



**Pragmatic Communication following
Traumatic Brain Injury in Early Childhood**

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requirements for the degree,
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Statement of Authorship

This thesis is my own work containing, to the best of my knowledge and belief, no material published or written by another person except where referred to in the text.

Signed



Date 22/4/05

Simone Bassi

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Abstract

Traumatic brain injury (TBI) is one of the most common causes of acquired disability during childhood. Most of the literature to date has used standardized tests to explore the impact of TBI on children's cognitive skills, with little exploration of children's higher level functional skills, especially in the language/communication domain. Difficulties in these areas are likely to contribute to persisting social and academic difficulties often associated with TBI. The aim of the present study was to explore the impact of TBI on children's pragmatic communication skills, their ability to effectively use language in a social context. A longitudinal design was used to compare the pragmatic communication skills of children who had sustained mild ($n = 9$) and moderate-severe ($n = 11$) TBI between the ages of 3 and 7 years to a group of uninjured children ($n = 9$). The children were matched on age, gender, and pre-injury Vineland Adaptive Behaviour Score. Children were asked to explain how to play a popular children's game initially after injury, with follow-up assessment at 30 months. Using Damico's (1985) Clinical Discourse Analysis method as a guide, explanations were rated on the quantity and quality of information supplied as well as the organization and efficiency of responses. Multivariate analysis of variance did not differentiate the three groups on the procedural discourse task. Group trends were explored given the small sample size, and this did reveal large effect sizes of the moderate-severe TBI and mild TBI groups at both the acute phase and 30 month follow-up. Factors contributing to the lack of statistically significant group differences are discussed, including lack of power, insensitivity of the discourse task, variability within groups, and tester bias. Implications of these trends are discussed as well as avenues for future research.

Traumatic brain injury (TBI) is one of the most common causes of acquired disability during childhood. Yet despite its potential to have far reaching consequences for the child, family, and health and education systems, there has been a considerable delay in research examining the full extent of its effects. This appears to have largely stemmed from early overly optimistic views of children's recovery from brain insults. Fortunately, the last ten years has seen extensive research efforts directed towards a more comprehensive understanding of the impact of childhood TBI. This has resulted in extensive documentation of its acute impact, however, the long-term effects and recovery patterns of childhood TBI still require further study. A greater understanding of the recovery process will be important in guiding rehabilitation needs but also for furthering our understanding of the development of cognitive skills.

This thesis will present an overview of the epidemiology, mechanisms, and pathology of childhood traumatic brain injury. Issues relevant to the exploration of recovery following childhood TBI will be discussed and the current knowledge regarding the neurological, cognitive, behavioural, and functional recovery patterns will be outlined. The impact of TBI on pragmatic communication skills will be given particular attention and a rationale for the present study's investigation of the recovery of children's procedural discourse skills will be provided.

1.1 Incidence

In a comprehensive review of epidemiological studies conducted in the United States of America between 1975 and 1995, Kraus (1995) estimated that at least 180 per 100,000 children will experience a TBI in any one year. Most of these will be mild (76 – 85%), with about 8 – 10% being classified as moderately severe, and 6 – 13% as severe. A higher prevalence rate has been recorded in Victoria, Australia, with an estimate that 375 per 100,000

children aged between 0 and 14 years were hospitalised with TBI between 1987 and 1988 (Head Injury Impact Committee, 1991).

Difficulties accurately establishing the incidence of paediatric TBI arise because of variations in the classification of TBI, age ranges, source of information and how the cases are found. The prevalence of mild TBI is particularly hard to measure as many children who sustain these injuries do not present to hospitals or even general practitioners (Kraus, 1995). In cases where they do attend hospital, their mild TBI may be overlooked in the presence of substantial orthopaedic injuries. Despite these variations, boys are consistently found to be more likely to sustain a TBI, with ratios ranging from 1.3 to 1 to 2.2 to 1 (Kraus, 1995).

1.2 Causes

Traumatic brain injury occurs when the brain sustains damage as a result of the head forcefully coming in contact with another object, such as a car's windshield. In children, this most commonly occurs as a result of falls and transport-related accidents, which includes situations where a child is injured as a result of being a passenger in a car or being hit by a car as a pedestrian or on a bike (Kraus, 1995). It can also result from an indirect force which causes abrupt movement of the head, such as the whiplash that occurs when a vehicle stops quickly or when an infant is shaken, though instances of brain injury following these situations are less frequently reported.

1.3 Mechanisms

The situations causing TBI provide important information on the mechanics underlying the injury. Typically, instances producing brain injury involve two mechanical forces operating on the head, namely *impression* and *acceleration - deceleration*. Impression forces occur when there is direct contact between a stationary head and a physical force, for example if a heavy object fell from a cupboard onto a child's head. 'Pure' instances of brain injury as a result of impression forces are very rare (Pang, 1985). The vast majority of cases

involve at least some degree of acceleration-deceleration forces. These occur when there is impact with a moving head. Acceleration-deceleration forces can be either *translational* (linear), when the force is directed at the centre of the head, or *rotational*, where the head rotates in any dimension in a vertical or horizontal plane. Most instances producing TBI involve a combination of both translational and rotational forces.

1.4 Pathophysiology

TBI comprises two categories of injury: primary and secondary. Primary injuries result directly from the impact and include contusions, diffuse axonal injury (DAI), haemorrhages and skull fractures. Secondary injuries are indirectly related to the trauma and include haematomas, cerebral oedema, raised intracranial pressure, acute cerebral swelling, post-traumatic epilepsy and post-traumatic hydrocephalus.

1.4.1 Primary injuries

Primary injuries can be further categorised as focal or diffuse injuries. Focal brain injuries are localised areas of tissue destruction such as contusions, lacerations, or haemorrhages that are usually large enough to be visualised on CT or MRI and can be seen by the naked eye at autopsy. Both impression and acceleration forces cause focal injuries through projecting the brain into bony protuberances within the skull. Regardless of the site of impact, there are a number of common sites of damage, which are illustrated in figure 1. In particular, frontal and temporal regions are especially prone to focal injuries due to the irregular rough surfaces of the anterior and middle fossa, the falx cerebri and tentorium. The occipital lobe is rarely a site of damage due to the relative smooth surface of the posterior fossa (Selzer, 1995a).

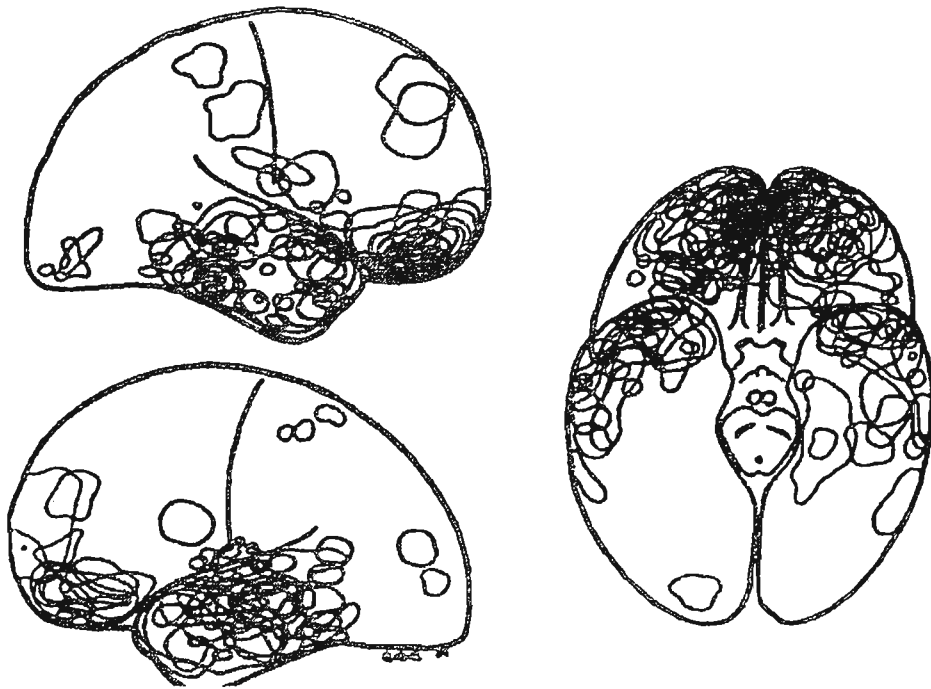


Figure 1. Common sites of cerebral contusion: From Courville, (1945).

In contrast to focal injuries, diffuse brain injuries reflect axonal 'white matter' damage which is distributed more globally throughout the brain and is not so visible on imaging (Selzer, 1995a). An extensive amount of early research provided convincing evidence that rotational forces are most influential in producing diffuse brain injuries (Ommaya and Gennarelli, 1974, 1976; Bandak and Eppinger, 1994). Rotational forces cause the brain to swirl and oscillate around inside the skull. As a result of the differing densities of regions within the brain, these areas swirl and oscillate in different directions and at different speeds, stretching and straining axons. If torn, ruptured or twisted, the axon retracts and degenerates back to its cell body and may eventually result in the death of the entire neuron. If the damage is significant, the post-synaptic (connecting) neuron may also be affected (Stein, Brailowsky, & Will, 1995).

Consequently, this process has the potential to have widespread effects. Although the axonal damage is diffusely distributed, areas that are most susceptible to shear-strain injuries are junctions between white and grey

matter, the corpus callosum, thalamus, basal ganglia, medial frontal lobes, superior cerebral peduncles and the pontine-medullary junction (Oppenheimer, 1968; Zhou, Khalil, & King, 1994).

It was believed that these 'shear-strain' injuries were solely responsible for the DAI seen following TBI. More recent experimental research with animals has challenged this position by revealing that diffuse axonal and neuronal injury can occur in brains that have no evidence of mechanical tearing (Yeates, 2000). Rather, evidence is growing in support of a biochemical contribution to DAI as well. These reactions are believed to occur over an extended period of time following TBI and to enforce their effects through the exacerbation of hypoxic-ischaemic injury that commonly occurs following TBI.

Using a 'fluid percussion model', Dixon, Lyeth, & Povlishock (1987) have been able to approximate the events that occur following a typical high velocity impact head injury by releasing a saline solution under pressure on an animal. Several potentially damaging biochemical changes have been postulated which act as a cascade of interacting events.

Studies have identified a breakdown in the blood brain barrier (BBB) at three sites regardless of the site of impact. These include, 1) the cortex immediately adjacent to the point of impact, 2) the hippocampus, and 3) other subcortical structures including the dorsal thalamus, septal nuclei, pontine tegmentum, periaqueductal gray, substantia nigra, and the rim of the ventricular and cisternal spaces (Bigler, 1997). As the BBB has important functions in protecting neurons and glia from toxins, its breakdown allows blood cells, proteins and toxic substances to make contact with and damage neurons (Stein, Brailowsky, & Will, 1995).

At the same time, an excessive release of excitatory neurotransmitters, glutamate and aspartate, as well as calcium ions occurs throughout the brain (Stein et al, 1995). This results in excitotoxicity with prolonged over-excitation impairing metabolic cell function and having the potential to cause cell death (Choi, 1995). It has also been postulated that there is an increase in free

radicals, which are also damaging to weakened neurons. This is indirectly derived from findings that treatment with free radical scavengers reduced the impact of TBI (Novack, Dillon, & Jackson, 1996).

1.4.2 Secondary pathology

The most important implication of these findings is that there may be a window of opportunity during which treatment may be able to reduce the severity of TBI. At present, however, our limited understanding of the biochemical reactions to TBI forces medical attention towards the prevention of the secondary injuries which result indirectly from the trauma.

Two of the most common secondary injuries seen in children are acute cerebral swelling and cerebral oedema (Pang, 1985). Both of these conditions result in an increase in brain volume, the first due to an increase in blood content as a result of vasodilation, and the second as a result of an increase in the water content. These generally occur as non-specific responses to brain trauma.

Both of these conditions have the effect of raising intracranial pressure. In severe cases the increased pressure can cause herniation, whereby brain tissue is forced down through the foramen magnum and compresses the brainstem. This is the most common cause of death following TBI (Bruce, 1995). Raised intracranial pressure also reduces cerebral blood flow causing ischaemic brain damage. Hypoxic - ischaemic brain injury is common following severe TBI with post-mortem reports indicating that 90% of brains have evidence of ischaemic injury, most typically within the hippocampus and watershed zones (Novack, Dillon, & Jackson, 1996). Hypoxic-ischaemic injury also occurs as a result of reduced cerebral pressure that commonly occurs with shock and systemic injuries to heart and lungs.

Less commonly occurring secondary injuries are hematomas. These occur when blood vessels are torn during the violent movement of the brain following impact. The blood that is released forms a clot or hematoma. These

can occur between the skull and outer surface of brain (epidural), beneath the meninges of the brain but still on the surface (subdural) or within the brain mass (intracerebral). Epidural hematomas are usually a result of a fracture breaking the surface vessels. As children's skulls have greater flexibility than adults, these rarely occur. Intracerebral hematomas are also relatively uncommon. Subdural hematomas however, do occur and are often associated with fatality through raising intracranial pressure and causing herniation.

Finally, children can also develop a number of complications during the subacute stages post-injury, although these are relatively uncommon. Obstruction to cerebrospinal fluid flow can result in posttraumatic hydrocephalus. Children with skulls fractures are more vulnerable to infections and there is also an increased risk of posttraumatic seizures, particularly in children injured at a young age, or with focal pathology, or severe injury (Anderson, Northam, Hendy, & Wrennall, 2001; Bruce, 1995).

1.4.3 Time frame of pathology

The pathophysiology of TBI continues for some time after the initial trauma, with time frames varying according to individual characteristics, injury severity and treatment approaches. Most degeneration is complete within three months of the injury (Bigler, 1997). Figure 2 depicts the enlargement of the ventricles that occurs as a result of the progressive white matter degeneration and cerebral atrophy.

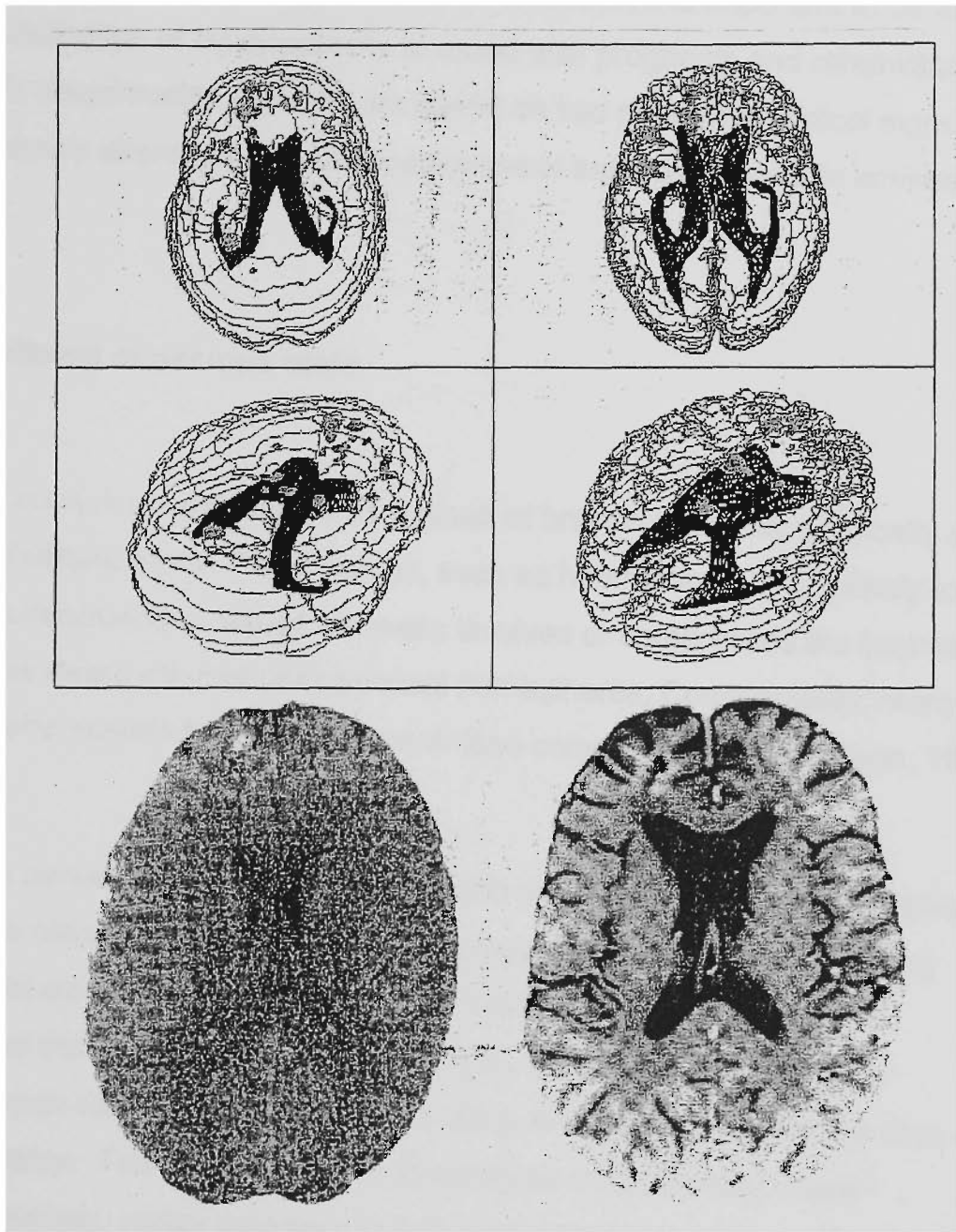


Figure 2. Neuroanatomical changes after TBI: day of injury compared to one year later. The left column depicts a day of injury CT scan with 3D representation above. The right column depicts follow up MRI scan showing enlarged lateral ventricles which is an indication of tissue degeneration in the frontal regions. Adapted from Bigler, 1997.

1.5 Classification

The broad range of pathology associated with TBI makes accurately classifying the severity of injury difficult. However, it is important to obtain some indication of injury severity to assist with prognosis and rehabilitation. Current classification systems are based on two prominent clinical signs of TBI, namely altered or loss of consciousness and post-traumatic amnesia (PTA).

1.5.1 Altered conscious state

Loss of consciousness occurs as a result of brainstem damage typically as a result of diffuse injury. Focal injuries, such as haematomas are unlikely to affect consciousness unless the mass involves or compresses the brainstem or causes dysfunction of both cerebral hemispheres. Consequently, many people who sustain focal injuries never lose consciousness (Anderson, 1996).

Unless a period of loss of consciousness is directly witnessed, it is inherently difficult to obtain a reliable account of its existence and duration from any person, let alone a child. Consequently, Teasdale and Jennett (1974) developed the Glasgow Coma Scale (GCS), which is used by medical professionals to obtain a standardised rating of consciousness at the time of administration. The scale assesses three areas of functioning: visual responsiveness, verbal responsiveness, and motor capabilities (refer to table 1). Based on an individual's score, their brain injury can be classified as severe (8 or lower), moderate (9-12), or mild (13 – 15). Although the GCS is the most widely used measure of TBI severity, it has a number of important limitations. Firstly, whilst attempts have been made to modify it for children, assessment of infants and young children can be unreliable. Also, the GCS score provides only an indication of the child's level of consciousness at the time of administration. As scores vary over time, injury severity classification may vary according to which score is used. The timing of the assessment is

also problematic for milder injuries, as children’s altered consciousness may have resolved by the time they reach the hospital and receive medical attention.

Table 1. The Glasgow Coma Scale (Teasdale & Jennett, 1974).

Category		Score
Eyes open	Never	1
	To pain	2
	To verbal stimuli	3
	Spontaneously	4
Best Verbal Response	None	1
	Incomprehensible	2
	Inappropriate words	3
	Disoriented conversations	4
	Oriented conversations	5
Best Motor Response	None	1
	Extension	2
	Flexion abnormal	3
	Flexion withdrawal	4
	Localising pain	5
	Obeys commands	6
Total		15

1.5.2 Post-traumatic amnesia

PTA refers to the period of recovery in which the altered brain functioning does not allow for the fixation of new experiences into long term memories. It is characterised by an increase in the child’s level alertness and arousal, but with ongoing confusion and disorientation. Duration of PTA is a better indicator of brain injury severity than duration of loss of consciousness (Chadwick, Rutter, Shaffer, & Shrout, 1981; Levin, Benton, & Grossman, 1982), but is rarely measured in acute hospital settings. Children’s versions of the Galveston Orientation and Amnesia Test (Ewing-Cobbs, Levin, Fletcher, Miner, & Eisenberg, 1990) and the Westmead PTA Scale (Shore,

Marosszeey, Sandanam, & Batchelor, 1986) have been developed to assess PTA, but like the GCS, children are not always able to respond to these measures appropriately (Anderson and Yates, 1997). These measures include a variety of questions which assess autobiographical memory (name, age, date of birth), orientation (time and place) and the ability to remember items from one day to the next (pictures, names). According to this indicator, TBI is classified as mild if duration of PTA is less than 24 hours, moderate if less than 7 days, and severe if longer than one week.

Table 2. The Children’s Orientation and Amnesia Test (COAT)

General orientation

- 1. What is your name (first, last)?
- 2. How old are you? When is your birthday (month, year)?
- 3. Where do you live (city, state)?
- 4. What is your father’s name? What is your mother’s name?
- 5. What school do you go to? What grade are you in?
- 6. Where are you now?
- 7. Is it daytime or nighttime?

Temporal orientation

- 8. What time is it now?
- 9. What day of the week is it?
- 10. What day of the month is it?
- 11. What is the month?
- 12. What is the year?

Memory

- 13. Say these numbers after me in the same order?
(strings of numbers of increasing length are presented to the child for recall)
 - 14. How many fingers am I holding up?
 - 15. Who is on Sesame Street (or substitute other TV show)?
 - 16. What is my name?
-

1.6 Factors influencing outcome from paediatric traumatic brain injury.

TBI is the leading cause of death in children - half of all deaths are due to trauma, and half of these are a result of brain injuries (Kraus, 1995). Death is more common following severe TBI (ranging from 12 – 62% of hospital admissions), and is fairly uncommon after moderate (<4%) and mild (<1%) TBI. Due to the many medical technological advances that have occurred over the last 15 years, the survival rate of TBI has grown rapidly, with many children surviving previously fatal injuries.

A number of epidemiological studies have explored the outcomes of those children that survive. Using a gross measure of outcome, the Glasgow Outcome Scale (Jennett & Bond, 1975), these studies indicate that 75 – 95% of children with TBI display a 'good recovery', 10% show 'moderate disability', 1-3% show a 'severe disability', and less than 1% remain in a persistent vegetative state (Kraus, 1995). However, a 'good recovery' does not exclude neurobehavioural impairment or associated functional disabilities.

Not surprisingly, studies using more comprehensive methods of assessing neurobehavioural outcome have revealed that, once children emerge from PTA, they demonstrate a vast array of cognitive, behavioural, and social-emotional difficulties. Nevertheless, studies consistently find considerable variation within their groups of TBI children across all areas assessed. Dennis (1989, 1999, 2000) has conceptualised a framework for understanding the variable recovery of children following TBI as involving the complex interaction of an array of biological and environmental factors (see figure 4). In this regard, the biological aspects of the injury are moderated by the developmental level of the child, the time since the injury and the 'reserve'. The 'reserve' of the child incorporates their pre-injury characteristics (physical and mental health, academic and social functioning), as well as the family resources, school resources, and access to rehabilitation. These factors will be discussed followed by a review of the most recent studies of the acute and long term neurobehavioural changes associated with paediatric TBI, detailing where possible the influence of these factors.

