by developing a research base. Reference norms that define normal and abnormal performance for various patient groups are easily developed from the research base and provide for a widely applicable and comprehensive assessment of brain function" (p. 73, Osmon, 1987).

The Wechsler Memory Scale is probably the most completely explored psychometric test of memory (Bigler, 1988).

WECHSLER MEMORY SCALE (WMS)

Form I

In 1945 after a decade of investigation, a fast, easy and practical memory examination was introduced by David Wechsler. The Wechsler Memory Scale (WMS) includes seven subtests measuring Personal and Current Information; Orientation; Mental Control; Logical Memory; Memory Span; Visual Reproduction; and Associate Learning (Chelune & Bornstein, 1988).

Standardization was based on 200 normal subjects, 25 - 50 years of age, with age-correlated factors up to age 64 (based on linear extrapolation). A number of studies have since introduced normative data for older populations proposing that a linear extrapolation is deceptive. On the whole these studies infer that memory capacity deteriorates with age more rapidly than Wechsler calculated. However, these studies have failed to examine a non-institutionalized elderly sample across a large age range (Haaland, Linn, Hunt & Goodwin, 1983). It was also some years

before researchers proved empirically derived norms for younger subjects. When Ivinskis, Allen & Shaw (1971) did extend the WMS norms down to the 10-year age level, a comparison of the subtests scores with the Wechsler Intelligence Scale for Children (WISC) and Wechsler Adult Intelligence Scale (WAIS) revealed that the WMS was of questionable validity.

Concern also arose over the issue of prorating in the WMS. In principle the score of a missing subtest can be calculated by converting the scores of the remaining subtests into 'z scores', working out an average, and thus estimating the missing score. Two problems can occur with this procedure, firstly the WMS manual (and some proposed extensions of the norms) lack the means and standard deviations for the 30-39 and 50-59 age groups. Secondly some particular age groups can produce remarkably small standard deviations on the Information and Orientation subtests leading to invalid estimations of the Memory Quotient (MQ) after prorating (Charter, 1981).

Some statistical procedures were developed in order to generate score corrections for age and MQ equivalents, these were also intended to be comparable with IQ. Larrabee, Kane & Schuck (1983) refer to a review in which a mean inter-correlation of .81 is reported between the WAIS and WMS scores. It was noted that this could be partially due to overlap, where the Digit Span subtest appears in both the WAIS and WMS. Also the WMS age correlations are based on age-related changes in the Wechsler-Bellevue IQ scores.

After the publication of the WMS there was considerable controversy about its value as a psychometric instrument. Various limitations were identified; (1) The norms were inadequate and too old to reflect contemporary levels of performance; (2) It measured verbal memory, with only one subtest involving nonverbal material; (3) No measures of delayed recall of learned material were included; (4) Techniques for scoring the Logical Memory (LM) and Visual Reproduction (VR) subtests seemed too brief and imprecise for good inter-scorer agreement; (5) Concern about the concept of "Memory Quotient" (MQ) and whether it measured anything other than IQ; (6) Finally little was known about the reliability, and with disagreement over the factor structure the validity is also questioned (Prigatano, 1978; Herman, 1988).

Erickson & Scott (1977) went as far as suggesting that the Wechsler Memory Scale did little more than verify norms for a group of tasks typically contained in any mental status examination. That the Logical Memory, Memory Span, and Visual Reproduction tasks were borrowed from intelligence tests, emphasises that point.

Since the WMS had essentially dominated the area of clinical memory assessment, it is surprising that relatively little research using the scale has been published. When the WMS was reviewed in 1953 only nine publications were in the literature, with the number extending only to eighty eight in the next twenty years (Erickson & Scott, 1977).

When the WMS was used to compare various clinical groups no distinctions could be made to separate the subjects in a number of studies. Cohen (1950; cited Howard, 1950) administered the WMS to groups of 'psychoneurotics', 'organics' and 'schizophrenics' yet could not discriminate between them at a 5% level of confidence.

The Wechsler Memory Scale was originally published with the assertion that "it should be useful in detecting special memory deficits in individuals with specific brain injuries" (p. 58, Bachrach & Mintz, 1974). However, research with the WMS and head-injured populations has demonstrated diminished scores on many subtests, such as mental control (where response time is examined) and Logical Memory (Crossen & Wiens, 1988).

In 1982 Bornstein describes lateralization effects, where patients with left lesions scored poorly on Logical Memory and Associate Learning subtests, compared to patients with lesions on the right side who achieved low scores in Visual Reproduction. A further study by Chelune & Bornstein (1988) demonstrates that the double dissociation between verbal and nonverbal memory functions was not confined to the relationship of the immediate and delayed scores on Logical Memory compared to Visual Reproduction subtests, but also increased to include the immediate and delayed scores on the paired - associate tasks.

David Ivison (1986) considered the bearing of proactive inhibition in brain-damaged subjects, particularly those with frontal lobe lesions and the Logical Memory subtest. Ivison found that although performance was better on paragraph A for his subgroups, it could not be deduced how much the variation is due to proactive inhibition, for example, the American liner story being naturally more difficult to recollect than the Anna Thompson story. Only a counterbalanced presentation of the paragraphs over a broad sample might deal with the problem.

Form II

In 1956 Stone et al. (cited Erickson & Scott, 1977) produced Form II of the WMS. This alternative form was designed by joining items from Form I with comparable items equally as difficult, and then giving both forms to bright, nonorganic students and patients.

Little work has been done on this second form, however studies comparing the two have found few significant differences, apart from the Logical Memory and Visual Reproduction subtests. As cited in Bloom (1959) & Ivison (1988), the Logical Memory and Visual Reproduction subtests of WMS-II are easier, and the Associate Learning test was easier on Form I. Although it was also noted that when the entire WMS Form II is given the differences tend to cancel out and the total WMS scores would be equivalent. The alternate form, WMS-II, allows evaluation of the alterations in memory function over time (Keesler, Schultz, Sciara, & Friedenber, 1984).

Russell's (1975) version of the Wechsler Memory Scale (RWMS)

In 1975 Russell (cited Keesler et al., 1984) proposed a version for administering and scoring the WMS which substantially improved the traditional method, and as a result was adopted widely by neuropsychologists. The revision included only subtests from the WMS-1 with suitable discriminative validity (i.e. the Logical Memory [which he renamed Semantic Recall] and the Visual Reproduction Subtests [which he renamed Figural Recall]).

The Logical Memory and Figural Visual subtests were chosen because they seemed to be the most sensitive to brain damage, and distinguished between verbal and figural memory. A delayed recall condition was then included to evaluate retention over a 30 minute interval. The other 5 subtests, however, were abandoned because they failed to discriminate between mild brain-damaged patients and nonbrain-injured subjects in a mixed group (Loring and Papanicolaou, 1987).

Other improvements included adopting scale scores, and implementing scoring criteria "that (1) keep the same basic premise of scoring ideas, rather than exact words, and (2) allow both full credit scores for equivalent ideas and half credit scores for partially correct ideas" (p. 161, Sweet & Wysocki, 1984).

Russell's alterations were not without their faults. Crosson, Hughes, Roth & Monkowski (1984), and Iverson (1990) have inferred that Russell's norms may be too stringent for the Logical Memory subtest, and would classify too many non-neurological subjects as impaired. Further, there was no provision for the effect of age, sex or education. Normative data for Russell's (1975) original study was somewhat inadequate. It was based on a small number of 30 normal subjects and 75 brain-damaged subjects, and included too many of the volunteers with high levels of education.

Power et al.'s version of the Wechsler Memory Scale

Power, Logue, McCarty, Rosenstiel, & Ziesat (1979) reviewed the literature on both the WMS and RWMS and found that little respect had been paid to the dilemmas in scoring the Logical Memory subtest. As a result they devised a set of supplementary rules that have become moderately precise and formalized. They are not meant to alter or succeed the original rules, but rather to simplify several vague situations that are not resolved by the original procedures.

Power et al. (1979) attempted to alleviate the lack of scoring consistency by proposing that half credit responses be given if minor changes or omissions are made. According to them a score of "zero would equate with complete failure to recall,... full credit of one point would equate with exact reproductions... and scoring as half credit reflects a recognition of the essential accuracy of the response while penalizing to some extent the tendency to modify the idea" (p. 334, Power et al., 1979).

Indeed, it has been shown that application of the Power et al. (1979) criteria may reduce the amount and quality of information through lowering absolute LM scores. However, Waddell & Squires (1987) note that the approach of crediting modest discrete units of the LM recall is more complicated to utilize considering it failed to add anything of significance.

WECHSLER MEMORY SCALE - REVISED (WMS-R)

The Wechsler Memory Scale - Revised (WMS-R) was published in 1987. The revised edition was an effort to redress the weaknesses identified in the WMS, while included more up-to-date neuropsychological views of memory function. Three new nonverbal subtests were added to generate a better equilibrium between verbal and nonverbal measures of attention and learning. Figural Memory, a recognition task containing obscure visual forms; Visual Paired Associates, a colour-form paired associate task; and Visual Memory Span, a nonverbal equivalent of the well-known digit span task. Notable revisions were also made in the seven original subtests in an effort to balance the immediate and delayed recall trials (Chelune & Bornstein, 1988; Herman, 1988).

Standardization was performed on a sample of 16 to 74 years olds selected to represent the non-impaired United States population. The six age groups: 16-17, 20-24, 35-44, 55-64, 65-69, and 70-74 years consisted of approximately 50 cases each, with balanced numbers of males and females, chosen to duplicate the general population in terms of race, geographic region and education (Herman, 1988).

The scoring criteria for each of the original subtests were reviewed and adjusted when necessary. In particular the instructions for scoring the Logical Memory and Visual Reproductions subtests were developed and made more precise, in an attempt to improve the inconsistency of scores given by independent raters (Herman, 1988).

Butters, Salmon, Cullum, Cairns, Troster, Jacobs, Moss & Cermak (1988) give ample evidence to prove that the WMS-R is preferred to the WMS in appraising memory disorders in amnesic and demented patients. For example, previously the Memory Quotient (MQ) ranged from 70 to 80 for severely amnesic patients, appearing to blatantly underrate these individuals' almost complete inability to reserve new verbal and figural materials (Butters et al., 1988).

