

**Executive functioning and the interpretation of social
information following traumatic brain injury.**

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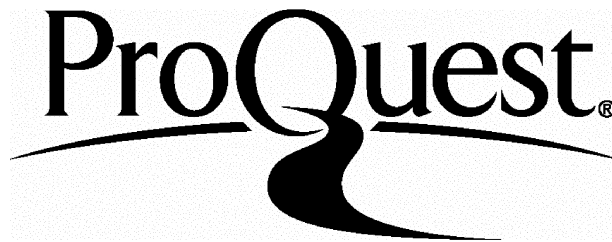
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	page
CONTENTS	
CONTENTS OF TABLES AND FIGURES	5
ACKNOWLEDGMENTS	6
ABSTRACT	7
1. INTRODUCTION	9
Chapter 1	
1.1. Terminology	9
1.2. The incidence and causes of TBI	10
1.3. Neuropathology	11
1.4. Severity classification of TBI	13
1.5. The outcome of TBI	16
1.5.1. Neurophysical problems	17
1.5.2. Personality problems	17
1.5.3. Cognitive problems	18
1.5.4. Emotional problems	19
1.5.5. Vocational problems	20
1.5.6. Social and family problems	21
1.6. Overview of TBI outcome: The importance of problems functioning in a social context and the role of cognitive and emotional factors	23
Chapter 2	
1.7. Cognitive and emotional deficits following TBI	25
1.8. Cognitive deficits	25
1.8.1. Attentional deficits	25
1.8.2. Memory deficits	32
1.8.3. Executive deficits	35
1.8.4. Language deficits	38
1.8.5. Theory of mind deficits	45
1.8.6. Summary of cognitive deficits	49
1.9. Emotional deficits	50
1.9.1. Summary of emotional deficits	52
1.10. Overview of cognitive and emotional deficits	53
Chapter 3	
1.11. The relationship between cognitive deficits and social functioning following TBI	54
1.12. Studies examining attention	54
1.13. Studies examining memory function	55
1.14. Studies examining executive function	56
1.15. Studies examining executive and pragmatic functioning	58
1.16. Studies examining theory of mind	61

	page
1.17. Overview of existing research examining the relationship between cognitive deficits and social functioning following TBI: A rationale for the current study	62
1.18. Aims and hypotheses	65
2. METHOD	69
2.1. Design	69
2.2. Participants	69
2.2.1. TBI group	69
2.2.2. Control group	70
2.2.3. Significant others	70
2.2.4. Sample characteristics	70
2.3. Procedure	75
2.4. Measures	76
2.4.1. Screening measures	76
2.4.2. Social interpretation measures	77
2.4.3. Neuropsychological measures of executive function	84
2.4.4. Neuropsychological measures of anterior attentional processes	88
2.4.5. Neuropsychological measure of memory	91
2.4.6. Theory of mind measures	91
3. RESULTS	94
3.1. Analysis of data	94
3.2. TBI and Control group performance on the social interpretation measures	96
3.2.1. Do the TBI and Control group differ significantly on the pragmatic judgment task?	96
3.2.2. Do the TBI and Control group differ significantly on the social skill judgment task?	98
3.2.3. Do the TBI and Control group differ significantly on the conversation judgment task?	100
3.2.4. Is there a relationship between performance on the three social interpretation tasks?	105
3.3. TBI and Control Group performance on the neuropsychological measures	111
3.3.1. Do the TBI and Control group differ significantly on measures of attention and executive function?	108
3.3.2. Do the TBI and Control group differ significantly on the memory measure?	108
3.4. TBI and Control group performance on the theory-of-mind-type social comprehension tasks	111
3.4.1. Do the TBI and Control group differ significantly on the Story comprehension task?	112
3.4.2. Do the TBI and Control group differ significantly on the Strange stories task?	113

	page
3.5. Relationship between performance on the social interpretation task and the measures of attention and executive function and theory-of-mind-type social comprehension tasks	113
3.5.1. Is there a relationship between performance on the pragmatic judgment task and the measures of attention and executive function and the theory-of-mind-type social comprehension tasks in the TBI and Control group?	114
3.5.2. Is there a relationship between performance on the social skill judgment task and the measures of attention and executive function and the theory-of-mind-type social comprehension tasks in the TBI and Control group?	114
3.5.3. Is there a relationship between performance on the conversation judgment task and the measures of attention and executive function and the theory-of-mind-type social comprehension tasks in the TBI and Control group?	114
3.6. Relationship between the theory-of-mind-type social comprehension tasks and performance on the measures of attention and executive function	117
3.7. Overview of the current findings	119
4. DISCUSSION	122
4.1. Performance on the social interpretation tasks	122
4.1.1. The pragmatic judgment task	122
4.1.2. The social skill judgment task	125
4.1.3. The conversation judgment task	128
4.2. Performance on the non-social neuropsychological measures of attention and executive function	130
4.2.1. Anterior attention functioning	130
4.2.2. Executive function	132
4.3. Performance on the higher-level theory-of-mind-type social comprehension tasks	134
4.4. Explaining performance on the social interpretation tasks	135
4.4.1. Factors contributing to performance on the conversation judgment task	137
4.4.2. Factors contributing to performance on the pragmatic judgment task and social skill judgment task	139
4.5. Limitations of the study and directions for future research	145
4.6. Implications of the findings for rehabilitation and social functioning following TBI	147
4.7. Concluding comments	149
5. REFERENCES	151
6. APPENDICES	169
6.1. Ethical approval for the study	169
6.2. Information sheet	170
6.3. Consent form	171
6.4. Access to medical records consent form	172

	page
6.5. Consent form to contact significant others	173
6.6. Pragmatic judgment task	174
6.7. Social skill judgment task	176
6.8 Judgment of language and para-language in real-life-type conversation task	178

CONTENTS OF TABLES AND FIGURES		page
Table 1.1.	Severity classification of TBI according to the GCS and PTA.	14
Table 2.1	Matching between groups.	71
Table 2.2	Occupation of participants.	71
Table 2.3	Living arrangements of participants.	72
Table 2.4	Causes of TBI.	72
Table 2.5	Lesion characteristics.	74
Table 2.6	Characteristics of significant others.	75
Table 3.1.	Mean group scores for the response types on the pragmatic judgment task.	97
Table 3.2.	Mean group scores for the 'non-literal appropriate correct' variable on the pragmatic judgment task.	98
Table 3.3.	Mean group scores for the response types on the social skill judgment task.	99
Table 3.4.	Mean group scores for the 'skilled correct' variable on the social skill judgment task.	100
Table 3.5.	Mean group scores for the free recall on the conversation judgment task.	101
Table 3.6.	Mean group scores for the manner ratings on the conversation judgment task.	104
Table 3.7.	Mean group scores for the para-language ratings on the conversation judgment task.	104
Table 3.8.	Correlations between the three social interpretation measures in the TBI group.	106
Table 3.9.	Correlations between the three social interpretation measures in the Control group.	107
Table 3.10	Mean group scores for the measures of attention and executive function.	110
Table 3.11.	Mean group scores for the DEX.	111
Table 3.12.	Mean group scores for the measure of memory function.	112
Table 3.13.	Mean group scores for the Story comprehension task.	112
Table 3.14.	Mean group scores for the Strange stories task.	113
Table 3.15.	Correlations between the three social interpretation tasks and the attention and executive function measures and theory-of-mind-type social comprehension tasks in the TBI group.	115
Table 3.16.	Correlations between the three social interpretation tasks and the attention and executive function measures and theory-of-mind-type social comprehension tasks in the Control group.	116
Table 3.17.	Correlations between the theory-of-mind-type social comprehension tasks and measures of attention and executive function.	118
Figure 1.	Pragmatic judgment task: Mean scores for the TBI and Control group for each response type.	97
Figure 2.	Social skill judgment task: Mean scores for the TBI and Control group for each response type.	99

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ABSTRACT

Traumatic brain injury (TBI) is commonly associated with problems in social functioning. There have been very few studies conducted to elucidate the specific contribution of cognitive deficits to these problems. Previous studies have suggested that executive impairment might be related to poor social decision-making. This study aimed to examine whether TBI was related to problems with the interpretation of social information and to what extent any problems were associated with executive impairment.

The performance of seventeen TBI non-aphasic participants was compared to seventeen healthy control group participants matched in age, sex and NART IQ on neuropsychological tests of executive function, theory-of-mind-type social comprehension tasks and three real-life-type social tasks involving the interpretation of social information. The social interpretation tasks consisted of a pragmatic judgment task, a social skill judgment task and a conversation judgment task. The first two tasks presented a series of short written social interactions between pairs of characters. It was necessary to rate alternative verbal responses made by one character, which varied in their degree of context appropriateness and skill. The third task involved judging the manner and para-linguistic features of characters in an audible conversation.

The TBI group performed more poorly on the pragmatic judgment and social skill judgment tasks. They demonstrated poor inferential sensitivity by failing to differentiate adequately between alternative responses. They were also significantly impaired on the measures of attention, executive function and theory-of-mind-type social comprehension, compared to the Control group. It was argued that difficulty appreciating the appropriateness and skilfulness of responses reflected poor inhibitory control resulting from deficits in executive functioning. Despite a lack of correlational evidence to support an executive explanation, this was considered more plausible to an account in terms of selective theory of mind impairment. TBI

group performance on the conversation judgment task was generally similar to the Control group. They judged the manner of the characters as accurately as the Control group. However, they appeared less sensitive to the presence of para-linguistic features. It was speculated that this might have been due to poor attention or difficulties retaining and retrieving information. Overall, the findings suggest that there is a need for further research examining the interpretation of social information in TBI patients. The implications for rehabilitation were discussed.

1. INTRODUCTION

The introduction will consist of three chapters. In chapter one I shall discuss the nature and outcome of traumatic brain injury. It will be emphasised that considerable problems in social functioning are observed following TBI and cognitive and emotional deficits appear to contribute markedly to these problems. Chapter two will then review in more depth these cognitive and emotional deficits. In chapter three I will focus on cognitive deficits and examine existing research looking at the relationship between these deficits and problems in social functioning. The rationale for the current study and experimental hypotheses will then be provided.

Chapter 1

1.1. Terminology

The term 'traumatic brain injury' (TBI) refers to brain injury resulting from a trauma of external force applied to the head and its contents. TBI is in contrast to other causes of brain injury such as disease or vascular accident. The National Head Injuries Association (NHIF) in the USA note that the external force in TBI will usually produce diminished and altered states of consciousness, which can cause impaired cognitive abilities and physical functioning (NHIF, 1989). Although the term 'head injury' is often used to describe this patient group, TBI is preferred as it implies damage has occurred to the brain itself, as opposed to superficial damage to the face or head (Powell and Wilson, 1994).

The term TBI will refer to the experimental population used in this study. It should be noted here that there are two main types of TBI: closed (or blunt) injuries and open (penetrating) injuries. The skull remains intact and the brain is not exposed in closed TBI. In contrast, open

TBI occurs when a missile, such as a bullet, penetrates the skull and traverses the brain tissue. (These two types of TBI are not necessarily mutually exclusive however. For example, motor vehicle accidents can cause closed and open injuries). The population in this study had a closed TBI. Details regarding the nature of the injuries will be provided where obtainable.

1.2. The incidence and causes of TBI

There is a high incidence of TBI in the modern Western world and it is the most common form of brain injury (Kurtzke, 1984). This primarily reflects the fact that more people are suffering injuries as a result of the increased use of motorised transport, coupled with improved survival rates due to advances in the medical management of acute brain conditions (Bontke, 1990). However, despite the high incidence of TBI it is unfortunate that the provision of health care for people with TBI remains underdeveloped in most countries in the world (Chamberlain, 1995).

It is difficult to obtain precise figures regarding the incidence of TBI, particularly as epidemiological studies vary in terms of data collection (Berrol, 1989). For example, Parker (1990) notes that some studies are limited to hospitalised patients, while others include a range of severity levels. The location of studies also affects the reported level of incidence. Jennett (1989) found that countries such as England, Japan and Sweden reported half as many fatal injuries as the United States. Also, inner city areas have a higher incidence of TBI compared to rural areas (Willer et al, 1990).

It is unsurprising therefore, that there is a great deal of variability in reported incidence figures. Closed TBI is by far the most common type of injury, whereas open TBI, with the exception of war wounds, account for less than 10% of all TBI (Grafman and Salazar, 1987). In the United States the general incidence of TBI has been found to range from 500,000 to more than

1.9 million a year (Berrol, 1989). Kraus et al (1984) estimated the incidence of TBI at 180-200/100,000 of the population per year. Tennant (1995) reported a rate of 297 per 100,000 in a region covered by the North West Regional Health Authority. In terms of the severity of TBI, Lezak (1995) notes that fewer than 10% of all TBI victims are severely injured. A study on an Australian sample found moderate and severe TBI estimated at 12-14/100,000 and 15-20/100,000 of the population per year respectively (Tate et al, 1998).

There is greater agreement between studies that that the peak ages for TBI are in the 15-24 age range, with high incidence rates in the first five years and in older adults aged 75 or over (Goldstein and Levin, 1990; Kalsbeek et al, 1980). Furthermore, males consistently outnumber females 2:1 (Kraus et al, 1984; Naugle, 1990).

Motor vehicle accidents are by far the most common cause of TBI and account for about 45% of all injuries (Jennett and Frankowski, 1990). The frequency of these accidents peaks in the 18-25 age range (Selecki et al, 1981). Falls are the most frequent cause of TBI in older adults and the very young (0-4 years), while in the 5-14 age group sporting accidents account for a large proportion (Tate et al, 1998).