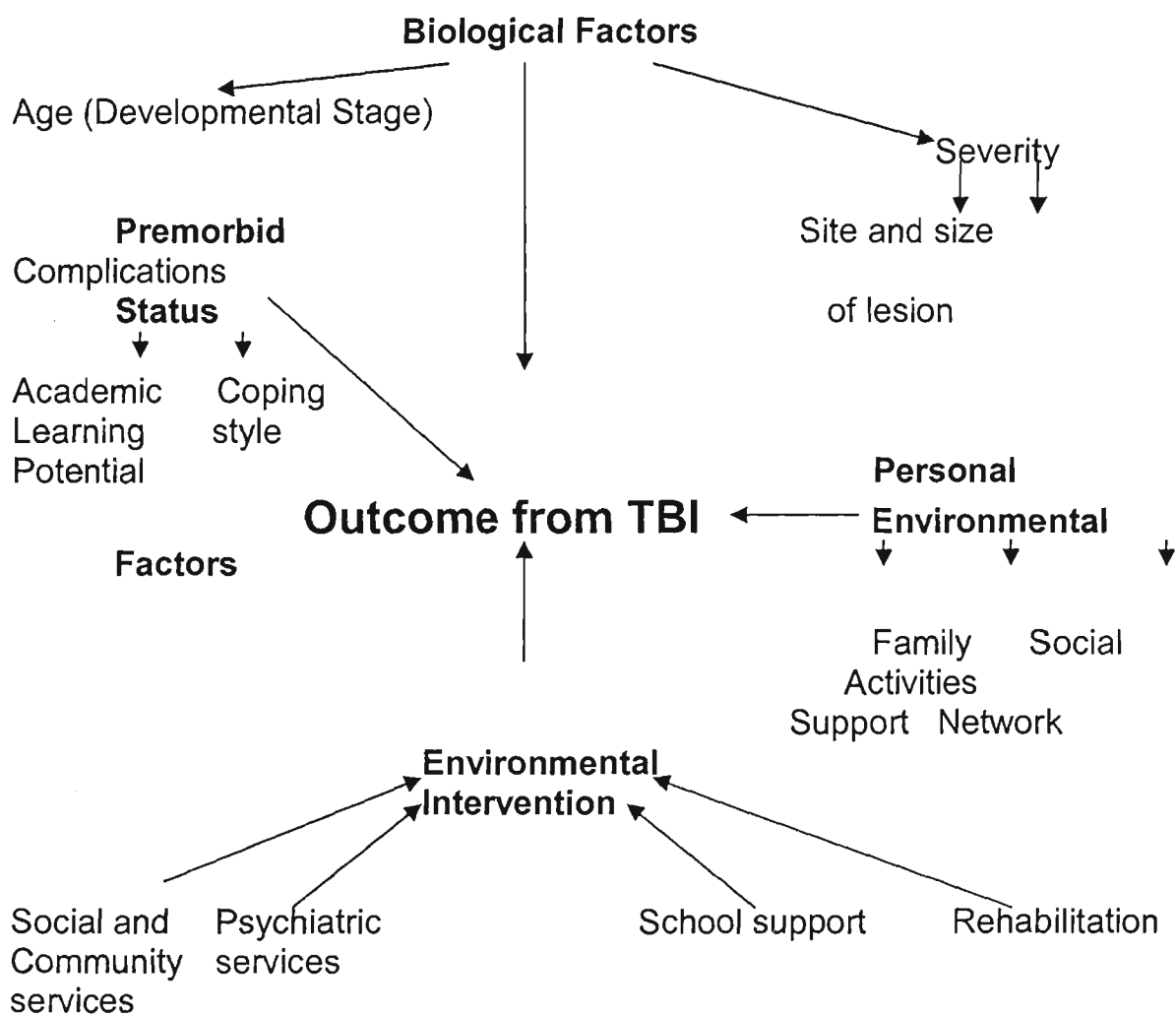


Figure 3. Factors that influence outcome from TBI in children.
Adapted from Dennis (2000).

1.6.1 Biological factors

Theories of physiological recovery and plasticity

Brain function recovers at a physiological level after injury as a result of treatment initiatives and the brain's own capacity to repair itself. Surgical treatment approaches such as evacuation of haematomas, insertion of shunts to reduce intracranial pressure, and restoration of pulmonary function, act to reduce pressure on the brain and help to restore normal metabolic function to

assist the recovery process. However, it is believed that these processes will only be effective in restoring function to brain areas with functional, not structural, damage.

Presently, the exact mechanisms underlying the brain's own capacity for restoration, or 'plasticity', are not fully understood. Studies have described morphological changes in surviving neurons including changes in the number of post-synaptic receptors, increases in the size and complexity of dendritic trees, as well as collateral sprouting of spared axons to innervate denervated neurons (Schieber, 1995; Selzer, 1995b). Theories have been postulated that these processes assist recovery of function either through substitution and /or reorganisation of nerve structures and functions whereby undamaged brain areas take over the function of the damaged area (Stein, Brailowsky, and Will, 1995). The exact functional impact of these processes are unknown.

Brain development

The notion of plasticity has especially important implications for children's recovery from TBI as their brains are already in a dynamic phase of development. Although all neurons are formed and placed in their appropriate brain regions before birth, the newborn's brain is immature and is not fully developed until early adulthood (Reinis & Goldman, 1980). Its development involves the interaction of additive events (synaptogenesis, myelination) and subtractive events (cell death, axon retraction, synapse subtraction).

Synaptogenesis – the formation of connections between neurons – occurs at a rapid rate over the first two years of life. Long range connections are formed first, followed by shorter connections. Although these connections are able to transmit information, they do not reach adult level of efficiency until they are fully myelinated. Myelination, the increase in the fatty sheath that surrounds neuronal axons, occurs in the sensory areas first, followed by the motor areas. Long range axons, such as those connecting the frontal lobe, undergo myelination last and are not fully myelinated until early adulthood (Reinis & Goldman, 1980).

As these additive events are occurring, elimination of cells, axons and synaptic connections is also occurring to combat the overproduction of neurons that occurs before birth. This is a selective process whereby the neurons that make and maintain functional connections are maintained. While most elimination occurs in the first 6 months of life, the neuronal density of the frontal cortex is 55% above adult levels at 2 years of age, and still 10% above adult levels at 7 years of age (Bates, Thal, & Janowsky, 1992).

1.6.2 Influence of age at injury and time since injury

Consequently, a brain injury during childhood places significant stress on the brain to establish restorative neurological connections, whilst still undergoing the additive and subtractive events of normal brain development. Given the changes occurring in the function of the child's brain and their growing cognitive, emotional and social development, it would be expected that the age of the child at the time of injury would have important implications for their subsequent outcome.

Early research by Kennard (1936, 1940) painted an overly optimistic view of the impact of brain injury on young children, suggesting that children's brains are more capable of recovering from trauma than fully mature brains. This was largely born out of case studies of children with focal lesions who showed good acquisition of language or motor skills and children with a variety of aetiologies showing rapid resolution of aphasia (Taylor and Alden, 1997). These findings were taken to suggest that the immature brain has greater plasticity enabling reorganisation for undamaged regions to subserve the functions ordinarily served by the damaged brain tissue. While this is indeed true in some instances of focal injury, it by no means reflects the full picture.

In opposition to this 'plasticity' theory, the 'vulnerability' hypothesis proposes that children are more vulnerable to brain injury than adults, particularly when the damage is diffusely distributed as in TBI. Hebb (1949) was one of the first to consider that young children may be especially vulnerable to the impact of brain insult. In comparison to older children, they are in the process of

acquiring many skills and they have fewer well established skills to work from. Skill acquisition may be hampered by generalised cognitive difficulties, such as poor attention, memory and new learning, which result from the damage.

Additionally, disruption of brain development during phases of skill development may result in difficulties in establishing the neurological bases to these skills. Whilst it is easier for the brain to reorganise and redistribute key functions during childhood, this process may have a deleterious effect on further brain development with increased neural connections 'crowding' future more adaptive connections. This would place the frontal lobes and its connections in the most vulnerable position following TBI, given that they undergo the most protracted course of development (Anderson, Northam, Hendy, & Wrennall, 2001; Dennis, 1999). This hypothesis would predict that children may show age appropriate development for some time after an injury but begin to display difficulties as development begins to place greater demands on damaged areas (Dennis, 1989, 2000).

Early research employing cross-sectional designs and summary outcome measures failed to find a relationship between age at injury and cognitive and behavioural outcome (Chadwick, Rutter, Shaffer, & Shrout, 1981). But more recent research utilising longitudinal methods have suggested that younger children are more vulnerable to the effects of severe TBI than older children (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2000; Thompson, Francis, Stuebig, Fletcher, Ewing-Cobbs, Miner, Levin, Eisenberg, 1994; Anderson, Morse, Klug, Catroppa, Haritou, Rosenfeld, & Pentland, 1997; Slomine, Gerring, Grados, Vasa, Brady, & Christensen, Denckla, 2002; Levin, Song, Ewing-Cobbs, Chapman, & Mendelsohn, 2001). These will be discussed in greater detail when reviewing studies of the outcome from TBI.

1.6.3 Influence of Injury-related factors

A child's capacity to recover from TBI is also expected to be related to the severity of the injury as well as to secondary features such as focal lesions and complications. The majority of research looking for predictors of outcome has explored the influence of injury severity. Both longitudinal and cross-sectional studies have clearly established that injury severity, as measured most typically by GCS score, is a reliable predictor of cognitive and behavioural outcome in the short and long term (Yeates, Taylor, Drotar, Wade, Klein, Stancin, Schatschneider, 1997; Anderson, Morse, Klug, Catroppa, Haritou, Rosenfeld, & Pentland, 1997; Slomine, Gerring, Grados, Vasa, Brady, Christensen, & Denckla, 2002).

Research has demonstrated that the location and size of focal lesions reliably alters outcome and deep brain lesions are associated with poorer outcome (Grados, Slomine, Gerring, & Vasa, 2001). Secondary complications such as increased intracranial pressure and post-traumatic epilepsy are also prognostic of poor cognitive outcome (Kieslich, Marquardt, Galow, Lorenz, and Jacobi, 2001), and acute pupillary abnormalities were also predictive of poorer cognitive outcome, although only in older children (Thompson, Francis, Stuebig, Fletcher, Ewing-Cobbs, Miner, Levin, & Eisenberg, 1994).

Although injury severity is a consistent predictor of outcome, its predictive contribution is relatively low, accounting for between 20 and 30% of the variance in outcome (Yeates, Taylor, Drotar, Wade, Klein, Stancin, Schatschneider, 1997; Anderson, Morse, Klug, Catroppa, Haritou, Rosenfeld, & Pentland, 1997). This has led researchers to look for other influential variables.

1.6.4 Pre-injury functioning

Dennis' model (1989) also posits that a child's outcome from TBI will be influenced by the child's level of functioning prior to the injury. The demographics of the TBI population in general includes a higher proportion of children with attention-deficit hyperactivity disorder, learning disabilities, and low socio-economic status (Kraus, Rock, & Hamyari, 1990; Donders, & Strom, 2000). Consequently, it would be reasonable to expect that children's premorbid difficulties may be exacerbated by the injury. Unfortunately, at this point in time, this issue has received very little attention in the literature, with children fitting these groups often being excluded from study (Farmer, Kanne, Haut, Williams, Johnstone, & Kirk, 2002). Consequently current research results are not entirely representative of the TBI majority.

1.6.5 Environmental factors

Research manipulating the stimulation level of environments in animals with brain injury has shown that enriched environments enhance recovery (Kolb & Wishaw, 1996; Stein, 1991). However, neuropsychology has only recently begun to consider the role of environmental influences on children's outcome from TBI, and indeed most neurological illnesses.

There is strong evidence that severe TBI causes significant persistent distress in the entire family (Perlesz, Kinsella, & Crowe, 1999; Wade, Taylor, Drotar, Stancin, Yeates, & Minich, 2002). It is anticipated that the family's ability to adjust and cope with the injury would have significant consequences for the child's recovery. Studies of children with other chronic illnesses have consistently shown that behavioural adjustment is related to family adjustment (Wallander & Thompson, 1995). Research with children with TBI is beginning to show that family adjustment moderates the impact of the injury, particularly with respect to the child's long-term behavioural and functional outcome (Donders & Strom, 2000; Kinsella, Ong, Murtagh, Prior, & Sawyer, 1999).

Families with children with TBI are often from low socioeconomic backgrounds (Ewing-Cobbs, Duhaime, & Fletcher, 1995) and as a result they often have minimal access to resources such as rehabilitation, child care, specialist services, home help, and recreation services. Preliminary research findings do suggest that the availability of resources also impacts on the family's adjustment and child's outcome (Max, Roberts, Koele, Lindgren, Robin, Arndt, Smith, & Sato, 1999; Yeates, Taylor, Wade, Drotar, Stancin, & Minich, 2002).

1.6.6 Methodological considerations

In order to gain a full appreciation of the impact of paediatric TBI, it is necessary to give adequate consideration to the many potentially influential variables within a developmental framework. This means understanding its impact on subsequent development, not just on outcomes at particular points in time. The last five years has seen a growing awareness of these issues, with increasing numbers of outcome studies employing prospective longitudinal designs. This type of design provides a more accurate picture of the impact of the injury on children's ongoing development, given that changes may not necessarily be evident until further down the track. It also allows investigators to gain more accurate retrospective estimates of the child's and the family's pre-injury functioning. Longitudinal assessment is limited, however, by the need to use different tests over time, as each test possesses its own psychometric properties. Despite this limitation, this design method far outweighs cross-sectional designs.

While many of the recent longitudinal studies have included measures of potential biological influences, such as injury severity, lesion locations, and age at injury, psychosocial measures, particularly of post-injury functioning, have not received much attention. Many current longitudinal studies are also limited to one to three years post-injury and thus do not give a good indication of how children tackle later developmental stages. Nevertheless, these studies are beginning to provide a glimpse of the real impact of paediatric TBI and the complex interaction of biological and psychosocial factors.

1.7 Neurobehavioural outcome from paediatric TBI

1.7.1 Intellectual functioning

Depressed Full Scale Intelligence Quotients (IQ) is a consistent finding in the acute phase following moderate and severe paediatric TBI. A well-established relationship has been identified between the severity of injury and the decrement in performance on the WPPSI-R and WISC-III with the mean performance of severely injured children being in the low average range, the mean performance of the moderately injured children being in the average range but still below those with mild injuries or control children with or without orthopaedic injuries (Chadwick, Rutter, Shaffer, & Shrout, 1981; Fletcher, Miner, & Ewing-Cobbs, 1987; Anderson, Morse, Klug, Catroppa, Haritou, Rosenfeld, & Pentland, 1997; Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2000). A growing body of evidence suggests that mildly injured children do not experience a reduction in IQ score (Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2001; Jaffe, Polissar, Fay, & Liao, 1995; Ponsford, Willmott, Rothwell, Cameron, Ayton, Nelms, Curran, & Ng, 1999; Satz, Zaucha, McCleary, Light, & Asarnow, 1997 for review).

Children generally obtain lower scores on the Performance Scale subtests of the Wechsler scales (PIQ) than on the Verbal scale subtests (VIQ). This has been interpreted as reflecting the different demands of these domains. Specifically, the Performance Scale subtests rely on fluid problem solving skills as well as motor skills and speed, whereas the Verbal Scale subtests are heavily dependent on previously acquired knowledge which is generally unaffected by acquired brain damage.

Interesting patterns are emerging in regard to the recovery of intellectual skills. A number of studies have described differential recovery rates depending on the severity of injury and the age at injury. While children of all severities show most marked improvements in the first 6 months to 1 year, children with severe TBI show more rapid improvements over this time.

Following this period, improvements tend to plateau (Jaffe, Polissar, Fay, & Liao, 1995). Despite these improvements, children who experience a severe TBI continue to display persisting reductions in IQ scores at 4 years (Yeates, Taylor, Wade, Drotar, Stancin, Minich, 2002) and 6 years after the injury (Verger, Junque, Jurado, Treserras, Bartumeus, Nogues, & Poch, 2000).

Studies of the recovery rates of children injured during early childhood, typically prior to 7 years of age, have been less promising. These have failed to find evidence of rapid improvement in IQ score typically seen in older children. Instead younger children show flatter recovery curves reflecting ongoing development but limited recovery (Anderson, Morse, Klug, Haritou, Rosenfeld, & Pentland, 1997; Anderson, Catroppa, Morse, Haritou, & Rosenfeld, 2000; Ewing-Cobbs, Fletcher, Levin, Francis, Davidson, & Miner, 1997). These findings suggest that these children will continue to fall further and further behind their peers, although further follow-up is required to ascertain if this is true.

Some preliminary findings on the role of environmental factors in intellectual outcome suggest that they have a small but significant influence. Reports have generally found that psychosocial factors, including socioeconomic status, overall social stressors, resources and family functioning explain between 5 to 10% of the variance in intellectual outcome (Anderson et al 1997; Max, Roberts, Koele, Lindgren, Robin, Arndt, Smith, & Sato, 1999; Yeates, Taylor, Drotar, Wade, Kelin, Stancin, and Schatschneider, 1997; Yeates et al, 2002). This would suggest that whilst the severity of the child's head injury is likely to have the greatest impact on their intellectual outcome, psychosocial factors may also play a smaller yet significant part in enhancing or impeding their intellectual recovery. However, as these studies have not investigated outcome beyond 12 months post-injury, it is possible that environmental factors exert their influence later in the recovery process.

1.7.2 Language skills

Language functions were once considered to be relatively resilient to the effects of TBI. This misconception resulted from findings that children tend to obtain lower PIQ scores than VIQ scores on the Wechsler scales.

Furthermore, although children are often impaired on standard aphasia measures in the acute phase of the injury, specific aphasic syndromes rarely persist beyond this time (Chapman, Levin, & Culhane, 1995; Ewing-Cobbs, Levin, Eisenberg, & Fletcher, 1987).

Nevertheless, closer scrutiny of children's language often reveals persisting subtle impairments in both receptive and expressive language. Both preschool and school aged children with severe brain injuries perform less well on standard measures of receptive and expressive language as well as measures of confrontation naming and verbal fluency compared to normal controls (Anderson, Morse, Klug, Catroppa, Haritou, Rosenfeld, & Pentland, 1997) and orthopaedic controls (Yeates, Taylor, Wade, Drotar, Stancin, & Minich, 2002) and these deficits are still evident up to 4 years after the injury.

Findings regarding the consequences of mild and moderate injuries on language functioning are less conclusive. Studies are difficult to compare due to differences in tests, age ranges, and groupings of TBI severity. Anderson et al's (1997) group of 32 pre-school aged children with mild-moderate injuries performed similar to controls on receptive and expressive measures acutely and 12 months post-injury. An absence of receptive and expressive deficits was also reported in a group of mildly injured TBI children using standard measures. However, this group was found to display reduced verbal fluency and difficulties with story recall, possibly suggesting higher level language difficulties that were not detected using standardised measures (Anderson et al 2001). Using different tests of receptive and expressive language, due to the wide age range studied (4 months to 7 years), Ewing-Cobbs, Fletcher, Levin, Francis, Davidson and Miner (1997) also reported subtle expressive language deficits in their group of children with mild-moderate TBI.

Unfortunately this study did not include a control group to clearly establish evidence of a relationship between TBI and aspects of language competency. Finally clear impairment in expressive vocabulary and verbal reasoning were found in a moderate TBI group of older children (6 to 12 years) which persisted 4 years post-injury in comparison to orthopaedic controls (Yeates, Taylor, Wade, Drotar, Stancin, Minich, 2002).

Despite these relatively good performances on standard assessments, teachers and clinicians often report a severe deterioration in children's ability to express and to comprehend complex ideas or information (Ylvisaker, 1993). It is becoming increasingly clear that standard tests of language do not capture the full nature of children's language difficulties post TBI. Research initiatives are now being towards more functional aspects of language such as pragmatic communication and discourse. These will be discussed at the end of this review.

1.7.3 Nonverbal skills and Motor skills

As already discussed, children with moderate and severe TBIs experience persisting deficits on nonverbal or performance based tasks. They also perform poorly on tests of construction, visuo-spatial and visuo-perceptual analysis. Poor performances within these areas may also be exacerbated by reduced motor skill and speed, as these are also required in completing these tasks. Thompson et al (1994) explored the recovery of these skills over time, using growth curve analysis, a statistical technique which is particularly sensitive to detecting individual changes in performance over time. Overall, these children showed gradual improvements over time. However, they also found that the rate of improvement differed depending on the severity of injury and age at injury. In particular, children who suffered severe injuries at younger ages improved at a slower rate than older children with severe injuries and same aged children with milder injuries.

1.7.4 Attention

Attention and concentration difficulties are common complaints following TBI. It is believed that attentional functions are particularly vulnerable to TBI as they are subserved by a widely distributed neurological network in cortical and subcortical brain regions. Most research exploring attentional functions following paediatric TBI has relied on the freedom from distractibility index from the Wechsler scale (Anderson, Catroppa, Haritou, Morse, Pentland, Rosenfeld, & Stargatt, 2001) or the continuous performance task, neither of which adequately assesses the various components of attention based on theoretical models. Nevertheless, these studies have revealed the typical dose-response relationship, with severely injured children performing most poorly. In an attempt to provide a more in-depth understanding of attentional skills following TBI, Catroppa, Anderson, and Stargatt (1999), assessed 13 mildly injured children, 19 moderately injured and 11 severely injured children on a range of attentional tasks which assessed each of the domains described by Mirsky's model of attention. These were the continuous performance task, the trail making test, the letter cancellation, and contingency naming. Attentional deficits were present in both the moderate and severe TBI groups across all domains acutely after injury and 6 months later. The mild group performed well, although the lack of a control group makes it difficult to evaluate their performance.

There appears to be an age at injury effect, with children injured at younger ages performing worse on attentional measures than those injured later in childhood (Dennis, Wilkinson, Koski, & Humphreys, 1995; Ewing-Cobbs, Prasad, Fletcher, Levin, Miner & Eisenberg, 1998). Recent findings also suggest that there is a time since injury effect, with different patterns found for different domains. Specifically, Dennis, Guger, Roncadin, Barnes, & Schacher (2001) found that children's level of distractibility improved over time, but their ability to inhibit or modulate their responses declined over time.

1.7.5 Memory and new learning

Like attentional functions, memory functions are also subserved by a number of cerebral areas, including the temporal lobe and hippocampus, frontal regions, and subcortical structures. The diffuse distribution of this network increases its vulnerability to diffuse damage. Furthermore, the hippocampus is especially sensitive to ischaemic injury often associated with TBI and the frontal and temporal lobes often sustain structural damage as a result of the impact. Consequently, memory difficulties appear to be an inevitable consequence of TBI.

Studies have consistently identified memory impairments and difficulties learning new information with repetition in children after severe TBI (Anderson, Catroppa, Haritou, Morse, Pentland, Rosenfeld, & Stargatt, 2001; Donders & Hoffman, 2002; Farmer, Kanne, Haut, Williams, Johnstone, & Kirk, 2002), however the nature of these deficits have not been extensively researched. Preliminary findings suggest that there are injury severity effects, age at injury effects as well as effects of task demand.

Overall, children with severe TBI tend to have generalised difficulties with recollection of both verbal and nonverbal material, although children injured at a young age have shown greater difficulties recalling visual material. This may reflect the fact that this is a skill established early in life. Children with severe TBI perform below age expectations on all aspects of new learning tasks, although there is some evidence that they perform better when provided with recognition cues.

The impact of mild and moderately severe TBI on memory is less clear. Some studies have reported intact memory functioning on tasks of varying complexity and modality (Yeates et al 2002; Max, Roberts, Koele, Lindgren, Robin, Arndt, Smith, Sato, 1999). Others have reported more selective deficits than those seen in children with severe TBI (Anderson, Catroppa, Haritou, Morse, Pentland, Rosenfeld, Stargatt, 2001). Children with mild and moderate

TBI perform normally in learning trials of a list learning task, but have difficulties retrieving information after a delay (Catroppa & Anderson 2002). Young children with mild TBI have also shown reduced performances recalling stories (Anderson, Catroppa, Morse, Haritou, Rosenfeld, 2001).

It is important to note that, even in severely injured children, there are memory functions which remain intact. For instance, procedural memory or implicit memory has been shown to be unaffected by TBI (Ward, Shum, Wallace, & Boon, 2002). Children with severe TBI also tend to perform consistent with age expectations on tests of immediate, rather than short term, memory (Catroppa & Anderson, 2002).

Studies of the recovery of memory functions following TBI has revealed some concerning results. In addition to traditional findings of persisting deficits over time (Yeates, et al 2002), two studies of children with severe TBI have described a deterioration in verbal memory capacity over time (Anderson, Morse, Klug, Catroppa, Haritou, Rosenfeld, & Pentland, 1997; Catroppa, & Anderson, 2002). Consistent with Dennis' model, this reflects 'emerging difficulties' as children fail to acquire the necessary developmental skills.

Studies have also identified some potentially important moderator variables. In a longitudinal study Yeates et al (1997) found that memory functioning in children with severe TBI was influenced by their level of family functioning. Above average family functioning buffered the effects of the TBI on memory, while children from poorly functioning families performed worse. Children with premorbid learning difficulties also experience more declines in memory functioning following TBI of any severity (Farmer, Kanne, Haut, Williams, Johnstone, & Kirk, 2002).

1.7.6 Executive functions

Executive functions incorporate a range of skills, such as planning and organisational skills, behavioural regulation, working memory and self-monitoring, which enable purposeful goal-directed behaviour (Stuss and Benson, 1986). Given that the frontal lobe and its connections are highly vulnerable during instances of TBI, it is expected that executive deficits contribute a significant role to children's cognitive and adaptive profile following TBI. However, research exploring this area is relatively sparse due to the limited number of available tests with adequate norms for children and theoretical limitations in this construct (Anderson, 2002).

Most studies exploring the impact of TBI on executive functions have employed a cross-sectional design and many have not included a control group. Those that have included a control group reveal impairments in working memory up to 5 years post severe TBI (Hanten, Levin, & Song, 1999; Levin, Hanten, Chang, Zhang, Schachar, Ewing-Cobbs, & Max, 2002) and impairments in metacognition (Hanten, Bartha, & Levin, 2000). Impairments in planning have also been documented on the porteus maze test in severe TBI children three years post-injury when compared to mildly injured children (Levin, Song, Ewing-Cobbs, Roberson, 2001).

Due to limited test availability and difficulties accurately assessing executive functions in structured clinical testing situations, a complementary approach to measuring executive functions following TBI has been to use parent report using a new measure, the Behaviour Rating Inventory of Executive function (BRIEF). Preliminary results support long-term (5 years) executive dysfunction, with most deficits in those with severe TBI (Mangeot, Armstrong, Colvin, Yeates, & Taylor, 2002; Vriezen & Pigott, 2002). BRIEF ratings predicted children's adaptive functioning, behavioural adjustment, and performance on a working memory task. It also predicted parent psychological distress, perceived family burden and general family functioning. These results highlight the widespread impact of executive difficulties.