Many maintain that because the general memory index is divided into verbal and visual memory subscores it is therefore devised to assess laterality of memory function (Loring, Lee, Martin & Meador, 1989). Chelune & Bornstein (1988) found that out of the 13 WMS-R subtests, patients with unilateral brain damage varied significantly on 4 all verbal in nature, which they suggested was peculiar that the right- and left- lesion groups differed significantly on the WMS-R verbal subtests but not on the nonverbal / visual subtests.

The Logical Memory Subtest (LM)

In the 48 years since its introduction the Logical Memory subtest of the WMS has been a focus of controversy. Through the presentation and recall of story passages LM is an indication of auditory - linguistic memory (Abikoff, Alvir, Hong, Sukoff, Orazio, et al., 1987). Wechsler describes the two memory passages in the WMS as being "similar to the memory selection on the 10th year of the Stanford - Binet and similarly scored" (p. 88, Wechsler, 1945). Except for a few alterations in the instructions and the rules for scoring, the Logical Memory paragraphs in both WMS's Form I and II were from the group of five equivalent passages chosen for the Army Performance Scale (1921; Stone, Girdner & Albrecht, 1946).

As mentioned above, the Logical Memory component of the WMS Form II was more difficult than the traditional version, although, it has been noted by Abikoff et al. (1987), that Form I has more words to remember and therefore usually has less verbatim recall. The comparison of the degree of difficulty of the two selections in the LM subtests for both forms of the WMS show that for the WMS-I Story A (Anna Thompson...) is simpler than Story B (the American Liner New York...) particularly for the male group. Whereas the WMS-II memory selections appear to be approximately equivalent in difficulty (Bloom, 1959).

Story A of the Wechsler Memory Scale - Revised is the same version as the original scale, only modified to omit dated references. However a new story has been exchanged for the original Story B, specifically written to be more equal in difficulty to Story A (Wechsler, 1987).

The rules for scoring the WMS-R have been altered to be more specific and thorough, in order to increase the objectivity of scoring and thereby improve inter-scoring agreement. In addition, the total score is no longer the 'average' number of ideas recalled on both stories, but the 'total' number of ideas recalled on both stories.

The Logical Memory test has been a topic of discussion because of the scoring, particularly of the 'ideas' contained in various passages. Wechsler (1945; p. 92) required "recording verbatim and scoring according to the number of ideas as marked off in selection", nevertheless no specific instruction actually request verbatim recall. As a result some examiners have changed Wechsler's instructions to read "try and remember as much of the passage as you can, using as many of the same words and phrases" (p. 342, Loring & Papanicolaou, 1987).

As mentioned in the previous chapter cognitive research has established that verbatim recall is not a dependable indicator of prose memory. Typically people use their background knowledge (of words and phrases, recall of similar events and cultural assumptions) to arrange the relationship between components of the story in order to facilitate understanding and thus recall (Webster et al., 1992).

Sweet & Wysocki (1984) maintain that a less than precise 'exact reproduction' should still be regarded correct if the ideas are equal. "If a very commonplace substitution of his / her own vocabulary has taken place, does this represent different "ideas"?" (p. 160, Sweet & Wysocki, 1984). An understandable reason for such substitutions would be that the stories do not necessarily fit all cultural and socioeconomic variations among individuals because of the obsolete and awkward grammar and syntax.

However, a study with acceptable Australian alternatives (for the various Americanisms throughout the script), demonstrated results that did not change the difficulty of this subtest when related to the US norms for subjects aged 20 - 29 and 40 - 49 (Iverson, 1990). Similarly Waddell & Squires (1987) report results of a New Zealand normative study, using the Power et al. (1979) scoring system, which did not add any new information when compared with Wechsler's (1945) criteria.

Some hierarchy is necessary in cases where the information contained is neither equally significant nor equally well retained (Loring & Papanicolaou, 1987). Haut, Petros & Frank (1990) noted that from as early as 8 years of age story recall is extremely swayed by structural relevance, where units more critical to the overall essence of the story are recalled more frequently.

Haut et al. (1990) looked at temporal lobe seizure patients who experienced lateralized memory deficits and recorded that the closed head injured (CHI) patients, and the control subjects, favoured the essence in their recalls rather than the negligible parts at both the immediate and delayed retention tests. The CHI patients recalled less than the controls and forgot prose text at a more faster rate, especially the more essential ideas.

One interesting exception to the results was that the comparative group differences were larger for the least essential ideas for Story B and for the more essential ideas for Story A. There are two feasible solutions; that the subjects became more practised after Story A and; Story A was more complicated, thus results show the impaired sensitivity to the semantic structure of prose (Haut et al., 1990).

Another area of debate in Logical Memory testing pertains to the issue of prompting in delayed - recall. If a subject can not remember a thing from the stories, Russell (1975; cited Loring & Papanicolaou, 1987) maintains that a prompt should be supplied by asking "do you recall a story about a washer woman?". Except that the piece used to prompt the subject is not counted in the delayed score. The Boston version of the WMS contains an immediate - recall prompt, asking particular questions regarding story components, in an attempt to measure retention rather than the ability to recover information upon demand (Loring & Papanicolaou, 1987).

Although the Logical Memory subtest appears to have face validity, interpreting the literature is complicated because the reader does not know the instructional set read to the subjects nor which scoring criteria has been applied for any one specific study. For example, an average score of 12 responses could refer to 12 verbatim responses, 12 'similar' responses, or a combination of full & half credit responses (Loring & Papanicolaou, 1987).

Loring & Papanicolaou (1987) propose that to improve the recall of the WMS passages, the passages should be divided to approximate the story's grammar and come to some agreement of distinguishing a memory unit, using a propositional representation network. Also, given that people change and extract the gist of what is presented, verbatim recall can never be a sound method of scoring.

SUMMARY:

This chapter outlines the issues surrounding the eventual publication of the revised Wechsler Memory Scale, and in particular the Logical Memory Subtest. In the present study the most recent WMS-R version of the LM subtest was used to compare the results of TBI clients and Control subjects. A comparison of the LM passages of the WMS-1 revealed that Story A (Anna Thompson...) was easier than Story B (the American Liner New York...) particularly for the male group. Story A of the WMS-R is the same version as the WMS, only modified to omit dated references and Story B has been rewritten to be more equal in difficulty to Story A.

The first three chapters have established TBI clients do not perform as 'normal subjects' do on free recall memory tests. The purpose of this study was to examine the Logical Memory passages in order to make comparisons for TBI subjects and Controls. Would any one of the WMS-R stories be any easier for males versus females? Comparison were also made using other demographic variables which may affect the performance of TBI and Control subjects, such as age, race and level of education.

The use of the LM subtest meant that the recall could be examined in terms of the quality of responses. A hierarchy of the most important items was made and it was hypothesised that like the closed head injured patients of Haut et al.s 1990 study, TBI clients will favour the essence relative to the negligible parts, recall less and forget at a faster rate than the Control subjects. Qualitative analysis was based on whether the clients recalled the basic gist, used serial position effects, introduced their own wording, or made their own conclusions that were not part of the text.

The two passages were counter-balanced on a few occasions to eliminate any proactive inhibition or "practice effects" that may have occurred. This also helped to determine whether any one passage was more difficult, for example in terms of age, culture, education or severity of head trauma.

Lastly the qualitative analysis of the present study examined the items of the WMS-R which did not fit all cultural and socioeconomic groups, some of which were even grammatically incorrect or obsolete. To spite the fact that both Waddell and Squires (1987) and Ivison (1990) did not find any alterations in difficulty when they changed various Americanisms and tested New Zealand and Australian samples respectively, it was expected that a New Zealand version would benefit some subjects by establishing a more familiar background knowledge.

CHAPTER FOUR:

THE PRESENT STUDY

In the last 15 years there has been an increase in attention to the traumatic brain injury (TBI) dilemma and the term "silent epidemic" has been used to describe the prevalence. In New Zealand with its 3.3 million population 200 people are admitted to hospital each week and a further 400 are treated as the result of a head injury, not to mention the many minor injuries which go unreported (Gronwall, Wrightson & Waddell, 1990; NZ Head Injury Society Inc., 1992).

The most commonly cited and longest lasting cognitive deficit reported after TBI is that of impaired memory. In a study reported by Binder (1986) complaints of memory difficulties were described by 59% of minor head injured patients and 90% of those moderately injured. Yet, research into memory after TBI is dated, controversial and not always applicable to all populations.

In the last 30 years memory research has developed an applied focus as well as continuing the theoretical laboratory based experiments of previous years. However although progress has enabled researchers to focus more on every day life situations, the scope of memory research is broad and some aspects of memory are obviously more advanced than others. For example the majority of memory tests examine verbal memory which is considerably easier to score than an abstract figure of nonverbal memory. On the other hand the recall of prose passages is not an advanced area of verbal memory and lags behind knowledge of nonsense word and syllable recall.

Despite the criticism of the Wechsler Memory Scale (WMS) clinical testing of memory has relied heavily on the revised edition (WMS-R). The Logical Memory (LM) subtest is particularly useful in assessing both the verbal aspects of memory through the verbal recall of prose passages, and the long term aspects of memory through the delayed presentation of the passages. However discrepancy exists in the scoring of the LM subtest and many psychologists argue that Wechsler's verbatim recall is not a fair indicator of prose memory. The text does not necessarily fit all cultural and socioeconomic groups and substitutions in grammar

are often made to facilitate understanding and recall, which many contest is not a reflection of different ideas as long as the basic theme is still maintained. As a result alterations have been made to the scoring criteria of the LM to include a number of full and half credit responses.

In the present study verbal memory was compared in TBI and Control subjects using the immediate and delayed recall of the Logical Memory passages from the WMS-R. The aim was to (a) replicate findings that TBI patients do not recall as many items and forget at a faster rate than Control subjects; (b) formally examine the clinical observation that TBI clients perform better on Story B in comparison to Story A; and (c) that females recall more items from Story A compared to Story B and similarly that males recall more items from Story B than Story A. The demographics were used to provide epidemiological information on the age, race and educational groups most affected, plus the proportion of clients in the severe / moderate / mild groups and various assessment intervals.

The data gathered in the present study were also studied qualitatively. Comparisons were made firstly from the hierarchy of items recalled from TBI clients and Control subjects to determine how the TBI clients refined the text, whether they sacrificed the negligible parts as opposed to the essence of the story or *visa versa*. Secondly comparisons were made using scoring criteria to determine (a) whether the subjects tried to remember everything in its entirety from the beginning (primacy) or the end (recency); (b) whether the subjects remember the exact wording, or made it more memorable by using their own words and terminologies; and (c) were any intrusions based on assumptions that were not part of the original text.