1.3. Neuropathology

I shall now briefly refer to the neuropathology of TBI. The focus will be on closed TBI. There are typically two stages of neuropathology in closed TBI, referred to as primary and secondary brain damage. Primary brain damage occurs at the time of the injury as a direct result of the forces exerted on the brain. There are usually classical coup injuries where the brain is lacerated and bruised at the point of impact and also contracoup injuries at distant points due to the brain ricocheting against the bony skull protuberances (Coxe, 1978). The force of the injury and the rotational acceleration of the brain can also cause the white matter to stretch,

resulting in shearing and swelling of nerve fibres. This can result in diffuse axonal injury (Strich, 1961). Furthermore, neuronal damage is often accompanied by small haemorrhages from ruptured blood vessels scattered throughout the cerebral white matter and lower structures (Bostrom and Helander, 1986). These haemorrhages may also cause haematomas within the skull (Lezak, 1995).

Secondary brain damage consists of subsequent damage caused by the physiological processes triggered by the primary damage. The consequence of haemorrhages, including tissue swelling and alterations in blood volume and flow, are particularly significant in causing secondary damage (Adams et al, 1985).

Therefore, it is typical with trauma particularly involving momentum, that a pattern of multi-focal or bilateral damage is observed without clear evidence of lateralisation (Bigler, 1981). The potential for widespread damage in this group, undermines precise functional localisation (Manly and Roberston, 1997). However, the orbital and lateral surfaces of the frontal and temporal lobes are particularly vulnerable to such injury due to their proximity to the bony shelves and the anterior and middle fossae (Courville, 1945). These anatomical factors are considered to account for similarities in behavioural deficits displayed by both closed TBI patients and by patients with focal lesions to the frontal lobes and have led to this group being studied in terms of further exploring prefrontal functions (Stuss and Gow, 1992).

It is worth briefly commenting on the neuropathology of open TBI, particularly as this type of injury tends to have different neuropathological consequences compared to closed TBI (Lezak, 1995). In open TBI, high-velocity missile wounds cause very serious focal and diffuse damage and are usually fatal, whereas low-velocity missiles or missile fragments produce focal lesions restricted to the areas of direct damage (Grafman and Salazar, 1987). This usually results in

relatively circumscribed and predictable cognitive losses (Lezak, 1995), which is generally in contrast to the multi-focal pathology in closed TBI (Levin et al, 1982).

1.4. Severity classification of TBI

Measuring the severity of TBI has typically relied upon assessing the altered state of consciousness of patients, which can vary from transient disorientation to deep coma. Differences of opinion do exist, however, in terms of the most useful measurement approach (McDonald et al, 1999). The Glasgow Coma Scale (GCS, Jennett and Bond, 1975) is a widely used scale and classifies severity according to the presence, degree and duration of coma. Points are gained in three categories: eye opening, best motor response and best verbal response. However, there are problems with the GCS, particularly as it may fail to classify exceptional cases (Lezak, 1995). For example, Richardson (1990) notes that patients who are admitted with little or no loss of consciousness but who later suffer mental deterioration due to internal bleeding, are routinely misclassified. Furthermore, King (1997) commented that GCS is often not recorded in the acute hospital medical notes and is therefore unavailable in a post-acute care setting.

Another classification system relies instead on measuring the length of post-traumatic amnesia (PTA) to ascertain severity (Bond, 1990). PTA refers to the period of confusion experienced after regaining consciousness from a coma and is defined as the failure to lay down new memories for ongoing events (Russell and Smith, 1961). Estimates of severity of TBI are generally consistent with GCS ratings (Bigler, 1990). However, there are also problems assessing PTA. For example, Gronwall and Wrightson (1980) note that although it is agreed that PTA does not end until the patient begins to register a continuous experience, deciding when this continuous registration returns is difficult when patients are confused or aphasic.

Despite the problems associated with using the GCS and PTA, they do appear to be important tools in predicting outcome, such as social relationships and employment level (Jennett and Bond, 1975). (Table 1.1. shows the classification of severity of TBI according to the GCS and PTA; cf. McDonald et al, 1999).

Table 1.1 Severity classification of TBI according to the GCS and PTA

Severity	GCS	PTA
Mild	13-15	less than 1 hour
Moderate	9-12	1-24 hours
Severe	3-8	more than 24 hours

More recent technological procedures are also aiding the evaluation of TBI severity. These include computerised tomography (CT), magnetic resonance imaging (MRI), positron emission tomography (PET) and single proton emission computer tomography (SPECT). It is unfortunate that many of these procedures are not available to patients due to the expense (Giles and Clark-Wilson, 1993). Furthermore, despite the potential benefits of these procedures, Ponsford (1995b) argues that it is not possible to gain an accurate picture of the extent of damage using any of these techniques, particularly due to the complex combination of diffuse and focal damage often observed following closed TBI. Visual imaging with MRI is quite sensitive to traumatic damage even when the injury is not very severe (Gandy et al, 1984) However, although MRI has been shown to be more effective in identifying lesions than CT scans, it may not be sensitive to microscopic lesions and a discrepancy between early and late MRI scan findings can occur (Levin et al, 1987). Furthermore, the neuropsychological significance of abnormalities may only be fully apparent some time after TBI (Wilson et al, 1988).

It is argued that due to difficulties evaluating and quantifying the severity of TBI, it is sensible to draw not only upon neurologically based findings but also on information derived from neuropsychological and functional assessments (Ponsford, (1995b). This is particularly

important as the severity of TBI relates reasonable well to behavioural and neuropsychological outcomes.

1.4.1 Moderating factors affecting the severity of TBI

It is important to briefly refer to a number of factors that can affect the severity of the TBI outcome.

1.4.1.1. Age at injury

It appears that advancing age is generally associated with greater morbidity and mortality (Stambrook et al, 1993), although a complex relationship exists between age and the two important predictors of severity, coma duration and PTA (Lezak, 1995). Gronwall and Wrightson (1974) found that after a period of concussion, more older than younger adults experienced slowed processing and persistent memory deficits. TBI in older adults usually occurs as a result of falls at home, causing high mortality rates and intra-cranial hematomas (Goldstein and Levin, 1990). It should be noted however, that within the category of severe TBI, age has been shown to make no additional contribution to the severity of cognitive deficits (Wilson et al, 1991)

1.4.1.2. Repeated TBI and poly-trauma

It is evident that repeated TBI has a cumulative effect on cognition (e.g. Gronwall, 1989b) in addition to the finding that a single TBI doubles the risk of a future brain injury (Gaultieri and Cox, 1991). The effects of repeated injury can be found in contact sports such as boxing (Oates, 1992). For example, cognitive deficits such as problems with attention and memory are common in boxers (Drew et al, 1986).

It is also observed that TBI can often result in trauma to other parts of the body, which in turn can contribute to the severity of the neurobehavioural condition (Parker, 1990; Lezak, 1995). For example, patients who have suffered multiple damage to the skeleton are less likely to benefit from rehabilitation, compared to those with one or no such injuries (Groswasser et al, 1990).

1.4.1.3. Pre-injury alcohol abuse

Poorer neuropsychological outcomes one year after a TBI are observed with patients with a prior history of alcohol abuse (Dikmen et al, 1993). However, regardless of severity the relationship between alcohol abuse and neuropsychological status is a complex one, particularly as patients who perform less well on tests are likely to be poorly educated and have pre-morbid lifestyles which involved an increased risk of brain injury (Lezak, 1995).

1.5. The outcome of TBI

A range of problems can be experienced as a result of TBI (e.g. Neuman, 1995; Lezak, 1995). In fact, it has been found that only 8% of patients who have suffered TBI avoid clinically significant deficits in either neurophysical or neuropsychological functioning (Tate et al, 1989). This is largely due to the multi-focal nature of TBI affecting the interplay between many factors including cognitive, linguistic, physical, behavioural and organic (Togher et al, 1999). Inevitably, these problems also have implications for social functioning (Lezak, 1995).

I shall now briefly review problems occurring after TBI. It should be noted that most outcome studies have addressed either mild or severe TBI (Lezak, 1995).

1.5.1. Neurophysical problems

It is estimated that 75% of patients with severe TBI have ongoing neurophysical impairments (Jennett et al, 1981; Thomsen, 1984). These include problems with fits, incontinence and movement (e.g. Neuman, 1995). Dysarthria is also a persistent problem following TBI (e.g. Beukelman and Yorkston, 1991). This refers to a group of speech disorders resulting from damage to the central and peripheral nervous systems, affecting muscular control and basic processes of speech production (Wertz, 1985). The incidence of dysarthria has been reported to occur in 8% (Thomsen, 1984) to 100% (Ylvisaker, 1986) of TBI patients.

Furthermore, difficulties with smell discrimination (e.g. Martzke et al, 1991), visual competence (e.g. Gianutsos and Matheson, 1987), balance (e.g. Brown, 1990) and hearing (e.g. Lezak, 1989b) have also been reported.

1.5.2. Personality problems

Personality changes are very common following severe TBI, occurring in about 60-80% of the population (Brooks et al, 1986). These changes also seem to persist, since similar prevalence figures are observed in these patients many years later (Brooks et al, 1986). The types of personality changes observed include complaints of irritability (e.g. Thomsen, 1984), anger outbursts (e.g. Eames, 1990), poor planning and disinhibited behaviour (e.g. Lezak, 1978), unrealistic self-appraisal and poor self-insight into deficits (e.g. Levin et al, 1991; Prigatano, 1987a).

It is worth noting that although pre-morbid personality is thought to have some influence on personality change after TBI, research tends to suggest that it is unlikely to account for the extent of personality change seen post-morbidly (McDonald et al, 1999). Indeed, attempts to

link pre-morbid personality variables to psychological and social outcome have been unsuccessful (Tate, 1998).

Despite the significance of personality changes, it should be emphasized that personality is a broad construct underpinned by a range of neuropsychological processes. It is unsurprising therefore that documented personality problems have often been described in terms of underlying deficits, including cognitive functions (e.g. Lezak, 1978) or emotional functions and arousal (e.g. Kinsella et al, 1991; Levin et al, 1991).

1.5.3. Cognitive problems

Patients sustaining a severe TBI will suffer problems in many aspects of cognition (Lezak, 1995), although some functions are retained at near pre-morbid levels (Newcombe, 1982). Common problems include attentional deficits (e.g. Brouwer et al, 1989), difficulties with the acquisition and retrieval of information (Bennett-Levy, 1984) and executive control and self-regulation of behaviours (e.g. Levin et al, 1991; Stuss, 1991). Although aphasia is relatively rare (except with appropriate focal lesions), impaired pragmatic functioning is often observed (Sohlberg and Mateer, 1990).

In terms of the course of cognitive problems in severe TBI, there is evidence of some spontaneous improvements in the short term but little change over many years with persistent complaints of cognitive problems (Lezak, 1995). For example, attentional problems can improve relatively quickly but then reach a plateau within about six months to a year after injury (Gronwall and Sampson, 1974). Memory problems can improve over a longer period of time (e.g. O'Brien and Lezak, 1981) but tend not to reach normal levels (Paniak et al, 1989), while problems associated with executive functions are often the most intractable of cognitive disorders (Stuss, 1985).

Mild TBI typically causes less cognitive impairments, although attentional deficits (e.g. Hugenholtz et al, 1988) and impaired verbal retrieval (e.g. Broe, 1982) are often observed (Lezak, 1995). There is disagreement about the duration of cognitive problems in mild TBI (Leininger et al, 1990). Some studies suggest that problems dissipate in a few months (e.g. McLean et al, 1983), while others studies have indicated that problems such as attentional deficits can persist for much longer (e.g. Levin et al, 1987).

1.5.4. Emotional problems

There can be many changes in emotional functioning following severe TBI. Generally there is either an exacerbation or muting of affective experience and response (e.g. Wood and Cope, 1989). For example, patients have been found to be aggressive, quarrelsome, short tempered and impulsive (Kinsella et al, 1991). In addition, decreased initiative, loss of spontaneity and apathy are also frequently reported (Thomsen, 1984). Similar to the course of cognitive difficulties following severe TBI there is evidence of some improvement in emotional problems particularly in the short term (e.g. Eames et al, 1990), while there is little change in more persistent complaints of problems (e.g. Thomsen, 1984).

Mild TBI is particularly associated with fatigue (e.g. Lezak, 1988d), which coupled with poor concentration tends to cause irritability and frustration due to difficulty performing everyday activities (Boll and Barth, 1983). There is some evidence to suggest that fatigue and these associated problems dissipate over time (e.g. McLean et al, 1983), while others studies suggest a continuation over many years (e.g. Levin et al, 1987).

It should also be noted that depression and anxiety trouble many mildly and severely injured patients, particularly in the longer term (Tyerman and Humphrey, 1984). This may partly reflect a patient's gradual appreciation of their disablement and limitations (Prigatano, 1987b).

1.5.5. Vocational problems

A devastating effect of TBI is a failure to return to work, although employment figures differ widely due to methodological heterogeneity between studies, such as varying definitions of work status and duration of follow-up (Crepau and Scherzer, 1993). It has been found that anywhere between zero and 30% of severely injured patients who were previously employed regained full-time employment (Brooks et al, 1987) and the majority of these dropped occupational status or maintained their previous level with difficulty (Tate et al, 1989b). Melamed et al (1992) found that even with mild TBI less than a third of patients returned to pre-morbid levels of employment.

Brooks et al (1987) found that only 29% of severely injured patients were employed at 2-7 years post-injury and very few had received vocational rehabilitation. It would appear that appropriate rehabilitation can increase the employability of patients (Ben-Yishay et al, 1987b), although only slight rises in work figures have been found with such provision (e.g. Johnson, 1987).