Other cross-sectional studies have been designed to investigate predictors of performance on executive function tests rather than dysfunction. These have revealed inconsistent findings most likely a result of variations in TBI severity, ages, tests used, and possibly time post-injury. While Levin, Song, Schiebel, Fletcher, Harward, Lilly, and Goldstein (1997) found support for an injury severity effect using the Wisconsin Card Sorting Test, the Tower of Hanoi, and the Controlled Oral Word Association Test, Slomine, Gerring, Grados, Vasa, Brady, Chritensen, and Denckla (2002) found that injury severity only predicted the number of perseverative errors made on the WCST, and was otherwise unrelated to performance on the Tower of London or 20 Questions test. This may have been a result of the different tests used as well as smaller range in injury severity included in Slomine et al's study.

With regard to recovery, three longitudinal studies have revealed that performance on tests of executive functions improve over time (Levin et al, 1997; Yeates et al, 2002). When comparisons are made with an orthopaedic control group however, children remain below age expectations despite these improvements (Yeates et al 2002). Consistent with the vulnerability hypothesis, children injured at an earlier age tend to recover at a slower rate (Levin et al, 2001).

A number of studies have explored the impact of focal lesions on executive function performance. Generally, volume of prefrontal lesion is predictive of performance on executive function tests (Levin, Song, Ewing-Cobbs, & Roberson, 2001; Levin et al, 1997; Levin, Song, Ewing-Cobbs, Chapman, & Mendelsohn, 2001) with the exception of one study which did not find this association (Slomine et al 2002). Particularly interesting are the results on word fluency performance. While right frontal lesions have no significant effect, left frontal lesions interact with age, with adverse effects shown in older children with left frontal lesions (Levin et al, 2001).

1.7.7 Academic performance

The vast number of cognitive deficits experienced by children following severe TBI places them at high risk of academic failure (Taylor, Yeates, Wade, Drotar, Klein, & Stancin, 1999). Actually documenting academic outcome is hampered, however, by a number of difficulties. Standardised tests of academic ability are not sensitive to higher level changes associated with TBI and teachers have been reported to be reluctant to identify low academic performance post TBI (Kinsella, Prior, Sawyer, Ong, Murtagh, Eisenmajer, Bryan, Anderson, & Klug, 1997).

In a prospective longitudinal follow-up study of academic status following mild-moderate and severe TBI in children and adolescents, Ewing-Cobbs, Fletcher, Levin, Iovino, and Miner (1998) found that 79% of the severely injured group had failed a grade or received special education assistance. This finding is similar to Kinsella et al's (1997), which reported that two years following injury, special education assistance was required by 70% of the children with severe TBI, 40% of the children with moderate TBI, and none of the children who had sustained a mild TBI. Thus scholastic difficulties appear to be a persisting consequence of moderate and severe TBI.

Using standard academic achievement tests, such as the Wide Range Achievement Test (WRAT), children with head injuries do not differ consistently from normal developing children on single word reading, although weaker maths and spelling skills have been documented (Kinsella et al, 1997; Taylor, Yeates, Wade, Drotar, Klein, Stancin, & Minich, 2002). Although these findings indicate that single word reading skills are relatively resilient to the effects of TBI, age at injury effects have been documented, with preschool TBI children demonstrating difficulties acquiring literacy skills. This has been demonstrated even in preschool children sustaining mild TBI (Gronwall, Wrightson, & McGinn, 1997).

These findings suggest that academic failure may result from a combination of cognitive and behavioural difficulties (i.e. reduced attention, memory, new learning, executive skills) limiting their ability to participate in classes and engage in new learning. Indeed, Kinsella et al (1997) demonstrated that children with poorer performances on tests of new learning and verbal fluency were more likely to require academic support.

Recent studies are beginning to identify the important impact of the family's level of functioning on children's academic achievement post TBI. Taylor et al (2002) found that children from high stressed, socially disadvantaged (low SES) families were more likely to perform poorly at school. By comparison, children from well functioning and well supported families were more likely to achieve greater academic success in spite of severe TBI.

1.7.8 Adaptive functioning and behavioural adjustment

The majority of research on the consequences of childhood TBI has focused on neuropsychological and academic outcome, with behavioural adjustment just recently receiving attention in the research literature. There has been considerable debate regarding the underlying cause of observed behavioural and adaptive changes, with some authors arguing that problems are a manifestation of pre-existing behaviour and family issues, while others support a neurological basis to these changes.

Assessment of behavioural adjustment and adaptive functioning typically involves the use of the Child Behaviour Checklist (Achenbach, 1991) or the Vineland Adaptive Behaviour Scales (Sparrow, Balla, Cicchetti, 1984). These commonly identify problems with hyperactivity, impulsivity, socially disinhibited behaviour, and poor emotional control. Severely injured children have been consistently found to have a higher incidence of behaviour problems as reported by their parents, with rates reported between 30% and 50% (Fletcher, Ewing-Cobbs, Miner, Levin, & Eisenberg, 1990; Kinsella, Ong, Murtagh, Prior, & Sawyer, 1999; Donders & Ballard, 1996). Children with

moderate injuries are also reported as having subsequent behavioural problems, however, to a lesser extent than those with severe injuries (Taylor et al 2002). Findings of behavioural problems post mild TBI have been inconclusive, with some studies failing to find a higher rate of behavioural problems post injury.

These behavioural problems are present during the first months after injury and persist up to four years post injury (Schwartz, Taylor, Drotar, Yeates, Wade, & Stancin, 2003). In comparison to the recovery seen in cognition, some studies suggest that behavioural problems increase with time and persist into adulthood (Klonoff, Clark, Klonoff, 1995), as depicted in figure 4.

In general, studies examining behavioural and psychological adjustment post TBI have been criticised for using standardised checklist which were not designed to be sensitive to the consequences of TBI. Bloom, Levin, Ewing-Cobbs, Saunders, Song, Fletcher, and Kowatch (2001) and Max et al (1999) have explored psychological outcome from TBI using semi-structured interviews of the parent and child. These studies have revealed a number of novel (newly presenting) psychiatric disorders, most typically ADHD and depression. These studies have revealed a common finding that these disorders occur and persist in approximately 50% of study groups of varying severity.

Family circumstances have been found to moderate both behavioural and academic performance 12 months after injury (Taylor et al 2002; Yeates et al 1997; Anderson, Catroppa, Haritou, Morse, Pentland, Rosenfeld, & Stargatt, 2001). While biological factors such as the severity of injury and the age of the child at injury heavily influence cognitive outcome, behavioural and academic adjustment appears to be more amenable to environmental factors. Using growth curve analysis, Yeates et al (1997) demonstrated that children with severe injuries showed better recoveries if they were from well functioning families. This may result from well-adjusted and high socio-economic status families having more support and greater access to rehabilitation services.

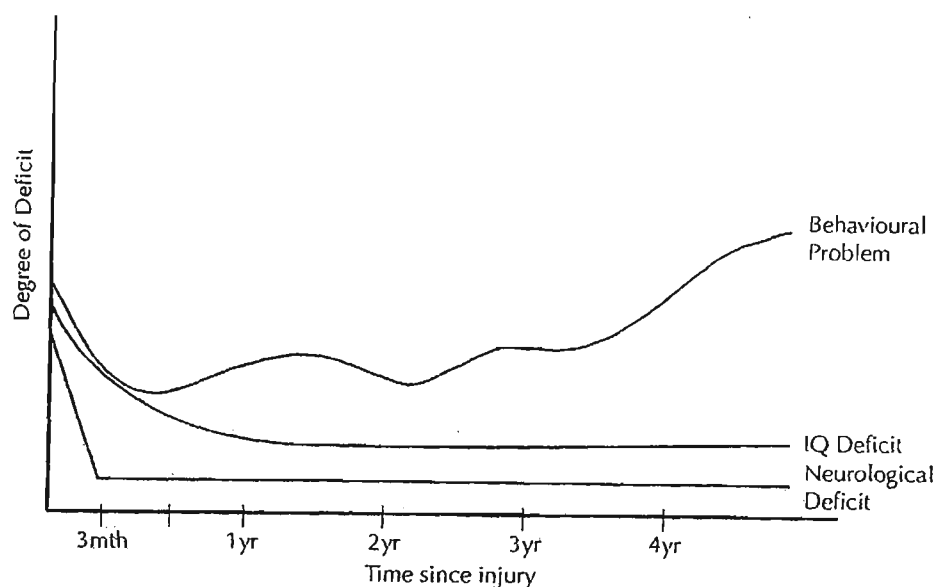


Figure 4. Cognitive, neurological, and behavioural recovery following TBI. This graph illustrates the persisting behaviour problems seen following TBI in spite of improvements typically seen in intellectual functioning and neurological functioning. From: Anderson, Northam, Hendy, and Wrennall (2001).

An overview of these previous studies illustrate that severe TBI, and to a lesser extent moderate TBI, is associated with wide ranging cognitive deficits in intelligence, higher level language skills, attention, memory, executive functions as well as functional declines in academic performance, behaviour, and psychological functioning. Research exploring the consequences of TBI on the components of these processes is growing, however, there is still a long way to go in understanding the full impact of paediatric TBI, particularly with regards to 'higher level' skills. While improvements occur fairly rapidly over the first 6 to 12 months, there is clear evidence for long term residual deficits in all areas. It is expected that higher level cognitive deficits contribute

to the persisting and often worsening emotional-behavioural and academic functioning.

The consequences of mild TBI is less clear. Although most well designed studies point to good recoveries, there is some evidence that subtle higher level deficits may persist. Until there are more thorough studies of executive functions in children following mild TBI, particularly involving follow-up assessments well into adolescence and early adulthood, clear conclusions cannot be formed. It will also be important for future research to explore those children with mild TBI who fail to make complete recoveries, to ascertain whether there are any factors associated with their suboptimal outcome. Failure to find evidence of recovery / improvement in performances over time does not necessarily mean that they have not sustained any damage. The impact of MTBI may not become apparent until children are required to learn new skills (Gronwall, Wrightson, & McGinn, 1997).

Chapter 2. Pragmatic communication

A higher level skill which may be affected by TBI but which has not been explored in any great detail in children is pragmatic communication. Findings that many children show relatively good recoveries on formal assessments of language, but ongoing communication problems at school and home, suggests that research needs to explore the impact of traumatic brain injury on more complex 'real world' language functions.

Pragmatics is a broad ill-defined area of linguistics concerned with the way language and nonverbal behaviour is used *in context* as a communication tool to achieve certain social ends, that is, the ability to communicate rather than simply talk (Bates, Thal, & Janowsky, 1992). It encompasses a wide variety of skills including providing the listener with accurate and sufficient information, taking turns during a conversation, staying on track, as well as maintaining appropriate eye contact and posture. The verbal aspects of pragmatic communication are most evident during discourse.

Discourse is defined as a sequence of ideas which are expressed to serve the communicative function of conveying a message (Chapman, Levin, and Lawyer, 1999). In comparison to the well defined rules governing other aspects of language, such as grammar and semantics, there are no exact or absolute rules for evaluating the effectiveness of pragmatic communication or discourse (Becker, 1990). Rather, this can only be evaluated on a situational basis as generally appropriate or inappropriate, taking into account the knowledge base of the involved individuals as well as social and cultural conventions.

Discourse can take on a number of genres depending on the communicative intent of the speaker. For example, a speaker can engage in a conversation (conversational discourse) and relate a story about a mishap on their recent overseas trip (narrative discourse) and they may then explain how you would

arrive at this destination (procedural discourse). Each genre of discourse has its own structure (Lund & Duchan, 1988).

From a theoretical perspective, it seems obvious that discourse ability is important to social and academic functioning. This has been supported empirically through identification of relationships between narrative discourse ability and academic performance and the ability to develop and maintain peer interactions (Chapman, Levin, & Lawyer, 1999).

2.1 Model of discourse

A model of discourse has been developed which represents the multiple levels of discourse under two main structures: linguistic and information (Chapman, 1995). The *linguistic structures* encompass the individual words, clauses, and sentences of discourse. These are well documented and understood. The *information structures* have only recently been defined. These encompass propositions, superstructures and macrostructure. Propositions refer to units of meaning, superstructure refers to the conventional schemas used to organise discourse (i.e. setting, action, resolution), while macrostructure refers to processes used to reduce the information while maintaining the central meaning (e.g. theme, gist, summary).

2.2 Assessment of discourse

The context dependency and subjective nature of discourse makes assessing its effectiveness a challenging task. Given these issues there are understandably a very limited number of standardized assessment tools available to practitioners (see Adams, 2002 for a review). Of those available, only one, the Test of Language Competence – Expanded (Wiig and Secord, 1989) has been used as a research tool in the paediatric TBI population (Dennis and Barnes, 1990, 2000). This test assesses the ability to create 'speech acts' - utterances or sentences which fit a context - by asking children to make up a sentence to fit a depicted scene using two given words. While the ability to create speech acts is a necessary constituent skill for discourse,

these tasks do not provide the full picture of a child's ability to produce discourse. Nevertheless both studies revealed persisting deficits in this skill in both mildly and severely injured children.

In order to obtain more naturalistic observations of discourse, researchers and practitioners provide children with a prompt designed to elicit a particular genre of discourse , such as “Tell me a story” for narrative discourse and “Tell me how you make your bed” for procedural discourse. Conversational discourse is often obtained through recordings of conversations between children during play activities with their peers or siblings or with a speech therapist.

The transcripts derived from these recordings are then evaluated using a number of measures which often vary markedly between studies but have a close association with Grice's (1978) maxims and the Clinical Discourse Analysis Method developed by Damico (1985).

Grice's (1978) “Co-operative principle” posits that people assume a degree of cooperation from their conversation partner. Specifically, he has defined four maxims which speaker's adhere to when conversing. The maxim of *Quantity* states that contributions should be as informative as required, *Quality* states that contributions should be truthful and accurate, *Relation* states that contributions should be relevant, and *Manner* states that contributions should be clear and orderly. Grice notes that these maxims can be deliberately violated for certain effect such as sarcasm, but when unsophisticatedly violated, they result in ineffective communication. Based on this principle, Damico (1985) identified 17 behaviours under the four conversational maxims which can be considered detrimental to functional discourse. These are summarised in table 3.

2.3 Normal development of discourse

Although comprehensive developmental norms exist for most language skills, our current knowledge of the normal development of discourse skills is

exceptionally limited. By 3 to 4 years of age, most children have mastered basic language structures. They are able to refer to past events by 2 years of age and can combine two events by three and a half (Chapman, 1995). Rule taking skills in conversation appear to develop around 3 years of age (Adams, 2002). It has been suggested that there is a reorganization of language between 4 and 6 years when children begin to use grammar for discourse purposes. During this time the child learns that the use of a pronoun, such as 'he', requires that it has been established prior to its use (Bates et al, 1992). Between 4 and 7 years, children show improved sequential ability in producing narratives with increased cohesiveness developing between 9 and 12 years. The ability to provide appropriate level of information is developed by 7 years (Adams, 2002).

Table 3. Discourse analysis parameters proposed by Damico (1985, 1991).

Quantity	Quality	Relation	Manner
Insufficient information bits	Message inaccuracy	Poor topic maintenance	Linguistic non-fluency
			Revision behaviour
Non-specific vocabulary		Inappropriate response	Delay before responding
Need for repetition		Inability to ask appropriate questions	Inability to structure discourse
Informational redundancy		Situational inappropriateness	Difficulty with turn taking
		Inappropriate speech style	Insufficient attention to and use of gaze
			Inappropriate intonational contours

2.4 Cognitive bases of discourse

Discourse clearly involves an interaction between cognitive and social skills as well as linguistic abilities. However, the cognitive bases of each genre of discourse are not yet well understood. It is expected that there are different relationships between each discourse genre and cognitive variables. There is

a general consensus that all forms of discourse reflect the workings of higher level cognitive skills, including attention, memory and executive functions, although there has been little empirical research to establish the validity of these associations (Chapman, Levin, & Lawyer, 1999; Brody, Perkins, & McDonald, 1999). Some research findings in adults with dementia and stroke suggest that procedural discourse may place less demand on these skills than narrative and conversational discourse (Ulatowska & Chapman, 1994; Ulatowska, North, & Macaluso-Haynes, 1981). Table 4 summarises the hypothesised impact of cognitive deficits on discourse function (Brody, Perkins, & McDonald, 1999; Chapman, Levin, & Lawyer, 1999; Coelho, 1999).

2.5 Impact of TBI on discourse

Given the pathology of TBI and its ability to produce diffuse insults affecting attention, information processing speed, memory, language and executive functions, it is expected that discourse would not be immune from the effects of TBI. Indeed, adult studies have implicated deficits in attention / concentration, mental flexibility, planning / organisation, and self-regulation, as being substantially responsible for difficulties using discourse appropriately in everyday settings (Brody, Perkins, & McDonald, 1999). Anecdotal descriptions of social communication following paediatric traumatic brain injury have emphasised disconnected, tangential discourse and organisational deficiencies (Ylvisaker, 1993). A small number of studies have systematically explored the impact of TBI on discourse in adults and children.

Table 4. Impact of cognitive deficits on discourse

Cognitive deficit	Resulting discourse behaviours
Slowed information processing	<p>Slowed speech</p> <p>Longer and more frequent delays before responding and whilst speaking</p> <p>Reduced efficiency i.e. fewer meaningful words, less information</p>
Working memory deficits	<p>Reduced connectedness / coherence because of less ties</p> <p>Reduced monitoring of discourse resulting in more repetitions and greater tangentiality</p>
Reduced memory function	<p>Impaired recall or retrieval of events may lead to disorganised explanation of events</p> <p>Less relevant information provided</p>
Planning and organisational problems	<p>Disorganised discourse with information presented out of sequence</p> <p>More revisions and false starts</p> <p>More repetitions</p> <p>Tangential, laborious discourse</p>
Reduced initiation	<p>Reduced spontaneity and fluency</p> <p>Less information provided</p> <p>More external prompting required</p>
Poor conceptual ability (abstraction)	<p>Long explanations due to a failure to convey the central point</p> <p>Concrete, inefficient, laborious discourse</p>
Disinhibition	<p>Unable to inhibit ideas that come to mind while talking leading to tangential responses and discourse that is off task. May contain inappropriate / irrelevant information.</p>

2.5.1 Narrative discourse

Discourse studies on children with TBI have almost exclusively focused on their production of narrative discourse. The main reason being that there is more information about the normal development of narrative skills, than other types of discourse (conversational, procedural).

Most studies have assessed narrative discourse skills either by asking children to spontaneously generate a story or by telling the children a story and then asking them to retell the story with the aid of visual prompts. Overall the findings demonstrate the vulnerability of pragmatic communication skills to TBI.

The studies using the story retelling method generally analysed children's narrative discourse based on their language structure (i.e. number of words, grammatical complexity) and information structure (i.e. the number of propositions used by the child, the episodic structure and production of the gist of the story). Impairments in the information domain measures, especially in the ability to provide an organised story sequence and the ability to produce the gist of the story, have been revealed in school age children during the acute phase (Chapman, Watkins, Gustafson, Moore, Levin, & Kufera, 1997) and one to five years post-injury (Chapman, 1995; Chapman, Levin, Wanek, Weyrauch, & Kufera, 1998; Ewing-Cobbs, Brookshire, Scott, & Fletcher, 1998). Consistent with most outcome studies, there was considerable variability in the TBI children's performances, with some performing at a similar level to the control children. As hypothesised, these discourse deficits were evident despite the TBI groups performing normally on standard language measures.

In a more recent study, Chapman, Sparks, Levin, Dennis, Roncadin, Zhang, and Song (2004), extended these earlier findings to explore children's ability to produce summaries of lengthier written and verbal text, rather than retelling the story. As was expected, their group of severe TBI children (aged 7 to 14 years) demonstrated difficulties with the task, failing to adequately summarise and generalise the information conveyed.

Chapman, McKinnon, Levin, Song, Meier, and Chiu (2001) have also used a story generation method to assess narrative discourse skills, but using sequenced pictures as a prompt. Unlike the previous studies, this included longitudinal assessment of children, providing the first glimpse at the recovery of these skills. They compared 22 severely injured and 21 mild-moderately injured children aged between 5 and 10 years of age. Over the three years, they found that the severely injured children were worse off than the mild-moderately injured children across all domains of quantity, quality, relation and manner. Qualitative analysis also indicated that the severe group recovered at different rates across the four measures over the three year interval. Unfortunately, the lack of a normally developing control group hinders the findings of this study as it is difficult to separate normal developmental gains from recovery. It also fails to prove or disprove the evidence of deficits following mild-moderate injuries.

Given the variability often seen in discourse performance following TBI, researchers have explored possible factors which may account for this variability. Analysis of age at injury demonstrated that children injured at a younger age are more likely to experience more significant narrative discourse difficulties (Chapman et al 1998; Chapman et al 2004; Ewing-Cobbs et al 1998). This pattern emerges whether comparisons are made between children injured before or after 4 years of age, or before or after 8 years of age. Children who display acute language difficulties are also likely to experience more widespread discourse difficulties (Ewing-Cobbs et al 1998). Chapman, Levin, Wanek, Weyrauch, and Kufera (1998), have also explored the impact of focal frontal lesions superimposed on diffuse injuries. Both left

and right frontal lesions were associated with deficits in information structure, while only left frontal lesions were associated with language structure deficits.

Studies assessing discourse by asking children to generate stories have differed in their method, resulting in some conflicting findings. Jordan, Murdoch, and Buttsworth (1991) asked children to tell a story when prompted by an action figure. Using this approach they failed to identify any differences between mildly injured, severely injured and normally developed age matched children. By contrast, Biddle, McCabe, and Bliss (1996) elicited a personal narrative by an interviewer relating a personal experience and then asking the child to describe a similar experience. Their group of twelve year old children ($n = 10$) with heterogenous injury severities (7 mild-moderate, 2 severe, 1 unavailable injury information) performed worse on most measures, with the exception of the number of explicit propositions they gave. This suggests that they produce as much discourse as normally developing children, but in a less coherent and efficient manner. They also compared their group of injured children to a group of adults with TBI, and used findings that children performed worse than adults as support for the vulnerability hypothesis. However, this comparison is questionable, given that normally developing children's pragmatic communication skills are in the process of development and not comparable to adults.

2.5.2 Conversational discourse

Campbell and Dollaghan (1990) failed to find persistent deficits in conversational discourse in their group of severely injured children, although they only included measures of language structures. Considerable variability was noted within the group, and investigation of individual cases revealed that 5 out of the nine subjects showed marked deficits at one year.

Morse, Haritou, Ong, Anderson, Catroppa, and Rosenfeld (1999) presented preliminary findings on small groups ($n=5$) of pre-school children with mild, moderate, and severe injuries compared to a normally developing control group. Conversational discourse was assessed by applying Damico's

discourse analysis to transcripts of a 10 minute play segment between the child and a therapist. Overall the study did not find any statistically significant differences between the groups, although the severely injured children tended to make a greater proportion of errors in the relation category, particularly with respect to maintaining the topic of conversation and responding appropriately. Once again, there was significant variability within the TBI groups which undoubtedly clouded findings in these very small groups.

2.6 Procedural discourse

Procedural discourse is a goal-oriented monologue genre which is concerned with explaining to a listener how something is done. Intuitively this type of genre requires the speaker to be specific and clear, whilst maintaining the topic. Consequently, it is expected that procedural discourse places demands on planning and organisational abilities, as well as perspective taking and self-regulation. Given the lack of tests available to assess executive functions in young children, assessment of procedural discourse may provide an alternative 'real-world' view of a child's executive abilities. Surprisingly, this genre of discourse has not been studied in children with traumatic brain injury. However, it is one of the most frequently studied discourse genres in adults with traumatic brain injury.

2.6.1 Procedural discourse in adults with traumatic brain injury

Overall, research studies have used one of two different methods for eliciting procedural discourse. The first, drawn out of studies on adults with aphasia or alzheimer's dementia, requires subjects to explain how they do a number of everyday tasks, such as buying groceries (Hartley and Jensen, 1991) or withdrawing money from the bank (Snow, Douglas, and Ponsford, 1997). In these studies, the researcher's identify the important or essential steps within each task on the basis of them having been used by at least 80% of the normal sample in the study (Hartley and Jensen, 1991) or a sample of clinicians (Snow et al 1997). Both studies used modifications of Damico's

discourse analysis to quantify the content of the output provided by the subjects.

Hartley and Jensen's (1991) study found that their group of 11 severely injured adults performed below their normal age matched control group on a number of measures. Overall they left out more important steps in the task, they were less fluent, and more vague, however, there was considerable variability within the group. Snow et al (1997) also found that their group of 26 severely injured adults produced less important steps than an age matched control group of university students. However, the number of important steps produced by the TBI group did not differ to a group of age matched orthopaedic patients of similar educational and sociodemographic background, supporting Snow et al's (1997) hypothesis that essential steps or propositions is closely related to sociodemographic background. Nevertheless, their clinical discourse analysis still revealed differences between the TBI group and both control groups. Specifically, the TBI group displayed more difficulties staying on the topic and they provided more redundant, repetitive, and vague information. Once again, there was considerable variability within the TBI group, with some performances overlapping with the control groups.