The two passages were counter-balanced on a few occasions to eliminate any proactive inhibition that might of occurred as David Ivison found in 1986, also to eliminate the effects of practice, which are a major drawback of the WMS-R.

Lastly the qualitative analysis of the present study examined the individual items of the LM passages some of which are grammatically incorrect or obsolete. It was expected that a New Zealand version would benefit subjects by establishing a more familiar background knowledge.

The following hypotheses were developed to examine these questions. The hypotheses have been separated into the quantitative / qualitative distinction in order to make the comparisons more visible.

Quantitative Recall of the TBI versus Control Group.

Hypothesis 1:

TBI subjects will have significantly lower scores on the immediate and delayed recall on both LM stories, than Control subjects.

Hypothesis 2:

TBI clients will score significantly higher on Story B than Story A.

Hypothesis 3:

(a) Females will score significantly higher than males on both immediate and delayed recall of Stories A and B.

(b) Females will score significantly higher on Story A than Story B.

(c) Males will score significantly higher on Story B than Story A.

(d) There will be differences between female TBI and Control groups and male TBI and Control groups.

Hypothesis 4:

Recall scores on the story presented first will be significantly higher than the score of the story presented second.

Hypothesis 5:

Recall of the New Zealand modified LM subtest will be significantly easier for the New Zealand Control subjects.

Hypothesis 6:

- (a) **Age:** TBI and Control subjects in the 10 - 20 and 21 - 30 age groups will perform significantly higher in both immediate and delayed recall than other age groups.
- (b) **Race:** Pakeha TBI and Control subjects will perform significantly better on both immediate and delayed recall than other ethnic groups.
- (c) **Education:** TBI and Control subjects with lower levels of education will perform significantly lower in both immediate and delayed recall compared to those subjects with higher levels of education.
- (d) **Severity:** TBI subjects with the lower PTA scores will perform significantly higher in both the immediate and delayed recall than those with higher PTA scores.
- (e) **Assessment Interval:** TBI subjects with a greater interval between date of injury and assessment would perform significantly better on both immediate and delayed recall in comparison to those with a smaller time interval.

Qualitative Results of the TBI versus Controls.**Hypothesis 7:**

- (a) Control subjects will recall more of the basic gist than TBI clients and will have less items that are not goal directed.
- (b) Control subjects will not be as affected by "primacy" or "recency" memory as TBI clients.
- (c) Control subjects will not change as much of the original wording as the TBI clients.
- (d) Control subjects will not make as many intrusions as TBI clients.

CHAPTER FIVE:

METHOD

Setting

The selected neuropsychological tests were administered to the traumatic brain injured (TBI) subjects concurrently with neuropsychological assessment in an interview room at the Applied Psychology Clinic.

The Control subjects' testing was carried out in the field. A room was made available at the prison and at the university in order to carry out the administration.

Subjects

One hundred and twenty nine male and female subjects were involved in this study. The **experimental** group contained eighty clients who had sustained a TBI. Access to the head injured participants was through the Director of the Psychology Clinic. Those TBI participants that were deemed suitable were either currently attending the Psychology Clinic for neuropsychological assessment, or had done so in the last 5 years. On attending the Clinic each client is given the choice of whether or not their results could be used for research. It was understood that (a) participation did not involve them in any extra work, as the studies would involve tasks routinely assessed during a neuropsychological assessment, and (b) declining to take part would not disadvantage the client in the service that they receive from the clinic in any way at all. Interested clients are then asked to sign a consent form (Appendix 3). Participants presently visiting the Clinic are given both an information sheet / explanatory letter detailing the study (Appendix 1) and a consent form (Appendix 3).

The selected TBI subjects were based primarily on the directors discretion, but generally those regarded as suitable fulfilled the following criteria:

- (a) have sustained brain trauma as the result of injury
- (b) are between the ages of 18 and 65 years
- (c) are of a comparable ethnic origin
- (d) are not learning or language impaired
- (e) do not have a history of psychiatric illness

The forty nine participants that acted as **Control** subjects were recruited from the Manawatu Prison (13 subjects), and selected internal and extramural students from Massey University (36 subjects). The rationale for selecting prison inmates and students as Control subjects was primarily because they represented most age, socio-economic and cultural groups in New Zealand.

The Control volunteers were (a) informed of the nature of the study and their rights as participants, (b) given an information sheet / explanation letter (Appendix 2), (c) given the opportunity to ask any questions, then (d) asked to sign their consent (Appendix 3). Given the nature of the study the Controls were matched as closely as possible to the TBI subjects and selection was based on :

- (a) age
- (b) sex
- (c) ethnic affiliation
- (d) education
- (e) occupation
- (f) handedness

It was also required that the Control subjects did not:

- (g) have any previous injuries which involve the head
- (h) have a history of psychiatric illness
- (i) have a history of substance abuse

Table 5.1 summarises the demographic characteristics of the TBI and Control subjects.

Table 5.1: Demographic Characteristics of the TBI and Control subjects.

	Control N = 49	TBI N = 80
Sex		
Female	16	26
Male	33	54
Gender		
11 - 20	8	16
21 - 30	23	34
31 - 40	10	16
41 - 50	7	11
51 - 60	1	2
61 -	-	1
Race		
Pakeha	36	67
Maori	8	11
Other	5	2
Handedness		
Left	6	11
Right	43	59
Both	-	1
Don't know	-	9
Years Secondary Education		
- 3	10	50
4 - 6	8	16
7 - 9	25	10
10 -	6	1
Special	-	2
Don't know	-	1

In order to preserve the confidentiality of the participants, all test papers and notes were identified by a code number during the research. Information linking the codes and the identity of the participants were kept separately from the research material. Only the director knew the identity of the clients with TBI.

Measures

The measure used was the Logical Memory sub-test of the Wechsler Memory Scale Revised (WMS-R). The distracter tasks were the Rey Complex Figure Test (CFT), the Stroop Colour - Word Test, and if time permitted, 20 Questions or a subtest of the Wechsler Adult Intelligence Scale (WAIS). Each test was given by following the standard procedure outlined for each particular test by their designers.

The Logical Memory Subtest of the WMS-R:

The subtest comprises of two short stories, A and B (Appendix 4). Story A is about a woman who is robbed and because she had four unfed children and her rent was due the police felt sorry for her and set up a collection for her. Story B is about a truck driver whose axle breaks causing him to skid off the road into a ditch, hitting the dashboard, but because it is night he is afraid no one will assist him until his two - way radio buzzes.

Before Story A is presented the subjects are told "to listen carefully because when I (the examiner) am through I want you to tell me (the examiner) everything that I read to you". The subjects are then read a small passage and asked "Now what did I read you? Tell me everything begin at the beginning". What the subject recalls is recorded verbatim. A second passage is read after similar instructions. The subject's score is the number of ideas which he / she produces correctly on both passages. Both stories contain 25 items and take approximately 10 - 15 minutes each to complete.

After 30 minutes of distracter tasks the subjects are asked to tell the examiner everything they can remember of first Story A then Story B. This delayed-recall is recorded verbatim and scored according to the number of items recalled correctly. Comparison of immediate and delayed scores enables the calculation of the percentage retained.

Distracter Tasks:

The distracter tasks were selected because they were typical of neuropsychological assessment and did not involve verbal memory.

Rey Complex Figure Test:

The Rey Complex Figure was devised in 1941 to investigate both perceptual organization and visual memory in brain damaged subjects. In 1944 it was standardized by Osterrieth to obtain normative data from normal children and adults, children with learning and adjustment problems, behaviourally disturbed adults, and adults with traumatic brain injury and endogenous brain disease (Lezak, 1983).

The test material consists of Rey's Complex Figure, a pencil and a blank piece of A4 paper. The subject is first instructed to copy the figure in their own time while being recorded. The examiner carefully observes the subject copying the way in which the subject constructs the figure.

Overall evaluations of the success of a drawing can be obtained by using an accuracy score based on a unit scoring system. The reproduction of each unit can score up to 2 points, the highest possible number of points is 36. The accuracy score provides a good measure of how well the subject reproduces the design, regardless of the approach used. However Osterrieth has identified 7 different procedural types in order to analyze the drawings in terms of the patient's method of drawing as well as specific errors.

The Stroop Test:

In 1935 the Stroop was developed to measure the ease at which the patient could shift his / her perceptual set to conform to changing demands. The objective of the Stroop test is to evaluate the patient's ability to perform a secondary task when confronted with competing information from the primary task.

The material for this test consists of three white cards, each containing five columns of twenty items. Randomized words - "blue", "green", "red" and "yellow" - are printed in black print on Card A. Card B displays coloured crosses in the same array of the four colours. Finally Card C is identical to Card A except each colour name is printed in some colour other than the colour it names.

There are three trials, each consisting of reading aloud a different task. On trial 1, the subject reads Card A; on 2 he / she reads Card B; for 3 he / she reads the word and ignores the colours on Card C. The subject is instructed to read or call out the colour "as fast as you can" and each trial is given 40 seconds timed by stopwatch. The subject is immediately corrected whenever an error is made and the word on which the error is made recorded. This recorded word is later used to determine the mental set that was being employed.

Procedure

Experimental subjects: Since the majority of the TBI data had been collected before the commencement of the present study there was not much opportunity to control the version used or the order in which the passages were given. All 80 TBI clients were administered the immediate trial of the WMS-R and 71 of those were also asked for delayed recall.

The **Control subjects** were randomly assigned one of four tests, the WMS-R, the counter-balanced WMS-R (alternated - Story B first), the New Zealand version (see Appendix 5), and the counter-balanced NZ version.

Table 5.2 summarises the allocation of subjects according to version type and order of administration.

Table 5.2: A summary of the version administered and the order in which each was conducted for both the TBI and Control subjects.

	TBI WMS-R	WMS-R	Controls Alternate WMS-R	NZ version	Alternate NZ version
Immediate	80	35	11	1	2
Delayed	71	32	5	1	2

Each of the Logical Memory stories were recorded on standard recording protocol, underlining items correctly recalled and recording verbatim any variations to the text. Scripts for both Control and TBI subject groups' were scored by the examiner to maintain consistency, this included scripts already marked earlier by other examiners.