Reported studies indicate that cognitive and emotional problems are more directly related to vocational failure than physical impairments (Brooks et al 1987; Lezak, 1995). Crepau and Scherzer (1993) performed a meta-analysis of cognitive predictors of work status and found that measures of executive functions and flexibility correlated above other cognitive functions including language, attention and memory. It has been suggested that problems with executive functioning may mean that patients are unable to alternate between multiple task demands

successfully (Zeigarnik, 1987), interact appropriately with colleagues (e.g. Sale et al, 1991) or adapt to a changing environment (e.g. Parente et al, 1991). In terms of emotional factors, Crepau and Scherzer (1993) found that irritability, depression and aggressiveness correlated moderately with work status.

1.5.6. Social and family problems

There is considerable research showing that TBI has a marked affect on various aspects of social functioning (e.g. Wedell et al, 1980; Lezak, 1987e; Oddy et al 1985; Grattan et al, 1994). Oddy et al (1978) found that relatives rated patients with severe TBI as having reduced leisure activities, increased boredom and reduced social contact compared with their pre-morbid life. Also, Tate et al (1989b) reported that 50% of patients with severe TBI had limited or no social contacts, very few leisure interests and difficulties forming new relationships more than one year later.

Research also indicates that TBI has considerable implications, not only for the victim but also partners and family members (e.g. Florian and Katx, 1991; Jackson and Haverkamp, 1991). There are reported problems within marital relationships following TBI (Tyerman, 1996) and evidence of high divorce rates (Tate et al, 1989). Lezak (1988) notes that some spouses have reported feeling like they are married to a stranger. Difficulties with sexual relations have also been documented (e.g. Florian et al, 1989). The most common complaint of male patients and their partners is a reduced frequency of sexual relations, including sexual contact and satisfaction (O'Carroll et al, 1991).

Also, following severe TBI it is relatively common for patients to return to live with their parents rather than their previous living situation. In fact, Jacobs (1988) found that 48% of a TBI sample lived with their parents when only 35% had lived with them pre-morbidly.

Ponsford et al (1995a) showed that 64-68% of severely injured patients relied more on their parents or spouse for emotional support than prior to the injury. Therefore, it appears that close family members often bear the burden of care.

In considering these social difficulties, it is argued that problems in the cognitive and emotional domain account for much of the longer-term social handicap (Bond, 1976; Lezak, 1995; Tate, 1991). Oddy and Humphrey (1980) found that poor performance on cognitive tests and personality changes related more strongly to disrupted social life than physical disabilities in TBI patients. In fact, it has been consistently found that many reported social problems do not result purely from inadequate physical mobility or driving skills (Brouwer et al, 1990). Brooks (1988) reported that although physical impairments added to the family burden at one year after injury, it was the patients' dependency and social isolation that was considered to be the principle burden at five years. Also, Thomsen (1990) found that those characteristics most likely to distress family members were emotional disturbances including childishness, emotional lability and unreasonableness. In a review of family problems following TBI, Jackson and Haverkamp (1991) noted that family members often experienced depression, anxiety, isolation, financial stress and anger due to personality changes in the TBI patient.

Camplair et al (1990) also found that problems in sexual relations between patients with TBI and their partners were often the result of decreased sexual drive, loss of empathy and childishness displayed by the patient. It would appear that problems within marriages increase overtime (Oddy and Humphrey, 1980) and Tyerman (1996) argues that when the patient has undergone characterological changes, rather than just physical, the nature of the relationship between partners may change and threaten the viability of the marriage.

Also, Tyerman (1996) suggest that many TBI patients may no longer feel they belong socially due to changes in their personality. The idea that TBI patients can perceive the inadequacy of their relationships is supported by a study by Ellass and Kinsella (1987). They reported that TBI patients could provide examples of how their relationships had changed following their injury. It has also been argued that TBI patients rely on close family members due to the realisation of permanent changes, reducing self-esteem and lowering their expectations of finding a partner (Elass and Kinsella, 1987). Wedell et al (1980) found that patients rated as suffering significantly more personality change by family members had less contact with friends. These patients also tended to form relationships that were rated as more superficial.

It is important to note that the impact of TBI on family life is not always negative and observed personality changes can sometimes have positive consequences (Ponsford, 1995c). Brooks (1984) reported that some families became stronger and more resilient after the injury.

1.6. Overview of TBI outcome: The importance of problems functioning in a social context and the role of cognitive and emotional factors

It is clear from the reviewed research on the outcome of TBI that patients and indeed relatives can experience a range of difficulties. However, problems functioning in a social context represent a particularly significant and long-term difficulty (e.g. Lezak 1995; Neuman, 1995). In fact, it is argued that impairment in social functioning can present more of a barrier to management and rehabilitation than other neurological deficits (Grattan et al, 1994) and cause the greatest burden to sufferers and their families (e.g. Jennet et al 1981; Blyth, 1981).

It is unfortunate, therefore, that service provision in the UK has primarily focused on acute care (British Psychological Society, 1989) with very little provision in terms of rehabilitation to help individuals achieve greater independence or lead more productive roles in society (Greenwood and McMillan, 1993). Furthermore, the limited statutory provision for ongoing rehabilitation following discharge to the community for patients with TBI often diminishes markedly after six months (Murphy et al, 1990).

There are also of course, numerous practical reasons that can lead to problems in social functioning. These include financial difficulties due to unemployment, mobility problems due to being legally barred from driving and difficulties associated with legal matters such as claims for compensation. However, the reviewed research suggests that it is the psychological (cognitive and emotional) changes and deficits after TBI that relate more strongly to poorer social outcomes (e.g. Tate, 1991; Lezak, 1995). These psychological changes appear to impact upon many areas where adequate and successful social functioning is needed, including vocational settings (e.g. Corthell, 1990), family life (e.g. Brooks, 1988) and independence (e.g. Tate et al, 1989b; Ponsford et al, 1995a).

Despite the importance of cognitive and emotional functioning, very few studies have been conducted to elucidate the specific nature and role of cognitive and emotional deficits underlying poor social functioning following TBI (Channon and Crawford, 1999). I intend to review these studies in chapter three. However, in order to fully examine and interpret this research, it is necessary to firstly understand in more depth the nature of cognitive and emotional deficits following TBI. This shall be the focus of the next chapter.

Chapter 2

1.7. Cognitive and emotional deficits following TBI

I shall now review cognitive and emotional deficits that can occur following TBI. The clinical features of these deficits will be described in addition to evidence from experimental studies. The review will also include a brief discussion of neuropsychological models and neuroanatomical correlates associated with these deficits (although it is important to note that it is not possible to provide comprehensive account of these issues). Cognitive factors are of greater interest in this study and will therefore be examined in more detail. The review will discuss cognitive and emotional functioning separately, although it is acknowledged that they are interdependent to some extent.

1.8. Cognitive deficits

The focus will be on deficits of attention, memory, executive function, language and theory of mind.

1.8.1. Attentional deficits

1.8.1.1. Clinical features

Problems with attention and concentration are common throughout the range of TBI severity, although more frequent and persistent with severe TBI (e.g. Oddy et al, 1985; Binder, 1986). Longitudinal studies of severe TBI suggest that although attentional problems show some

improvement shortly after injury they tend to reach a plateau and remain below pre-morbid levels (Gronwall, 1987).

Poor attentional processing inevitably impacts upon the way many patients can perform a variety of routine everyday tasks. For example, to successfully go shopping the patient may have to consider aspects of the task separately, such as writing a shopping list, determining bus connections and calculating the overall time involved. Even patients with mild TBI report difficulty doing more than one thing at a time (Newcombe, 1985). Furthermore, severe TBI patients are often easily distracted and may abruptly shift from one task to another. Ponsford and Kinsellas (1991) noted that therapists often complain that patients make mistakes due to lapses of attention.

1.8.1.2. Defining attention

There has been considerable debate about the nature of attention (e.g. see Gronwall, 1987). Some researchers have argued that highly modality-specific attentional processes exist (e.g. Allport, 1992). In contrast, it has been proposed that attention is a system with different components related to distinct anatomical areas (e.g. Posner and Petersen, 1990). Brain imaging studies have provided strong neuroanatomical evidence to suggest that attention is fractionised into different supra-modal systems (e.g. see Manly and Robertson, 1997) with an anterior and posterior system. The posterior system appears to be responsible for the spatial allocation of attention, whereas the anterior system is concerned with the executive control of attention (Stuss et al, 1995). The focus here will be on the anterior system¹ primarily as most

¹ It should be noted that Stuss et al (1995) hypothesised that a set of seven attentional processes could be identified. These would be activated during attentional tasks and underpinned by a set of anatomical mechanisms. However, it is not possible to refer to all postulated processes due to the limited scope of this discussion. Furthermore, the clinical relevance of these separable attentional processes is debatable.

studies examining attention following TBI have considered aspects of this system, in particular the processes of sustaining attention and selective attention.

1.8.1.3. Sustained attention:

1.8.1.4. Models and neuroanatomical correlates

Sustained attention refers to the ability to maintain attention over a long period of time. It has often been measured using a vigilance task paradigm e.g. a subject watches a screen over a long period to identify the occurrence of a rare target event (see Mackworth, 1950). The effects of damage to the frontal lobes have produced broad agreement that these structures sub-serve a particular executive role in controlling activity to produce coherent and effective behaviour (Luria, 1966; Shallice, 1988). Although attentional deficits following focal frontal lobe damage present a somewhat inconsistent neuropsychological picture (e.g. Van Zomeren and Brouwer, 1987), abnormal performance on selective attention tasks have been reported (e.g. Bench et al, 1993). Therefore, Manly and Robertson (1997) argue that this provides evidence to suggest that adequate frontal lobe function is necessary for sustaining attention over time. In fact, they note that studies of sustained attention in patients with focal lesions to the frontal lobe (e.g. Wilkins et al, 1987) generally indicate that anterior damage leads to greater difficulty than posterior damage.

This localisation has received additional support from functional imaging studies (e.g. Cohen et al, 1992, Wilkins et al, 1987). For example, using a sustained attention task, Cohen and Semple (1988) demonstrated that the activation of the right prefrontal cortex was associated with a reduction in the anterior cingulate and the posterior parietal cortex. These areas have been associated with selective attention and the ability to inhibit responses (e.g. Bench et al,

1992). This in turn may be a necessary part of sustained attention via the ability to remain alert and resist possible distractions (Posner and Peterson, 1990).

Furthermore, the prefrontal cortex also has connections with reticular structures of the brain stem, which provide a basis for the endogenous modulation of arousal (Heilman et al, 1987). This may be important in sustaining attention by weakening arousal to salient but irrelevant stimuli and promoting arousal to stimuli that might not produce an automatic response but remain relevant to the task (Manly and Robertson, 1997).

Manly and Robertson (1997) comment that problems sustaining attention in patients with focal frontal lobe damage and the demonstrated anatomical mechanisms linked to the prefrontal cortex (in particular the right hemisphere) appear consistent with the cognitive model of prefrontal executive function proposed by Norman and Shallice (1980). This model argues that many situations activate well-learned responses (via schemata), which in turn control complex motor and cognitive acts. The selection of specific schemata will depend upon the level of activation relative to the level of competing signals and the influence of higher level controlling schemata. (This refers to a system of contention scheduling). It is proposed that this system results in the ability to perform complex (but routine) tasks such as driving in a successful and automatic way. However, when a situation is novel or when the activated schemata are inappropriate the system is ineffective and the supervisory attentional system (SAS) must intervene to bias the competition between response schemata through excitatory or inhibitory modulation (see Shallice, 1988).

Stuss et al (1995) have applied the concepts of the SAS to the process of sustaining attention. It is argued that a SAS is needed to monitor and potentially alter the activity levels of activated schema. This process is vital in sustained attention tasks since when there are long intervals

between relevant events, selected schema (e.g. respond to a tone) will gradually lose activation and thus control over the necessary response (see Stuss et al, 1995).

1.8.1.5. Experimental evidence

This cognitive understanding of the executive control of sustained attention and demonstrated anatomical links is reasonably consistent with evidence of deficits in sustained attention following TBI. Since patients with TBI are vulnerable to damage to the prefrontal cortex it is unsurprising that clinical observations suggest that they have difficulty sustaining attention (e.g. McKinlay, 1981). However, Manly and Robertson (1997) note that experimental studies using vigilance paradigms have produced varied results, tending to show no differences in performance between TBI patients and controls (e.g. Ponsford and Kinsella, 1992; Spikman et al, 1996). However, there is some evidence that TBI patients are more impaired in terms of accuracy, speed and consistency in performing these prolonged tasks, irrespective of whether an overall decline in performance is observed compared to controls (e.g. Loken et al, 1995; Stuss et al, 1989; Robertson et al, 1997). It is important to note that the relationship between performance on sustained attention measures and clinical observations of concentration problems following TBI has been largely untested (Robertson et al, 1997).

1.8.1.6. Selective attention:

1.8.1.7. Models and neuroanatomical correlates

An important aspect of attention is the ability to select information from a potentially huge range of possible inputs. It has long been recognised that such selectivity is necessary due to

the limited capacity of attention (e.g. Broadbent, 1971). It is also reasonable to suppose that an integral part of selecting information is the ability to suppress (or inhibit) responses to inputs.

The process of selective attention has also been conceptualised in terms of prefrontal executive functions and the SAS (Norman and Shallice, 1980; Stuss et al, 1995). The SAS is activated particularly when specific selection among schema is necessary and when inappropriate schema must be inhibited (Stuss et al, 1995). This would need to occur particularly during novel situations involving varied or complex information.