The second main method used by researchers to elicit procedural discourse is the 'dice game', a simple board game which has previously been used to explore the development of perspective taking in children. This requires subjects to play the game with the examiner and then explain how to play the game into a tape-recorder as though explaining to someone who is totally unfamiliar with the game. Two studies have done case analyses using this task, one comparing two adults with severe brain injuries to 12 age matched controls (McDonald, 1993), and one comparing three late adolescents (2 severely injured, 1 mildly injured) to 36 controls (Turkstra, McDonald, & Kaufmann, 1996). Both found evidence for pragmatic deficits in these severely injured adult subjects. In particular, McDonald (1993) noted that their type of difficulties were closely related to their profile of executive deficits, with one subject providing overly repetitive stimulus bound responses and the

other providing empty answers and requiring considerable prompting. The mildly injured subject performed as well as the controls.

McDonald and Pearce (1995) extended their study to include a larger sample of 20 severely injured and 20 age matched controls. Consistent with previous findings, the TBI group mentioned fewer essential steps and provided more irrelevant points. There were considerable variability in performances which possibly reflects the wide-ranging pathology in this group.

The previous literature review highlights a number of areas in the outcome from childhood TBI that require further study. In particular, our understanding of the impact of TBI on higher level functional skills is scarce. In this regard, it seems especially warranted to explore the impact of TBI on pragmatic communication skills. Studies that have investigated this area consistently reveal difficulties in children and adults following moderate-severe TBI, despite normal performances on standard assessments of language, suggesting that pragmatic communication skills are especially vulnerable to TBI. These difficulties may contribute to social – behavioural difficulties as communication breakdowns may lead to social isolation or frustration. Given that social and behavioural difficulties often progressively worsen following TBI and have the most disabling impact on a child's life, insights into the nature of pragmatic communication difficulties may provide avenues for appropriate management.

At present, research has largely focused on children's pragmatic communication skills during narrative discourse, with some preliminary studies completed of conversational discourse. To date, the impact of TBI on children's procedural discourse has not been investigated. Although the cognitive bases underlying each genre of discourse have not been empirically validated, it is theorised that procedural discourse places demands on executive functions, including planning and organisational ability, working memory, abstraction and perspective taking. Based on this assumption, procedural discourse tasks are often used by therapists to assess executive skills, as there are a limited number of formalised tests of executive functions for young children. Empirical research clearly documenting the pattern of normally developing and TBI children's performances on these tasks is clearly needed to guide the use of these tasks in clinical practice.

To most accurately identify changes in pragmatic communication, we also need to explore the developmental process of these skills. This can only be

achieved using a longitudinal assessment design. Unfortunately only one study has employed this design in exploring children's pragmatic communication following TBI. While the cross-sectional studies are useful for documenting group differences at one point in time, they are unable to illustrate how children's pragmatic communication skills develop and change over time. Longitudinal analysis provides a means of documenting differences in rates of development versus recovery and also of identifying emerging difficulties which do not present until several years after the injury.

Exploration of the impact of TBI on pragmatic communication has thus far focused solely on the impact of moderate-severe TBI. The impact of mild TBI is largely unknown. Studies which have included a mild TBI group have had a very small sample size (Morse et al, 1999), or they have not included a control group to compare the mild TBI group's performance against (Chapman, McKinnon, Levin, Song, Meier, and Chong, 2001). Thus further research is clearly needed to evaluate the impact of mild TBI on the development of procedural discourse skills. Although most studies assessing intellect, attention and memory, report good recoveries from mild TBI, there have been some indications of persisting subtle higher level difficulties (Anderson, Catroppa, Morse, Haritou, Rosenfeld, 2001; Catroppa and Anderson, 2002; Ewing-Cobbs, Fletcher, Levin, Francis, Davidson, and Miner, 1997). Given the complexity and highly challenging nature of discourse, it is possible that this may be more sensitive to changes associated with mild TBI.

3.1 Aims

The present study aims to:

- Explore the impact of traumatic brain injury on pragmatic communication skills during a procedural discourse task in children aged between 3 and 7 years at the time of injury.
- Explore the recovery of pragmatic communication skills with assessments during the acute phase (1 to 3 months) following injury and again at 30 months post injury.

- Explore the impact of injury severity on procedural discourse, with comparisons of mildly injured and moderate-severely injured children.

3.2 Hypotheses

- The group of children with moderately-severe traumatic brain injuries will display more errors across the domains of quantity, relation, and manner compared to the group of normally developing children at both assessments.
- The moderate-severe TBI group will also display more errors across the domains of quantity, relation, and manner compared to the mild TBI group at both assessments.
- During the acute phase of recovery, the group of mildly injured children will display more errors in the quantity, relation and manner domain compared to the group of normally developing children. There will be no differences between the mild TBI and control groups at the 30 months follow-up

The present study employed a prospective longitudinal design using archival data consisting of video footage, cognitive test scores, and injury and pre-injury information. This information was originally collected as part of a larger study of outcome following childhood TBI at the Royal Children's Hospital (Anderson, Morse, Klug, Catroppa, Haritou, Rosenfeld, & Pentland, 1997) which was supported by the Australian National Health and Medical Research Council and the Royal Children's Hospital Research Foundation. Approval to conduct the study was granted by the Royal Children's Hospital Ethics in Human Research Committee and the Victoria University Psychology Department Ethics Committee (see appendix A).

3.1 Research Participants

A total of 29 children participated in this study: 9 children with mild TBI, 11 children with moderate-severe TBI, and 9 normally developing uninjured children. All children were selected from a larger group of children who had taken part in a broader study of outcome following childhood TBI being undertaken at the Royal Children's Hospital, Melbourne.

3.1.1 The Larger Study

TBI participants

Children with TBI were recruited from consecutive admissions to the Neurosurgical Ward of the Royal Children's Hospital, Melbourne between June 1993 and June 1997. Over this time, 96 children were recruited to participate in the larger study on the basis of the following three inclusion criteria:

1. Aged between 3 and 7 years at the time of injury
2. Documented evidence of a TBI, including period of altered consciousness
3. Medical records sufficiently detailed to determine severity of injury

Diagnoses of TBI were initially assigned during hospital admission on the basis of injury history, conscious state, MRI / CT scans and neurological examination. Children's level of consciousness was measured according to the Glasgow Coma Scale (GCS). The admission GCS was recorded by the admitting medical officer. Nursing staff on the neurosurgical ward recorded neurosurgical observations every 4 hours, with recordings continuing until the child had regained consciousness. Duration of post-traumatic amnesia was not measured, as the measures available for this age group of children are not sufficiently reliable.

Children were classified into groups according to severity of injury based on admission GCS, neurological assessment findings and brain imaging results as follows:

- (1) *mild TBI*: GCS 13 – 15, no evidence of mass lesion on CT/MRI and no neurological deficits
- (2) *moderate-severe TBI*: GCS less than 13 and / or evidence of mass lesion on CT/MRI and/or neurological deficits.

Children were excluded from the larger study if the TBI was a result of child abuse or was an open penetrating head injury; if there was a history of a previous head injury, or if there was evidence of preexisting physical, neurological, psychiatric or developmental disorder.

All children who had sustained a moderate-severe TBI received speech therapy as part of their rehabilitation program.

Normally developing participants

The larger sample of normally developing un-injured children comprised 36 children aged between 2 and 7 years who were recruited via schools and child care centers. Children were excluded if they had a history of neurological, developmental or psychiatric disorder.

3.1.2 The Present Study

Participants in the present study were selected from this larger sample on the basis of two criteria:

- 1. Intelligible speech during procedural discourse task
- 2. Completed and cooperated with procedural discourse task initially after injury and at 6 month and/or 18-30 month follow-up.

From the 96 TBI participants in the larger study, 9 children with mild TBI and 11 children with moderate-severe TBI met the above criteria. The injury characteristics of the TBI groups are presented in table 5.

Table 5. Injury characteristics of the TBI groups

Injury characteristic	Groups	
	Mild TBI (n = 9)	Mod-severe TBI (n = 11)
Age at injury (years); M (SD)	5.2 (1.2)	6.0 (1.3)
GCS (on admission); M (SD)	14.0 (1.5)	8.1 (2.4)
GCS (24 hr); M (SD)	14.8 (.8)	12.6 (2.9)
Duration of coma; n (%)		
None	7 (78)	5 (45)
< 10 minutes	2 (22)	1 (9)
< 1 day	0 (0)	2 (18)
1 – 7 days	0 (0)	3 (27)
Neurosurgical intervention n (%)	0 (0)	4 (36)
Abnormal CT / MRI findings n (%)	0 (0)	8 (73)
Neurological abnormalities n (%)	1 (11)	5 (45)
Cause of injury n (%)		
MVA (passenger)	0 (0)	2 (18)
MVA (pedestrian / cyclist)	1 (11)	3 (27)
Fall / blow	8 (89)	5 (45)
Other	0 (0)	1 (9)

GCS = Glasgow Coma Scale

MVA = Motor vehicle accident

The non-injured normally developing children were selected to match the TBI groups on age, sex, and pre-injury adaptive functioning (Vineland Adaptive Behavior Score). Nine of the 36 normally developing children were selected to act as a normative comparison group. The demographic characteristics for all three groups are presented in table 6.

Table 6. Demographic characteristics of groups.

Characteristic	Groups		
	Mild TBI (n = 9)	Mod-Severe TBI (n = 11)	Controls (n = 9)
Age at initial testing (years); M (SD)	5.2 (1.2)	6.0 (1.3)	5.4 (1.8)
Sex (male:female)	5:4	6:5	4:5
Socioeconomic status*; M (SD)	4.0 (.89)	4.8 (.88)	3.5 (1.01)
Full Scale IQ; M (SD)	115 (23)	110 (11)	112 (16)
VABS; M (SD)	107 (19)	102 (18)	110 (8)

*Daniel's (1983) Scale of Occupational Prestige

3.2 Measures

3.2.1 Parent Questionnaires

Demographic and Injury Questionnaires

Data were collected on each child's medical and developmental history, parental education and occupation, and family constellation. Socioeconomic status (SES) was coded using Daniel's Scale of Occupational Prestige (1983). This scale was developed and normed on the Australian population. It rates parent occupation on a 7-point scale, where a high numerical score represents a lower SES.

Adaptive functioning

Children's preinjury adaptive functioning was assessed using the Vineland Adaptive Behavior Scale (VABS; Sparrow, Balla, & Cicchetti, 1984). This has a structured interview format, where parents are asked to describe their child's functional behaviour in three domains: communication, daily living, and socialization. Standard Scores (mean = 100, standard deviation = 15) are obtained for each domain as well as a Total Adaptive Behavior Score which

encompasses each domain. For the purposes of this study, the Total Adaptive Behavior Score and the Communication Score were used in analyses. The scale was completed by all parents on enrolment in the larger study, to obtain the most reliable estimate of their child's preinjury functioning.

3.2.2 Cognitive measures

Intellectual functions

Intellectual functions were assessed using the most commonly used tests to assess children's intellectual ability. The Wechsler Preschool and Primary Intelligence Scale – Revised (WPPSI-R, Wechsler, 1989) was administered to children aged less than 6 years 6 months, and older children were administered the third edition of the Wechsler Intelligence Scale for Children (WISC-III, Wechsler, 1991). Full Scale IQ scores, Verbal IQ scores, and the Performance IQ scores (mean = 100, standard deviation = 15) were used in analyses.

Expressive language

Expressive One-Word Picture Vocabulary Test (EOW-PVT; Gardner, 1979):

This task measures a child's ability to provide names for pictorial stimuli.

Standard scores (M = 100, SD = 15) were calculated, and these were included in analyses.

Verbal Fluency (McCarthy, 1972): Children are required to name items in four categories: things to eat, animal, things to wear, and things to ride. There is a 20 second time limit for each category. The total number of correct responses is calculated and an age equivalent score is obtained.

Receptive language

Peabody Picture Vocabulary Test – Revised (PPVT-R; Dunn & Dunn, 1981):

This task evaluates children's receptive skills for single words, with items graded in order of difficulty. Standard scores (M = 100, SD = 15) were employed in statistical analyses.

Test of Auditory Comprehension of Language – Revised (TACL-R; Carrow-Woolfolk, 1985): This measure includes a number of subtests that tap aspects of language comprehension. Deviation quotients ($M = 100$, $SD = 15$) were calculated and included in analyses.

3.3 Procedural discourse task

The procedural discourse task involved the children explaining how to play one of two common children's games 'snap' or 'guess who'. The formal instructions for each game, as outlined by the game developers, are included in Appendix B. In summary, 'snap' is a card game in which two or more players are given an equal amount of cards. Players then take turns to place a card down in the centre between the players and when consecutively placed cards have the same picture, players attempt to 'snap' or slap their hand on top of the cards. The first to do so is the winner and receives the cards. The process continues until one person has won all the cards in the deck.

Guess Who is developmentally more challenging and is generally recommended to be played by children 7 years or over. This game is played by two players. Each player has a board which has a number of people's faces on it which can be flipped up and down. Each player chooses a card which depicts one of the faces on the board and they keep this secret from the other player. The aim of the game is for each player to guess who the other player's person is. This is done by each player taking turns to ask questions to identify the person through the physical characteristics of the person. Based on the answers, players can eliminate people who do not fit the descriptions by flipping these people down on the board. The first player to guess who the other player's person is the winner.

It was necessary to choose two games of varying complexity to ensure that there was a developmentally appropriate and challenging task for children at different developmental levels. This was especially important given the longitudinal nature of the study and wide age range in participating children (3 to 7 years).

The procedural discourse task began with children playing the particular game with a speech therapist or child psychologist. The decision regarding the game used to elicit the procedural discourse was made at the discretion of the therapist on the grounds that it was most suitable for the child's developmental level. Children were then asked to explain to the therapist how to play the game. The typical introduction to the task was "Can you explain to me how we played that game. Imagine that I have never played it before. I want you to explain it to me from start to end, going step by step". Prompting was avoided if possible. However, when children provided brief responses, therapists provided prompts such as "and then what happens" or "and how do you win this game". In cases where children were very reluctant to respond, therapists began with general prompts but progressed to increasingly more specific prompts such as "what did we do first", to "what did we do when the cards matched", "when the cards matched we". In addition to prompting, therapists also clarified responses when these were not clear.

Transcription

Samples of discourse were video recorded with a Panasonic NV-M40 VHS camera and then each sample was transcribed orthographically including all repetitions, fillers (um's, ah's, and mmm's), and delays in responses.

Nonverbal responses were not recorded as children were not consistently in the same camera view. Transcriptions commenced at the completion of the therapists introduction to the task. Any repeated explanations of the task requirements were included in the transcript.

Samples were then segmented into 'communication units' based on Barrie-Blackley, Musselwhite and Rogister's (1978) protocol. A communication unit is an independent clause, or meaningful unit, with all its modifiers. Segmenting according to the communication unit rather than the phonological unit was chosen as this method retains the semantic meaning of what is being communicated. There are a number of rules which guide this segmentation process which are outlined in Table 7 including examples taken from the data.

Table 7. Segmenting Rules – Barrie-Blackley et al (1978, pp 102 – 110)

Rule number	Rule	Example
1	A CU need not be complete in structure	T: and who wins.. the person with the most C: cards
2	A 'sentence' that contains utterances that can 'stand alone' (i.e. a compound sentence conjoined with 'and', 'and then', or 'then') is considered two or more CUs	C: then I said the name C: then I won the game
3	A conjoined 'sentence' in which subject or verb deletion has occurred will be counted as one CU, provided it falls within one PU	C: and we put the cards down and went snap
4	The child's use of terminal juncture (i.e. pauses) may produce grammatically independent predications that are not complete in structure	C: give on to you (pause) C: one to me (pause) C: one to you
5a	'Adjoined' utterances are counted as one CU, provided all clauses fall within one PU	C: don't know maybe if you have all the cards?
	Some additional segmenting conventions may be necessary Segmenting 'adjoined' CUs: If two or more clauses are linked to an adjoining clause, the entire utterance is counted as one CU.	C: you get a card put it here and you flip these up
	If the child begins by adjoining, the changes to conjoining, the utterance is divided according to the rules for conjoining	C: if you ask them does you person have a hat and they say no you put down all the people with hats
5b	Segmenting 'asides' in CUs: An explanation or expansion within or at the end of a CU is counted as part of the CU to which it refers.	C: and then you get a card a new card

Transcription reliability

A random selection of 7 percent of segments (one participant from each group) were also transcribed by a second rater to gain a measure of transcription accuracy. Word-by-word comparison revealed 94% agreement between transcriptions, with a range of 82% to 100%. Any unclear utterances

within the entire sample were clarified by a speech therapist. Appendix C includes an example of a transcript and its completed rating form.

Outcome measures

Outcome measures to evaluate the pragmatic communicative efficiency of the procedural discourse samples were derived using Damico’s Clinical Discourse Analysis model as a reference. Table 8 outlines the present study’s outcome measures and their relationship to Damico’s Clinical Discourse Analysis model and Grice’s four conversational maxims. A description of the outcome measures and how they were operationalised follows.

Total number of communication units produced

This provides a measure of the quantity of verbal output produced by the child. The primary examiner and a second rater independently segmented 7% of all discourse samples. Reliability regarding the number of communication units was 98% for the selected sample.

Content score: percentage of essential steps produced

This provides a measure of the quantity of relevant and essential information conveyed by the child. As there are a number of steps involved in playing each game, it was necessary to establish which steps are considered essential to understanding how the game is played. Using a procedure described by Snow, Douglas and Ponsford (1997), operational definitions of essential steps for playing ‘Snap’ and ‘Guess Who’ were obtained by asking four speech therapists to provide written descriptions of how to play each game. A step was classified as essential if it was included in 75% (3 out of 4) of the descriptions. Table 9 lists the 9 essential steps for ‘Snap’ and the 12 steps for ‘Guess Who’. Due to the use of different games, children’s responses were converted to a percentage score.

Table 8. Procedural discourse outcome measures as derived from Grice’s maxims and Damico’s Clinical Discourse Analysis model

Grice’s maxim	Damico’s parameters	Study outcome measures
Quantity <i>Contributions should be as informative as required</i>	Insufficient information bits	Total number of communication units
		Content score: <i>percentage of essential steps produced</i>
	Non-specific vocabulary	Total number of nonspecific words
	Need for repetition	Therapist burden - Number of therapist prompts - Number of therapist clarifications - Number of therapist redirections
Relation <i>Contributions should be relevant</i>	Informational redundancy	Verbosity score - Number of correct but unessential steps - Number of redundant communication units
	Poor topic maintenance	Percentage of output on-task
Manner <i>Contributions should be clear and orderly</i>		Listener burden - % of clear steps - % of ambiguous steps
	Inability to structure discourse	Organisational score

*Main outcome measures shown in bold type.

Listener burden

This measure was developed to provide further information about the informativeness of the explanation provided. While the content score indicates how much essential information is conveyed, the listener burden measure indicates how clearly this information is conveyed.

To establish this measure, the content score was further categorized into the number of the essential steps stated clearly and directly (*percentage of clear steps*) and the number of essential steps stated ambiguously or required the listener to make an assumption or inference to establish its meaning (*percentage of ambiguous steps*). A clearly stated step must not contain any nonspecific vocabulary or nonspecific references to the game, otherwise it is considered to be ambiguous.

The listener burden measure was derived from the ratio of the number of ambiguously stated steps to the number of clearly stated steps. Thus a lower score indicates that the steps have been communicated in a clear direct manner, whereas a higher score suggests the listener has had to infer or make some assumptions about what has been said. Overall, this measure provides an indication of how hard the listener had to work to understand the child's explanation.

Table 9. Essential steps for playing ‘Snap’ and ‘Guess Who’.

Snap	Guess Who
1. Deal out the cards	1. Each player has a board
2. Each player should have the same number of cards	2. Each board has lots of different people's faces
3. Players hold their cards face down	3. The faces sit upright / you have to flip the people's faces up
4. Players take turns	4. Each player picks a card from the pile
5. Players put down / turn over cards	5. You don't show your card / person to the other player
6. Cards are put down in the middle / between players	6. The aim of the game is to guess the other player's person and they have to guess yours
7. When the top two cards are the same / match, you slam down your hand on top of them (and say snap)	7. Each player asks questions e.g. does your person have brown hair
8. The first person to 'snap' gets to have the cards in the pile	8. If the answer is yes you flip down the people without that feature (brown hair)
9. The person with all the cards is the winner	9. If the answer is no you flip down all the people that do have that feature
	10. You keep going until you only have a few people / one person left
	11. You ask them is it's one of these people / this person
	12. The first person to guess the other player's person is the winner

Total number of non-specific words

This provides further detail about the informativeness of the response, with more non-specific words suggesting a vaguer response. Non-specific words included: thing, stuff, it, that, there, and here. These words were not recorded as non-specific if they had been clearly referenced in a previous communication unit. For example:

Child: You pick a card

Therapist: And then what happens

Child: You put it in the front of the board. ('it' clearly refers to the card).

Therapist burden

This is a measure of how hard the therapist had to work to obtain a suitable answer from the child. The overall 'therapist burden' measure was derived from the sum of three separate measures:

1) the total number of times the therapist prompted the child

e.g. "and then what happens", "and how do you win", "what did we do first"

2) the total number of times the therapist clarified a responses

e.g. Child: you get one to you one to me one to you one to me

Therapist: oh until we both have half each (clarification)

Child: [nods]

e.g. Therapist: what was that? (clarification)

Child: they miss

Therapist: so if you miss out you don't get any (clarification)

Child: nuh yeh

3) the total number of times the therapist repeated or rephrased the task instructions

e.g. Therapist: OK, now you tell me how to play snap. You pretend I don't know how to play (3 second pause)

Therapist: How do you play snap [child's name]. Can you tell me?

Higher scores are indicative of higher therapist burden, or greater therapist involvement in eliciting the procedural discourse.

Verbosity score

This is a summary measure which provides an indication of the efficiency of the child's explanation. It incorporates two separate measures:

- 1) the total number of times the child produced a correct but unessential step in the game

e.g. Child: first we shuffle it (shuffling is not listed as an essential step for playing snap)

- 2) the total number of times the child produced redundant information, that is, information which was new but did not provide any further information

e.g. Child: you ask them if they're male or female

Therapist: ahm

Child: or you can ask them what their eyes are or if they have a hat

Therapist: ahm

Child: or if they don't have a hat

Therapist: ahm

Child: or if they have glasses or if they don't have glasses

Therapist: ahm

Child: and if they have a moustache (or a) or if they (they) have a beard.

Higher verbosity scores reflect a more verbose, inefficient explanation.

Percentage of output on-task

This was operationalised as the percentage of communication units which were related to explaining the task (regardless of whether they were incorrect, verbose etc). Communication units which diverted from the explanation were counted as being off-target. Thus a smaller percentage is indicative of a tangential explanation.

e.g. Child: (you) you have to stop for the other persons turn

Therapist: oh I see

Child: hey it's cold under the table

Organisational score

Children's responses were evaluated according to the order in which they presented the steps of the game. Children lost a point for each step which was out of sequence, hence negative scores are suggestive of a disorganized response.

Summary Outcome Measures

Given the large number of dependent variables, eight outcome measures were chosen to use as the main outcome variables in statistical analyses. These are the Total number of communication units, Content score, Therapist burden, Verbosity score, Percentage of output on-task, Mazes, Organisational score and Listener burden (as shown in bold in table 8). These were chosen as the main variables as they summarise much of the data obtained and theoretically tap the essential elements of Grice's maxims of quantity, relation and manner. Grice's maxim of quality, which pertains to the accuracy of the information, was not included as a main variable. Previous research suggests that TBI does not impact on children's or adult's ability to provide accurate information.

Rating reliability

The examiner counted the frequency of each of these outcome measures for each transcript. To obtain a measure of inter-rater reliability, an experienced speech pathologist rated a 17% (16) of the transcripts, randomly chosen from the entire sample, on a selection of outcome measures. Agreement was high for most measures – 98% on the content score, 93% on the percentage of essential steps stated, 99% on the percentage of essential steps omitted, 98% on the listener burden score, and 96% on the therapist burden score. The poorest agreement was for the percentage of essential steps inferred (70%) and the number of non-specific words used (79%).

4.4 Procedure

The data for the present study were obtained from a larger set of data archived at the Royal Children's Hospital. The procedure for obtaining this original data set has been outlined in various publications based on this data set (Anderson, Catroppa, Haritou, Morse, Pentland, Rosenfeld, Stargatt, 2001; Anderson, Catroppa, Morse, Haritou, Rosenfeld, 2000; Anderson, Catroppa, Morse, Haritou, Rosenfeld, 2001; Anderson, Morse, Klug, Catroppa, Haritou, Rosenfeld, Pentland, 1997).

For the present study, children were selected according to the inclusion criteria described for the current study. Each child's video segment of procedural discourse was identified and transcribed orthographically. A selection of these were transcribed by a second person to ensure reliability. Once the rating scheme was devised, the primary researcher and an experienced speech pathologist applied the scheme to two transcripts. Any confusion / discrepancy in scoring was resolved through comparison and discussion of scores. This resulted in further clarification to several measures. The primary researcher then rated all of the transcripts according to the revised rating scheme. Transcripts were rated in random order and the rater was blind to the child's group status. The speech pathologist then scored a random selection of transcripts and inter-rater reliability was established.