The scoring criteria used was stringent and based on criteria derived from the best parts of the three most popular scoring methods. Verbatim recall was required as stipulated by Wechsler's (1945) instructions, however half credits were also allocated for minor changes or omissions as stipulated by Power et al. (1979), and for very close approximations as stipulated by Russell (1975).

The raw scores were used for quantitative analysis, the significance of the comparisons were calculated using independent t tests. Each t test was conducted in relation to the comparisons made by the hypotheses set out in Chapter 4.

Quantitative testing also involved analysis of variance (ANOVA) when the variance was based on three or more sources.

The individual scripts were used for the qualitative analysis, and were examined firstly in terms of their overall performance, where any features that stood out because they were important or different from other subjects' recall were noted. The scripts were then systematically broken down and studied according to a list of set criteria;

- (a) gist or nonessential / not goal directed responses
- (b) primacy or recency effects
- (c) the words used
- (d) the presence of intrusions

These figures were compared and analyzed in the results chapter below.

CHAPTER SIX:

RESULTS

Part 1: Quantitative

T tests for independent samples were used to analyse whether the difference between any two variables was significant. When more than two variables were compared an analysis of variance (ANOVA) table was used to determine whether the difference between variables was significant.

Hypothesis 1

TBI subjects will have significantly lower scores than Control subjects on the immediate and delayed recall on both LM Stories.

Table 6.1 presents the results for both groups on immediate and delayed recall of LM Stories A and B.

Table 6.1: Mean scores of Control and TBI subjects on immediate and delayed recall of Logical Memory Stories A and B.

	Immediate			Delayed		
	Cont. n = 45	TBI n = 80	<i>t</i>	Cont. n = 36	TBI n = 71	<i>t</i>
Story A	10.18	8.18	2.51*	7.35	4.92	3.18*
Story B	9.71	9.08	0.82	7.76	5.75	2.75*
<i>t</i>	0.53	-1.17		-0.46	-1.38	

* significant at 0.5 level

As predicted, the TBI group scored significantly below the Control group on both delayed trials (Story A; $t(106) = 3.18$ and Story B; $t(106) = 2.75$).

However on immediate trials there was a significant difference between the two groups **only** on Story A ($t(123) = 2.51$). The results therefore for the most part support hypothesis 1, except for immediate recall on Story B.

(There was as expected, a highly significant difference between immediate and delayed trials of recall on both Stories A and B for both groups. This highly significant difference indicates that recall after 30 minutes of distracter tasks was considerably less than at initial recall. The loss shown in this study is more significant than that seen in Control subjects as found by previous studies.)

The performance of the Control subjects on the Logical Memory passages, is presented separately in Table 6.2.

Table 6.2: Mean scores of Control subjects on immediate and delayed recall of Logical Memory Stories A and B.

	Story A	Story B	<i>t</i>
Immediate n = 45	10.18	7.35	0.53
Delayed n = 37	9.71	7.76	-0.46
<i>t</i>	3.00*	2.30*	

* significance at 0.5 level.

While the difference between immediate and delayed recall is significant as could be expected (Story A; $t(80) = 3.00$ and Story B; $t(80) = 2.30$), there was no significant difference in mean scores between the two Stories, for the Control group at either immediate or delayed recall. The degree of difference between immediate and delayed recall is more marked for TBI subjects than Control subjects.

Hypothesis 2

TBI subjects will score significantly higher on Story B than Story A.

The same results for the TBI group as reported in Table 6.1 are presented separately in Table 6.3.

Table 6.3: Mean scores of TBI subjects on immediate and delayed recall of Logical Memory Stories A and B.

	Story A	Story B	<i>t</i>
Immediate n = 80	8.18	9.08	-1.17
Delayed n = 71	4.92	5.75	-1.38
<i>t</i>	5.03*	5.17*	

* significant at the 0.5 level

Although TBI subjects scored slightly higher on both immediate and delayed recall of Story B compared to Story A, this difference was not statistically significant. This is surprising given the finding that there was no difference between the TBI and Control groups on immediate recall of Story B. It appears however that this could be due to the Control group scoring slightly higher on Story A than Story B, and that for the TBI group the reverse occurred thus emphasising the difference.

Any advantage that the TBI group had in scoring well on the immediate recall of Story B was cancelled out by the delayed trial as there was a significant difference between TBI and Control subjects on delayed recall of **both** Stories A and B. Table 6.3 also shows a highly significant difference between immediate and delayed recall trials on both stories (Story A; $t(149) = 5.08$ and Story B; $t(149) = 5.17$).

Hypothesis 3

(a) *Females will score significantly higher than males on both Stories A and B, at both immediate and delayed recall.*

Table 6.4 compares female and male scores for both immediate and delayed recall of Stories A and B.

Table 6.4 Mean scores of female and male subjects on immediate and delayed recall of Logical Memory Stories A and B.

	Control			TBI		
	Female	Male	<i>t</i>	Female	Male	<i>t</i>
Story A						
Immediate	11.33 n=30	7.81 n=16	2.65 *	8.65 n=26	7.94 n=54	0.73
Delayed	8.32 n=28	4.33 n=9	3.03 *	5.52 n=21	4.66 n=50	0.96
Story B						
Immediate	10.13 n=30	8.63 n=16	1.35	9.35 n=26	8.94 n=54	0.40
Delayed	8.54 n=28	5.33 n=9	2.26 *	6.33 n=21	5.50 n=50	0.76
<i>t</i>						
Immediate	1.22	-0.50		-0.56	-1.28	
Delayed	-0.23	-0.56		-0.59	-1.11	

* significant at .05 level

Control females scored significantly higher than Control males on immediate ($t(44) = 2.65$) and delayed recall ($t(35) = 3.03$) on Story A and delayed recall of Story B ($t(35) = 2.26$) as shown in Table 6.4. But no such difference was found between female and male TBI subjects, where females scored only slightly higher than males on both stories at immediate and delayed recall.

(b) Females will score significantly higher on Story A than Story B.

There was minimal but non significant support for Hypothesis 3b for the female Control group only. As shown in Table 6.4, the TBI female group scored slightly higher on Story B than Story A. Both TBI groups recalled slightly more of Story B than Story A at delayed recall although the differences were not significant.

(c) Males will score significantly higher on Story B than Story A.

There was slight but non significant support for Hypothesis 3c, as shown on Table 6.4, with both male groups scoring higher on Story B at immediate and delayed recall than on Story A. This was also so for TBI females as pointed out above. Control females consistently performed better on Story A.

(d) There will be differences between female TBI and Control groups and differences between male TBI and Control groups.

The hypothesis that there would be differences between female TBI and Control groups and differences between male TBI and Control groups is examined in Table 6.5.

Table 6.5: Mean scores of female Control and TBI groups and male Control and TBI groups.

	Females			Males		
	Cont.	TBI	<i>t</i>	Cont.	TBI	<i>t</i>
<i>n</i> Immediate	30	26		16	54	
Delayed	28	21		9	50	
<hr/>						
Story A						
Immediate	11.33	8.65	2.38*	7.81	7.94	-0.11
Delayed	8.32	5.52	2.48*	4.33	4.58	-0.27
Story B						
Immediate	10.13	9.35	0.73	8.63	8.94	-0.26
Delayed	8.54	6.33	3.54	5.33	5.50	-0.11
<i>t</i>						
Immediate	1.22	-0.56		-0.50	-1.28	
Delayed	-0.23	-0.59		-0.56	-1.11	

* significant at 0.5 level

This hypothesis was confirmed for females on both immediate recall ($t(54) = 2.38$) and delayed recall ($t(47) = 2.48$) of Story A only, but unexpectedly, not for males. TBI males performed as well as Control males, on both stories at immediate and delayed recall.

Hypothesis 4

The score of the story presented first will be significantly higher than the score of the story presented second.

The order in which the Stories were presented is examined in Table 6.6.

Table 6.6: Mean performance with reversed order of administration for Control subjects.

		WMS-R		Alt. WMS-R	<i>t</i>
		<i>M</i>		<i>M</i>	
Story A	(1st)	10.80	(2nd)	7.91	1.89
Story B	(2nd)	9.94	(1st)	8.55	1.06
<i>t</i>		0.14		-0.31	

The results support hypothesis 4. There was a slight, but not significant, difference between the stories where the first story presented had a higher recall. Surprisingly the scores on the reversed WMS-R were considerably lower than the scores on the WMS-R.

Hypothesis 5

Recall of the New Zealand modified LM subtest will be significantly easier for the New Zealand Control subjects.

N.B: It should be noted that the mean scores in Table 6.7 through to Table 6.13 are the total means of Story and Story B, rather than the individual Story means of Tables 6.1 - 6.6.

The effect of substituting NZ corrected versions of the stories is shown in Table 6.7.

Table 6.7: Mean performance of the NZ version versus the WMS-R for the Control subjects.

	WMS-R <i>M</i>	NZ Version <i>M</i>	<i>t</i>
Immediate	19.63	20.67	-0.20
Delayed	15.24	17.67	-0.57
<i>t</i>	2.71*	1.46	

* significant at 0.5 level

Although more of the NZ version was recalled by Control subjects on both the immediate and delayed trials, than the US version, the difference was not significant. A comparison of immediate and delayed recall of the WMS-R was significant whereas the difference between the two trials of the NZ version was not significant.

Hypothesis 6

(a) TBI and Control subjects in the 10 - 20 and 21 - 30 age groups will perform significantly higher in both immediate and delayed recall than other age groups.

Table 6.8 presents the scores on Logical Memory subtests according to different age groups.

Table 6.8: Mean scores of different age groups in Control and TBI subjects on Logical Memory.

	11-20yrs	21-30yrs	31-40yrs	41-50yrs
Controls				
Immediate	19.5 n=8	22.14 n=22	17.60 n=10	14.8 n=5
Delayed	14.63 n=8	16.82 n=17	15.43 n=7	10 n=5
TBI				
Immediate	18.63 n=16	14.26 n=34	19.56 n=16	21.55 n=5
Delayed	13 n=14	7.72 n=29	12.21 n=14	13.91 n=11
<i>t</i>				
Immediate	0.34	3.83*	-0.57	-1.18
Delayed	0.59	4.78*	1.06	-0.6

* significant at 0.5 level

The only age group in which a significant difference was found was in the 21 - 30 year age group where the TBI group scored below the Control group, on both immediate recall ($t(54) = 3.83$) and delayed recall ($t(44) = 4.78$).