As with sustained attention, there appears to be anatomical evidence to support this conceptualisation. For example, Cohen and Semple (1988) found increased activity in the right prefrontal cortex and reduced activity of the anterior cingulate and posterior parietal cortex when normal subjects performed a simple discrimination task. It was argued that this finding was consistent with an inhibitory relationship. Bench et al (1993) also associated these brain areas with the process of selective attention.

It is important to refer to an alternative influential cognitive model, which uses the concept of working memory to account for attentional phenomena, particularly selective attention. The model proposed by Baddeley (1986) and Baddeley and Hitch (1974) conceptualises working memory as a system for the temporary maintenance and manipulation of information. It is argued that relatively complex tasks (e.g. driving a car) can be performed at a semi-automatic level, requiring minimal conscious attentional resources due to cues triggering habitual responses. Schneider and Shiffrin (1977) note that such tasks can be performed simultaneously with other tasks with little interference between the two.

However, when the task is demanding or novel, working memory is utilised to juggle cognitive resources. It consists of an attentional control system or central executive (CE),

which coordinates performance by controlling two slave systems, the phenomenological loop (which retains verbal information) and the visuospatial sketchpad (which preserves visual information). It is proposed that the CE uses these sources of information to suppress habitual responses and guide goal directed behaviour (see Baddeley, 1986; 1990). The CE is considered to be limited in its capacity both in terms of the amount of information it can process at one time and the speed with which this occurs. Therefore, with increasing amounts of information the rate at which tasks are performed decreases (Baddeley, 1986). If demands are increased further, errors occur which typically reflect a failure to inhibit habitual responses (Baddeley, 1966).

It should be noted that little is known about the operation of the CE (Baddeley, 1990). However, although this model differs from the model of attention proposed by Norman and Shallice (1986) in so far as it anchors the process of memory to real-life tasks (Philips, 1997 book), Baddeley (1990) has linked the CE component theoretically and anatomically with the SAS.

1.8.1.8. Experimental evidence

These cognitive models explaining selective attention and the associated anatomical links to the prefrontal cortex appear reasonably consistent with the performance of TBI patients on tasks purported to measure selective attention. Studies tend to show that patients are slow to respond on demanding tasks (McDonald et al, 1999). For example, severe TBI patients while accurate on the Stroop Test compared to matched controls, were slow under neutral conditions as well as conditions requiring the suppression of competing responses (e.g. Ponsford and Kinsella, 1992; Stuss et al, 1985). In addition, divided attention tasks have frequently shown that patients with severe TBI are no less accurate than controls but significantly slower (e.g. van Zomeran, 1981; Shum et al, 1990).

There are also reported problems in the accuracy of performance. Ponsford and Kinsella (1992) found that TBI patients were significantly less accurate than controls on tasks requiring divided attention such as the Paced Auditory Serial Addition Test (Gronwall, 1977). They concluded that TBI patients perform more poorly on a range of attentional tasks compared to control subjects due to reduced speed of information processing, which can sometimes result in reduced accuracy.

1.8.1.9. Summary of attentional deficits

Attentional deficits are frequently observed clinically following TBI. The experimental evidence, to some extent, supports these observations. In particular, there is evidence that over time the consistency and accuracy of performance may well be reduced in addition to a reduction in the speed of information processing, affecting the amount of information that can be attended to.

However, McDonald et al (1999) note that TBI patients have generally performed better than expected in many experimental studies of attention. Nevertheless, they comment that a failure to elicit impaired attention on abstract experimental tasks cannot be taken as an absence of attentional deficits, particularly bearing in mind frequent clinical observation to the contrary. Therefore, they suggest that further work is needed to elucidate the nature of attentional problems in a way that can be translated to everyday behaviour.

1.8.2. Memory deficits

1.8.2.1. Clinical features

TBI is often associated with problems with the retrieval of information acquired prior to the injury and difficulty with the acquisition of information (Bennett-Levy, 1984). These difficulties are particularly observed following severe TBI (Lezak, 1995). In addition to amnesia associated with the period of PTA, patients experience a loss of recall for events immediately prior to the injury. There may also be marked loss of important autobiographical information prior to the accident, such as a last birthday celebration. Furthermore, difficulties recalling ongoing events mean that they forget appointments or instructions and forget how to get to places. This can also impact upon a patient's ability to function independently at home, cope with procedures in a work setting and limit their capacity to pass school or university exams.

1.8.2.2. Definitions of memory

Memory is a broad term encompassing many processes and underpinned by a range of anatomical structures. Hodges (1994) notes that a useful distinction in clinical practice is between anterograde and retrograde memory. This distinction seems to encompass the nature of reported memory deficits following TBI and shall therefore provide the framework for the discussion here.

1.8.2.3. Anterograde memory: models, neuroanatomical correlates and experimental evidence

Anterograde memory refers to the acquisition of new information. It would appear that a feature of TBI is impairment in the capacity to lay down new information. Lezak (1995) notes that problems can result from an inability to actually store (or consolidate) the information in the first place, which is similar to memory disorders seen following damage to the hippocampus and the medial temporal lobes.

Furthermore, there is evidence that TBI patients have impaired learning. Millis and Ricker (1994) found that TBI patients showed inadequate storage of information due to passive and disorganised learning strategies. Also, there is evidence that the recall of information in TBI patients is affected and contaminated by irrelevant intrusions (Haut and Shetty, 1992). Furthermore, Cooke and Kausler (1995) found that severe TBI patients had difficulty encoding and recalling the temporal sequence of information.

There is evidence that problems in impaired learning are similar to problems reported following frontal lobe lesions (e.g. Stuss et al, 1994; della Rochetta and Milner, 1993). It is possible given the propensity for damage to be sustained in the frontal areas in TBI that these memory deficits also arise from damage to the frontal cortex and adjacent subcortical systems (McDonald et al, 1999). It has been speculated that frontal lesions may disrupt memory as a secondary effect, impairing the coordination, monitoring and organisation of online information (Shimamura, 1994). However, the specific role and mechanisms of the frontal lobe in memory problems (and associated executive and working memory involvement) remains unclear (Mayes and Daun, 1997).

It should also be noted that procedural learning (i.e. conditioned responses such as driving that are not consciously available) can be impaired following TBI (Baddeley et al, 1987). This aspect of memory impairment has been linked to lesions in the basal ganglia and is thought to represent a distinct memory problem (Mishkin and Appenzellar, 1987).

1.8.2.4. Retrograde memory deficits: models, neuroanatomical correlates and experimental evidence

Retrograde memory refers to the recall of previously learned material. TBI patients can experience loss of memory for events prior to the injury, although there can be considerable

variability (Squire, 1987). In some patients, particularly those remaining in PTA, retrograde amnesia can extend for several decades (Levin et al, 1985). Once out of PTA, retrograde amnesia does tend to reduce to a limited period prior to the injury, although memory loss across decades can be observed (Hunkin et al, 1995). Baddeley (1990) reported that patients with severe TBI demonstrated faulty autobiographical knowledge as a result of intrusions or confabulation.

1.8.2.5. Summary of memory deficits

Memory deficits following TBI often consist of problems in the acquisition and retrieval of information. These deficits are most prominent and persistent following severe TBI, although there can be marked variability. A complex range of anatomical structures are involved in memory functioning. It would appear that the frontal lobe might contribute particularly to aspects of impaired learning, although further understanding is needed.

1.8.3. Executive deficits

1.8.3.1. Clinical features

Executive deficits are considered in general to be the most severely disturbed cognitive function (Johnstone et al, 1995). It is unfortunate therefore, that such deficits are viewed as the most disruptive to successful rehabilitation (Lezak, 1995). There is however, variation in the degree of impairment, influenced by injury severity, pre-morbid intelligence, motivation and the nature of the task (Shallice and Burgess, 1991).

In less severe cases of TBI, patients will be able to perform routine behaviours but have difficulty dealing with more novel situations and focusing attention voluntarily. After more

severe TBI, there can be marked impairments in the control of behaviours, such as rigidity, inflexibility and perseveration. Patients may also be impulsive, disinhibited and easily distracted. Apathy and difficulty initiating behaviours can also be observed.

Furthermore, problem-solving abilities may be disrupted, with a tendency to focus on concrete or superficial aspects, with limited capacity for subtle and abstract appreciation. Patients may also have problems evaluating their performance, which can cause a failure to learn from experience.

1.8.3.2. Defining executive functions

The term executive function has been used to describe a range of often poorly defined processes, such as problem solving, planning and cognitive estimation (Burgess, 1997). The focus of recent theoretical conceptualisations regard executive function as a process or set of processes whose primary purpose is to facilitate adaptation to novel situations (Burgess and Cooper, 1996). Executive function is thought to work by controlling more fundamental cognitive functions and routine skills (e.g. McCarthy and Warrington, 1990; Shallice, 1982).

Executive function has traditionally been linked to the frontal lobes (Benton, 1991). Damage to this brain area has resulted in symptoms collectively known as 'frontal lobe syndrome' (see Stuss and Benson, 1986 for a review) However, attempts to link executive behaviours to particular brain areas have proved problematic (Reitan and Wolfson, 1994). Baddeley and Wilson (1988) argue that this problem is avoided if emphasis is placed on exploring the distinction between executive and non-executive behaviours, irrespective of the anatomical basis. The value of this position has been questioned however (see Rabbit, 1997).

1.8.3.3. Models and neuroanatomical correlates

There have been various models of executive function (e.g. Luria, 1973; Kimberg and Farah, 1993; Duncan, 1993; Norman and Shallice, 1986; Shallice and Burgess, 1991). These have all attributed executive function to aspects of the frontal lobes and their rich connections to other brain areas. Therefore, it is argued this can account for executive problems resulting from diffuse pathology after TBI, as problems may not necessarily reflect disruption to a 'centre' in the frontal lobe but rather lesions to frontal distributed networks (Mesulam, 1990).

Shallice and Burgess (1996) note that many accounts of executive function describe a unitary process (e.g. Kimberg and Farah, 1993). However, the influential SAS model proposed by Norman and Shallice (1986) and Shallice and Burgess (1991) emphasise that the prefrontal cortex is the seat of one over-riding 'system' i.e. it does not carry out a single process but interacts with other systems outside itself. The theoretical and anatomical aspects of this model were touched on earlier in the discussion regarding attentional processes and will not be repeated here. It is worth noting however, that current work regarding the anatomical basis of this model are directed towards identifying separable subcomponent processes such as the involvement of right frontal regions in monitoring behaviours and the left frontal region in strategy evaluation (see Shallice and Burgess, 1996).

In explaining executive deficits following TBI, the model proposes that these occur due to impairment of the SAS, which should normally override routine and habitual behaviours producing adaptive responses. Therefore, it is argued that behaviours often observed in TBI such as perseveration, stimulus-bound responding and distractibility are due to habitual responses triggered automatically (Duncan, 1986).

It was noted earlier that the SAS model has parallels with the CE in Baddeley's (1986) working memory model. Both are hypothetical constructs however, and are only useful

clinically if they improve an understanding of mechanisms in the brain which underlie impairment in the everyday functioning of patients with executive problems. However, Burgess and Shallice (1997) do argue that describing an executive system in which various processes can be impaired singly or in combination, does account for the observation that patients with executive problems do not necessarily exhibit the same constellation of problems in their everyday lives.

1.8.3.4. Experimental evidence

There are many studies reporting impaired executive behaviours following TBI (e.g. Levin et al, 1991; Stuss, 1987; Tate, 1991). These include difficulties in self-correction (Walsh, 1985; Lezak), problems controlling and directing behaviour (Goldstein and Levin, 1989), limited self-awareness (Prigatano, 1991b) and problems with perseveration and inflexibility (Lezak, 1995). Lezak (1995) emphasises that the social implications of these difficulties are potentially very damaging.

1.8.3.5. Summary of executive deficits

Deficits in executive functioning are common and disruptive problems following TBI and affect many aspects of behaviour. Impairment in executive functioning has been linked to the frontal lobe. The influential SAS model emphasises that executive functioning should be viewed as a system, which controls and mediates behaviour in novel and complex situations.

1.8.4. Language deficits

1.8.4.1. Clinical features

It is relatively rare for patients to suffer from aphasia following TBI. It has been estimated that between 2% and 14% of patients had an aphasic disturbance (Heilman et al, 1971). Aphasia has been described in terms of representational linguistic levels of phonology, morphology, syntax and lexical semantics (Code, 1991). It would appear that these problems are usually avoided unless dominant language areas are damaged.

However, loss of communication skills following TBI is common (McDonald et al, 1999). It is observed that, unlike many aphasic patients who seem to communicate better than they talk, TBI patients appear to have difficulty in the reverse (Holland, 1984). Hence, it is frequently observed that patients have difficulty in managing at a conversational level (Groher, 1977). This problem tends to be related to increasing severity of TBI.

These communication problems (or non-aphasic language disorders) have been conceptualised in terms of impaired pragmatic functioning.

1.8.4.2. Defining pragmatics

Pragmatics is concerned with the way language is used and the context of its use, rather than the form the language takes (Levinson, 1983). It is in contrast to other areas of language study such as syntax and semantics, which focus on the structure and meaning of language, independent of use (Body et al, 1999).

Therefore, a particular focus of pragmatics is the view that language is interdependent with contextual and social features of a situation (Togher et al, 1999). For example, one of these contextual features is the relationship that exists between people.

1.8.4.3. Pragmatic function: Models, neuroanatomical correlates and experimental evidence

Body et al (1999) note that there has been a vast array of approaches to pragmatic function covering disciplines including linguistics, philosophy, sociology and psychology. I shall briefly touch on some of the major concepts and approaches in the following discussion.