For the larger study, children were initially assessed on cognitive and discourse measures once acute neurological dysfunction / post-traumatic amnesia had resolved, thus there was some variability in the timing of this assessment (0 – 3 months). Reassessments with the same test protocol were conducted at 6 months, 12 months, 18 months and 30 months after their initial assessment. The present study used only the data obtained from the acute and 30 month assessments. In the circumstances where a child did not complete the procedural discourse task at the 30 month assessment, their 18 month assessment results were used instead. Overall most (75%) children completed the procedural discourse task at the 30 month assessment.

Assessments were conducted by a child psychologist or one of three experienced speech pathologists. Attempts were made to maintain consistency in therapists across assessments, however, there were occasions when a child was seen by different therapists over time. Most assessments were conducted in a quiet therapy room at the Royal Children's Hospital, although, in some circumstances, children were assessed in their home or in a quiet room at their school. Younger children (under four years) were often assessed in the presence of a parent / caregiver. In general the assessment protocol took two hours to complete. Children were given breaks throughout assessments as needed to reduce the impact of fatigue and to maintain an optimal level of motivation.

5.1 Preliminary analyses

The data were analysed using SPSS version 11.5. Preliminary analyses were computed to establish whether there were any confounding variables and to ensure statistical assumptions of analysis techniques were met.

5.1.1 Group scores on demographic and pre-injury variables.

The three groups were selected to closely match on background and pre-injury variables which could possibly impact on their performance on the procedural discourse task and hence confound the results. Statistical comparison using one-way analysis of variance (ANOVA) revealed that there was no significant difference between the groups' mean age at initial assessment, $F(2,26) = .92$, $p = .41$, gender, $F(2,26) = .13$, $p = .88$, or their pre-injury Vineland Adaptive Behavior Score or Communication Score, $F(2,23) = .17$, $p = .85$; $F(2,24) = .65$, $p = .53$, respectively. Although a greater proportion of children in the control group (55%) completed the procedural discourse task at 18 months, compared to 11% of the mild TBI children and 9% of the moderate-severe TBI, there was no significant difference between the groups' mean age at the follow-up assessment, $F(2, 28) = 1.73$, $p = .19$.

A significant difference was found between the groups' mean socioeconomic status (SES) scores, $F(2,26) = 5.13$, $p = .01$. See table 10 for means and standard deviations. Post hoc comparisons using Tukey's statistic revealed one significant group difference, with the moderate-severe TBI group coming from a lower SES background than the control group, $p = .01$. This is consistent with the demographics of TBI populations reported in comparable studies (e.g. Kraus, Rock, & Hamyari, 1990). Given that verbal ability is related to SES (Snow & Douglas, 2000), analyses were computed using SES as a covariate to control for group differences.

Table 10. Demographic and pre-injury functioning of TBI and control groups.

Characteristic		Groups		
		Mild TBI (n = 9)	Mod-Severe TBI (n = 11)	Controls (n = 9)
Age at initial testing (years);	M	5.16	6.01	5.43
	SD	1.20	1.33	1.76
Age at 30 month testing (years);	M	7.74	8.70	7.44
	SD	1.49	1.47	1.84
Gender				
number of boys		5	6	4
number of girls		4	5	5
Socioeconomic status*	M	4.01	4.83	3.52
	SD	.89	.88	1.01
VABS				
total adaptive score ¹	M	114.86	110.36	112.13
	SD	22.49	10.90	15.63
communication score ²	M	106.88	101.55	109.75
	SD	18.73	18.02	7.46

M = mean, SD = standard deviation, * p < .05; ¹ n = 7 (mild TBI), 11 (mod-severe TBI), 8 (control); ² n = 8 (mild TBI), 11 (mod-severe TBI), 8 (control)

5.1.2 Group scores on intellectual and standard language measures

The groups' performances on standard tests of intellectual functioning and language ability were explored to establish whether they are representative of the normal population and how they compare to the typical research findings of children's outcome following TBI. See table 11 for group means and standard deviations.

Repeated measures analysis of covariance with SES as a covariate was used to explore group differences on intellectual and language measures and to explore the change in these abilities over the two assessment sessions. Analyses for all measures of intellectual ability (Full scale IQ, Verbal IQ, Performance IQ) and language ability (PPVT, EOWT), revealed non significant interaction effects and non significant main effects of time and group, with the exception that the mild TBI group obtained higher scores on the PPVT at the 30 month assessment. These findings were unexpected as they are not consistent with typical findings of reduced intellectual functioning and language ability in the acute phase following moderate-severe TBI. However, there is a

trend in the expected direction, with the moderate-severe TBI group obtaining lower scores on all measures. Examination of effect sizes does suggest that there is a clinically significant difference between the moderate-severe TBI group and control group on the Full scale IQ and Performance IQ. Thus the lack of statistically significant differences appears to be due to the low power of the study (ranging from less than 6% to 69%) as a result of small sample sizes.

Table 11. Groups performances on standard intellectual and language measures at acute and 30 month assessments.

Cognitive measures	Groups								F	p
	Controls (n = 9)		Mild TBI (n = 9)			Mod-Severe TBI (n = 9)				
	M	(SD)	M	(SD)	ES	M	(SD)	ES		
<i>Full Scale IQ</i>										
acute	111	(12)	108	(17)	.25	101	(7)	.83	.30	.74
30 month	109	(10)	107	(13)	.20	103	(9)	.60	.03	.97
<i>Verbal IQ</i>										
acute	108	(14)	98	(12)	.71	101	(8)	.50	1.74	.19
30 month	105	(14)	101	(12)	.29	99	(10)	.43	.09	.92
<i>Performance IQ</i>										
acute	113	(13)	116	(22)	.23	102	(7)	.85	2.02	.15
30 month	111	(9)	113	(14)	.22	107	(8)	.44	.34	.71
<i>PPVT</i>										
acute	103	(22)	105	(18)	.09	103	(9)	-	2.33	.12
30 month*	102	(7)	114	(16)	1.71	104	(10)	.29	3.79	.05
<i>EOWT</i>										
acute	112	(15)	117	(21)	.33	110	(18)	.13	1.03	.37
30 month*	116	(15)	129	(24)	.87	115	(13)	.07	.82	.46

PPVT = Peabody Picture Vocabulary Test
EOWT = Expressive One-word Picture Vocabulary Test
*n = 4 (Mild TBI), n = 9 (Mod-Severe TBI), n = 6 (Control)
M = mean, SD = standard deviation, ES = effect size against control group

Closer examination of the group mean performance on the IQ variables suggests that there is less variability in the performances of the moderate-severe TBI group than the mild TBI and control groups (see table 11). Tests of homogeneity of variance revealed that the differences in the standard deviations of the groups are statistically significant

for the Performance IQ scores, Levene’s statistic = 6.02, p = .01, and non-significant but approaching significance for the Full scale IQ scores, Levene’s statistic = 2.99, p = .07.

Inspection of each child’s performance on intellectual and language measures indicated that several children had large discrepancies between their verbal IQ and performance IQ and their performances on additional receptive and expressive language tests suggested they had significant language difficulties. Further inspection of these children’s VABS communication scores revealed two children with low scores (one of 66 and one 79). As this score is based on the child’s pre-accident level of communication, this suggests that the language difficulties evident on formal testing and on the procedural discourse task cannot be clearly attributed to acquired deficits. Consequently, a separate data set was constructed removing the data of these two children (one from each TBI group). Analyses were conducted for both data sets and are reported for both when different results were found, otherwise, results are reported for the larger original data set.

5.1.3. Game used to elicit procedural discourse

The type of game used to elicit the procedural discourse task was made at the therapists’ discretion on the basis of the child’s developmental level. Regardless of group status, most children explained how to play ‘Snap’ at the acute assessment and most children explained ‘Guess Who’ at the 30 month assessment, as shown in table 12. Both groups had a similar proportion of children explaining each game at the acute assessment and the 30 month assessment, $\chi^2 (2) = .28, p = .87$.

Table 12. Game used to elicit procedural discourse at each time point and for each group

Assessment stage / Game		Groups		
		Mild TBI (n = 9)	Mod-Severe TBI (n = 11)	Controls (n = 9)
Acute	Snap (%)	78	73	78
	Guess Who (%)	22	27	22
30 months	Snap (%)	11	9	22
	Guess Who (%)	89	91	78

5.2 Procedural discourse task

The results of the preliminary data analyses indicate several important implications for the analyses used to test the study's hypotheses. Firstly, SES needs to be included as a covariate to control for the group differences in this variable as this has the potential to influence the ability to perform the task. Secondly, the mild TBI and control groups have children with a wider range of intellectual ability than the moderate-severe group, with some of these children displaying difficulties in the verbal domain. As such, analyses will be conducted for the entire group and for a selected sub-group without children with pre-existing verbal difficulties (defined by 20 point PIQ>VIQ discrepancies, and VABS communication score below 80). Finally, as there is no significant difference in the proportion of children explaining each game in each group, analyses can be conducted combining data obtained for each game. Scores have been converted to percentages on selected variables (as explained in Chapter 4) to control for differences in quantity of output for each game.

5.2.1 Test of statistical assumptions

In designing this study it was planned that the hypotheses would be tested using multivariate and univariate analysis of covariance techniques with SES as a covariate. As these techniques are based on assumptions of normality and equality of variance, these assumptions were tested to ensure valid statistical findings.

This test of assumptions showed that the group scores were not normally distributed on many of the outcome measures during the acute and 30 month assessments. During the acute assessment, Shapiro-Wilk tests of normality were significant (indicating deviation from normality) for the moderate-severe group on the total number of communication units, the mild TBI group on the content score, the control and moderate-severe TBI group on the listener burden score, and all groups on the verbosity and ontarget output scores (as shown in table 13). There was no violation of normality for the therapist burden score. During the 30 month assessment, Shapiro-Wilk tests of normality were significant for the mild TBI and moderate-severe TBI group on the total number of communication units, the control and mild TBI groups on the listener burden score, the control and moderate-severe TBI group on the therapist burden score, all

groups on the verbosity and on-target output score, and the control and moderate-severe TBI groups on the mazes score. There was no violation of normality on the content score.

Outliers were identified for most outcome measures. These were checked to ensure they were scored and entered accurately but they were not removed from analyses as they reflect the variability in children's performances on the procedural discourse task. Although there were univariate outliers, there were no multivariate outliers identified using mahalanobis distance.

Equality of variance was tested using Levene's test. This showed that the variability in the group standard deviations did not reach statistical significance for most outcome measures at both assessment stages, with the exception of the percentage of output ontarget at the acute assessment, $F(2,26) = 7.65$, $p = .002$ and the content score at the acute assessment which approached significance, $F(2,26) = 3.22$, $p = .056$. For multivariate analyses, Box's test of equality of covariance was not significant for the acute assessment measures, $F(2, 42) = 1.27$, $p = .12$. Unfortunately though, equality of covariance was violated for the 30 month assessment outcome measures, $F(2, 42) = 1.64$, $p = .01$.

5.2.2 Group differences at the acute assessment

During the acute assessment, it was expected that the moderate-severe TBI group and mild TBI group would display difficulties across the domains of quantity, relation and manner.

To test these hypotheses, single factor between subjects multivariate analysis of variance was conducted. Although MANOVA is fairly robust to violations of normality (Tabachnick & Fidell, 1996), its sensitivity to outliers and the small group numbers in the present study means that the results should be interpreted cautiously.

To enhance sensitivity, six main outcome measures were entered: four assessing the domain of quantity, 1) Total number of communication units (c-units), 2) Content score, 3) Therapist burden, 4) Verbosity score, and one assessing the domain of relation, 5)

Percentage of output on-task, and one assessing the domain of manner 6) Listener burden. These main variables were chosen because they summarise much of the data obtained. The organizational score was also not included due to the lack of spread or ceiling effect in the scores. Most children received a score of 1, with all steps in correct sequence, with the exception of three children, one from each experimental group.

The MANCOVA including SES as a covariate was not statistically significant but approached significance, $F(12,42) = 1.95$, $p = .06$. Further analysis, whilst not statistically justified by this overall F value ($p = .06$), was carried out for its heuristic value. Examination of the univariate ANOVA's revealed a significant group difference in the percentage of output on-target, $F(2,25) = 3.59$, $p = .04$. Post hoc simple contrasts revealed that the procedural discourse of the moderate-severe TBI group was significantly less on-task, containing more diversions and unrelated information than both the control group, $p = .02$ and the mild TBI, $p = .05$. Examination of the groups' standard deviations indicates greater variability in the moderate-severe group's performance suggesting that this was not an area of difficulty for all of the children who sustained a moderately-severe TBI. However, as both assumptions of normality and equality of variance are violated, the statistical validity of this finding is questionable.

To explore the groups' performances on the procedural discourse task in more detail, group comparisons were then completed for the remaining outcome measures using ANCOVA. These did not reveal any statistically significant group differences.

Despite the lack of significant findings, some interesting trends are evident in the data. In particular, the TBI groups tend to place greater burden on the listener and therapist and provide more redundant information during their explanations.

5.2.3 Group differences on the procedural discourse task at 30 months

It was hypothesized that while both TBI groups would improve over time, it was expected that the moderate-severe TBI group's performance would remain below the control group while the mild TBI group would perform at a similar level.

To test these hypotheses, MANOVA was computed, comparing the group performances on the selected main outcome measures (total number of communication units, content score, therapist burden, verbosity score, percentage of units on-task, and listener burden). This did not reveal any significant group differences at the 30 month assessment, $F(12,42) = .43$, $p = .49$. Further analysis of subsidiary measures using ANOVA did not reveal any significant differences between the groups.

Trends evident during the acute assessment persisted but to a lesser extent at this stage of assessment. The TBI groups were more verbose, providing more redundant information, and placed greater burden on the listener and therapist.

Table 13. Procedural discourse task: main outcome measures at acute and 30 month assessment.

	Control n = 9	Mild TBI n = 9	Mod- Severe TBI n = 11		
	M (SD)	M (SD) ES	M SD ES	F	p
<i>Number of c-units</i>					
Acute	8.25 (5.41)	7.20 (5.12) .19	9.36* (5.5) .21	.45	.64
30 months	10.0 (3.96) 8	7.60* (3.53) .63	11.21* (9.93) .29	.76	.48
<i>Content score</i>					
Acute	.28 (.14)	.27* (.12) .07	.32 (.20) .29	.71	.50
30 months	.39 (.16)	.32 (.15) .44	.35 (.12) .25	.51	.61
<i>Listener burden</i>					
Acute	.61* (.29)	1.08 (.86) 1.62	1.42* (1.43) 2.79	.66	.53
30 months	.51* (.54)	.72 (1.18) .39	.62* (.31) .20	.24	.79
<i>Therapist burden</i>					
Acute	2.58* (2.39)	3.70 (2.45) .47	4.07 (4.27) .62	.44	.65
30 months	1.75* (1.86)	2.90 (2.77) .62	2.00* (2.57) .13	.64	.54
<i>Verbosity score</i>					
Acute	1.50* (1.62)	1.10* (1.52) .25	1.07* (1.54) .27	.21	.81
30 months	1.83* (2.08)	1.60* (1.43) .11	3.21* (5.55) .66	.65	.53
<i>% Ontarget responses</i>					
Acute	.99* (.04)	.97* (.07) .50	.90* (.14) 2.25 3.59	.04	
30 months	.95* (.11)	.96* (.06) .09	.97* (.07) .18	.08	.92

*Scores are not normally distributed, $p < .05$.

Table 14. Group differences on subsidiary procedural discourse measures

	Control n = 9		Mild TBI n = 9			Mod- Severe TBI n = 11				
	M	SD	M	SD	ES	M	SD	ES	F	P
<i>Essential steps directly stated (%)</i>										
Acute	.20	(.08)	.17	(.14)	.38	.18	(.19)	.25	.80	.46
30 months	.33	(.16)	.25	(.19)	.50	.26	(.13)	.44	.19	.83
<i>Essential steps ambiguously stated (%)</i>										
Acute	.08	(.09)	.11	(.10)	.33	.13	(.10)	.56	.29	.75
30 months	.06	(.07)	.11	(.16)	.71	.09	(.05)	.43	.23	.79
<i>Non-specific vocabulary</i>										
Acute	1.83	(1.40)	1.90	(2.13)	.05	1.86	(1.51)	.02	.79	.47
30 months	1.25	(1.14)	1.30	(1.34)	.04	.64	(1.15)	.54	.42	.66
<i>Correct but unessential steps</i>										
Acute	1.25	(1.66)	.40	(.52)	.51	.93	(1.07)	.19	2.45	.11
30 months	.92	(1.08)	.30	(.67)	.57	.79	(1.12)	.12	1.38	.27
<i>Redundant information</i>										
Acute	.00	(.00)	.70	(1.25)	0	.14	(.53)	0	2.46	.11
30 months	.92	(1.62)	1.20	(.92)	.17	2.21	(5.62)	.80	1.38	.44

5.2.4 Change in performance over time

Repeated measures analysis of variance (Severity X Time) was conducted to examine the association between injury severity and performance on the procedural discourse task across the acute and 30 month assessments. Analyses were completed for the eight main summary outcome measures, 1) Total number of communication units produced, 2) Content score, 3) Listener burden, 4) Therapist burden, 5) Verbosity score, and 6) Percentage of output on-target.

Total number of communication units

There was no significant interaction effect, $F(2,25) = .12$, $p = .89$, and no significant effect of group $F(2,25) = 1.06$, $p = .36$, or time, $F(1,25) = .09$, $p = .77$, with all groups showing a small increment in performance over time.

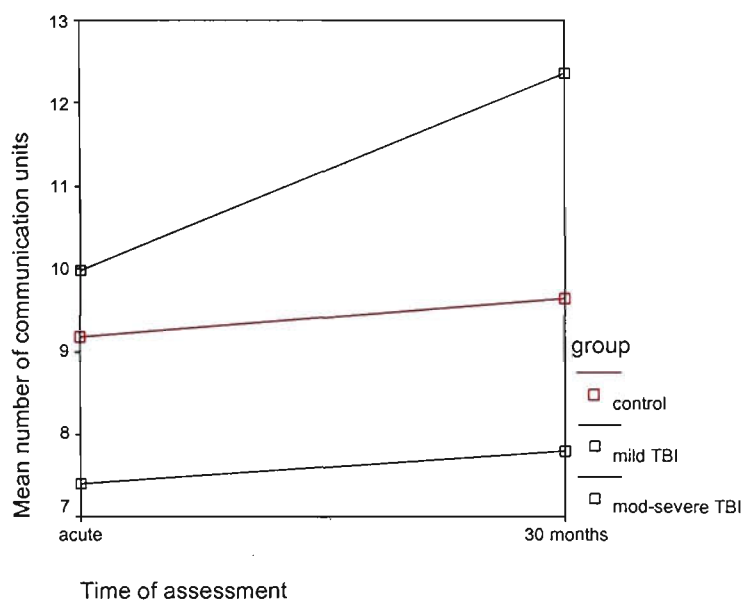


Figure 5. Mean number of communication units produced by each group

Content score

There was no significant interaction effect [$F(2,25) = .56$, $p = .58$], or main effects of group [$F(2,25) = .73$, $p = .49$] or time [$F(1, 25) = .12$, $p = .74$]. Unexpectedly, there was a trend for the moderate-severe group to outline more of the essential steps required to play the game than the control or mild TBI groups. However, the moderate-severe TBI group did not display any improvement in their performance on this measure, while the control group's performance improved significantly, $t(11) = -3.05$, $p < .05$.

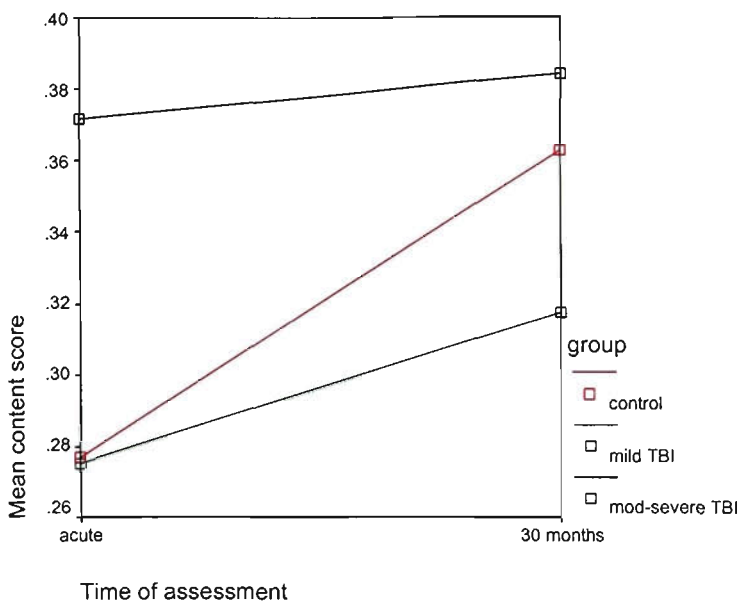


Figure 6. Mean content score for each group

Listener burden

There was no significant interaction effect of group X time on the listener burden measure, $F(2,25) = .24$, $p = .79$ and no main effect of group, $F(2,25) = .58$, $p = .57$. The timing of the assessment nearly had a significant effect on performance on the measure, $F(1,25) = 3.28$, $p = .08$, with groups placing less burden on the listener by stating steps of the game with greater clarity at the 30 month assessment. Overall though, the control group tended to place less demand on the listener. Taken together with the group performances on the content score, this suggests that although the TBI groups mentioned more of the essential steps in the game, the control group did so in a clearer more direct manner.

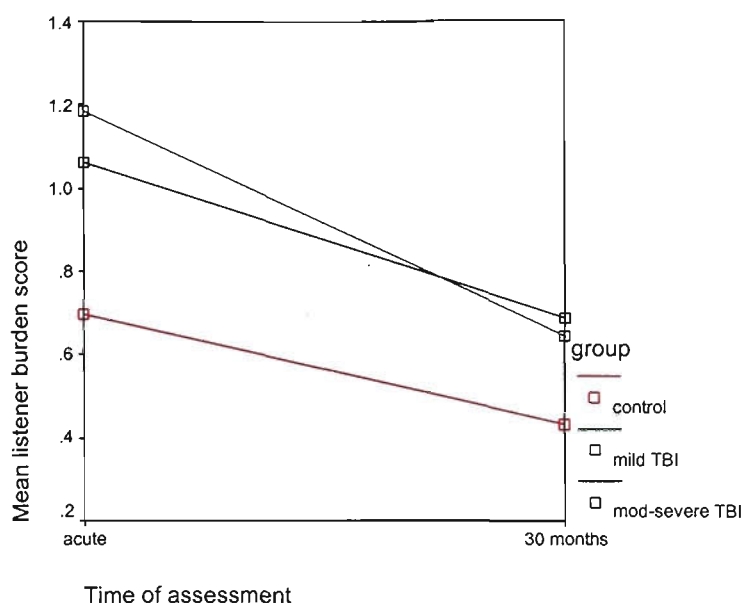


Figure 7. Mean 'listener burden' score for each group

Therapist burden

There were no significant interaction effect, $F(2,25) = .04$, $p = .96$, or main effects of group, $F(2,25) = .85$, $p = .44$, or time, $F(1,25) = .37$, $p = .55$, on the therapist burden measure. All groups tended to require less prompting and redirection from the therapist at the 30 month assessment, with the control group showing most improvement.

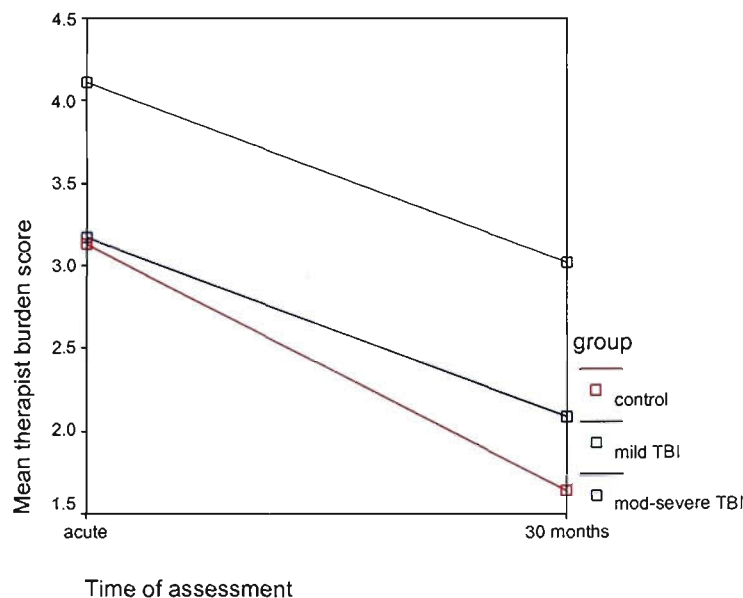


Figure 8. Mean 'therapist burden' score for each group

Verbosity score

There were no significant interaction, or main group or time effects, $F(2,25) = .69, p = .51$; $F(2,25) = .47, p = .63$; $F(1,25) = .78, p = .39$. However, examination of the group means and standard deviations reveals a trend for the moderate-severe TBI group to show difficulties producing efficient explanations, providing more redundant and unessential information, which emerges over time. The increase in verbosity score for the moderate-severe TBI group was not significant however due to the variability in performances, $t(10) = -1.03, p = .33$.