(b) Pakeha TBI and Control subjects will perform significantly better on both immediate and delayed recall than other ethnic groups.

Table 6.9 shows the results of TBI and Control subjects from different ethnic groups.

Table 6.9: Mean scores of different ethnic TBI and Control groups on the performance of Logical Memory.

	Pakeha	Maori	Other
<i>n</i> Control	36	8	5
TBI	67	11	2
Controls			
Immediate	21.25	15.75	16.67
Delayed	15.83	9.5	16
TBI			
Immediate	18.12	11.45	20
Delayed	11.07	7	12
<i>t</i>			
Immediate	1.97	1.03	-0.39
Delayed	2.87*	0.79	0.46

* significant at 0.5 level

A significant difference was found between TBI and Control 'Pakeha' on the delayed trial ($t(88) = 2.87$) but not between TBI and Control 'Maori' or 'Others'. ie. 'Pakeha' Controls did much better than TBI subjects at delay as would be expected, but this was not found for 'Maori' or 'Other' subjects. Here there was only a slight but non significant difference which appeared to be primarily due to 'Maori' Control subjects not doing as well as 'Pakeha' Controls. Although the 'Maori' group **appears** to have performed lower than the 'Pakeha' group at both immediate and delayed recall, this effort is accounted for by the fact that there was a higher proportion of males with lower education in the 'Maori' group. Generally the 'Other' groups performed better than the 'Pakeha' and 'Maori' groups but the numbers were too small to be significant.

(c) TBI and Control subjects with lower levels of education will perform significantly lower in both immediate and delayed recall compared to those subjects with higher levels of education.

Table 6.10 shows the results of TBI and Control subjects with different levels of education.

Table 6.10: Mean scores of Control and TBI subjects with different levels of education on Logical Memory.

	Years of Education		
	<-3	4-6	7-9
Control			
Immediate	16.67 n=9	14.71 n=7	21.36 n=25
Delayed	7 n=3	7.5 n=4	16.6 n=25
TBI			
Immediate	16.06 n=50	20.56 n=16	19.7 n=10
Delayed	8.91 n=43	15.47 n=15	14.78 n=9
<i>t</i>			
Immediate	0.21	-1.61	0.60
Delayed	-0.57	-1.62	0.69

The level of education did not significantly affect the recall of either the TBI or Control subjects. The largest difference was for the subjects with 4 - 6 years of education, where TBI subjects performed considerably better on the immediate and delayed trials, than Control subjects! However one-way analysis of variance showed no significant between the groups. It should be noted that the TBI subjects generally had fewer years secondary education than the Control subjects.

(d) TBI subjects with lower PTA scores will perform significantly higher in both the immediate and delayed recall than those with higher PTA scores.

Table 6.11 shows the results of TBI subjects with varying levels of PTA.

Table 6.11: Mean scores for mild, moderate and severe TBI groups on Logical Memory recall.

	Severity of TBI			
	Mild	Moderate	Severe	
Immediate	19.22 n=18	17.63 n=19	16.26	n=43
Delayed	14.11 n=18	11.53 n=17	8.47	n=36

One-way analysis of variance indicated that the TBI clients with mild severity performed better than the moderate and severe clients respectively in both the immediate and delayed trials as was expected, but the differences were not statistically significant.

(e) TBI subjects with a greater interval between date of injury and assessment will perform significantly better on both immediate and delayed recall in comparison to those with a smaller time interval.

Table 6.12 shows the results of the TBI subjects using the interval between the time of injury and assessment.

Table 6.12: Mean scores for different intervals between injury and assessment in TBI subjects.

	Years Between Injury and Assessment					
	1-2	3-4	5-6	7-8	9-10	11+
Immediate	18.41 n=44	17 n=17	20.5 n=4	13.6 n=5	15.2 n=5	13.17 n=6
Delayed	11.2 n=40	10.36 n=14	15 n=3	10.75 n=4	10 n=5	4.8 n=5

The results comparing the assessment interval are inconsistent. The group showing the highest recall were 5 - 6 years post injury, on both immediate and delayed trials. Contrary to hypothesis 6e overall recall was higher in the first 6 years after injury and from then onwards dropped off considerably, but the differences were not significant.

Part 2: Qualitative

Qualitative analysis was used to explore the nature of what was recalled rather than the amount recalled.

Hypothesis 7

(a) Control subjects will recall more of the basic gist and fewer non goal directed content than TBI subjects.

(b) Control subjects will not be as affected by "primacy" or "recency" memory as will TBI subjects.

(c) Control subjects will not change as much of the original wording as the TBI clients.

(d) Control subjects will not make as many intrusions as the TBI clients.

Table 6.13 presents a general summary of results examining the quality of recall for both Control and TBI subjects.

Table 6.13: Percentage of Control and TBI subjects exhibiting different types of recall.

	Control %	TBI %
Gist	75.5	64.6
Primacy	9.8	16.5
Recency	9.8	14.0
In order	45.6	43.9
Own wording	68.4	79.3
Intrusions	65.2	59.1

(a) Control subjects will recall more of the basic gist than TBI subjects.

Although the greatest difference between the two groups is in the amount of overall gist recalled, results show that Control subjects recall more of the basic theme of the passages than the TBI clients. This is contrary to the results associated with Tables 6.14 and 6.15 presented below which suggest that more of the essential items are recalled by TBI subjects, however it should be noted that although key items are remembered this does not indicate an understanding of the overall gist.

In order to compare the quality of the recall, both passages were divided into the 25 individual items and every time one of the items was recalled the result was tallied, the total score for each item was then divided by the number of subjects to form a hierarchy of the top ten items recalled from Story A and Story B.

Table 6.14 presents a hierarchy of the top 10 items recalled from Story A for Control and TBI subjects.

Table 6.14: Comparison of the 10 most recalled items from Story A for Control and TBI subjects.

Controls		TBI
1.	The police	The police
2.	Anna	and robbed
3.	Thompson	Anna
4.	and robbed	took up a collection
5.	of 56 dollars	Boston
6.	Boston	Thompson
7.	took up a collection	for her
8.	for her	She had four
9.	She had four	of 56 dollars
10.	for two days	small children

Story A

The same items were recalled in the top nine positions by both the Control and TBI subjects. The tenth most commonly recalled item for Control subjects was "*for two days*" while TBI subjects remembered the "*small children*". Overall, the main differences were in the order in which the items were recalled. "*The police*" was the most remembered detail for both groups. Control subjects then remembered her name, the robbery, the amount, where she lived, then the collection. TBI clients recalled the robbery and the collection on more occasions than Control subjects, and apart from the recall of Boston tended to be less interested in proper nouns, such as her name and the amount taken. An item that is important yet omitted from both the TBI and Control recall was "*were touched by the womans story*", however this was most likely due to a substitution of the subjects own words as mentioned below.

Table 6.15 presents a hierarchy of the top 10 items recalled from Story B for the Control and TBI subjects.

Table 6.15: Comparison of the 10 most recalled items from Story B for Control and TBI subjects.

Controls	TBI
1. truck	Then his two-way radio
2. a 10 ton	truck
3. Robert	a 10 ton
4. "This is Grasshopper"	broke
5. Miller	was driving
6. in the Mississippi	when his axle
7. was driving	Robert
8. to Nashville	carrying eggs
9. then his two way radio	"This is Grasshopper"
10. carrying eggs	in the Mississippi

Story B

There were more differences in the top 10 items recalled from Story B by the Control and TBI subjects than shown in Story A. Control subjects recalled "*Miller*" and "*to Nashville*" where TBI clients remembered "*when his axle*" "*broke*". This again indicates that TBI clients tend not to recall proper nouns as frequently, with "*Miller*" and "*Nashville*" not even appearing on the top 10 list as they did with the Control group, however the items the TBI clients recalled instead were more pertinent to the text. The most common item recalled by TBI clients was the "*two-way radio*" (which was the 9th most recalled item for Control subjects). Also the fourth most remembered item by Control subjects "*This is Grasshopper*" was recorded 9th by TBI clients, however this is a more unusual element and it could be its bizarre content or the fact that it was the last item that made it more memorable to Control subjects.

The results found when comparing the succession of recalled items demonstrates that while the TBI subjects recall items similar to those of the Control subjects there were some important differences which need to be examined further. Studying the items individually fails to emphasise the overall differences.

(b) Control subjects will not be as affected by "primacy" or "recency" memory as will TBI subjects.

This hypothesis is confirmed with the TBI group evidencing a higher percentage (16.5% recency and 14% primacy) than the Control group (9.8% recency and 9.8% primacy) as shown in Table 6.13. Tables 6.14 and 6.15 have recency and primacy in more detail, by listing the 10 most recalled items for each of the two stories. TBI subjects rely more on both their primacy memory (LTM) and recency memory (STM) than do the Control subjects, as was predicted.

The smallest difference between Control and TBI subjects is in the order of recall, Control subjects' recall was only slightly more often in the correct sequence than TBI subjects' recall.

(c) Control subjects will not change as much of the original wording as will TBI subjects.

As predicted the TBI subjects were more likely to fill gaps (79.3%) than Control subjects (68.4%). Both groups made up names;

*"Emma" "Alison" "Sarah" "Smith" "Robertson"
"Eric" "Tom" "Peter" "Graham" "John Thompson" "Richard Mills"*

places or locations;

*"Memphis" "New Brighton" "Tennessee" "South Delta" "Oklahoma"
"Townsville" "South Carolina"*

and an occupation for Anna;

*"a cocktail waitress"
"worked in a cafe bar selling coffee"
"school teacher"
"as a cashier in a clothes shop"
"at a hospital"
"at a post office"
"unemployed"*

Some subjects preferred not to guess and said:

*"I can't remember her name" "on some Street"
"from somewhere to somewhere"*

The difference in the amount of own wording introduced was quite considerable, the main substitution involved the phrase *"touched by the womans story"*. Both Control and TBI subjects recalled more familiar phrases such as;

"felt sorry for her"
"took pity"
"were sympathetic"

TBI clients frequently replaced "took up a collection" with terms like;

"opened a fund"
"rallied together for a collection"
"got a charity together"
 and even *"had a whip round and a piss up"*

Story B also had a number of word replacements, particularly by the TBI clients, for example *"there was no traffic and he doubted that help would come"* was replaced by;

"it was a quiet road and he didn't think anyone would come"
"he didn't think he'd be rescued"
"in the middle of nowhere"
"deserted road and no cars going past"
"he didn't think he'd get a ride coz no traffic"

Other changes in the wording included slang terms such as;

"kids" "chick"

Again this was predominantly from the TBI clients who recalled words such as;

"cops" "bucks" "couldn't have a feed"
"dude called Robert" "a joker called Robert" "went into dash - dork"
"got a flatty"

On the whole TBI subjects appeared to remember isolated details and guess at or make up links to join them into a logical reconstruction.