Central to pragmatic functioning is the process of inferring meaning, particularly as in everyday communications we may not always mean exactly what we say. In other words, the speaker may only provide part of the meaning explicitly. The explicit (or literal) meaning of an utterance corresponds straightforwardly to its intended one. In contrast, the inferred meaning (or pragmatic meaning) requires interpretation, which utilises a range of factors, such as general knowledge, social awareness and inferential ability (Body et al, 1999).

There have been a number of models explaining the process of pragmatic interpretation. Speech act theory (Austin, 1962; Searle, 1969) proposes that verbal acts are used to achieve a particular goal and the speaker must indicate (and the hearer identify) its purpose. For example, we might use a particular command to get a person to do what we want. It is noted however, that interpreting the purpose is not always straightforward since many speech acts are indirect, such as in the case of irony.

Grice (1975) offered a contrasting perspective, arguing that all conversants follow a 'cooperative principle'. This refers to the idea that people assume that what is said to us is said in good faith and at some level truthful and explicit as it needs to be. This assumption is based on a set of 'maxims of conversation': maxim of quantity ("Don't say any more or less than you need to"), maxim of quality ("Don't say anything which you believe to be false"), maxim of relevance ("Be relevant"), maxim of manner ("Don't be obscure or ambiguous") (Body et al, 1999). It is argued that what helps us to infer meaning is the assumption that people are

following these maxims. For example, person A says: "I'm going to run a marathon" and person B says "Yeah, and I am going to fly to the moon!" If the comment by person B is taken literally it breaks the maxim of relevance and quality. However, if we assume that B is implicating "I don't believe you" by saying something equally false, then we can derive a meaning that is not breaking these maxims at all. Thus it is argued that blatant disregard for a maxim will cause the person to reconsider the utterance in order to make sense of why it was said in such a way. This will inevitably involve taking into account the context.

Sperber and Wilson's (1986) criticised these 'traditional' views of pragmatic processing, particularly as they did not take into account the attitude of the speaker. They proposed the 'Relevance Theory' which has been referred to as an 'Echoic' model (McDonald and Pearce, 1996). This theory explains pragmatics in terms cognitive processing rather than principles of use. It refers to the 'relevance principle', which assumes that any utterance takes the form it does for a good reason. In the case of irony, sarcastic comments are recognised as relevant because the speaker echoes an earlier proposition previously stated and in doing so their attitude is attached to it. McDonald and Pearce (1996) highlighted the essential difference between the 'Echoic' and traditional Gricean model. According to the traditional view, the cue that alerts the listener to sarcasm is the contradictory nature of the remark (which is then rejected by applying rules to infer the intended meaning), whereas in the 'Echoic' model the cue is the attitude of the speaker.

Body et al (1999) argue that although explanations of pragmatic functioning offer useful descriptive accounts, they do not provide a coherent understanding of the mechanisms underlying the observed communication problems. In particular, they note that there is very little consideration of pragmatic problems in cognitive terms and although the 'Relevance Theory' makes some attempt to ground pragmatics in cognitive theory, no specific detail essential for such an understanding is provided.

McDonald (1992b) also emphasises that cognitive factors should play an integral part in understanding pragmatic impairment. There appears to be support for this view. Perkins (1998) argues that pragmatic ability is not a primary entity itself but the secondary consequences of interactions between more fundamental cognitive sub-systems. Kasher (1994) also notes that as pragmatics covers a range of phenomena it is likely different cognitive processes are involved.

It is reasonable to assume therefore, that there should be a relationship between cognitive processes (with varying anatomical bases) and pragmatic functioning following TBI. I shall now consider research examining this relationship.

1.8.4.3.1. Pragmatic deficits and attention

It is reasonable to assume that attentional problems might impair the speed and efficiency in which TBI patients can comprehend conversation. It has been observed that patients seem to have difficulty comprehending complex utterances in distracting environments (Thomsen, 1975). It is also possible that these deficits might affect the efficiency of language production (Body et al, 1999). TBI patients have also been shown to produce more ambiguous sentences and speak more slowly (Hartley and Jenson, 1991), in addition to producing less information per minute (Ehrlich, 1988). However, Body et al (1999) note that there is very little evidence linking these problems to reduced information processing capacity.

1.8.4.3.2. Pragmatic deficits and memory

There is very little evidence to suggest a relationship exists between memory impairment and pragmatic ability (Body et al, 1999). Marsh and Knight (1991) found that measures of new learning and memory did not correlate with estimates of communication competence.

1.8.4.3.3. Pragmatic deficits and executive functioning

Since pragmatic functioning requires sensitivity and adaptation to the context, in addition to the ability to infer meaning, it is unsurprising that executive functioning has been argued to play an important role. McDonald and Pearce (1996) note that theories of executive function would postulate that patients with executive impairments would have reduced appreciation of inferential meanings in language because they are stimulus-bound to the most concrete aspects of the information given and are not able to suppress their tendency to respond in a routine way to such attributes. This would create difficulty appreciating alternative meanings and associations.

There is evidence to suggest the involvement of executive functioning in language processing (see Alexander et al, 1989). It has been found that non-aphasic language impairment observed following frontal lobe lesions resemble communication problems following TBI (McDonald, 1993a). Studies examining patients with focal lesions suggest they have a tendency to respond to concrete associations and produce disorganised discourse without showing concern (Alexander et al, 1989). Luria (1976b) found that discourse in patients could be affected by irrelevant intrusions and perseveration. There is evidence also that patients use simpler and shorter phrases (Kaczmarek, 1984).

The susceptibility for TBI patients to suffer damage to the frontal lobes has been mentioned earlier. Studies of communications problems in TBI patients do mirror these focal lesion studies. Prigatano et al (1986) reported that TBI patients produced tangential and irrelevant

communications. Thomsen (1984) found that patients had a tendency to leave sentences unfinished, speak more slowly and rely on set expressions.

McDonald (1993a) notes that studies of language functioning in patients with frontal lobe damage have mainly been confined to performance on conventional cognitive and linguistic tests. There have been very few studies exploring broader aspects of pragmatic functioning following frontal damage, such as the comprehension of conversational inference, sarcasm and deceit. This issue has only been addressed by a few studies. These will be considered in chapter three.

It should be mentioned here that problems in pragmatic functioning following TBI (particularly with frontal lobe involvement) are very similar to the type of communication problems observed in patients with right hemisphere damage resulting from, for example, cardiovascular accident (see McDonald, 1993a for a review). McDonald (1993a) argued that despite the overlap between the problems in these patient groups, divergent theoretical approaches have been developed to account for these findings with very little integration. Right hemisphere non-aphasic problems have been considered mainly in terms of impaired 'gestalt' processing, which is in contrast to executive explanations in patients with frontal lesions. It was suggested that frontal lobe and right hemisphere lesion research should address the potential interaction between these areas. McDonald and Pearce (1996) emphasised that it remained unclear what cognitive mechanisms underpinned problems in patients with right hemisphere lesions, whereas in frontal lobe studies some attempt had been made to delineate the cognitive processes involved.

1.8.4.4. Summary of language deficits

Although TBI is not typically associated with aphasic problems, it is evident that non-aphasic pragmatic communication difficulties present a significant difficulty. There has been some attempt to explain the cognitive processes contributing to these problems. Executive function appears to play a particularly important role although there have been very few studies examining the relationship between broader aspects of pragmatics and executive function.

1.8.5. Theory of mind deficits

1.8.5.1. Clinical features

TBI patients have been described as having an impaired capacity for social perspectiveness, reflected in self-centred behaviour and limited ability to empathise and self-reflect (Lezak, 1978A). More recently, Lezak (1995) noted that reduced self-awareness and empathy particularly following moderate and severe TBI has negative consequences for social functioning.

I shall now consider the role of theory of mind impairment in contributing to these reported problems.

1.8.5.2. Defining theory of mind

Theory of mind has been defined as the ability to recognise and comprehend other people's mental states (e.g. Baron-Cohen, 1985). It should be noted that theory of mind appears to be similar to the concept of empathy, although Restak (1984) notes that various definitions and measurement approaches has limited a clear understanding of this concept. This is complicated further by the fact that there appears to be very little discussion in the autism or TBI literature about the relationship between theory of mind and empathy. It would appear that two aspects

of empathy have been considered in the literature. The first is cognitively based empathy (which is associated with perspective taking) and the second is affectively based empathy (which involves vicarious arousal). Thus, the concept of cognitive empathy is reasonably consistent with theory of mind. Both these concepts will be the focus of the following discussion. The concept of affective empathy has been given very little explicit consideration following TBI but appears to overlap with the literature on emotional deficits considered later.

1.8.5.3. Models and neuroanatomical correlates

The concept of theory of mind has largely been associated with understanding the interpersonal and social deficits observed in infantile autism (e.g. Baron-Cohen, 1985). It has been argued that theory of mind is an important factor in the normal development of social, communicative and imaginative abilities. There have been two levels of theory of mind described. First order belief attributions refer to the ability to think about another person's thoughts about an objective event. Second (or higher) order belief attributions refer to the ability to think about another person's thoughts about a third person's thoughts about an objective event.

Brain imaging studies in healthy controls suggest a link between theory of mind and the frontal lobes, although Channon and Crawford (2000) note that specific brain areas identified have varied according to the task used and further understanding is required. The left frontal lobe has been implicated (Fletcher et al, 1995; Goel et al, 1995) in addition to the right orbitofrontal region (Baron-Cohen et al, 1994). In addition, Baron-Cohen et al (1999) speculated about the role of the left amygdala in social processing.

Very few brain lesion studies exist exploring the role of the frontal lobe in theory of mind. There is some evidence to suggest that patients with lesions involving the frontal lobe have

difficulty performing tasks which tap higher-level theory-of-mind-type social comprehension (e.g. McDonald and Pearce, 1996; Bara et al, 1997; Channon and Crawford, 2000). (These studies will be reviewed in chapter three). However, some studies also implicate impaired ability in lesions to the right hemisphere (e.g. see Happé et al, 1999; Bronwell et al, 1990; Winner et al, 1998).

Channon and Crawford (2000) note that there is disagreement about the contributions of the frontal lobe and right hemisphere. McDonald (1993a) argues that it is important not to ignore the possibility that impairment in theory of mind tasks in right hemisphere studies could be attributable to frontal lobe impairment due to diffuse lesions often observed in patients. A recent study by Channon and Crawford (2000) showed that patients with left anterior lesions performed significantly more poorly on a higher-level theory-of-mind-type story comprehension task, compared to patients with right anterior and posterior lesions. They argued this finding was consistent with brain imaging studies implicating the involvement of the left frontal lobe in theory of mind.

Although there is evidence to suggest that theory of mind is linked to the frontal lobes, this brain area is also associated with executive function. Therefore, this raises the issue of the relationship between theory of mind and executive function.

1.8.5.3.1. Theory of mind and executive function

There is debate in the autism literature about the relationship between theory of mind and executive function and the degree to which these constructs are separable processes (e.g. Bishop, 1993). It has been argued that theory of mind and executive function deficits arise as a result of damage to areas of the prefrontal cortex (Ozonoff et al, 1991). This issue has not been considered in patients with frontal lesions, apart from the recent study by Channon and

Crawford (2000). In this study it was found that patients with left anterior lesions showed impairment on the theory-of-mind-type social comprehension task, although patients also demonstrated deficits in executive function. Therefore, it was unclear whether theory of mind or executive deficits contributed to this poor performance. To consider this issue they raised three hypotheses. Firstly, it was hypothesised that there might not be any relationship between theory of mind and executive function other than anatomical proximity in the frontal lobes. Executive and theory of mind impairment could arise separately due to damage to critical brain areas affecting both processes. A second hypothesis speculated that impairment was the result of general executive impairment, rather than a selective theory of mind deficit. Thirdly, it was suggested that there might be two separate routes to impaired performance, arising from disruption to broader executive impairment or to specific theory of mind ability. In other words, lesions may cause executive impairment and smaller focal lesions may affect theory of mind performance as a result of selective deficits. They noted that recent models of executive function (e.g. Shallice and Burgess, 1996) suggest that separable subcomponent processes exist and thus theory of mind might represent one of these. In considering these hypotheses the researchers postulated that generalised executive impairment could account for the observed impairment without needing to evoke the concept of theory of mind, although it was acknowledged that further work was needed.

1.8.5.4. Experimental studies

Research examining theory of mind deficits following TBI is sparse. As noted above, studies tapping higher-level theory-of-mind-type social comprehension tasks will be reviewed in chapter three. It is worth noting that in a recent study by Channon and Beeson (unpublished), TBI patients did not have difficulty performing a first order theory of mind. Bara et al (1997) also found that TBI patients could adequately complete classical tests of theory of mind, including the 'Smarties task' (Perner et al, 1987).

There are a small number of studies in the literature on empathy and TBI. These have looked at the concept of cognitive empathy. They tend to show reduced empathy in TBI patients compared to healthy controls on self report measures (e.g. Grattan and Eslinger, 1989; Grattan et al, 1994). The study by Channon and Beeson (unpublished) was consistent with these findings, showing that TBI patients had a significantly reduced level of cognitive empathy, compared to control participants. There is also evidence to suggest that TBI patient may report normal empathy one month post injury compared to relative reports but rate their empathy as more impaired at six months post injury (see Grattan and Eslinger, 1990).

1.8.5.5. Summary of theory of mind deficits

TBI results in behaviours that appear to reflect problems in theory of mind and cognitive empathy. Experimental evidence suggests that first order theory of mind is intact in TBI patients, although studies tapping higher-level theory of mind are few in number. There is evidence that links theory of mind to the frontal lobes. However, this anatomical link and the relationship between theory of mind and executive function requires further elucidation.