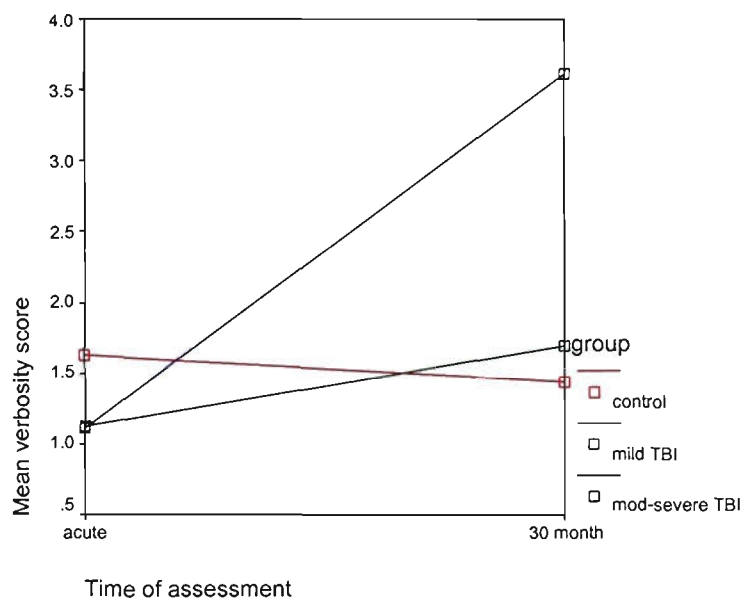


Figure 9. Mean ‘verbosity’ score for each group

Percentage of output on-task

The interaction effect for the percentage of output that was on-task was close to significance, $F(2,25) = 3.00, p = .07$. While there was a trend for the moderate-severe TBI group to remain more on-task at the 30 month assessment, the control group showed some marginal reduction in performance at the 30 month assessment. Group and time effects were not significant, $F(2,25) = 1.46, p = .25$ and $F(1,25) = 2.58, p = .12$, respectively.

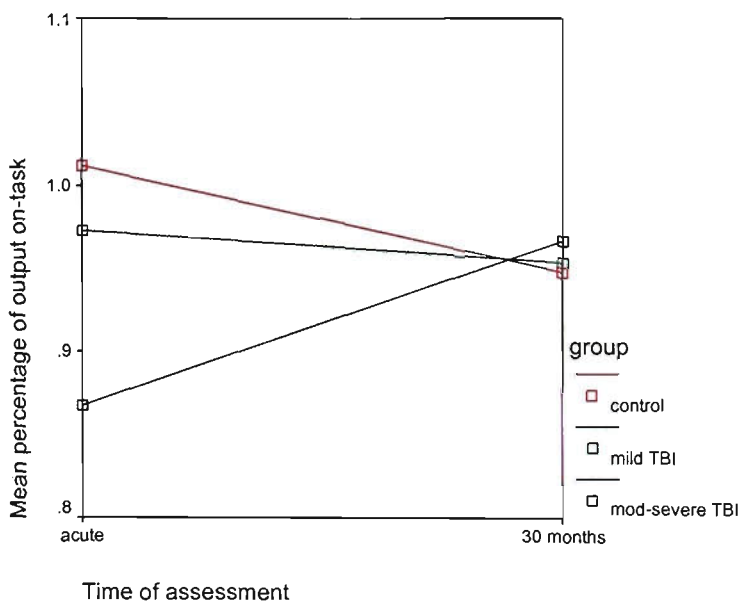


Figure 10. Mean percentage of output that was on-task for each group

5.3 Is performance on the procedural discourse task related to performance on standard cognitive tests?

5.3.1. Intellectual function

There were no significant correlations between Full Scale IQ and PIQ and the procedural discourse task outcome measures. VIQ was significantly related only to the number of communication units uttered by the child ($r = .419$, $p = .011$) and the verbosity of the child ($r = .398$, $p = .016$) i.e. children with higher verbal IQ's tended to speak more.

5.3.2. Language

Performance on the procedural discourse task was most related to performance on other less structured but standardized language measures, Renfrew Bus Story and Verbal Fluency. The information content score of the Bus story was related to the number of communication units spoken by the child ($r = .650$, $p = .000$), the percentage of essential steps stated by the child ($r = .475$, $p = .012$), the percentage of essential steps inferred by the child ($r = .387$, $p = .046$), the content score ($r = .661$, $p = .000$), and the verbosity score ($r = .510$, $p = .007$). Similarly, Verbal Fluency performance was related to each

of these outcome measures as well: number of communication units ($r = .387$, $p = .020$), percentage of essential steps stated ($r = .335$, $p = .046$), percentage of essential steps inferred ($r = .338$, $p = .044$), content score ($r = .517$, $p = .011$), and verbosity score ($r = .332$, $p = .048$).

EOWT (expressive vocabulary) performance had no significant relationship with the procedural discourse performance and PPVT (receptive vocabulary) score was only related to the number of communication units ($r = .406$, $p = .014$).

Chapter 6. Discussion

The number of published studies exploring the impact of moderate-severe TBI on children's pragmatic communication skills is slowly growing. However, the present study is the first to use a procedural discourse task to compare the pragmatic communication ability of both a mild and moderate-severe TBI group of children to a non-injured age matched comparison group of children. In the paediatric pragmatic communication literature, it is one of the few studies to use a developmentally sensitive approach to document these changes, employing longitudinal analysis to explore children's performances during the acute phase of recovery and 30 months after injury.

It was expected that the group of children with moderate-severe TBI would demonstrate widespread pragmatic communication difficulties both during the acute phase of recovery and 30 months after injury when compared to the control group of children or the mild TBI group of children. However, the moderate-severe TBI group performed significantly poorer than the control group and the mild TBI group on only one measure of pragmatic communication used in this study and only at the acute phase of recovery. Of all the pragmatic communication skills measured, the children with moderate-severe TBI displayed most difficulty keeping their explanations of 'snap' or 'guess who' on task. Compared to the control group, their explanations included more information that was unrelated to the task. This would appear to reflect heightened levels of distractibility, either to external stimulation and / or their own thoughts and a reduced ability to inhibit these distractions effectively. Studies of attention following paediatric TBI frequently document this as an area of difficulty in the early stages after injury (Anderson, Catroppa, Haritou, Morse, Pentland, Rosenfeld, & Stargatt, 2001; Catroppa, Anderson, and Stargatt, 1999; Dennis, Guger, Roncadin, Barnes, & Schacher, 2001).

This is a statistically significant and clinically meaningful finding. However, it must be considered cautiously and used for heuristic purposes only, as the

assumptions underlying this analysis were violated and sample sizes are very small.

In contrast to expectations, there were no statistically significant differences between the moderate-severe TBI group and control group at the 30 month follow up assessment. Changes in performances over time did not statistically differ between the groups. For most measures the moderate-severe TBI group improved at the same rate as the controls and mild TBI groups. Thus there was no indication of recovery.

The procedural discourse task also failed to statistically differentiate the mild TBI and control groups. It was hypothesized that the mild TBI group would perform below the control group on outcome measures during the acute phase, but there were no significant differences found between the control group and mild TBI group on any measures during the acute phase or 30 month follow-up.

Taken at face value, these results suggest that TBI had little impact on children's ability to perform the procedural discourse task. This appears to conflict greatly with growing empirical evidence demonstrating the vulnerability of pragmatic communication skills to TBI (Chapman, Watkins, Gustafson, Moore, Levin, & Kufera, 1997; Chapman, Wanek, Weyrauch, & Kufera, 1998; Ewing-Cobbs, Brookshire, et al 1998; Chapman, Mckinnon, Levin, Song, Meier, & Chiu, 2001). The lack of statistically significant group differences is not so surprising however, when consideration is given to the power of the study to detect these differences. Due to the very small sample size and wide variability in performances, the present study's power was between 10 and 20% on most measures, with a reasonable power of 80% obtained on only two measures: 'percentage of output on-task' and 'listener burden'. As a consequence of the study's poor power, group differences failed to reach significance even on IQ scores, despite large effect sizes and group differences on IQ frequently documented in studies with larger samples.

Given that the study had limited statistical power to detect group differences, examination of effect sizes and trends is especially warranted. Doing so revealed some interesting findings in the acute and 30 month data, although these must be interpreted cautiously as differences did not reach statistical significance and group sizes are small. Even so, differences between the moderate-severe TBI group and control group were evident in the quantity and especially the manner of conveying the information. In particular, moderate-severe TBI had a large effect on the 'listener burden' measure and the duration of pauses during the explanation taken at the acute phase of recovery. Medium to large effect sizes were also evident on the 'therapist burden' measure and duration of delays. Thus although the moderate severe TBI group's explanations included as many essential steps as the control group, their explanations were more ambiguous and indirect. As a consequence the listener (tester) was placed in a position where they had to provide more redirection and prompting to gain some understanding of the child's response.

Moderate-severe TBI had less extensive effect on the pragmatic communication outcome measures at the 30 month assessment, although clinically significant effects were still evident. Interestingly, the moderate-severe TBI group's explanations were affected differently at this stage of recovery. While their responses remained on-task and they no longer scored poorer on the 'listener' and 'therapist burden' measures, their responses were more verbose, including more redundant and repetitive information, than the control group's explanations. There was a tendency for the moderate-severe TBI children to have difficulties picking out or generalizing the salient points of the game, which may reflect a failure in developing age appropriate abstraction and generalization skills. It may also reflect a failure to develop age appropriate monitoring skills, as Dennis et al's (2001) longitudinal study also documented emerging difficulties with inhibiting and monitoring responses despite a reduction in heightened distractibility seen in the acute phase.

Overall, examination of the change in performance over time suggests that the moderate-severe TBI group's explanations became less efficient over time. They produced more communication units at the 30 month assessment than the acute assessment and were more on task at the 30 month assessment, yet there was no change in the percentage of steps they provided. In effect, they were talking more but saying less.

Exploration of the trends in the mild TBI group's performances revealed a similar pattern but weaker impact of mild TBI on pragmatic communication during the acute phase of recovery. Mild TBI had a large effect on listener burden scores, with children tending to display difficulties clearly communicating steps to play the game. More moderate effects were evident in their need for redirection and prompting from the tester, and in their ability to stay on task. By 30 months after injury, there was still a tendency for the children with mild TBI to require prompting and redirection from the therapist. Otherwise though, the initial burden they placed on the listener had resolved. Interestingly, the mild TBI group tended to outperform the control group on some measures, providing more succinct (less verbose) responses.

In exploring these trends, there does appear to be persisting deleterious effects of moderate-severe TBI on pragmatic communication skills which are consistent with previous studies exploring pragmatic communication. These preliminary findings also support the typical dose response relationship seen in most outcome studies from TBI, with notable but less extensive effects of mild TBI. The effects of mild TBI were most marked in the early stages after injury, but with some possible persisting subtle effects 30 months post injury. It must be noted though, that the effects of TBI have not been as strongly portrayed in the present study as they have in previous studies.

Comparing the present study's results to those of previous studies is somewhat limited due to the different discourse tasks used and differences in the way outcome measures have been operationalised. Nevertheless, most studies use Grice's maxims of quantity, quality, relation, and manner as a guideline and comparisons have revealed several similarities.

Similar to the present study, Morse et al's (1999) investigation of conversational discourse during the acute phase of recovery also failed to find significant group differences due to their very small sample size. Nevertheless they also identified a trend for their severe TBI group to display difficulties maintaining the topic of conversation just like the present moderate-severe TBI group displayed difficulties staying on task when providing their explanation of 'snap' or 'guess who'. Thus there appears to be growing evidence that tangentiality is a characteristic feature of children's communication in the early stages of recovery from TBI.

By comparison, longer term persisting communication difficulties appear to centre around difficulties with abstraction and generalization. For example, previous studies of narrative discourse one to three years post-injury have consistently revealed impairments in TBI children's ability to outline the 'gist' or central meaning of the story (Biddle, McCabe, & Bliss, 1996; Chapman and colleagues, 1995, 1997, 1998, 2001; Ewing-Cobbs, Brookshire, Scott, Fletcher, 1998) and to provide summaries of stories (Chapman, Sparks, Levin, Dennis, Roncadin, Zhang, & Song, 2004). To some extent this failure to adequately extract and communicate the abstract 'bigger picture' of the story was manifested in the present study by the moderate-severe TBI children displaying difficulties providing succinct, generalised explanations to the games.

The present study failed to identify any impairment in the planning / organizational component of TBI children's discourse as there was a ceiling effect on the organisational measure, with all children presenting steps to the games in a coherent sequence. This was a particularly unexpected finding as previous studies of narrative discourse commonly cite this as an area of difficulty and planning / organizational difficulties are a common feature of TBI (Levin, Song, Ewing-Cobbs, Roberson, 2001).

This does not appear to reflect the true nature of procedural discourse, as both narrative and procedural discourse involve the communication of

information in steps or sequences and thus both are theoretically believed to require organizational and planning skill. However, this is based on the assumption that procedural discourse is a monologue task.

Monologue tasks are meant to be easier to research because they are easier to control. However, in the present study the tester provided prompts, redirection, as well as asking for clarification when eliciting the procedural discourse. In using this approach, an uncontrollable variable was introduced to the study. As tester's styles vary, not all the variation in the tester's behaviour can be attributed to the child's communication style. Moreover, the testers were aware of the diagnosis of the child and hence their interaction style may have been influenced by this knowledge. This tester bias may have confounded the results.

Even so, measures were taken to control for the variability in tester involvement by including a 'therapist burden' score. Indeed, there was a trend for the TBI groups to place greater burden on the tester.

Incorporating the therapists' communication in the analyses provided a more realistic account of each child's procedural discourse style as well as providing a glimpse of how the child's style impacts on their communication partner. However, this direction itself may have altered the skills tapped by the task. That is, the tester's involvement may have provided enough scaffolding and structure to reduce the demands of the task on the children's executive functions, memory, attention, and information processing. It is highly likely that children's responses would have been more disorganized and less well planned if this support wasn't provided.

Children may also have developed a strong schema from playing the game and from visual cues provided by having the game parts in front of them during the task. This may also have reduced the challenge level of the task from an organizational and memory perspective. Previous research and the current findings indicate that TBI children produce similar amounts of information as normally developing children. This has been interpreted to

suggest that memory functions do not play an important role in discourse. However, findings that TBI children's memory improves with prompts and cues (Catroppa & Anderson 2002), suggest that children may have much more difficulty recalling steps to a game when the game stimuli are not available to cue them.

The 'challenge level' of the task, a notion coined by Dennis (2000), is a particularly important factor in understanding the results. This posits that existing cognitive impairments will only be detected when the task is sufficiently challenging. This is used to explain why children often perform well on standard cognitive tests in the structured, quiet setting of the clinic, but show significant impairment in real-life situations such as school. In these types of environments greater demands are placed on the ability to multi-task and work in the face of distractions and time pressure.

This cautions against interpreting non significant results as a sign that TBI does not affect the skill being measures. For instance, while the findings in the present study are relatively weak at a statistical level, it is important to remember that the procedural discourse task was completed under ultimate conditions that are not representative of real life situations. Everyday situations are more likely to place children's pragmatic communication skills under greater pressure and may result in less favourable outcomes.

The present study's organizational measure was clearly not challenging enough to detect difficulties. Chapman, McKinnon, Levin, Song, Meier, Chiu (2001) also obtained a ceiling effect on the planning – organizational measure they used during a narrative discourse task. This suggests that future studies need to refine organizational measures to more accurately document the effect of TBI.

Also, consideration needs to be given to the developmental appropriateness of measures used. Given that planning skills do not begin to emerge until 7 to 9 years of age and are not fully developed until early adolescence (Anderson, 2002), the planning measures of the procedural discourse task may not have

been a developmentally appropriate measure for the present study's sample. Future evaluation at 12 years of age might be more appropriate in detecting developmentally appropriate progress.

Previous studies which have investigated procedural discourse and have used similar outcome measures have only been completed with adults. Thus comparisons with these studies are also limited as the present study investigates a disruption to a skill - pragmatic communication – in the process of development, whereas studies of adults reflects changes to an already acquired skill. Dennis (1989, 2000) proposes that skills develop in three sequential stages. During the first two stages of skill acquisition, skills are emerging and developing but are not yet fully functional. Skills become fully mature during the final stage, and it is only at this time that they can be assessed. Consequently, the impact of brain injury on immature or developing skills may not be fully realized until later in development. Given the wide range in developmental level of the children in this study, the failure to find strong group differences may be because many of the children had not yet developed efficient pragmatic communication skills. Thus a true effect of TBI may not be established until children are older and performance expectations increase.

Nevertheless, the trends evidenced in the current study do support the findings from studies with adults. Like the present study, the most commonly reported deficits in the adult literature are greater ambiguity or vague responses, verbosity, and difficulties staying on topic (Hartley & Jensen, 1991; Snow, Douglas, & Ponsford, 1997; McDonald, 1993; McDonald & Pearce, 1995; Tukstra, McDonald, & Kaufmann, 1996).

The underlying cognitive basis for these difficulties remains unclear, although some light is shed through the present study's results. Like many previous studies, the present study also failed to find a strong association between intellectual performance or basic receptive or expressive language skills and pragmatic communication skills. However, tests assessing higher level language skills such as verbal fluency and narrative ability were strongly

associated with procedural discourse ability. This provides some support for the use of the procedural discourse task as a higher level communication assessment tool.

The present study's findings also reflect the significant variability often seen as a characteristic feature in TBI. Results identified large standard deviations, with many performances overlapping with the control group. This heterogeneity in outcome is widely documented in the outcome literature as discussed in chapter one.

Variability in outcome would be especially apparent in the current study as the TBI groups incorporate varied combinations and severity of diffuse and focal pathology. Even though children are grouped according to mild or moderate-severe TBI there is still a vast continuum of severity within these groups. Furthermore, classifications were made on the basis of GCS and scan findings. Unfortunately the more accurate indicator of severity - duration of PTA - was not obtained because of difficulties assessing such constructs in young children as well as a lack of standardized indicators. This standard limitation hinders accurate classification of TBI severity in children under five years.

Children with detectable frontal damage (i.e. contusions, haematomas) may be at greater risk of discourse deficits (Chapman, Levin, Wanek, Weyrauch, & Kufera, 1998) and of executive dysfunction. Previous studies of adults show that pragmatic communication deficits vary according to the nature of executive deficits shown on formal assessment (McDonald, 1993). This suggests that some children may provide 'empty' responses as a result of reduced initiation, whereas others may provide repetitive, verbose responses as a result of rigidity and perseveration. Thus it is likely that there is not a unitary pattern of discourse deficits. Such individual difficulties are likely to be obscured in group analyses, and may be best examined by a single case study model.

The sample of children used in the present study incorporated a wide range of developmental levels as a result of the age range (preschool to primary school). It is likely that this factor also contributed to the variability in findings. This age range covers a wide range in neurophysiological development, particularly within the frontal lobe and its connections. Consequently, it would be expected that children's performances would vary as a function of their age and level of executive function maturity. Previous research does suggest that those injured at younger ages are more susceptible to discourse difficulties (Chapman, Levin, Wanek, Weyrauch, & Kufera, 1998).

Additional variability is also evident in all children's performance on the procedural discourse task. Due to the highly subjective nature of pragmatic communication the present study also used Damico's clinical discourse analysis model to operationalise these aspects of communication. Importance was placed on obtaining high inter-rater reliability for the outcome measures. Consequently, the present study had a similar high inter-rater reliability as other studies in this area, with reliability ranging from .70 to .99 and all summary outcome measures over .95. Using similar outcome measures, Snow, Douglas, Ponsford's, (1997) had reliabilities ranging from .52 to 1.0. Thus the lack of statistical group differences can not be attributed to unreliable measures.

Given the variability in outcome from TBI and variability in performances on the procedural discourse, group analyses can not provide a full account of the impact of TBI on individuals. Further insight into the impact of TBI on pragmatic communication during procedural discourse can be gained by exploring individual performances. Two cases were selected from the moderate-severe TBI group to discuss. These cases highlight the sensitivity of the procedural discourse task to changes in pragmatic communication skills and the variability displayed in individual's performances and recovery process.

6.1 Case study: ‘Daniel’

The following case study was chosen to illustrate the discrepancy between performances on standard tests of intellectual functioning and language ability and performance on the procedural discourse task. This case also illustrates the importance of longitudinal analysis, with difficulties becoming clearly evident at the 30 month assessment.

Daniel sustained a severe TBI at the age of 6 years, 3 months, after he was hit by a car whilst riding his bike. He lost consciousness for several hours and his lowest GCS score was 6, improving to 9 after 24 hours. He presented with sensorineural hearing loss and his CT scan was abnormal, depicting some subarachnoid blood.

Daniel was assessed one month after injury. His intellectual abilities were within the ‘average’ range for his age, with consistent performance across both verbal and nonverbal measures. His expressive and receptive language skills were above average, although his parents rated his pre-accident communication skills as being at a low average level. His general adaptive behaviour skills were rated within the average range for his age.

At the 30 month assessment, Daniel demonstrated improvements in intellectual and language functioning, performing above the average range in all areas. See table 11 for Daniel’s scaled scores on cognitive measures at the acute and 30 month assessment.

Table 15. Daniel’s scaled scores on intellectual and language measures.

	Acute assessment	30 month assessment
<i>WPPSI-R / WISC-III</i>		
Full scale IQ	98	111
Verbal IQ	98	105
Performance IQ	100	117
<i>PPVT</i>	117	114
<i>EOWT</i>	129	123
<i>VABS pre-accident</i>		
Adaptive Behaviour Score	99	
Communication Score	88	

Daniel's explanations of how to play 'Guess Who' paints a very different picture from this seemingly good recovery.

Acute assessment

Daniel's explanation of how to play 'Guess Who'.

T: Can you explain to me how to play that game

1. *Hmm*

T: What do you have to do

2. *You have to (gg) get a secret person*

T: Mmm

3. *And the other one has to get a secret person*

4. *And then you've got to guess who they are*

T: And how do you do that

5. *You like say has your person got a moustache*

T: mmm

6. *And if they say no you put all the ones all down without moustaches
moustache*

T: OK and then

7. *And then when you've done all of those people*

T: Mmm

8. *You can guess who they are Hoo!*

T: Fantastic

30 month assessment

Daniel's explanation of how to play 'Guess Who'.

T: Now you explain to me how to play that game

1. *What game*

T: That game

2. *This game*

T: Mmm

3. *You've just seen*

T: Well you pretend I don't know how to play you tell me

4. *OK well (2) you put up all these people*

T: Ahm

5. *And then you pick up one of those yellow cards*

T: Ahm

6. *The same as like ummm* [leaves seat looking for a specific card] (9)

T: That's all right Daniel we just need to know that there are cards (2)

T: Daniel (3)

T: Daniel (2)

T: That's all right just pick anyone

7. *Say my person was Sam*

8. *I'd say to the person I'm playing (2) (umm oh poop)*

9. *Well say this is the person I'm playing*

10. *And he's got Sam or she's got Sam*

T: mmm

11. *Then I'd ask like (has your person) is your person male or female*

T: mmm

12. *And they'd say umm male*

13. *And I'd put down all the females*

T: mmm

14. *So I'd put down (2) her her her her her* [puts females down] *and that's all*

T: Yeh

15. *And then when I've got this left (3)*

16. *(and then) (and then I) and then they'd ask me whatever they ask me*

17. *And then I'd ask them (umm) does your person have a hat*

18. *And they'd say no so I'd put down this person who has a hat this Eric and Bernard and (uhhhh)*

T: Ahm

19. *And then they'd ask me their question*

20. *And then I'd ask them (umm) does your person have glasses on and they'd say yes*

T: Ahm

21. *So I'd put down all the ones with glasses*

T: Ahm

[puts them down] (7)

T: So you keep asking questions until

22. *And then I'd ask like does your person have white hair*

23. *And they'd say (2)*

24. *And they'd have their turn*

25. *And then I'd ask them does your person have white hair and they'd say yes*

26. *And I'd put down Tom who has black hair and Joe who has yellow hair*

27. *(and then then) (and then I'd ask like) and then after their question then I'd ask them did your person have (ummm) (2) (ahhh) (is he) is your person bald and they'd say yes*

T: Ahm

28. *(then I'd) then they put that guy I'd put down that guy*

T: Ahm

29. *(then) (then they'd ask me) (then) (2) hang on this is meant to be my board*

30. *(I) I do whatever I said they do*

31. *And then I'd say is your person Sam*

32. *And then they'd say yes and it's Sam*

T: Ahm

33. *Identical (2)*

34. *Want to see again*

35. *Totally identical*

T: They are identical

36. *Nothing different except for that's yellow and that*

T: Ahm

37. *See*

T: Ahm and so how do you win

38. *Well you have to say my person or your person (was umm ohhh) was Richard (2)*

39. *This guy*

T: Ahm

40. *(then) then I'd have to have every single one*

T: Ahm

41. *Because they'd be asking questions*

42. *and then say (have) is your person Richard*

43. *(2) and (and) whoever says like (umm) your person (umm) say Richard first*

44. *I was Sam*

45. *(First) whoever said that first*

T: Mmm

46. *Except you've got to say it in turns*

T: Mmm

47. *Would win*

Daniel's explanation of Guess Who during the acute phase is relatively brief, providing only 8 utterances / communication units. The tester prompted him on 3 occasions for further information, which he responded to, although in somewhat limited and vague terms. As a consequence, the listener had to make inferences on several occasions. For example:

- ❖ "the secret person" is a character on a card
- ❖ the "other one" is the other player
- ❖ "done all of those people" occurs when you have put down most of the people/faces on the board

Daniel does not indicate how the game unfolds i.e. that players take turns asking questions before they can finally guess who the other person's character is. He does not explain how to win the game. Overall though, he does provide enough information for the listener to comprehend the basic elements of the game – that there are two players, each player has a secret person, each player has to guess who the other player's person is, and this is done by asking questions about the physical characteristics of the person. Daniel also remained on-task throughout the explanation and his responses unfolded in logical sequence, bearing in mind the tester's prompts. Overall, his explanation was fairly satisfactory and not reflective of any marked pragmatic communication difficulties.