(d) Control subjects will not make as many intrusions as the TBI clients.

Contrary to the hypothesis Control subjects made more intrusions (65.2%) than TBI subjects (59.1%) from both Story A and B. For example;

Story A: *"left late in her car"*
"she had been delayed"
"she rung from the station"
"she was on her way home"
"she had been mugged by a man"

Story B: *"his head struck the dashboard"*
 "his chest struck the steering wheel"
 "no witnesses to the event"
 "its on its side will you come and get it"

But TBI subjects also made a number of intrusions. For example;

Story A: *"walking home from work"*
 "burgled"
 "lost, stolen or raped"
 "had her purse stolen"
 "pinched some money"
 "robbed by a man who took all her money"
 "robbed a gunpoint"
 "held up by an armed robber"
 "knocked over"

The unfamiliar terminology *"City Hall Station"* caused intrusions such as;

"something about a train station"
"held up at the station"
"on the way home from the station"
"went for a ride on a tram or train"

Story B: Intrusions in Story B were mainly because the TBI subjects could not remember what type of accident actually happened, for example;

"collided through an intersection"
"hit a curb"
"drove off the road and crashed into a tree"
"veered off the road"
"into a gutter"
"lost control down a hill"

also;

"rang back to the depot"
"he radioed his mate"
"couldn't contact the police"
"at night (10 pm)"
"he gave up hope"
"his two way radio told him he was alive"

It should be noted that the TBI subjects frequently included a reference to an injury involving the head, more so than those made by Control subjects indicating that perhaps this is related to their own head trauma.

"suffered a head injury"
"hit his head against the dashboard"
"hit his head on the window"
"his face hit the dash"

The intrusions made by the TBI subjects were often more bizarre and out of context, for example;

Story A: *"got burgled and had four children and couldn't buy presents for Christmas"*
 "told the police that she stole it because she was walking along some street when she was arrested"
 "she went to the police reported it and they gave her a lift home and she said she'd been robbed of a bag of books"
 "she abnormally didn't have a husband"
 "coming home from shopping, had to cook tea, something wrong with the cat"

Story B: *"he saw a bright light and crashed his truck"*
 "coming home one day listening to the radio"
 "went home and joined his family after a long day"
 "he lived happily ever after"

TBI subjects were inclined to connect items they remembered no matter how outlandish, for example;

"broke his axle on some eggs"
 "they were throwing eggs at him thats why he had a crash"

CHAPTER SEVEN:

DISCUSSION

Epidemiology

Pretraumatic statistics indicate that the young adult male is most at risk of TBI, with motor vehicle accidents being a major cause of injury. In this study these findings were replicated. The majority of the TBI clients seen at the Psychology Clinic were male, 21 - 30 years of age, with less than 3 years secondary education.

However, when it was possible the New Zealand data obtained was compared to international figures, but it was not feasible to compare obtained levels of education to American studies because of the different schooling criteria. Similarly comparisons of SES, occupation or income were not practicable because of the differences in currency and living conditions in America.

At the same time the TBI clients of the Applied Psychology Clinic are not a fair representation of head injured subjects as a whole. Instead the subject population is a select portion generally referred to the Clinic for either a routine assessment or because they have not been assessed for some time but have persisting memory difficulties.

Quantitative

The present study was concerned with evaluating performance on WMS-R, Logical Memory Passages, in particular; TBI subjects performance compared to Control subjects, the quality of their respective responses, effect of using a New Zealand version of the subtest; differences between the groups as a function of sex, age, ethnicity, years of education, severity of TBI and assessment interval.

Control and TBI subjects (Hypothesis 1)

Brooks (1975) had found that individuals with severe closed head injury performed poorly on free recall tasks but not on tasks requiring immediate memory. Furthermore, it was found that impairment in free recall tasks tended to be more pronounced when recall was delayed by an irrelevant task. In the present study, a difference was found between Control and TBI subjects on the immediate trials but otherwise results replicated the Brooks study with a marked difference between the two groups seen at 30 minute delay (77% of information was lost to the TBI participants between immediate and delayed recall compared to a 48% loss for Control subjects). This perhaps indicates a difficulty with speed and attention and an inability to hold current information while considering new information.

An unexpected finding was in the poor performance of Control males, who performed at slightly lower levels than the TBI males! This is probably due to undisclosed head injuries, and/or past and/or current substance abuse in the Control population. (Subjects had been asked about prior head injuries and for their alcohol and drug history, those saying that they had a TBI or a moderate to severe alcohol and/or drug problem were screened out). While the selection of the Control group from the prison/university was intended to improve the match between the TBI/Control group, it has also been disadvantageous. It might also mean though that TBI subjects are doubly disadvantaged due to their injuries because these come on top of co-existent difficulties.

Equivalence of Story A & Story B (Hypotheses 2, 4 & 5)

Both stories are supposed to be of equal difficulty (Wechsler, 1987). But part of the rationale for conducting this study had been the observation that TBI subjects appeared to perform consistently better on Story B, possibly because they identified more with the subject matter. An example given by Squire et al. (1992) is of a baseball match where recall is better by those knowledgeable about baseball than those who are not.

This observation was partly authenticated in the study. While there was no significant difference between the stories for the Control group, the fact that there was no difference between TBI and Control groups on immediate recall of Story B, suggests that for the TBI group the stories are not equal. However, this "advantage" in TBI subjects was not maintained in the delayed comparison. Here while TBI subjects performed slightly better than they did on delayed recall of Story A, they were significantly below the Control group scores.

An alternate explanation for TBI clients performing better on Story B at delay is that proactive interference is operating, ie. that learning the first story somehow makes learning the second more difficult. Results indicate that the first story administered whether it is Story A or Story B benefits from the lack of interference that appears to affect the second story administered. Further examination is necessary but to counteract any possible effects of interference (as highlighted in the literature previously), both tasks were administered in reversed order. Results show that when the WMS-R was administered with Story A first, the mean number recorded was 10.80 compared to 9.94 whereas when the WMS-R was administered with Story B first, the mean number recorded was 8.55 compared to 7.91 for Story A.

In 1986 David Ivison considered the relevance of proactive inhibition in brain-damaged subjects, particularly those with frontal lobe lesions, and the Logical Memory subtest. Ivison found that although performance was better on paragraph A, it could not be deduced how much the variation was due to proactive inhibition, for example, the American liner story being inherently more difficult to remember than the Anna Thompson story. He concluded that only counterbalanced presentation of the paragraphs over a broad sample might address the question.

Although the results in the present study do support hypothesis 4 and indicate that the first story administered whether it is Story A or Story B benefits from the lack of interference that appears to affect the second story administered, it should be noted that the numbers of subjects in this comparison are small and further examination is necessary before conclusions can be drawn.

Sex Differences (Hypothesis 3)

Sex differences in verbal abilities are a common finding, with females generally performing better at verbal tasks and males better at spatial ones. The results in this study replicate these results. As a combined group, women scored significantly higher than men on Story A at immediate and delayed trials and Story B on delayed trial. On the immediate trial of Story B, there was no significant difference probably due to (as already stated) males identifying more with the Story B content.

An earlier investigation by Bloom (1959) suggested that passage A (Anna Thompson) was simpler than Story B (the American Liner New York) of the WMS-1 especially for the male subjects. In the present study the WMS-R Story A is a slightly modified version of the WMS-1, and Story B is a new story designed to be equated in difficulty to Story A. In this study, at no time did males (either TBI or Control) perform better on Story A. It was expected that the first thing the subjects' would remember was their own attitude towards the text and continue to base their recall on their emotional commitment (Bartlett; cited Baddeley, 1986). Therefore because of the nature of the passage it was hypothesised that female subjects might relate to the hardships experienced by Anna Thompson with her unfed children and overdue rent, just as males would identify with the truck driver. While Control females did perform better on Story A at immediate recall this difference was not significant. However female Control subjects delayed recall, and the female TBI clients immediate and delayed recall, scored slightly higher on Story B.

Utility of a NZ Version of the WMS-R Logical Memory Stories

Another aim of this study was to determine whether New Zealand populations are disadvantaged by the American nomenclature. It was predicted that substitution of more familiar New Zealand terminology would result in a higher overall recall because less time would be spent trying to interpret the meaning (hypothesis 5). As predicted the New Zealand modification of the LM subtest did result in a higher overall recall, however these results were not significantly different from the results obtained on the WMS-R at either immediate or delayed recall. At this stage however, it should be noted that the numbers of Control

subjects used to examine the advantage of a New Zealand version were small, time and subject numbers did not permit further examination of the correlation. So although it did appear that the more appropriate NZ version was more sensitive to a New Zealand sample, further research is needed.

These findings are contrary to a study by David Ivison (1990) who used acceptable Australian alternatives (for the various Americanisms throughout the script). Ivison found that the results did not alter the difficulty of the subtest when it was compared to the US norms for subjects aged 20 - 29 and 40 - 49. Similarly Waddell & Squires (1987) report results of a New Zealand normative study, using the Power et al. (1979) scoring system, which failed to add any new information when compared with Wechsler's (1945) criteria.

Age (Hypothesis 6a)

As highlighted earlier in the introduction, pre-traumatic factors such as age, gender, educational level, injury severity and time before assessment have all been shown to bias either outcome subsequent to brain injury or neuropsychological test performance. Also in the introduction it was noted that increasing age has a negative affect on head injury, and that younger brains suffer less after-effects for a shorter duration and have a greater ability to rejuvenate and accommodate compared to an older brain. Results from the present study further support previous research with Control 21 - 30 year old subjects remembered significantly more detail than the TBI clients of the same age, both on immediate and delayed recall. However it should be noted that the majority of subjects were in the 21 - 30 year age range and that perhaps the numbers of subjects in other ranges were not sufficient to show a clear age effect.