1.8.6. Summary of cognitive deficits

TBI is associated with a range of cognitive deficits. The review suggests that impairment in executive function may be very important, particularly as there are postulated links between executive processes and other cognitive systems including attention, memory, pragmatics and theory of mind. The role and relative importance of executive processes, particularly in social functioning will be considered in the next chapter.

1.9. Emotional deficits

1.9.1. Clinical features

It was noted earlier that TBI results in a range of emotional disturbance (Lezak, 1995). Irritability and fatigue are commonly reported following TBI (Dikman et al, 1993; Brooks et al, 1987). Severe TBI in particular can also be associated with aggressive behaviour, emotional lability, self-centredness and impulsivity (Kinsella et al, 1991). TBI patients may also misinterpret moods (Levin et al, 1991), show impaired affective empathy (Eslinger et al, 1996) and have difficulty with the accurate recognition of non-verbal emotional cues such as face perception and voice (Hornak et al, 1996). Depression and anxiety also trouble many patients (Lezak, 1995).

1.9.2. Defining emotion

The concept of emotion in psychology has historically proven refractory to definitional efforts. Contemporary theories of emotion have tended to recognise four factors: instigating factors (including external and internal events), physiological correlates, cognitive appraisal and motivation or arousal. Lezak (1995) notes that a complex relationship exists between psychogenic reactions and organic alterations. The way these factors contribute to emotional functioning may vary in TBI patients at different times.

The following discussion will be confined to the way emotion has been conceptualised and studied following brain damage.

1.9.3. Models, neuroanatomical correlates and experimental evidence

It has been argued (e.g. Damasio, 1996) that cognitive deficits do not sufficiently account for impairments in behaviour observed following brain injury, particularly frontal lobe damage. To address this issue two recent explanations in emotional terms have been proposed.

Rolls et al (1994) notes that emotion has often been defined as a state elicited by rewarding and punishing situations. For example, the emotion of fear is a state elicited by stimuli learned to be associated with punishment and joy is a state associated with rewarding stimuli. It is argued that since emotions are related to rewards and punishment, reinforcement contingencies will affect the probability of behaviour occurring. This explanation suggests that failure to correct behaviour when the reinforcement value of the event changes might lead to inappropriate emotional functioning and behaviour.

This aspect of emotional functioning has been linked to the frontal lobes, specifically the orbitofrontal cortex (Rolls, 1996). Rolls et al (1994) examined the performance of patients with ventral frontal lesions and patients without damage to this brain area on a simple discrimination task. This task required patients to learn that a point could be obtained by touching a stimulus on the screen and a point lost when a different stimulus was touched (reversal component). It was found that the patients with ventral frontal damage had greater difficulty modifying their responses and in particular continued to respond when the consequences were negative (i.e. in the reversal component). This also correlated with scores obtained on a questionnaire measuring disinhibited and socially inappropriate behaviour. It was argued that this reflected impairment in emotion-related learning, which could cause problems in everyday behaviour.

A further explanation also implicating frontal involvement in emotional impairment is the 'somatic marker' hypothesis proposed by Damasio (1994; 1995). This explanation argues that emotional abnormalities observed in patients with damage to the prefrontal cortex are in part due to an impaired ability to produce somatic states to emotionally charged stimuli. These somatic states operate at a bio-regulatory level, although influence processes at multiple levels. Thus, the effect of the somatic marker would not just be a 'feeling' but could also be 'intellectual' in nature. It is postulated that in order to adapt and modify responses in everyday situations a somatic 'signal' is needed. This 'signal' is triggered in response to complex learned associations (such as between gain and loss) and will provide a marker upon which to guide behaviour. This understanding overlaps with the emotion-related learning explanation (Rolls et al, 1994), particularly as emphasis is also placed on the behavioural affect of learned associations between stimuli.

There is some evidence to support the 'somatic marker' hypothesis. It has been found that patients with bilateral ventromedial frontal damage failed to react to emotionally charged stimuli (see Damasio et al, 1990; Damasio et al, 1991). Furthermore, Damasio (1996) reports that patients with ventromedial damage performed more poorly compared to control subjects on a card gambling task (see Bechara et al, 1994 for task details). It was found that patients made more choices that were riskier in that they involved the prospect of future punishment. It was postulated that this poor decision-making might be due to a somatic marker failure, weakening support processes such as attention and working memory rendering unstable the representations of future outcome. It is interesting to note that the relationship between this somatic marker explanation and decision-making conceptualised in executive terms (e.g. Shallice and Burgess, 1993) has not as yet been explored.

1.9.1. Summary of emotional deficits

Emotional problems following TBI are commonly observed. In addition to symptoms of depression and anxiety, which often appear to reflect a patients' difficulty in coping with their disability, there are other changes in emotional functioning. Recent explanations have implicated aspects of the frontal lobe in mediating and controlling the experience and behavioural expression of emotion. It has been argued that damage to this brain area can have important implications for social decision-making and behaviour, although there has been very little research particularly with TBI patients.

1.10. Overview of cognitive and emotional deficits

TBI is associated with many deficits in both cognitive and emotional functioning. In considering the nature of these deficits it is likely that their impact upon social functioning would be marked. The next chapter will focus on experimental studies examining the role of cognitive deficits in social functioning.

Although emotional factors will not be considered their contribution is acknowledged. Furthermore, it was noted at the beginning of this chapter that cognitive and emotional factors probably interact in a highly complex way in contributing to the range of problems observed following TBI. It is interesting to note that to what extent this interaction needs to be understood to adequately explain problems following TBI awaits further elucidation.

Chapter 3

1.11. The relationship between cognitive deficits and social functioning following TBI

I shall now review existing research examining the relationship between cognitive deficits and social functioning following TBI. It should be noted that relatively few experimental studies exist.

1.12. Studies examining attention

There have been a few studies looking at attention and social functioning following TBI. Melamed et al (1985) predicted that deficient performance in complex social situations might be related to information processing capacity. However, this notion was not supported by a study by Godfrey et al (1989). They found that patients with severe TBI were significantly impaired on two tasks measuring speed of visual information processing compared to controls. These tasks involved simple word rotation and visual search. Also, independent raters judged patients as being less socially skilled, likeable and interesting following laboratory based interactions. However, reduced speed of information processing did not correlate with these judged social deficits. They argued that tasks assessing vigilance or decision-making skills might be more predictive of impaired social functioning.

It is important to reiterate the point made by McDonald et al (1999) (see chapter two) suggesting that further research needs to elucidate the nature of attentional problems in a way that can be translated into impairments in everyday behaviour. In considering the measurement of attention, a recent behavioural approach is provided by the Test of Everyday Attention

(TEA) (Robertson et al, 1994). This test uses relatively familiar everyday materials to measure aspects of attention, thus arguably improving ecological validity. However, the relationship between performance on this test and social functioning following TBI has not as yet been reported. A further debatable issue is whether attention and social functioning should be examined independently of executive functioning, bearing in mind the theoretical overlap between these two cognitive processes.

1.13. Studies examining memory functioning

Similar to attention, studies of memory and social functioning are relatively sparse. Studies that do exist tend to suggest that memory deficits are not implicated in poor social functioning in patients with TBI (and focal frontal lobe damage).

Saver and Damasio (1991) reported that a patient with acquired sociopathy due to ventromedial frontal damage performed normally on tests of learning and memory despite demonstrating marked social problems. In fact, they argued that adequate social knowledge was retained as the patient demonstrated good reasoning with regard to social problems, including ethical and financial dilemmas. Damasio (1996) reiterated that basic memory following frontal lobe damage is not affected, including access to social knowledge. Marsh and Knight (1991) also report that numerous measures of memory and new learning were not correlated to estimates of social competence in TBI patients.

Furthermore, Channon and Crawford (1999) found that patients with anterior frontal lesions (and posterior lesions) were able to adequately recount factual information after observing real-life-type social situations. However, they noted that this finding should not rule out the possibility that patients may be impaired in their ability to make adequate use of prior knowledge in order to guide problem-solving.

There is support for the notion that patients may possess certain information but might not think to use it unless externally cued (Stuss and Gow, 1992). Lezak (1995) argued that this might be related to poor executive control of behaviour. This would appear consistent with the argument raised in chapter two, that frontal lobe damage may disrupt memory via secondary disruption to the online monitoring and organisation of information (Shimamura, 1994). However, as noted the role of the frontal lobe in memory problems (and associated executive and working memory involvement) remains unclear.

1.14. Studies examining executive functioning

Executive functions are thought to play a crucial role in the mediation of social behaviour, particularly as social situations tend to be relatively complex and novel and require the utilisation of higher-level cognitive processes. The link between deficits in executive functions and impairment in aspects of social functioning has been suggested following TBI (e.g. Lezak, 1995; Brooks, 1988; Silver et al, 1992 Crepau and Scherzer, 1993).

However, there are a small number of studies investigating this relationship. Channon and Crawford (1999) also made the important point that studies that do exist have tended to examine the effects of executive functions using impersonal (neuropsychological) tasks with abstract materials. Performance on these measures has then been correlated with general indices of social functioning. They argued that the use of real-life-type tasks is more likely to reveal the nature and extent of difficulties after brain injury.

The few studies that have attempted to address this issue have concentrated on different aspects of social problem-solving and decision-making. Shallice and Burgess (1991) studied three patients with extensive frontal lobe damage. Patients were given a limited amount of

time to plan and carry out various tasks in a street of shops. They found that the patients were impaired in their ability to shift appropriately between tasks and comply with rules of the test. Dimitrov et al (1996) also studied the effects of everyday problem-solving in patients with heterogeneous frontal lobe damage. They presented patients with stories describing everyday problems. It was found that patients were impaired in selecting the best solutions from a range of alternatives compared to healthy controls.

A recent study by Channon and Crawford (1999) examined problem-solving in real-life-type problems (Predicaments test). Patients with unilateral left and right anterior lesions involving the frontal lobe and posterior lesions were compared to healthy controls. The Predicaments test consisted of eight videotaped films (and corresponding written story versions) of people interacting in different social scenarios. For example, one film was concerned with a neighbour's failure to return a lawnmower. Patients had to recall factual details of each film and then generate and select optimal solutions. The results showed that patients with anterior lesions (particularly those with left-sided lesions) demonstrated greater impairment compared to the posterior group and healthy controls on the Predicaments test. This included impaired ability to appreciate the pertinent aspects of the scenario (despite processing the relevant facts), reduced fluency in generating possible solutions and to devise solutions judged to be socially appropriate. For example, based upon the example scenario, the optimal solution chosen by one anterior patient was "threaten him with legal action", which was not an option typically provided by healthy controls even when asked to generate as many solutions as possible. Also, both patient groups showed impairment on neuropsychological tests, including measures of executive function. Interestingly, in the anterior group the number of solutions generated and optimal solution quality scores correlated significantly with executive tests thought to involve strategy generation and response inhibition. It was concluded that deficits in executive functioning largely contributed to poor performance in the lesion group, although

unfortunately a larger sample size was considered necessary to examine adequately the contribution of specific prefrontal areas to performance.

Therefore, there is some evidence to suggest that deficits in executive function following frontal lobe damage affects performance on real-life-type tasks tapping social problem-solving. It is interesting to note that other aspects of social functioning, such as the interpretation and comprehension of social information has not been examined.

1.15. Studies examining executive and pragmatic functioning

In chapter two it was emphasised that problems in pragmatic functioning following TBI have tended to be explained in terms of impaired executive processes, although this relationship has mainly been supported using conventional linguistic and cognitive tests. There have been few studies exploring broader aspects of pragmatic functioning. A larger number of studies looking at communication problems in patients with right hemisphere lesions have used tasks tapping wider aspects of pragmatics (although as noted in chapter two the cognitive aspects of these problems have been given little attention). For example, patients with right hemisphere damage have been shown to have problems performing tasks involving the interpretation of indirect requests (Foldi 1987; Hirst et al 1984; Weylman et al 1989), humour (Bihrlé et al 1986; Brownell and Gardener 1988), and sarcasm (Kaplan et al 1990). Impairment on tasks requiring holistic and context-dependent inferences such as deriving the main point has also been reported (e.g. Hough 1990; Brownell et al, 1986).

A small number of TBI studies have adopted similar methodology to explore the contribution of cognitive deficits (particularly aspects of executive functioning) in impaired pragmatic functioning.

1.15.1. Comprehension of pragmatic inference

TBI patients have been found to have difficulty with pragmatic comprehension. McDonald and van Sommers (1993) studied two TBI patients with executive impairment. They found that while both patients recognised the inferred aspect an indirect request (e.g. “Can you pass the salt?”) one patient had difficulty understanding the role of the literal meaning. These same two patients also had difficulty comprehending non-conventional indirect speech acts in the form of sarcastic comments (McDonald, 1992b). This finding was supported by a later study by McDonald and Pearce (1996). In this study ten TBI patients (six severe cases) and twenty healthy controls were required to read pairs of literally inconsistent sentences. For example, person A said “What a great football game” and person B said “Sorry I made you come”. It was considered that the only way this could be seen as meaningful was if one of statements was interpreted as opposite to what it literally asserts and was thus viewed a sarcastic comment. They then asked participants to answer either yes or no to four questions, which judged whether they viewed the statement as insincere. For example, “Did person A think the game was bad?” They found that TBI patients performed more poorly compared to controls on these items.