However, at the follow up assessment, a considerable number of pragmatic communication errors are evident throughout his explanation of Guess Who. His explanation was very lengthy, including 47 utterances / communication units. His marked verbosity is characterised by difficulties summarizing or generalizing processes of the game. Instead he provides a step-by-step account of the game, showing a reduced capacity for abstract and flexible thought. Rather than giving one example of a question a player might ask (e.g. does your person have glasses) and then a general statement (e.g. and then we keep asking each other questions), he proceeds through a whole sequence of questions and responses, providing a lot of redundant information. This occurs despite several prompts from the tester, summarizing points he has made. Daniel shows poor awareness and use of the tester's

remarks on several occasions. He fails to modify his performance, continuing rigidly with his line of thought. For example:

Tester: That's all right Daniel, we just need to know that there are cards (2)

Tester: Daniel (3)

Tester: Daniel (2)

Tester: That's all right just pick anyone

and,

Tester: so you keep asking questions until

Daniel: and then I'd ask does you person have white hair

Daniel also provides information that is irrelevant to learning how to play the game, showing difficulties recognizing what is salient and important for the listener. For example:

Daniel: (showing card) Identical (2)

Daniel: want to see again

Daniel: totally identical

Tester: they are identical

Daniel: nothing different except for that's yellow and that

Daniel's explanation is generally well organized at a global level, as he outlines the sequences of the game in a step-by-step manner. However, some of his utterances are not well organized and are consequently difficult to understand. For example:

Daniel: well you have to say my person or your person (was umm ohhh) was
Richard (2)

Daniel: this guy

Tester: ahm

Daniel: (then) then I'd have to have every single one

Tester: ahm

Daniel: because they'd be asking questions

Daniel: and then say (have) is your person Richard

This level of organizational skill was not explicitly assessed by any of the pragmatic communication measures, however, Daniel's high number of linguistic non-fluencies and revisions does reflect poor internal planning / organizational ability.

From his performance on this task, Daniel would be expected to have significant difficulties interacting with his peers, particularly as they are likely to be less patient and provide less support than provided by the tester in this situation.

6.2 Case study: 'Emma'

The second case study, Emma, provides a contrast to Daniel, showing a good recovery despite some initial difficulties. Emma was a 7 year old girl who sustained a moderate TBI after she fell. She was unconscious for half a day and her initial GCS score 8 but this had improved to 15 24 hours later. Brain CT revealed a left frontal haematoma which was not surgically removed. She was assessed one month after the injury and performed in the 'high average' range for her on intellectual measures, although she performed marginally better on verbally mediated tasks than performed based tasks. She performed well on standard language measures and her parents rated her premorbid level of communication and general adaptive behaviour at a high level.

On reassessment 30 months later at 9 years and 7 months, Emma performed similarly on intellectual and standard language measures (see table 12).

Table 16. Emma's scaled scores on intellectual and language measures.

	Acute assessment	30 month assessment
<i>WPPSI-R / WISC-III</i>		
Full scale IQ	114	112
Verbal IQ	119	111
Performance IQ	107	111
<i>PPVT</i>	112	109
<i>EOWT</i>	133	130
<i>VABS pre-accident</i>		
Adaptive Behaviour Score	110	
Communication Score	122	

Acute assessment

Emma's explanation of Guess Who one month post-injury.

T: Can you tell me how to do it

1. *Yeh*

T: OK

2. *(you well) you know you have the two boards with all those things that sit up*

T: *Yeh*

3. *You've got to sit them up*

4. *And (you) you have a deck of cards*

5. *And you put them in there*

6. *And you gotta pick up one card*

T: *Yep*

7. *Then you pick up one card*

8. *And you them in there in this little slot at the front there*

T: *Yep*

9. *And you're not allowed to see my card*

10. *And I'm not allowed to see yours*

T: *Yep*

11. *(and we've got to ask) we've got to look at all the other people on there*

12. *And (we've got to ask) I'll ask you a question (like) like if I'm looking there*

(is)* has your person got glasses
13. and you've got to say yes or no to me

T: Mmm

14. And if it's no * (umm) * it's your go
15. And if its yes * (you) you can win another go you just get you just get a go after that

T: Yep

16. (and whoever) and when your getting close near the end and no
17. If it's no (you put down) you've got to put down all the people with glasses on (your umm on) the board
18. And if it's yes you've got to keep them up just keep them up
19. And (1) when you get near the end

T: Mmm

20. And people ask those names (under) underneath the men and the ladies
21. And you ask the names
22. And if you said like there's one called Bill

T: Mmm

23. If you said like Bill and my card was Bill you've won the game

T: Oh right

24. And they have little sort of like * things that you (stick in) stick (in this) (these) in these five holes down here when you win the games

T: Oh right

25. Stick in if you win a game

T: Like little score things

26. Yeh their yellow (thing) yellow ones

T: Good.

30 month assessment

Emma's explanation of Guess Who at the 30 month follow up

T: Can you explain to me how do we play that game. What are the rules?

1. ** Well first each player has a board*

T: Ahm

2. *And they flip up all their cards with the peoples faces on them*

T: Mmm

3. *And then they (umm) select a card from the pile*

4. *And then whoever goes first asks a question*

5. *And you've got to answer yes or no from what your card is in front of you (1)*

6. *(And then you) once its your turn you say like is your person got glasses*

7. *And they say no so you've got to flip down all the people (without) with glasses*

8. *But if they say yes it has got glasses we flip down all the people without glasses*

9. *And eventually you find out who it is*

T: That's fantastic

One month post-injury, Emma demonstrates some difficulties mentally organizing and planning her speech. As a result there are many revisions and false starts and some repetition of points throughout her explanation of Guess Who. For example:

Emma: (and we've got to ask) we've got to look at all the other people on there

and,

Emma: and you gotta pick up one card

Tester: yep

Emma: then you pick up one card

Otherwise though, she shows good pragmatic communication skills. Unlike Daniel, she demonstrates an awareness of her listener, establishing a common knowledge base prior to providing her explanation.

Emma: (you well) you know you have the two boards with all those things that sit up

She does not place great demand on the listener as she provides clear descriptions of processes and elements to the game, and as a consequence, the tester only makes one clarifying statement throughout her explanation,

Tester: like little score things

At the 30 month follow up, Emma no longer displays difficulties mentally organizing and planning her output. Her responses are more succinct and fluent, with fewer revisions and no repetitions. Once again she clearly explains elements and processes of the game, placing little burden on the listener to make inferences or assumptions. For example:

Emma: well first each player has a board

Tester: and they flip up all their cards with the peoples faces on them

and,

Emma: and you've got to answer yes or no from what your card is in front of you

As a consequence, the tester does not make any prompts / clarifying comments throughout her explanation. Overall, her explanation suggests that her pragmatic communication skills have recovered well.

These cases illustrate the variability in outcome that is seen in pragmatic communication following TBI. As Dennis has outlined, this variability may be a combination of injury factors, the child's and family premorbid level of functioning, and the supports available to the child and family post-accident.

In considering injury related factors, both children sustained a moderate-severe TBI, although Daniel had a lower Glasgow Coma Scale score and slower recovery of consciousness. Both children had abnormal brain CT scans. Emma's left frontal haematoma would predict poorer recovery of language and executive functions, however, this was not apparent on the procedural discourse task. It is also interesting to consider the mechanics of the injury, as this can be used to speculate about the level of diffuse injury sustained. Daniel's motor vehicle accident implies that there was greater acceleration-deceleration forces applied to his head, and consequently he may have sustained more diffuse damage than is likely to have occurred in Emma's fall.

Both children were from similar socioeconomic backgrounds. More information on the families' pre-accident level of functioning and their adjustment following the accident would have been helpful to consider the impact of these variables. In terms of post-accident supports, both children received speech therapy as part of their rehabilitation program.

Premorbidly, Daniel may have had some pre-existing language difficulties as his parents rated his communication as marginally below average, and below his general adaptive skills. Emma was rated as having above average communication skills by comparison. She also performed above average on standard tests of verbal reasoning, and receptive and expressive vocabulary. Nevertheless, Daniel also performed at an average level on verbal reasoning tasks, and above average on receptive and expressive vocabulary.

6.3 Implications for future research and intervention

There are a number of avenues for future research to explore in this area. As the present study was significantly limited by its small sample size, future research assessing procedural discourse with a larger sample of children is required. It would be important that this include longitudinal assessment of children as the present study has clearly shown that the impact of TBI varies over time. A greater understanding of the nature of pragmatic communication deficits at different time points post-injury will be important in guiding intervention strategies.

Future research will also need to carefully evaluate the developmental appropriateness of measures used at each assessment stage. Given the protracted development of executive functions, long-term follow up of children into at least early adolescence is likely to provide informative information on the impact of TBI. The present study was limited in detecting group differences on some measures, as many of the children had not yet developed these skills.

Given the complex interplay of factors that impact on outcome from TBI, future research should consider classifying TBI children into subgroups. This would help establish more homogenous groups which would assist in delineating the role of various factors in outcome. In doing so, this may lead to earlier and more effective identification of those children who are at risk of persisting pragmatic communication difficulties. While there is some existing research by Chapman and colleagues and Brookshire and colleagues which have made such efforts, with TBI children classified on the basis of focal pathology, age at injury, or evidence of acute language difficulties, similar approaches need to be explored with procedural discourse.

The communication deficits evident in the present study are likely to have implications for TBI children's social adjustment and academic performance. In the social realm, their difficulties may cause frustration and annoyance in their peers and teachers. The children with TBI themselves may become

frustrated by their own lack of communication success leading to acting out / externalizing behaviours or withdrawn / avoidance behaviours.

Academic difficulties may also result due to difficulties keeping to point, identifying and discussing salient information, summarizing written or verbal material, producing generalizations / gists, and being able to see the 'bigger picture'. These in turn may also lead to feelings of frustration with associated behavioural difficulties.

Empirical research is required to validate the hypothesized association between pragmatic communication difficulties and the abovementioned social-behavioural and academic difficulties. To date there has been no research in this area. This could be achieved by including measures of social-behavioural functioning, such as the socialization and communication domain of the Vineland Adaptive Behaviour Scale (Sparrow, Balla, & Cicchetti, 1984) or the Child Behaviour Checklist (Achenbach, 1991), taken on children's functioning post-accident. In terms of evaluating academic performance, previous outcome measures have included whether the child requires integration support, whether the child has had to repeat a class, or whether the child has been placed in a special development school. These measures provide a very gross indication of a child's academic performance. It would be more informative to obtain more explicit information regarding the child's functioning possibly through structured interviews with teachers or analysis of children's school reports. Clearly though this would be a very time consuming procedure.

Another interesting avenue for paediatric TBI pragmatic communication research to take is to explore children's discourse with their peers. To date, adult testers have primarily been involved in eliciting discourse with children. It is unclear whether this alters children's discourse, although it is expected that normally developing children may not be as patient or supportive communication partners as the testers were in the present study. Children are less likely to make accommodations for slowed responses, provision of insufficient information or unrelated information. Given that children spend

most of their time interacting with peers, exploration of peer interactions is essential to obtaining insights into the 'real world' impact of TBI.

Similarly, it would also be interesting to explore the impact of TBI on children's discourse in situations simulating everyday environments. Current research initiatives have been based on children's performance in the structured clinical setting where distractions are minimized. As a consequence, current findings may create an optimistic impression of the impact of TBI on children's pragmatic communication skills.

It is probably premature to arrive at implications for therapeutic intervention on the basis of these findings given the very small sample size and statistically non significant results. Further research is definitely required to validate and extend these findings. Nevertheless, the findings of this study together with previous pragmatic communication studies strongly suggests that pragmatic communication is a necessary skills to assess following TBI as it does provide important information not detected by formal assessment tasks. Ongoing monitoring of children's development is required, as some children's difficulties may not become evident until further down the track. These and other findings do suggest however, that this will not be an area of difficulty for all children following TBI. In particular, this is less likely to be an issue with children with mild TBI, although findings suggest that they are not immune to the effects of TBI and should also be routinely monitored. It is important to consider the wide normal variation of pragmatic communication skills.

Gathering information regarding the child's pre-accident pragmatic communication skills and style from parents and teachers together with post-accident functioning is essential to accurately identify changes in pragmatic communication.

If the findings of this study are replicated it suggests intervention for pragmatic communication is necessary and should include therapy addressing classifying and summarizing information, detecting salient points, and perspective taking. Although, in the early stages of recovery it may be most

useful to modify the environment to reduce level of distractions, given children's early heightened distractibility.

6.4 Conclusion

Overall, the present study's findings provide tentative support of the vulnerability of pragmatic communication skills to TBI. The study's results further our knowledge by providing preliminary support that the impact of TBI extends to procedural discourse. The procedural discourse task can effectively document higher level communication deficits which are not detected by intellectual or standard language measures. These difficulties are not experienced by all children following TBI but the typical dose response is evident, with more extensive deficits following moderate-severe TBI than mild TBI. Further research is required to identify factors which lead some children to experience persisting difficulties with communication, while others fail to show any sign of difficulty.

The findings also add to existing literature by documenting the changing impact of TBI on pragmatic communication skills over time. In the early days, children's discourse deficits appear to consist of difficulties keeping on track, providing information using clear and direct language, and fluently. A couple of years down the track, children have most difficulty providing generalised explanatory statements and tend to give rather concrete verbose explanations instead. These deficits are expected to contribute significantly to persisting and often worsening academic and social-behavioural functioning seen in some children following TBI. Therapeutic intervention addressing these issues is dependent on more extensive research efforts to enhance our presently limited understanding of this area.

Chapter 7. References

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Appendix A

The following pages contain the documentation relating to permission to conduct the study. They include:

- Approval from the Royal Children's Hospital Ethics in Human Research Committee.
- Approval from the Victoria University Ethics Committee

Department **ETHICS IN HUMAN RESEARCH
COMMITTEE**

Flemington Road,
Parkville, Victoria, 3052
Australia.
Telephone: (03) 9345 5
Facsimile: (03) 9345 57.

APPROVAL

EHRC REF. No: 92029 B

PROJECT TITLE: Linguistic development following head injury in pre-school children

INVESTIGATOR(S): V Anderson, S Morse

DATE OF RENEWAL APPROVAL: 12 August 1997

DURATION: 12 months

SIGNED:



COMMITTEE REPRESENTATIVE

15/8/97
DATE

CONDITIONS

ALL PROJECTS

1. Any proposed change in protocol and the reasons for that change, together with an indication of ethical implications (if any), must be submitted to the Ethics in Human Research Committee for approval.
2. The Principal Investigator must notify the Secretary of the Ethics in Human Research Committee of:
 - Actual starting date of project.
 - Any adverse effects of the study on participants and steps taken to deal with them.
 - Any unforeseen events.
3. A progress report must be submitted annually and at the conclusion of the project, with special emphasis on ethical matters.

DRUG TRIALS

4. The investigators must maintain all records relating to the study for a period of 23 years.
5. The investigator(s) must report to the Sponsor and the Ethics in Human Research Committee within 24 hours of becoming aware of any serious adverse event experienced by any subject during the trial.



Melbourne, Victoria

Department

Flemington Road,
Parkville, Victoria, 3052,
Australia.
Telephone: (03) 345 5522
Facsimile: (03) 345 5789
Telex: AA37281

DATE: 12th August, 1992

ROYAL CHILDREN'S HOSPITAL ETHICS IN HUMAN RESEARCH COMMITTEE

PROJECT NO: 92029

PROJECT TITLE: Linguistic development following head injury in pre-school children.

INVESTIGATOR(S): Dr. V. Anderson
Ms. S. Morse

APPROVAL: 5 years

COMMENT:

SIGNED:

[COMMITTEE REPRESENTATIVE]

The Principal Investigator is requested to notify the Secretary of the Ethics in Human Research Committee, Mrs. Christine Chow, of:

- (i) Actual starting date of project
- (ii) Any change in protocol and the reasons for that change together with an indication of ethical implications (if any).
- (iii) Adverse effects of project on subjects and steps taken to deal with them.
- (iv) Any unforeseen events.
- (v) For sponsored drug trials, the investigators must report to the Sponsor and Ethics Committee within 24 hours of his or her becoming aware of any adverse drug effect experienced during the trial by any patient.
- (vi) For drug trials, the investigators must maintain all records relating to the study for a period of 15 years.

At the conclusion of the project or every twelve months if the project continues, the Principal Investigator is requested to supply a concise report of the project with special emphasis on ethical matters.

Annual Report forms are available from the Royal Children's Hospital Research Foundation, ext. 5044.

72027

APPLICATION FOR CONSIDERATION OF ETHICAL IMPLICATIONS OF
RESEARCH PROJECT

ROYAL CHILDREN'S HOSPITAL ETHICS IN
HUMAN RESEARCH COMMITTEE

(a) TITLE OF PROJECT

Linguistic Development Following Head Injury in Pre-School Children.

(b) PRINCIPAL INVESTIGATORS

Dr. Vicki Anderson, Neuropsychology Co-ordinator - Department of Psychology, Royal Children's Hospital.

Ms. Sue Morse, Senior Speech Pathologist - Department of Speech Pathology, Royal Children's Hospital.

(c) AIMS OF PROJECT

Investigation of recovery patterns of language skills in young children following head injury. Pre-school children are targeted because of the rapid language development at this age, and the immaturity of the brain.

(e) WHAT SPECIFIC SCIENTIFIC QUESTIONS DOES THE PROJECT ADDRESS?

(i) Scientific Language

Specific hypotheses to be tested include:

- (i) Children suffering from head injury during the pre-school period will exhibit language deficits.
- (ii) Patterns of language development in these children will differ from those exhibited by normal children.
- (iii) Patterns of language development following head injury will be similar to those exhibited by language-delayed children.
- (iv) Measures of severity of head injury (eg. Glasgow Coma Scale, duration of Post Traumatic Amnesia), age at injury and maternal education will be predictors of poor recovery within the head injured group.

(ii) Simple English

- (i) Head injured children will exhibit language problems.
- (ii) Head injured children's language skills will develop differently to non-head injured children.
- (iii) Head injured children will show similar language development to children with language - delay.
- (iv) Severity of injury, age at injury and parental education level will influence language development in head injured children.

(f) WHAT IS THE THEORETICAL BASIS OF THESE QUESTIONS?

The present study will focus on language recovery and development following head injury for a number of reasons, (a) linguistic competence is essential to a range of activities including acquisition of knowledge and academic skills and development of socialization. Paediatric studies have identified such vulnerabilities in head injured children, but none have related these difficulties to language function; (b) functional deficits are often observed in linguistic areas following head injury. For example, verbal fluency, word retrieval and discourse function and narrative skill are commonly implicated; (c) formal test procedures which examine language under structured conditions appear unable to detect or explain the language disturbances reported in everyday life and (d) language development is most rapid during the preschool years. Thus it is hypothesized that traumatic brain injury during the critical time may alter the process of language acquisition and integration irreversibly.

(g) BRIEF DESCRIPTION OF PROJECT IN PLAIN ENGLISH

Children suffering head injuries commonly exhibit subtle language deficits which restrict their communication, learning and socialization skills. Commonly used tests of language, intelligence and behaviour do not detect these problems, although difficulties are frequently reported in daily activities. This study aims to investigate these problems by employing more functional measures of language skills. The study will also address the issue of recovery by comparing the language acquisition of head injured children with that of normal and language delayed children. Language delayed children will be recruited from the Speech Pathology Department at the Royal Children's Hospital. Healthy controls will be selected from Maternal and Child Health records, with

appropriate permission obtained from the Community Services Victoria.

(h) HOW CONFIDENT ARE YOU THAT YOUR PROJECT WILL ANSWER THESE QUESTIONS

Recent research suggests that the use of functional measures of language skill will allow a more realistic evaluation of language processes than previously employed standardized techniques, and so allow the detection of the problems frequently described by patients.

Previous research provides no clear idea of the quantitative differences expected between normal and head injured children on these functional measures. However, studies suggest that a 10 point difference in intellectual quotients is common. The IQ measure is considered less sensitive to detection of difficulties, but basing calculations on this variable a sample size of 30 would be necessary to detect a 10 point IQ difference with a power level of 0.8.

(i) WHY IS A PROJECT INVOLVING HUMAN SUBJECTS NECESSARY?

Because language skills are not applicable to other species.

(j) HOW SAFE ARE YOUR PROCEDURES? WHAT DISCOMFORT OR INCONVENIENCE IS INVOLVED?

All procedures involve paper and pencil tests or verbal responses. All are well standardized and commonly used with pre-school children.

No discomfort should be experienced, but families will be required to attend the hospital over a number of occasions for assessment and review.

(k) ETHICAL ISSUES OF THE PROJECT

Test procedures associated with this project are commonly used in clinical practice. Results from tests, videos and questionnaires will be strictly confidential. Information will not be released to other agencies without prior permission from families concerned.

(l) HOW WILL YOU EXPLAIN THE PROJECT TO THE PATIENT AND THE PARENTS?

(see attached information letters; separate letters for each group - A: To Head Injured Group, B: To Language Delayed Group, C: To Healthy Controls).

(m) DO YOU CONSIDER WRITTEN CONSENT NECESSARY

Yes (consent form attached)

(n) TIME SPAN OF RESEARCH

Initially project is designed to continue for 2 years from initial time of enrolment in project. However, it is hoped that funding may be obtained to extend this follow-up phase to 5 years.

(o) IS THE RESEARCH TO BE DONE IN A BLOCK OR ARE YOU REQUESTING PERMISSION FOR APPLYING A RESEARCH PROCEDURE TO OCCASIONAL PATIENTS OVER A LONG PERIOD OF TIME?

All head injured patients meeting research criteria will be approached to participate in the study. These will be seen on several occasions over a two year period initially.

(p) SOURCE OF FUNDING

Application made to N.H. & M.R.C.

Application to be made to Research Foundation, Royal Children's Hospital

Dear Parents,

This letter explains some details of our study. The purpose of our study is to learn more about language development following head injury in pre-school children. We know that language skills are rapidly developing during the pre-school years and that language is important for development of academic and social skills. Unfortunately head injury is a relatively common event in childhood but little is really known about how language or talking skills are affected, how they recover or continue to develop after such injuries.

Our study aims to follow head injured children for two years, to identify any problems that exist and learn how their language continues to grow.

The study will involve meeting with you and your child at the Royal Children's Hospital six times over a two year period as follows: the time just after injury, 3 months, 6 months, 12 months, 18 months and 2 years. During these meetings you will have the chance to discuss your child's progress, and complete some questionnaires. Your child will be involved in activities to assess their language skills, visual skills, learning and memory with a speech pathologist and neuropsychologist. Your child's talking will be videotaped for analysis in a play situation with you and the examiner. Your appointments will be scheduled as conveniently as possible and reimbursements for travel costs will be available if necessary. Inclusion in this study will in no way affect your child's rehabilitation therapy or medical management.

We hope by participating in this study, you will learn more about your child's language development. It may also help us to provide more effective treatment and management for children who are unfortunately injured as well as contributing to the current knowledge of clinicians and researchers in this area. Please note that any publications that arise from this study will not reveal information that identifies you or your child.

Any questions regarding the project entitled LINGUISTIC DEVELOPMENT FOLLOWING HEAD INJURY IN PRE-SCHOOL CHILDREN may be directed to either Vicki Anderson of the Department of Psychology or Susan Morse Department of Speech Pathology, Royal Children's Hospital on 345-5511.

We hope you will participate in this study. It is important for you to understand, however, that you are free to withdraw from the study at any time without explanation and that non participation in the study will not in any way affect access to the best available treatment and care at the R.C.H.

Sue Morse,
Speech Pathologist.

Vicki Anderson,
Neuropsychologist.

[REDACTED]

Dear Parents,

This letter explains some details of our study. The purpose of our study is to learn more about language development following head injury in pre-school children. Unfortunately head injury is a relatively common event in childhood but little is really known about how language or talking skills are affected, how they recover or continue to develop after such injuries. In order to be clear about the head injured child's difficulties we need to compare their performance with other children who have not had a head injury. Your child's language by comparison, can provide important information about how the head injured child's language has been disturbed by the trauma.

Our study aims to follow children for two years. It will involve meeting with you and your child at the Royal Children's Hospital six times as follows: at initial inclusion, 3 months, 6 months, 12 months, 18 months and 2 years. During these meetings you will have the chance to discuss your child's progress, and complete some questionnaires. Your child will be involved in activities to assess their language skills, visual skills, learning and memory with a speech pathologist and neuropsychologist. Your appointments will be scheduled as conveniently as possible and reimbursements for travel costs will be available if necessary. Inclusion as a comparison group will in no way interfere with your child's kindergarten or pre-school activities.