Ethnic Group (Hypothesis 6b)

Earlier research has shown that efficiency on memory tasks differs across cultural groups depending on factors such as a secondary language and familiarity with the test content, levels of education, religious and cultural persuasions. In this study, while 'Maori' subjects appeared to perform significantly lower than the 'Pakeha' and 'Other' groups, this difference is probably accounted for by the higher

proportion of males in the Maori group - with possible prior history of substance abuse and head injury. The results of the present study lend some support to the earlier research, however it should be noted that the numbers in the 'Maori' and 'Other' groups were exceedingly small.

On the whole there was no ethnic group which performed significantly better or worse. In the Control group the 'Pakeha' subjects performance was superior, followed by 'Other' then 'Maori' subjects. In the TBI group the 'Other' subjects performed best followed by 'Pakeha' and 'Maori' subjects.

Education (Hypothesis 6c)

It has been regularly found that there are significant correlations between years of education and test scores in normal subjects. Also in head injured clients a higher level of education normally indicates higher cognitive skills and with all other things being equal their recuperation tends to be better (Long & Ross, 1992). These findings were not replicated in the present study. While generally the Control subjects performed better with increasing levels of education, TBI clients had the highest scores in the 4 - 6 years of education group instead of the 7 - 9 year group as was expected. However, as already mentioned the majority of TBI subjects had fewer years of education than the Control group.

Another explanation is that because the Logical Memory passages reflect commonly occurring everyday life experiences such as hearing and remembering items of news, descriptions from others of important events, and messages from the telephone, they might not necessarily require a high level of education. It has been noted that IQ might provide a better estimate of a person's premorbid intellectual level than does educational level. An example given by Russell (1988) is a 65-year-old farmer who has an education level of 6 years because he had to drop out of school at an early age to help on the farm during an economic depression, yet his IQ is measured as 112 and not fairly gauged by his education level.

Severity of Injury (Hypothesis 6d)

The duration of post-traumatic amnesia (PTA) is an index of severity that has been found to be extremely useful in an analysis of memory deficits. Previous research concerning the degree of severity as measured by PTA on performance have found that TBI clients with mild severity perform better than those with moderate or severe injuries. In the present study the degree of severity did affect the TBI clients as was expected, and clients with mild severity performed better than moderate and severe clients respectively in both the immediate and delayed trials. It appears that the more severe the injury the more difficult it is to retain the passages. Brooks (1976) actually found a significant association between LM and PTA duration with a threshold of approximately four weeks after which PTA duration was less influential.

However Brooks (1989) later noted that the emphasis should not be on the degree of damage nor measure of severity because there is tremendous variability between patients and identical injuries in two separate individuals might produce quite different after-effects.

Assessment Interval (Hypothesis 6e)

The results comparing the figures across different assessment intervals are inconsistent. There was no clear indication as to whether less time or more time is an advantage. The highest recall was 5 - 6 years after injury for both immediate and delayed trials, and overall recall was higher in the first 6 years after injury and from thereafter dropped off considerably.

Studies by Brooks (1972, 1974, 1976) noted that time after injury when the patient was tested was not very important, although there was an indication that patients tested at the earliest interval of less than four months did perform more poorly than those seen later. In this study most subjects were seen more than 9 months after their injury, when it is expected that the bulk of cognitive recovery has occurred.

While Logical Memory in TBI subjects has often been studied, there is little record of the effect that TBI has on qualitative recall. Brooks (1976) and others note details like difficulty with speed and attention, complaining about "slowness" and being unable to hold information while considering new incoming information, but generally the qualitative analysis of data is a fairly new area of research. Discussion of the qualitative aspects of this study follows.

Qualitative Discussion (Hypothesis 7)

The raw scores of the LM are supposedly meant to be an indication of how well a person remembers a prose passage. A high score is expected to represent a basic understanding of the passage and a logical recollection of the events. However a person can score high on the LM with a vivid imagination, as long as the items are accurate they are scored correct no matter how elaborate the text has become they are not penalized for any fabrication. Similarly subjects who have a basic understanding of the events but have difficulty recalling the exact words are also disadvantaged by a qualitative scoring criteria.

The Logical Memory subtest was designed to examine discourse processing, that is, how subjects refine a fast series of prose sentences. Previous studies have extensively examined the recall of Logical Memory quantitatively, but few studies examine whether subjects understand the basic gist, whether they erase essential or nonessential elements, whether they remember the exact words or what words they do remember.

Most Frequently Recalled Sections

A main objective of the present study was to examine the content of the LM recall in terms of its quality. The ten most frequently recalled sections from both Stories were compared for the Control and TBI subjects to determine whether the content varied across the subject groups.

Although it was found that the top items recalled by both subject groups did not differ greatly for either Story A or B, there were a number of differences in their performances. To spite the fact that both groups basically recalled the same items in the top ten, the emphasis placed on their importance varied considerably (as discussed below).

Another noteworthy difference between the recall of the Control and TBI groups was the absence of proper nouns in TBI clients' recall. However at this stage it can not be determined whether this was due to a lack of importance to both people and place names, or whether proper nouns are a problem for TBI subjects. Although it should be mentioned that Squire et al. (1992) also note that material such as proper nouns do not afford rapid processing and are thus quickly forgotten.

Gist Recall (Hypothesis 7a)

A main difference between Control and TBI subjects was the focus of TBI clients on isolated facts, which were often essential for an overall understanding of the main theme. For example "*when his axle "broke"*" which is a contributing factor, perhaps even the cause of the passage, yet only featured in the TBI subjects top 10 items recalled from Story B. Control subjects, on the other hand, tended to place less emphasis on the relevant items instead focusing on the extra or non-goal directed items.

However the recall of isolated facts does not necessarily indicate a basic understanding of the text, on the contrary the results indicate that the TBI subjects did not score highly on measures of gist recall. Such conflicting results indicate that TBI clients place too much emphasis on remembering the exact details and thus fail to grasp the overall meaning. This could also explain why TBI subjects forget at a faster rate than the comparison groups, because forgetting surface structure occurs more rapidly than the forgetting of gist (Craik, 1979).

Understanding a story entails more than comprehending the sentences, it involves constructing the whole story and analysing what is happening and why (Smyth et al., 1990). The Control subjects, for example, recall less of the actual items yet have a better understanding of the gist, and can thus allocate more time committing extra or non essential items to memory.

As highlighted in the introduction, previous research by Gardner et al. (1983) also found that the head injured subjects in their study, specifically those with right hemisphere deficits, focused on isolated details rather than the entire text.

Primacy / Recency Memory (Hypothesis 7b)

In the recall of the LM passages there was not much evidence of either primacy or recency memory techniques being used, however when comparing the two groups the TBI subjects used primacy and recency more often than the Control subjects.

Change in Wording (Hypothesis 7c)

A considerable difference between the two groups occurred in the amount of their own words introduced. TBI clients remembered less of the original wording and included more of their own than the Control subjects. In general both groups of subjects displayed difficulty in memorizing the exact wording and instead tended to recall more successfully using their own language. The main substitution involved the American "*touched by the womans story*", both Control and TBI subjects recalled more familiar phrases such as "*felt sorry for her*", obviously understanding the meaning but not remembering the exact phrase which is not very common in NZ terminology. Similarly Story B had a number of replacements, including slang expressions such as "*cops*" "*dude*" "*joker*".

The results obtained in the present study are contrary to those reported by Gardner et al. (1983), who found that where normal subjects characteristically paraphrase the stories, patients with right hemisphere deficits attempt to repeat the prose verbatim as it was given.

Intrusion errors (Hypothesis 7d)

Errors are made when Control and TBI subjects remember only the gist or selected details and attempted plausible reconstructions to fill in the gaps (Kintsch, 1977). As Gardner et al. (1983) report head injured patients in particular, exhibit difficulties inhibiting confabulatory responses and often go on to justify the bizarre nature of the fabricated detail which has no obvious relevance to the text.

In this study Control subjects made more intrusions than TBI clients on both stories, substituting credible alternative explanations such as *"left late in her car"* *"she had been mugged by a man"* (Story A) and *"his chest struck the steering wheel"* *"no witnesses to the event"* *"its on its side will you come and get it"* (Story B).

TBI subjects were more likely to substitute more undesirable situations such as *"burgled"*; *"lost, stolen or raped"*; *"had her purse stolen"*; *"pinched some money"*; *"knocked over"* in Story A, whereas intrusions from Story B were mainly because the TBI subjects could not remember what type of accident actually happened, for example; *"collided through an intersection"* *"hit a curb"* *"drove off the road and crashed into a tree"*. It should be noted that the TBI subjects frequently included a reference to an injury involving the head, more so than those made by Control subjects indicating that perhaps this is related to their own head trauma.

The intrusions made by the TBI subjects were often more bizarre, embellished and out of context, for example; *"got burgled and had four children and couldn't buy presents for Christmas"* *"coming home from shopping, had to cook tea, something wrong with the cat"* *"he saw a bright light and crashed his truck"* *"broke his axle on some eggs"* *"they were throwing eggs at him thats why he had a crash"*.

As highlighted in research by Gardner et al. (1983) head injured subjects (particularly those with right hemisphere deficits) tend to have difficulty in ordering and integrating information. However the Control subjects' recall was only fractionally better organized.

Researchers have suggested that memory for a prose passage is done using schema. Using "frames" or "schema" allows the reader to understand these stories in terms of setting, characters, episodes, reactions, events and goals (Bower, 1976; Gentner, 1976; Kintsch et al., 1977). Both the TBI and Control subjects appeared to use such schema which would explain why they remembered gaps concerning names or places, *"I can't remember her name" "on some street" "from somewhere to somewhere"*.

Overall the three main schema-inducing processes were: sharpening by adding elaborative inferences, levelling out or omitting, and rationalising (Glass and Holyoak, 1986). These results were similar to those found by Bartlett (1982; cited Kintsch, 1977), he found that recall of a tale based on Pacific Northwestern Indians was extremely inaccurate. It was not unusual for the students to remember nothing more than a obscure notion or an isolated detail, yet proceeded to formulate a believable story (Kintsch, 1977; Glass & Holyoak, 1986). Then when recall was repeated Bartlett found that names, places and titles were changed; single features were missing; and the stories tended to become compressed and more concrete (Kintsch, 1977).