It was argued that this poor interpretation of sarcasm could be accounted for by conceptual problems related to poor performance on a test of executive functioning and was also consistent with the traditional Gricean view of pragmatic functioning (see chapter two). It was noted that the recognition of sarcasm requires the processing of the literal meaning of the remark and then a rejection of this in preference for the inferred meaning. Patients who are stimulus bound should be incapable of seeing beyond the literal meaning. The researchers also found that the addition of attitudinal information in the speakers voice (in an audiotaped version) did not improve performance, even in those patients who were capable of using this

type of information. Thus it was argued that this finding did not support the 'Echoic' model of pragmatic functioning (see chapter two).

Bara et al (1997) studied pragmatic inference in thirteen severe TBI patients and healthy controls. Participants watched brief videotaped interactions between characters. The interactions ended with direct and indirect speech acts. They adopted an open-ended response format in which participants were asked to freely report their understanding of the interaction and say what they thought would happen next. When responses were unclear, three interpretations of the interaction (inferential, literal and out of context) were presented to the participant at the same time. They needed choose the inferential interpretation to pass the item. It was found that the TBI patients could successfully comprehend more 'basic' indirect speech, whereas other indirect responses including deceit were poorly understood. It was suggested that indirect speech acts might vary along a continuum in terms of their inferential difficulty. Unfortunately, the relationship with performance on neuropsychological tests was not examined in this study.

1.15.2. Production of pragmatic inference

There is some evidence to suggest that TBI patients have difficulty producing conversational inference. McDonald and van Sommers (1993) found that TBI patients who had executive impairment were unable to produce effective hints that only alluded to the actual request by subtle innuendo. It was argued that this was partly due to an inability to refrain from stating their true intention. In a more recent study this finding was associated with neuropsychological measures of disinhibition (McDonald and Pearce, 1998).

1.15.3. Interpretation of social appropriateness

It is important to note that in addition to the comprehension and production of pragmatic inference (indirect speech), successful pragmatic understanding also requires broader appreciation of the social appropriateness of information, taking into account social knowledge and contextual factors. This issue has not been studied in TBI patients. Studies in patients with right hemisphere lesions have given some consideration to this issue. For example, Rehak et al (1992) found that patients with right hemisphere lesions (including anterior and posterior), in comparison to healthy controls, had difficulty interpreting and judging videotaped conversations, which violated aspects of the Gricean maxims. Brownell et al (1997) also found that relative to healthy controls, patients with right hemisphere lesions (usually involving the middle cerebral artery distribution) showed decreased use of familiarity variables when choosing formal over informal labels.

1.16. Studies examining theory of mind

It was noted in chapter two that there are very few studies examining theory of mind deficits following TBI. The tasks used in the studies of pragmatic functioning described above arguably involve a degree of theory-of-mind-type social comprehension (i.e. require reasoning upon another persons supposed mental state). Therefore, although it could be argued based upon this research that TBI patients have some impairment in this aspect of functioning, the issue of theory of mind has not been considered directly.

The recent study by Channon and Crawford (2000) referred to in chapter two, has examined higher-level theory-of-mind-type social comprehension in patients with frontal lobe damage. They used a story comprehension task, which consisted of twelve written conversations in the

form of vignettes. Participants were asked to explain the main characters speech or actions in each vignette. The link between the words or actions and the reasons behind them was not made explicit. The stories included examples of sarcasm, pretence, misunderstanding, lie, white lie, threat and dare. The final sentence contained information, which ensured that it was not possible to adequately understand the story using a literal interpretation. Hence, it was important to appreciate the mental state of the characters. Scoring was based upon participants accurately judging the words and actions of the characters, including a non-literal interpretation and the use of mental state terms.

As reported in chapter two patients with left anterior lesions performed significantly more poorly on this task, compared to patients with right anterior and posterior lesions. Patients failed to make non-literal interpretations. However, although this seemed to provide evidence of impairment in theory of mind, the authors argued that executive deficits might adequately account for the findings.

1.17. Overview of existing research examining the relationship between cognitive deficits and social functioning following TBI: A rationale for the current study

There is a paucity of research examining the relationship between cognitive deficits and social functioning following TBI. Research that has been conducted has largely been confined to abstract neuropsychological tests, which do not necessarily reveal the nature and extent of social difficulties. It is only recently that studies have used real-life-type tasks. These studies provide some evidence to suggest that TBI patients have difficulties with aspects of social decision-making and that executive deficits might underpin these difficulties. A few studies also indicate problems with theory-of-mind-type social comprehension and broader aspects of

pragmatic functioning. Deficits in executive functions have been linked to these problems, although their contribution remains poorly understood. It seems evident that to understand difficulties in social functioning it is important to carefully consider the relationship between executive functioning and other cognitive factors, including attention, pragmatic functioning and theory of mind. This view is consistent with current executive theory, which suggests that executive functions control and mediate other cognitive processes in novel and complex situations.

An aspect of social functioning given very little direct attention in previous TBI research is the 'earlier' interpretation and comprehension of verbal social information. To what extent deficits in executive functioning might affect this aspect of social functioning in TBI patients remains largely unknown. This will provide the focus of the current study. Examining this particular aspect of social functioning raises two issues, however. Firstly, it is acknowledged that everyday interpretation of social information relies not only upon verbal information but also involves the processing of non-verbal cues, such as body language. Despite the importance of this source of information, it is not the focus of the current study. Secondly, it is appreciated that any attempt to distinguish between different stages of social functioning is to some extent arbitrary, particularly as the frontal lobes are probably involved in multiple interacting cognitive processes at any one point in time (e.g. see Stuss et al, 1995).

Despite these issues, heuristically it is useful to consider this aspect (or 'stage') of social functioning and to explore the relationship with executive functions using real-life-type tasks. Valuable clinical information might be provided to inform psychological treatments for patients with everyday social problems.

1.17.1. Interpreting verbal social information: Executive functions and the relationship with other cognitive factors

How can the relationship between executive function and other cognitive factors be considered within the process of interpreting verbal social information? A theoretical link between executive functioning and attentional processes has been emphasised in the reviewed literature. Hence, deficits in sustained and selective attention observed following TBI should, in theory, be closely associated with deficits in executive functioning. It can be argued that these deficits might affect the ability of patients to accurately monitor, interpret and appreciate verbal social information. This issue has not been addressed in the TBI literature. Furthermore, the role of attention in social functioning has largely been measured using abstract tasks and considered independently of executive functioning.

It is reasonable to assume that memory functioning might not contribute markedly to this aspect of social functioning, particularly as the review suggests that adequate access to social knowledge is largely unaffected following TBI. However, the possible role of executive and memory processes in the on-line monitoring and organisation of information should not be ruled out, despite the fact that this relationship is poorly understood.

Executive processes have also been linked to successful pragmatic functioning. It is likely that understanding pragmatic inference would be crucial in interpreting and appreciating verbal social information. There are a few TBI studies demonstrating executive impairment and problems in the ability to comprehend indirect speech acts. However, the role of executive processes has not been considered in detail. Also, the broader issue of interpreting the social appropriateness (or skillfulness) of information has not been considered in patients with TBI. As noted, it is likely that this would particularly draw upon social knowledge and an understanding of contextual factors.

Finally, the ability to adequately comprehend other people's mental states is likely to affect the interpretation of social information. The review suggests that TBI patients are not impaired on first order theory of mind tasks and hence this would not require examination. However, there is some evidence to suggest that patients have difficulty with higher-level theory of mind processing, although the concept of theory of mind and the relationship with executive functioning has only recently been examined in TBI patients. It is clear that further elucidation is necessary.

1.18. Aims and hypotheses

The aim of the current study was to examine the performance of TBI adults on real-life-type social tasks involving the interpretation of verbal social information and to compare this to performance on non-social neuropsychological tests of attention and executive function. Higher-level theory-of-mind-type social comprehension tasks were also included.

The social tasks consisted of a pragmatic judgment task, a social skill judgment task and a conversation judgment task. These tasks were designed for the purposes of this study.

1.18.1. Pragmatic judgment task

This task aimed to examine the interpretation of direct (literal) and indirect (non-literal) speech acts presented in a written form. The task consisted of a series of items each presenting a brief conversation between characters in everyday social settings. Alternative literal and non-literal responses were provided by one character. These responses varied in their degree of context appropriateness. It was considered important in this study to examine the extent to which participants were able to differentiate between the appropriateness of these direct and indirect responses. The ability to make subtle context-dependent judgments and inferences based upon

different verbal information is likely to be important in social functioning. This issue had not been examined in the previous TBI studies looking at pragmatic inference. Thus, it was necessary to consider the most effective way to elicit this information. Previous studies had adopted closed and open response formats to access participant's pragmatic understanding. For example, closed formats have been used in asking participants to say whether speech acts were insincere or not or in requiring them to choose the best response from a selection (e.g. McDonald and Pearce, 1996). In contrast, an open format has been adopted in asking participants to freely describe their understanding (e.g. Bara et al, 1997). It was decided that a closed response format would be most useful in this study. Rather than selecting one alternative response or ordering them, participants would be asked to rate each in turn. This would provide information on both which response they ranked the highest and how much difference existed between their ratings.

1.18.2. Social skill judgment task

The aim of this task was to examine judgments about the skillfulness of written verbal interactions between characters in different everyday social contexts. Interpretations about the degree of skill involved in verbal interactions had not been examined in TBI patients. The format of the task was similar to the pragmatic judgment task, except the alternative responses varied in terms of the level of skillfulness. Each required a rating in terms of how socially skilled they were in the context. Similar to the pragmatic judgment task, it was likely that performance on this task would also require the ability to infer meaning. However, it was considered that performance would also require particular appreciation of the characters intention and the interpersonal impact of the responses. The responses would be presented in turn. Thus, this task would also provide information on both which response they ranked highest and how much difference existed between their ratings.

1.18.3. Conversation judgment task

It was acknowledged that interpreting verbal information relied not only on appreciating language but also para-linguistic information, such as tone of voice and prosody of speech. The conversation judgment task was an attempt to examine the interpretation of both language and para-language. The task presented an audible conversation between two people in a 'real-time' format. Judgments about the manner of the two people in addition to rating aspects of their para-language were required. This task therefore provided a real-life-type examination of performance.

It was accepted that these three tasks reflected overlapping areas of social interpretation. Furthermore, it was likely that multiple cognitive processes would contribute to task performance. In fact, the tasks were exploratory in the sense that no specific claims were made about underlying cognitive processes, although it was considered that performance might be related to measures of attention, executive function and higher-order theory of mind.

The study specifically examined the following hypotheses:

- TBI adults will perform significantly more poorly than healthy controls on three social interpretation measures: a pragmatic judgement task, a social skill judgment task, and a conversation judgment task.
- TBI adults will perform significantly more poorly than healthy controls on non-social neuropsychological measures of attention and executive functioning.
- A significant relationship might exist such that poorer performance on the three social interpretation tasks will be associated with poorer performance on the non-

social neuropsychological measures of attention and executive functioning in the TBI adults.

- **TBI adults will perform significantly more poorly than healthy controls on measures of higher-level theory-of-mind-type social comprehension.**
- **A significant relationship might exist such that poorer performance on the three social interpretation tasks will be associated with poorer performance on the measures of theory-of-mind-type social comprehension in the TBI adults.**

2. METHOD

2.1. Design

A between subjects design was used to compare seventeen adults with TBI to seventeen healthy controls.

2.2. Participants

A total of thirty-four Caucasian individuals participated in the study. The TBI and Control groups were matched for sex, age, years of education, and scores on the re-standardised National Adult Reading Test (NART, Nelson, 1991). English was the first language in all participants.

2.2.1. TBI group

The TBI participants were volunteers recruited via the Headway National Head Injuries Association. This is a charitable organisation founded in 1980, which aims to provide support and information for individuals with TBI, their relatives and carers.

To be included in the study, participants needed to be between 18 and 65 years of age, to have sustained TBI in adulthood and to be medically stable. It was anticipated that the group would be relatively heterogeneous in respect of site of lesion. However, individuals were selected who had suffered acceleration/deceleration injuries and closed (rather than penetrating) injuries, as they were likely to have fronto-temporal involvement. Also, individuals were selected on the basis that medical records or wherever possible a CT or MRI brain scan were likely to be available to document the presence of brain damage.

Volunteers were excluded if they had significant physical or psychiatric illness (e.g. previous neurological conditions, hydrocephalus or long standing epilepsy), drug or alcohol dependence, a history of learning difficulties or a diagnosis of dyslexia. Individuals currently taking medication with side effects likely to significantly affect their performance on neuropsychological testing were excluded.

Furthermore, volunteers were screened for severe cognitive impairment and expressive or receptive dysphasia. They were excluded if they obtained a pre-morbid verbal IQ score of below 85 on the NART or scored outside the normal range on the Test for Reception of Grammar (TROG, Bishop, 1982).

Overall, twenty-nine individuals were interested in participating in this study. Twelve were excluded as they did not meet all of the selection criteria.

2.2.2. Control group

The Control group comprised of healthy adult volunteers, matched to the TBI group for sex, age, years of education and NART scores.

2.2.3. Significant others

Data were collected from significant others for thirteen of the seventeen participants in the TBI group. (The missing data was due to failure to return questionnaire information). Data were collected from seventeen significant others for the Control group.

2.2.4. Sample characteristics

2.2.4.1. Matching between groups

Table 2.1 indicates that there were no significant differences between the groups in terms of age, years of education and NART scores. There were eleven men and six women in both the Control group and TBI group. The Control group contained sixteen right-handed participants and one left-handed participant. The TBI group contained fifteen right-handed participants and two left-handed participants.

Table 2.1: Matching between the groups.

	Control (n = 17) Mean (s.d.)	TBI (n = 17) Mean (s.d.)	t value	sig
Age	43.18 (10.14)	44.71 (10.29)	.436	.667
Education	13.12 (2.89)	13.65 (3.14)	.418	.679
NART	108.00(10.08)	107.00 (12.01)	.263	.794

2.2.4.2. Occupation of participants

Table 2.2 shows that the majority of the control group were in paid employment at the time of the study, compared to only one participant in the TBI group.