We hope by participating in this study, you will learn more about your child's language development. It may also help us to provide more effective treatment and management for children who are unfortunately injured as well as contributing to the current knowledge of clinicians and researchers in this area. Please note that any publications that arise from this study will not reveal information that identifies you or your child.

Any questions regarding the project entitled LINGUISTIC DEVELOPMENT FOLLOWING HEAD INJURY IN PRE-SCHOOL CHILDREN may be directed to either Vicki Anderson of the Department of Psychology or Susan Morse, Department of Speech Pathology, Royal Children's Hospital on 345-5511.

We hope you will help us with this study. It is important for you to understand, however, that you are free to withdraw from the study at any time without explanation and that non-participation in the study will not in any way affect access to the best available treatment and care at the Royal Children's Hospital.

Sue Morse,
Speech Pathologist.

Vicki Anderson,
Neuropsychologist.

Dear Parents,

This letter explains some details of our study. The purpose of our study is to learn more about language development following head injury in pre-school children. We know that language skills are rapidly developing during the pre-school years and that language is important for development of academic and social skills. Unfortunately head injury is a relatively common event in childhood but little is really known about how language or talking skills are affected, how they recover or continue to develop after such injuries.. In order to be clear about the head injured child's difficulties we need to compare their performance with other children who have language delay but no head injury.

Our study aims to follow children for two years. It will involve meeting with you and your child at the Royal Children's Hospital six times as follows: at initial assessment, 3 months, 6 months, 12 months, 18 months and 2 years. During these meetings you will have the chance to discuss your child's development, and complete some questionnaires. Your child will be involved in activities to assess their language skills, visual skills, learning and memory with a speech pathologist and neuropsychologist. Your appointments will be scheduled as conveniently as possible and reimbursements for travel costs will be available if necessary. Inclusion as a comparison group will in no way interfere with your child's current therapy or medical management.

We hope by participating in this study, you will learn more about your child's language development. It may also help us to provide more effective treatment and management for children who are unfortunately injured as well as contributing to the current knowledge of clinicians and researchers in this area. Please note that any publications that arise from this study will not reveal information that identifies you or your child.

Any questions regarding the project entitled LINGUISTIC DEVELOPMENT FOLLOWING HEAD INJURY IN PRE-SCHOOL CHILDREN may be directed to either Vicki Anderson of the Department of Psychology or Susan Morse, Department of Speech Pathology, Royal Children's Hospital on 345-5511.

We hope you will help us with this study. It is important for you to understand, however, that you are free to withdraw from the study at any time without explanation and that non participation in the study will not in any way affect access to the best available treatment and care at the Royal Children's Hospital.

Sue Morse,
Speech Pathologist.

Vicki Anderson,
Neuropsychologist.

Acquired brain injury in children is one of the most frequent causes of interruption to the normal course of development. However, the investigation of paediatric head injury lags far behind that of adult head injury. While much is now known about the recovery patterns of adults suffering from head injury, the process of recovery following paediatric head injury is less clear.

Many similarities exist between adult and pediatric head injury in terms of specific behavioural consequences. However, paediatric head injury differs from adult head injury in a number of important aspects. Firstly, the child's brain is incompletely developed: ongoing fusion of the skull leads to more flexible movement of the components of the skull. In the event of a blow to the child's head, the bone is able to absorb more of the forces of the impact, with less skull fractures occurring. This leads to more diffuse brain injury, and less focal damage. While this may be seen to be an advantage, resultant problems in cerebral function are frequently subtle and difficult to detect. In addition, such diffuse damage may disrupt ongoing development, particularly in areas of the central nervous system which are undergoing rapid maturation. Myelination of neurones and frontal lobe maturation are the most important of these processes and these are thought to be most rapid during the first 5 years of life (Hudspeth and Pribram, 1990; Thatcher, 1991). Neuropsychological literature suggests that these areas are intimately related to information processing and executive skills. Further, they are the areas of most vulnerable to damage as a result of the mechanical forces involved in head injury (Walsh, 1976). However, these abilities are often difficult to assess in young children. Kennard (1940) and others (Finger & Stein, 1982) suggest that while young children/animals may appear to have no observable deficits in the early stages of recovery, this is simply because the disrupted functions have not yet come into action. Thus, as the child matures certain 'executive' functions fail to emerge. It is only when the child is required to function more independently that these deficits become apparent.

Secondly, lack of consolidated skills: In contrast to the bank of well-learned skills available to the head injured adult, the preschooler has fewer consolidated abilities. Linguistic skills are rapidly developing, as are memory and learning skills. Clinical experience (and some pilot data) suggests that the young head-injured child has difficulty progressing in these areas. This hinders the child's capacity to acquire new skills, for example reading, spelling, mathematics which form the basis for development of a much wider range of skills through the education process. In the adult these are virtually automatic and generally unaffected by head injury.

Finally, Reduction of learning ability: It is well documented that head injury reduces attentional ability and new learning skills (Gronwall, 1987; Posner, 1987). Thus, there may be a

cumulative effect of such an injury on the young child; that is, the effect of the initial injury and the associated cognitive deficits plus the cumulative effects that these deficits cause for a child whose developmental tasks focus on attending to and learning new information.

Currently allocation of rehabilitation resources is heavily weighted in favour of adult head injury, possibly because of the popular view that children recover from head injury better than adults. This situation is perpetuated because of the limitations of paediatric head injury research including lack of longitudinal studies, retrospective designs, poor sample description, lack of control groups and inappropriate/inadequate experimental measures. As a result, findings are inconsistent and there is a lack of clarity in the field.

The present study will focus on language recovery and development following head injury for a number of reasons, (a) linguistic competence is essential to a range of activities including acquisition of knowledge and academic skills (Sima, 1985) and development of socialization (Gottman, 1983). Paediatric studies (Levin, Benton & Grossman, 1982) have identified such vulnerabilities in head injured children, but none have related these difficulties to language function; (b) functional deficits are often observed in linguistic areas following head injury. For example, verbal fluency, word retrieval (Sarno, 1984) and discourse function and narrative skill are commonly implicated (Parsons et al, 1989); (c) formal test procedures which examine language under structured conditions appear unable to detect or explain the language disturbances reported in everyday life (Ewing-Cobbs, 1987; Jordan et al, 1988; Sarno, 1984); and (d) language development is most rapid during the preschool years. Thus it is hypothesized that traumatic brain injury during this critical time may alter the process of language acquisition and integration irreversibly.

Recently in adult literature protocols employing discourse analysis have emerged, in an attempt to understand the difficulties experienced by head injured patients in naturalistic contexts, such as spontaneous conversation. Such studies have suggested that, despite normal performances on structured aphasia tests, deficits do exist in functional language skills, and that these may have significant effects in the communication and socialisation skills of head injured individuals. (Parsons, et al, 1989; Penn & Cleary, 1988).

Some initial data collected by the authors have suggested variation in the language performance of children post-head injury. Very young children showed increased difficulty establishing the structural components of language that is, words and grammar as well as using language in a functional way. Pre-school children, whose language was incompletely established pre-injury, may exhibit adequate language skills

on standardized tests, however they show reduced cohesion, fluency, specificity and logical organization in narrative. It appears that the ability to speak, and even speak a lot, does not necessarily indicate intact linguistic skills. At present allocation of rehabilitation resources (eg. educational and compensation systems) is based solely on standardised test scores and does not include more functional criteria. It is therefore important to be able to clearly document features of language in the head-injured population and thus to provide accurate information regarding outcome and preferred treatment to families, rehabilitators and educators to maximise the potential of these children.

RESEARCH PLAN

Subjects:

Head injured: 30 head injured children will be identified on admission to the Neurosurgery Ward at the Royal Children's Hospital, Melbourne. Numbers are based on an estimation of a 10 point difference in IQ between normal and head injured children. With a sample of 30 there would be 80% power at the one-tailed alpha level of 0.05 to detect a statistical difference between the groups.

Patient entry to the study will be consecutive. Based on examination of previous admission trends it is estimated that enrolment will occur over a twelve to eighteen month period.

Inclusion criteria will include:

- (i) age between two and five years at time of injury
- (ii) no history of pre-existing neurological, physical, audiological or psychiatric disorders
- (iii) normal language development prior to head injury
- (iv) head injury of moderate to severe degree.
- (v) period of loss of consciousness

A number of measures will be used to assess severity of injury, as to date, no one measure has been agreed to be uniquely useful in evaluation of paediatric head injury. The Glasgow Coma Scale (GCS) will be employed to identify moderate to severe injuries (GCS scores of 8 or less) and will be administered initially during the first 24 hours following injury. Additional measures will include length of coma and duration of post-traumatic amnesia (P.T.A.). Each of these measures will be administered daily until the subject is assessed as being out of P.T.A. A new measure of recovery, the Profile of Early Recovery in Children will also be employed to provide extra information and to evaluate the utility of the measure in a paediatric population.

Controls: Three control groups will be employed in the current study.

- (a) Normal language group A: 30 children, matched for preinjury linguistic ability (as estimated by language questionnaire), sex, SES and level of education of

primary caregiver will be included in this group. Criteria (i), (ii), and (iii) will apply to these children, who will be selected from maternal and child health agency records.

- (b) Normal language group B: 30 children matched for post injury linguistic ability, sex, SES and level of education of primary caregiver will comprise this group. Criteria (i), (ii) and (iii) will apply, and children will be selected from maternal and child health agency records. Permission will be sought from relevant agencies.
- (c) Language delayed group: 30 children matched for sex, SES and level of education of primary caregiver will be chosen from speech pathology referrals to the Royal Children's Hospital. Criteria (ii) will apply to this group. Children will also be matched to the head injured group with respect to postinjury linguistic abilities. This group is included as a comparison group to the normal language groups, providing an alternative pattern of language development to that observed in normal children. Educational level of primary caregiver, socio-economic status and general health status are included in the study as such factors have been noted to be relevant to the development of language in the pre-school child and thus need to be taken into account.

Head injured and language delayed children will also be matched with respect to speech therapy intervention. The normal control groups will not receive any linguistic intervention.

Relevant information regarding composition and functioning of family unit, will be documented.

Procedure:

- (i) Acute Phase: Children enrolled in the study will be monitored initially, with respect to neurological parameters. GCS scores, PTA measures will be collected until child has emerged from PTA, and duration of unconsciousness will be noted. CT scan data will provide information regarding specific aspects of cerebral pathology. Additionally, level of education of primary caregiver and socio-economic status will be noted. Parents will complete a language screening questionnaire (modified from Volpe) and the Personality Inventory for Children based on premorbid observations.

Level of language function will be rated on alternative days during the acute phase. Ratings of communication skills (ranging from eye contact and ability to respond to commands to total language recovery) will be based on the Profile of Early Recovery in Children.

The information collected at this stage will be employed to characterise the head injured sample, as such injuries frequently show significant variability.

(ii) Formal evaluations: At three months, 12 months and 2 years post-injury linguistic and neuropsychological evaluation will occur, with subjects from all three groups being assessed. Assessment measures will include.

(a) Intellectual evaluation.

1. Weschsler Preschool and Primary Intelligence Scale - Revised (WPPSI-R)

(b) Linguistic evaluation.

1. Peabody Picture Vocabulary Test - Revised (PPVT-R)
2. Test of Auditory Comprehension of Language Revised (TACL-R)
3. Verbal Memory - (McCarthy Scales of Children's Ability)
4. Expressive One-Word Picture Vocabulary Test (EOWFVT)
5. Verbal Fluency (McCarthy Scales of Children's Ability)
6. Photo Articulation Test (PAT)

(c) Visual processing evaluation.

1. Beery Visuo-Motor Integration Test (VMI)
2. Spatial Memory Test (L'hermitte & Signoret)

(d) Behavioural/Family factors.

1. Personality Inventory for Children (PIC) (parents)
2. General Health Questionnaire (parents)

(iii) Functional language evaluation: Language samples will be collected on 5 occasions - 3, 6, 12, 18, 24 months post head injury. Language samples will be elicited as follows:

(1) Children will be videod and tape recorded in a structured play situation with parent and examiner. The resultant language sample of 50 utterances will be rated by 2 independent raters, with respect to mean length of utterance, grammar, word use, pragmatics. No information will be provided to raters regarding the patient's history, although this may be clearly evident in some cases because of the child's physical disabilities.

(2) Oral narrative: Two tasks will be used

- (a) Story Retelling and
- (b) Story generation, from a picture stimulus. Narratives will be taped and analysed and rated by 2 independent raters with respect to the described parameters.

Data Analysis

Data analysis will be directed to comparing linguistic development across the four groups over a two year period. Individual analysis will be performed at each follow-up across follow-up to determine any differences among the groups in terms of developmental pattern. Relationships between neuropsychological variables and functional variables will be investigated to identify useful predictors of linguistic deficit.

Within the experimental group, the predictive power of the acute neurological and the psychosocial variables will be examined.

DESIGN

Table 1: Study Protocol

Phase	Assessment	Head Injured (n=30)	Control B (n=30)	Control A (n=30)	Lang
A. Acute Phase	Early Recovery Data Neurological Data Language Screening Questionnaire Behavioural Questionnaire General Health Questionnaire	✓ ✓ ✓ ✓ ✓ pre and post-injury measures	x x ✓ ✓	x x ✓ ✓	
B. 3 Months Post-Injury	Neuropsychological/Speech Assessment - IQ, language, visual skills, memory, behavioural questionnaires	✓	✓	✓	
	Functional language sample - structured play, oral narrative	✓	✓	✓	
C. 6 months Post-Injury	Functional language sample - structured play, oral narrative	✓	✓	✓	
12 months Post-Injury	Neuropsychological/Speech Assessment Functional language sample -structured play, oral narr.	✓	✓	✓	
10 months Post-Injury	Functional language sample -structured play, oral narr.	✓	✓	✓	
2 years Post-Injury	Neuropsychological/Speech Assessment - IQ, language, visual skills, memory	✓	✓	✓	
	Functional language sample -structured play, oral narrative	✓	✓	✓	

Victoria University
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Human Research Ethics Committee
Chair: Heather Gridley



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St.Albans Campus

TO WHOM IT MAY CONCERN

Monday, 23rdth December, 2002

The project titled **"Pragmatic communication skills in children after traumatic brain injury: effect of injury severity and age at injury"** conducted by **Ms. Simone Bassi** under the supervision of Dr. Alan Tucker at Victoria University together with Dr Vicki Anderson and Sue Morse at the Royal Children's Hospital received ethics approval from the Department of Psychology's Human Research Ethics Committee on 23/12/02.

This project is been undertaken as part of the Doctor of Psychology (Clinical Neuropsychology) program conducted at Victoria University.

It is noted that the project is to be conducted under the auspice of the Royal Children's Hospital.

Yours sincerely


Heather Gridley

Chair
Department of Psychology
Human Research Ethics Committee

Appendix B

The following appendix includes the formal instructions for 'snap' and 'guess who' as published by the game developers.

SNAP

How to play. Two or more players.

Shuffle the cards & deal them out equally among players. Each player puts their cards face down in front of them, in a pile.

In turn, each player turns up their top card & places it next to their own pile. When any turned up card matches a top card on any other pile, snap first wins both matching piles.

They are placed face down under their own pile. If a player calls "snap" by mistake or two players call "snap" together their piles are placed face up in the middle to form a pool. A player who turns up all their cards is out of the game. The last player left is the winner.

Guess Who?

INSTRUCTIONS

FOR 2 PLAYERS
AGES 6 AND UP

Object

Guess your opponent's Mystery Person before your opponent guesses yours.

Contents

2 gameboard trays, 24 Mystery cards, 48 Face cards and Face frames, 2 score keepers

The First Time You Play

1. Carefully twist the 48 Face frames and the 2 two-piece score keepers off of the plastic runners. Discard the waste.
2. Gently detach the 48 Face cards and the 24 Mystery cards from the sheet. Discard the waste.
3. Slide each Face card into a Face frame, as shown in Figure 1.

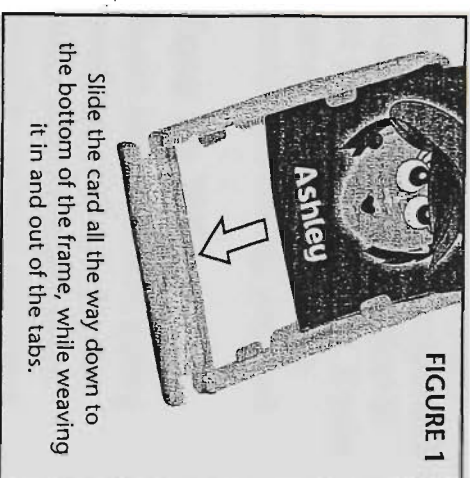


FIGURE 1

4. Attach the 48 loaded frames to their matching-colored gameboards. See Figure 2. It doesn't matter which gameboard positions the frames occupy. After attaching each frame, flip it up and down to make sure that it fits properly.

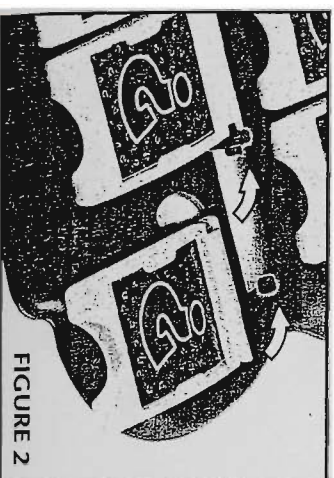


FIGURE 2

Attach a score keeper to each gameboard as shown in Figure 3. Use the score keepers for Championship Play only.

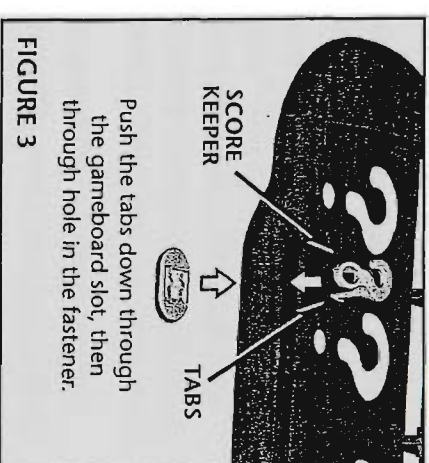


FIGURE 3

Game Setup

SET UP YOUR GAMEBOARD

Each player chooses a gameboard. Place your gameboard on a flat surface. Flip all of your frames upright by tipping your gameboard away from you; then set your gameboard flat again. Your opponent does the same.

DRAW YOUR MYSTERY CARD

Shuffle the Mystery cards. Choose one card at random and fit it into your Mystery card slot so that your Mystery Person faces you. See Figure 4.

Your opponent does the same. Then place all unused Mystery cards out of play. Sit facing your opponent, so that he or she can't see the Mystery Person on your card!

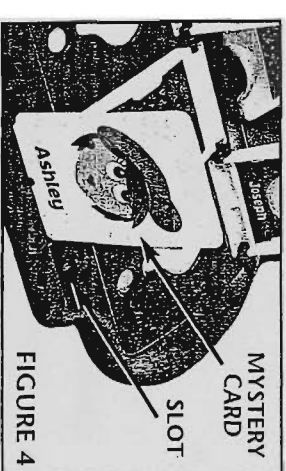


FIGURE 4

Gameplay

YOUR OBJECT

Your object is to guess the Mystery Person on your opponent's card by asking one question per turn, and eliminating any gameboard faces that don't fit the Mystery Person's description.

THE GAMEBOARD FACES

Notice the differences among the 24 faces on your gameboard. Hair and eye colors are different; some faces have beards, mustaches or big noses; some are wearing hats or glasses. As you play, you'll notice several other differences among the gameboard faces.

YOUR TURN

The younger player always goes first. On your turn, you may *either* ask a question, *or* guess who the Mystery Person is. But don't use your turn to guess the Mystery Person until you're ready! If your guess is wrong, you'll lose the game! Rules for asking questions and guessing the Mystery Person are explained below.

ASKING QUESTIONS

Until you're ready to guess who the Mystery Person is, ask your opponent *one* question per turn. Each question must have either a "yes" or "no" answer. For example, you may ask: "Does your person have white hair?" Your opponent must then answer either "yes" or "no."

After your opponent answers, you may be able to eliminate one or more gameboard faces. For example, if the Mystery Person has white hair, flip down all the faces that have black, brown, red or yellow hair. This leaves only the white-haired people as the possible Mystery person.

After you ask a question (and flip down any faces you can), your turn is over.

GUESSING THE

MYSTERY PERSON

When you're ready to guess who the Mystery Person is, make your guess on your turn, *instead* of asking a question.

To guess the Mystery Person, say (for example), "The Mystery Person is Andy." Your opponent must then tell you whether or not your guess is correct. If your guess is right, you win the game! If it's wrong, you lose!

How to Win

Players alternate turns asking questions, until one player makes a guess. If you guess correctly—or your opponent guesses incorrectly—you win the game!

Challenge Game

For an extra challenge, both players draw *two* Mystery cards, and place them side-by-side in their Mystery card slots. Your object is to guess who *both* of your opponent's Mystery People are!

You must say "both" or "either" when asking questions about the Mystery People. For example, you may ask, "Do both of your people wear

glasses?" or, "Does either of your people have black hair?" Be very careful when eliminating gameboard faces—and remember which questions you've asked!

For example, you ask, "Does either of your people have a beard?" Your opponent answers "yes." You cannot flip down any faces, because although *one* Mystery Person *definitely* has a beard, the other one may not!

To guess the Mystery People correctly, you must guess both of them on the same turn.

Championship Play

If you wish to play a series of games, slide the score keeper up one point for every game you win. The first player to win five games is the Champion!

Replacement Parts

- Replacement set of 48 plastic frames: \$3/set
- Replacement set of Face cards: \$2/set
- Replacement set of Mystery cards: \$2/set

Specify items wanted and send your request to the address below. Be sure to include your name and address along with a check or money order made payable to:

Hasbro Games
Consumer Affairs Dept.
P.O. Box 200
Pawtucket, RI 02862

Tel: 888-836-7025 (toll-free)

We will be happy to hear your questions or comments about this game. Write to: Hasbro Games, Consumer Affairs Dept., P.O. Box 200, Pawtucket, RI 02862.

Tel: 888-836-7025 (toll-free).

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Hasbro Canada Corporation, 2350
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J4G 1G2.

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PROOF OF PURCHASE



The following appendix includes:

- A transcript of a control child's response to the procedural discourse task
- The completed rating form for this response

Control 1

Female, aged 3 years 2 months

Acute assessment

Snap

T: can you tell me how to play snap (2)

1. when you get the right cards you go snap

T: so when what are the right cards *

T: you tell me from the start get the cards and then what

2. you spread them out

3. you get one to you one to me one to you one to me

T: ohh until we both have half each

[child nods]

T: and then what

4. (you) (and when you get you put) (if you get) (if you find) if you find the same one
(you) you put them in the middle

5. and you go snap

T: Ohh right

6. The person who has the same one goes snap

T: snap like that

7. yeh

T: and when do you stop (2)

8. (you) you have to stop for another persons turn

T: Oh I see

9. hey its cold under the table

T: Is it. Oh that's no good the heaters on so its very warm its very hot

T: So then how do you win how do you win snap

10. * when you have the same card

T: Oh right.

Follow-up assessment at 18 months

Aged 4 years, 8 months

Snap

T: how do you play snap step by step (2)

1. ahh you (put ca) (put some ca) put all the cards down

T: right

2. (til) till (the) they're the same

T: ahm

3. and when they're the same you snap them

4. and the person gets all those cards

T: yes very good

RATING FORM

ID 1 Assessment stage acute 6 18 30 Game Snap

Total no. of communication units 10

Total no. of essential propositions stated 2

Percentage of essential propositions stated .22

Total no. of essential propositions inferred 1

Percentage of essential propositions inferred .11

Percentage of essential propositions omitted .67

Content score .33

Listener Burden .67

Total no. of times therapist repeats / rephrases questions 0

Total no. of clarifying questions asked by therapist 1

Total no. of prompts used by therapist 3

Therapist burden 4

Total no. of nonspecific words 0

Total no. of correct BUT unessential units 1

Total no. of redundant communication units 0

Verbosity index 1

Total no. of incorrect propositions 0

Total no. of times child diverts from explanation 1

Total no. of responses which are incongruent to therapists statement 0

On task index .90

Total no. of fillers 2

Total no. of revisions 4

Total no of delays before responding 4

Durations of delays 6

Total no of pauses 0

Duration of pauses 0

Total no. of times talking over therapist 0

Organisational score -1

RATING FORM

ID 1 Assessment stage acute 6 (18)30 Game Snap

Total no. of communication units 4

Total no. of essential propositions stated 3

Percentage of essential propositions stated 33

Total no. of essential propositions inferred 0

Percentage of essential propositions inferred 0

Percentage of essential propositions omitted 67

Content score 33

Listener Burden 25

Total no. of times therapist repeats / rephrases questions 0

Total no. of clarifying questions asked by therapist 0

Total no. of prompts used by therapist 0

Therapist burden 0

Total no. of nonspecific words 0

Total no. of correct BUT unessential units 0

Total no. of redundant communication units 0

Verbosity index 0

Total no. of incorrect propositions 0

Total no. of times child diverts from explanation 0

Total no. of responses which are incongruent to therapists statement 0

Ontask index 1

Total no. of fillers 2

Total no. of revisions 3

Total no of delays before responding 1

Durations of delays 2

Total no of pauses 0

Duration of pauses 0

Total no. of times talking over therapist 0

Organisational score 1