Methodological Problems

Methodological weaknesses of this study include lack of time and availability of subjects and resources. With a larger subject pool the comparisons would be more significant and conclusive. The most outstanding finding was the poor performance of Control males, many of whom would not have been included if the numbers had permitted. If more time had been allocated a more extensive search for Control volunteers would mean a larger comparison between the original WMS-R and the New Zealand version proposed in this study. Further, manipulation of the experimental group could have meant that the New Zealand version would be tested on TBI subjects and thus compared to Controls.

Future Research

Considering the increasing number of injuries involving the head, and thus the large number of memory deficits that arise following TBI, the precise nature of the disturbance of memory is poorly understood. Thorough assessment of memory capabilities is essential, and the LM subtest is popular because it is quick and simple to administer. However, any further research with the WMS-R LM subtest should first address the methodological weaknesses outline above.

It is widely accepted that the Wechsler Memory Scales are not without their limitations, and numerous criticisms are recorded in the literature. For example, many contest that the phrasing of the passages is dated and redundant, causing many subjects to substitute their own vocabulary for the obsolete and unnatural grammar and syntax of the Wechsler stories. As suggested the results of the present study demonstrate that as they stand the passages are not sensitive to all New Zealand cultural and socio-economic groups and it would be worthwhile developing a NZ databank so that norms obtained from local studies could be compared to international figures.

The results of the present study also indicate that the story presented first whether it is Story A or B, benefits from the lack of interference created by the second story administered. As proposed by Ivison (1986) in the future an effort should be made to alternate the order of administration to prevent any effects of proactive inhibition.

Controversy also exists around the scoring criteria as to whether gist or verbatim recall is a better indicator of prose. Despite the fact that numerous supplementary criteria have been applied to score the LM passages, researchers disagree on which criteria is more applicable. As mentioned in the introduction a raw score of 12 does not tell the reader whether that is 12 average responses, a mixture of half and full credit responses, or even whether the instructions requested 'verbatim' or 'close responses'. Further research is certainly necessary to develop a more indepth method of scoring, including a qualitative measure to recall what is actually recalled.

Thorough neuropsychological evaluation is essential for recovery. If details of preinjury status, socioenvironmental influences and cognitive recovery are adequately assessed, difficulties in recovery can be predicted and thus overcome. Therefore it is essential that assessment techniques such as the LM of the WMS-R are further developed to be more situationally and culturally sensitive.

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APPENDIX 1:

Explanatory Letter / Information Sheet
(for Control Subjects)

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**FACULTY OF
SOCIAL SCIENCES**

DEPARTMENT OF
PSYCHOLOGY

.....th of..... 1993.

Dear Participant,

The purpose of this letter is to provide you with additional information regarding the research study currently being conducted in association with the Psychology Department, Massey University.

The study is being run by Joanna Harris, under the supervision of Dr Janet Leathem, as part of the requirements for a Masters Degree of Psychology.

The aim of the study is to explore memory difficulties associated with head injuries. To do this we need to determine how persons without head injury perform on the same tests. In particular aspects of verbal memory will be examined, using the Logical Memory sub-test of the commonly used Wechsler Memory Scale.

The actual time required to complete the test varies, but generally takes just over ½ an hour.

As researchers, we have a number of obligations to the people who participate in this study. Firstly, all information given will be confidential and anonymous. Every participant will be given a code number, and this will be the only form of identification used on any material associated with the study.

You are under no obligation to take part in this study - the choice is entirely yours. If you do participate, you have the right to withdraw from the study at any time. Should you decide to withdraw from the study, it will be assumed that your consent for the use of the information gained has been withdrawn also, and none of the information will be used.

Each participant has the right to ask any questions about the nature of the research at any stage during the study. If you have any enquiries please feel free to contact either Dr Leathem or Ms Joanna Harris through the Psychology Clinic (06) 358-5196.

Analysis of the results will hopefully contribute to the understanding of memory problems associated with traumatic brain injury. On completion of the research study a summary of the results will be posted to any interested participant on their request. (Please write the address that you would like this information forwarded to at the bottom of the consent form.)

If you are interested in taking part in the research study you will be asked to sign a consent form before the assessment interview can take place.

Thank you for your time and consideration.

Yours sincerely,

Janet Leathem PhD
Senior Lecturer
Clinic Director

Joanna Harris BSc
Researcher

APPENDIX 2:

Explanatory Letter / Information Sheet
(for TBI Subjects)

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**FACULTY OF
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DEPARTMENT OF
PSYCHOLOGY

.....th of 1993.

Dear Participant,

The purpose of this letter is to provide you with additional information regarding the research study currently being conducted in association with the Psychology Department, Massey University.

The study is being run by Joanna Harris, under the supervision of Dr Janet Leathem, as part of the requirements for a Masters Degree of Psychology.

The aim of the study is to explore memory difficulties associated with head injuries. As part of your assessment at the Psychology Clinic, aspects of your memory will be examined. We are interested in one particular aspect of memory and would like to take out and examine separately your performance on the Logical Memory sub-test of the commonly used Wechsler Memory Scale. Agreeing to take part in the study will not involve you in any extra "work". Likewise, not agreeing to take part in the study will in no way affect your assessment or treatment at the clinic.

As researchers, we have a number of obligations to the people who participate in this study. Firstly, all information given will be confidential and anonymous. Every participant will be given a code number, and this will be the only form of identification used on any material associated with the study.

If you do participate, you have the right to withdraw from the study at any time. Should you decide to withdraw from the study, it will be assumed that your consent for the use of the information gained has been withdrawn also, and none of the information will be used.

Each participant has the right to ask any questions about the nature of the research at any stage during the study. If you have any enquiries please feel free to contact either Dr Leathem or Ms Joanna Harris through the Psychology Clinic (06) 358-5196.

Analysis of the results will hopefully contribute to the understanding of memory problems associated with traumatic brain injury. On completion of the research study a summary of the results will be posted to any interested participant on their request. (Please write your the address that you would like this information forwarded to at the bottom of the consent form.)

If you are interested in taking part in the research study you will be asked to sign a consent form before the assessment interview can take place.

Thank you for your time and consideration.

Yours sincerely,

Janet Leathem PhD
Senior Lecturer
Clinic Director

Joanna Harris BSc
Researcher



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APPENDIX 3:

Consent Form

CONSENT FORM

I have read the information sheet for this study and have had the details explained to me. My questions about the research 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, and to refuse to answer any particular question. I agree to provide information to the researcher on the understanding that it is completely confidential and will not be used for any purpose other than this research.

I wish to participate in this study under the conditions set out on the Information Sheet.

Signed:.....

Name:.....

Date:.....

Researcher:.....

If you would like to receive information on results of this study, please leave your address in the space below:

APPENDIX 4:

Logical Memory 1:

Story A

Anna / Thompson / of South / Boston /, employed /
 as a cook / in a school / cafeteria /, reported /
 at the City Hall / Station / that she had been held up /
 on State Street / the night before / and robbed /
 of fifty - six dollars /. She had four / small children /,
 the rent was due /, and they had not eaten / for two days /.
 The police /, touched by the woman's story /, took up a collection /
 for her /.

Max. = 25

Total Story A

Story B

Robert / Miller / was driving / a ten - ton / truck /
 down a highway / at night / in the Mississippi / Delta /,
 carrying eggs / to Nashville /, when his axle / broke /.
 His truck skidded / off the road /, into a ditch /.
 He was thrown / against the dashboard / and was badly shaken /.
 There was no traffic / and he doubted that help would come /.
 Just then his two - way radio / buzzed /. He quickly answered /,
 "This is Grasshopper /."

Max. = 25

Total Story B

Max. = 50

Total Sum of Stories A & B

Logical Memory 2:

Story A

Robert / Miller / was driving / a ten - ton / truck /
 down a highway / at night / in the Mississippi / Delta /,
 carrying eggs / to Nashville /, when his axle / broke /.
 His truck skidded / off the road /, into a ditch /.
 He was thrown / against the dashboard / and was badly shaken /.
 There was no traffic / and he doubted that help would come /.
 Just then his two - way radio / buzzed /. He quickly answered /,
 "This is Grasshopper /."

Max. = 25

Total Story A

Story B

Anna / Thompson / of South / Boston /, employed /
 as a cook / in a school / cafeteria /, reported /
 at the City Hall / Station / that she had been held up /
 on State Street / the night before / and robbed /
 of fifty - six dollars /. She had four / small children /,
 the rent was due /, and they had not eaten / for two days /.
 The police / touched by the woman's story /,
 took up a collection / for her /.

Max. = 25

Total Story B

Max. = 50

Total Sum of Stories A & B

APPENDIX 5:

Logical Memory 3:

Story A

Anne / Thompson / of South / Wellington /, employed /
 as a cook / in a hospital / cafeteria /, reported /
 at the central police / station / that she had been held up /
 on Queen Street / the night before / and robbed /
 of fifty - six dollars /. She had two / small children /,
 the rent was due /, and they had not eaten / for two days /.
 The police /, touched by the woman's story /,
 started up a collection / for her /.

Max. = 25

Total Story A

Story B

Bob / Miller / was driving / a ten - ton / truck /
 down a highway / at night / in the central/ North Island /,
 carrying potatoes / to Hastings /, when his axle / broke /.
 His truck skidded / off the road /, into a ditch /.
 He was thrown / against the dashboard / and was badly shaken /.
 There was no traffic / and he doubted that help would come /.
 Just then his two - way radio / buzzed /. He quickly answered /
 "This is Grasshopper /."

Max. = 25

Total Story B

Max. = 50

Total Sum of Stories A & B

Logical Memory 4:

Story A

Bob / Miller / was driving / a ten - ton / truck /
 down a highway / at night / in the central / North Island /,
 carrying potatoes / to Hastings /, when his axle / broke /.
 His truck skidded / off the road /, into a ditch /.
 He was thrown / against the dashboard / and was badly shaken /.
 There was no traffic / and he doubted that help would come /.
 Just then his two - way radio / buzzed /. He quickly answered /
 "This is Grasshopper /."

Max. = 25

Total Story A

Story B

Anne / Thompson / of South / Wellington /, employed /
 as a cook / in a hospital / cafeteria /, reported /
 at the central police / station / that she had been held up /
 on Queen Street / the night before / and robbed /
 of fifty - six dollars /. She had two / small children /,
 the rent was due /, and they had not eaten / for two days /.
 The police /, touched by the woman's story /,
 started up a collection / for her /.

Max. = 25

Total Story B

Max. = 50

Total Sum of Stories A & B