Table 2.2: Occupation of participants.

Nature of occupation	Control (n = 17)		TBI (n = 17)	
	No.	%	No.	%
Paid employment	15	88	1	6
Voluntary work			4	23
Student			1	6
Day centre (Headway)			4	23
No occupation	2	12	7	42

2.2.4.3. Living arrangements of participants

Table 2.3 indicates that the majority of the Control participants were living with a partner at the time of the study, whereas the majority of the TBI participants were living alone.

Table 2.3: Living arrangements of participants.

Living with:	Control (n = 17)		TBI (n = 17)	
	No.	%	No.	%
Partner	14	82	6	35
Alone	1	6	8	47
Friends	2	12		
Parents			2	12
Siblings			1	6

2.2.4.4. Characteristics of the TBI group

The mean age at which the TBI had occurred was 34.4 years (s.d. 11.2). The mean length of time that had elapsed since participants sustained their TBI was 9.5 years (s.d. 8.5). The most recent TBI had occurred 2 years prior to participation in this study and the most distant was 35 years.

Table 2.4. shows the causes of TBI. As in the general population, road traffic accident was the most common cause of injury. Three participants had sustained their injury from falling.

Table 2.4: Causes of TBI

Cause of brain injury	Number of cases (n = 17)	Percentage of sample (n = 17)
Road traffic accident	14	82%
Fall	3	18%

All of the participants provided written consent to access medical records. Letters were sent to GP's requesting information regarding loss of consciousness following TBI, brain damage sustained (size, location and side of lesion) and results of any CT or MRI investigations. Hospital departments (medical records, CT and MRI departments) were contacted directly for scan results in cases where the GP did not know the results. In six cases no brain scan information was obtainable. Reasons for this included cases where the scans had been destroyed due to the passage of time and cases where records had gone missing. Self or relative reported information was relied upon in those cases where the GP or hospital could not provide information regarding loss of consciousness.

Table 2.5. shows the information obtained regarding loss of consciousness and lesion characteristics.

2.2.4.5.Characteristics of the significant others

As Table 2.6 indicates, the majority of Control participants chose their partners to rate them. For the TBI group, the most popular choice of rater was a friend.

Table 2.5: Lesion characteristics

Sex	Estimated duration of loss of consciousness (who reported) and severity classification	Estimated PTA and severity classification	Type	Location of brain injury of scan (where scan result was obtainable)
F	several days (patient) (very severe)			not obtainable
M	4 weeks (patient) (very severe)			not obtainable
M	several months (GP) (very severe)	4 days (severe)	CT	Bilateral temporal and frontal
F	several hours (patient) (moderate)		CT	Right temporal, left temporal parietal
M	3 weeks (patient) (very severe)		CT	Left thalamus and sub-cortical
M	3 weeks (GP) (very severe)	3 days (severe)	CT	Left frontal and left fronto-parietal
M	24 hours (hospital) (severe)	4 (severe)	CT	Bilateral temporo- parietal
F	3 weeks (patient) (very severe)	3 weeks (severe)		not obtainable
F	1 week (GP) (very severe)		CT	Left fronto-parietal
M	6 weeks (patient) (very severe)	7 weeks (severe)	CT	Left/right hemisphere parietal
M	6 weeks (GP) (very severe)	10 weeks (severe)	CT	Right frontal
F	1 week (GP) (severe)	2 days (severe)	CT	Left temporal frontal
M	1 month (patient) (very severe)		MRI	Bilateral temporal lobe
M	several hours (patient) (moderate)			not obtainable
M		8 weeks (severe)	CT	no haematoma identified
F		2 days (severe)		not obtainable
M	6 days (patient) (very severe)			not obtainable

Table 2.6: Characteristics of significant others

Significant others' relationship to participant	Control (n = 17)		TBI (n = 13)	
	No.	%	No.	%
Partner	12	70	5	38
Friend	3	18	6	46
Sibling	2	12	1	8
Parent			1	8

2.3. Procedure

The Joint University College London and University College London Hospital's Committee on the Ethics of Human Research provided ethical approval for the study as part of a larger project (see Appendix 6.1.). In accordance with the Committee guidelines for recruiting 'patients' via a voluntary organisation (rather than through a medical Consultant), GP's of the TBI volunteers were informed of their participation in the study where this was requested.

An information sheet about the study was read to all participants (see appendix 6.2) and written consent to participate was obtained (see appendix 6.3). Written consent to access medical records was also obtained (see appendix 6.4.). Furthermore, consent for a nominated significant other to be contacted by post was obtained (see appendix 6.5.). Significant others were sent one of the measures used in the study. The purpose of this was to obtain collateral scores in order to assess the accuracy of self-report data.

Participants were tested either at University College London, day centre premises attached to their Headway group or their homes. A fixed order of test administration was used to ensure that any fatigue or practice effects were similar across all participants. Participants were provided with breaks as necessary between testing to help to minimise the effects of fatigue.

2.4. Measures

2.4.1. Screening measures

2.4.1.1. Test for Reception of Grammar (TROG, Bishop 1982)

The TROG was used in this study to screen for poor language comprehension. The test requires participants to look at four pictures and to choose the one that represents a sentence spoken by the test administrator. The complete test takes between ten to twenty minutes to complete and consists of eighty four-choice items. The items are divided into twenty blocks with four items in each block. The blocks are arranged in order of increasing difficulty. The test is scored in terms of the number of blocks passed and in order to pass a block, participants need to get all four items correct. Testing is started at a baseline of five consecutive blocks correct and is discontinued when five consecutive blocks have been failed. All participants were started at block N in order to reduce administration time. The test manual suggests that for adults, failure on more than four blocks is of clinical significance. Therefore, this was used as a cut-off for inclusion in the study on the basis that those performing below this level might not have sufficiently good comprehension abilities to understand the test requirements or to answer questionnaires.

2.4.1.2. National Adult Reading Test (NART-2) (Nelson, 1991).

The NART is a graded adult reading test that is widely used to obtain an estimate of pre-morbid intelligence. The test requires participants to read aloud fifty irregularly spelled words. The score obtained is based on the number of items the participant pronounces incorrectly. This error score is then used to derive an estimated verbal IQ. In this study, the NART was given to all participants to screen for severe cognitive impairment. Participants obtaining more

that thirty errors, equivalent to a predicted WAIS-R verbal IQ of eighty-five or below, were excluded from the study.

2.4.2 Social interpretation measures

The aim was to develop real-life-type tasks to measure three areas involved in the interpretation of verbal social information. These tasks consisted of a pragmatic judgment task, involving the judgment of written pragmatic information, a judgment of social skill task, involving the judgment of skillfulness and appropriateness of written social information and a conversation task, involving the judgment of language and para-language in an audible 'real-time' conversation.

2.4.2.1 Pragmatic Judgment task

Task construction

The task involved the interpretation of direct (i.e. literal) and indirect (i.e. non-literal) speech acts presented in written form. In order to guide the generation of items it was necessary to provide a basic item protocol. It was decided that each item should consist of a short written conversation between two characters, occurring in an everyday context. The conversation would provide brief information about the context and end with a remark from one of the characters. The other character would then provide three alternative responses to the remark, which corresponded to three response categories: 'non-literal appropriate', 'non-literal neutral' and 'literal'. It was considered that these would provide an adequate categorical range of appropriateness. The 'non-literal appropriate' category would contain statements that went beyond a literal response to the remark and would be appropriate in the context. The 'non-literal neutral' category would also contain statements that went beyond a literal response to

the remark but would be considered less appropriate in the context. Finally, the 'literal' category contained statements that would be consistent with a literal understanding of the remark. Five males and five females (of varying ages) were asked to generate a sample of items. They were provided with the basic protocol, including the category descriptions.

Piloting

The generated items were then piloted using ten people. They were provided with category descriptions and asked to categorise each of the three responses in all the items. This resulted in some items either being refined or removed due to categorisation that was particularly variable. On the basis of this piloting, six items were included in the task (see appendix 6.6.). It was felt that these items had reasonable face validity and content validity, in so far as they seemed to adequately sample a range of direct and indirect speech acts in a range of everyday contexts. Furthermore, there appeared to be agreement regarding the extent to which the item responses were appropriate in the context.

Example item

Alison visited her friend (Rachel), as she did every week. On the wall, Alison was surprised to see a new picture, which was obviously an original oil painting. It showed a large elephant.

Alison says to Rachel *'Where did it come from?'*

- Rachel says *'It was left to me by my aunt, the one who died recently.'* ('non-literal appropriate')
- Rachel says *'It was painted by Alfred Jones, who's famous for his animal paintings.'* ('non-literal neutral')
- Rachel says *'It is an African elephant.'* ('literal')

Administration and scoring

The participants were asked to read each conversation and then give serial independent ratings for the three alternative responses, rather than selecting a single one or rank ordering the three. They were told to rate each response in terms of how appropriate it was in the context, using a Likert type (ordinal) scale from 1 (not at all appropriate) to 4 (very appropriate). The order of presentation of the 'non-literal appropriate', 'non-literal neutral' and 'literal' responses were counterbalanced across the six items. Each of the six items generated three scores, reflecting the three response categories. The score for each response ranged from one to four.

2.4.2.2. Social skill judgment task

Task construction

This task involved the judgment of social skill in a range of written social interactions. To guide the generation of items, the basic protocol adopted for the pragmatic judgment task was used. It was decided each item should consist of a short interaction between two characters occurring in an everyday context. The interaction would provide brief information about the context and end with a remark from one of the characters. The other character would then provide three alternative responses (a statement or action) to the remark, which corresponded to three categories: 'skilled', 'neutral' and 'unskilled'. As in the previous task, it was considered that these would provide an adequate categorical range of skillfulness. The 'skilled' category would contain responses that were considered socially skilled in the context and the 'neutral' category responses that would not be considered particularly skilled or unskilled. The 'unskilled' category would contain responses that seemed inappropriate in the context. It was also considered useful if the remark from the first character varied according to whether it was

considered to be 'skilled' or 'unskilled'. This avoided having all socially inappropriate initial interactions. (This was not considered within the analysis however). Similar to the pragmatic judgment task, five males and five females (of varying ages) were asked to generate a sample of items. The basic protocol, including category descriptions were provided and they were encouraged to consider a broad range of social situations and responses. The Gricean maxims referring to appropriate conversational rules (see chapter two) were also provided to help generate items.

Piloting

The generated items were then piloted using ten people. They were provided with category descriptions and asked to categorise the first remark and each of the three responses in all the items. This resulted in some items either being refined or removed due to particularly variable categorisation. On the bases of this piloting, six items were included in the task (see appendix 6.7.). (The first remark was 'skilled' in three items and 'unskilled' in the other three). It was felt that the items had reasonable face validity and content validity, to the extent that they seemed to adequately sample a range of everyday behaviours that differed in the degree of skillfulness.

Example item

John and Vicky enter a busy lift. They do not know each other. John's hand accidentally brushes Vicky's skirt.

John says to Vicky *'Oh, I'm sorry.'*

- Vicky says *'OK, don't worry'* and turns away. ('skilled')
- Vicky says nothing. ('neutral')

- Vicky says *'That's never happened to me before.'* ('unskilled').

Administration and scoring

Participants were required to read each interaction and then give serial independent ratings for the three alternative responses. Therefore, this task also did not require participants to select a single one or rank order alternatives. They were required to rate how socially skilled the response was in the context using a Likert type (ordinal) scale from 1 (not at all socially skilled) to 4 (very socially skilled). The order of presentation of the 'skilled,' 'neutral' and 'unskilled' responses were counterbalanced across the six items. Each of the six items generated three scores for the three response categories. The score for each response ranged from one to four.

2.4.2.3. Conversation judgment task

Task construction

The basic protocol for this task involved listening to a conversation between two characters presented on audiotape. Interpretation would be measured in two ways. Firstly, participants would be required to recall as much detail about the conversation as they could. Secondly, they would answer a series of questions about both characters in turn. These questions would require the rating of the characters manner (e.g. polite, irritating) and tone of voice and prosody of speech.

In generating the conversation, two issues were considered. Firstly, it was important that the conversation was realistic and reflected a possible everyday conversation. It was decided that the conversation should take place on a train and involve two men sitting next to each other.

To enable participants to identify the two men, the conversation referred to the fact that one man had a newspaper. Two people were used to record the conversation. Secondly, in considering the content of the dialogue, it was necessary that the manner of the two characters could be rated in addition to the tone and prosody of their speech. Therefore, it was necessary for the conversation to provide information that was noticeable but at the same time reasonably subtle, to allow for subjective differences in interpretation. The general theme of the conversation involved the man without the newspaper being reasonably friendly and keen to talk, while the other man was more interested in reading his newspaper. As the conversation progressed, the man without the newspaper became generally more inappropriate. It was also important that the conversation was a reasonable length, so opinions about the two men could be formed.

A range of positive and negative adjectives were selected as descriptions of peoples manner. For example, positive adjectives included polite and likeable and negative adjectives included abrupt and annoying. These would be rated on a Likert type (ordinal) scale from 1 (not at all) to 4 (very). Also, aspects of para-language were included such as speech loudness, pauses and stutters. These would be rated on a Likert type (ordinal) scale from 1 (never) to 4 (very often).

Piloting

The task was piloted using five males and five females (of varying ages). This was primarily to see whether the conversation dialogue reflected a real life conversation and to check that a reasonable amount of the conversation could be recalled. It would also check that it was possible to make interpretations about the characters. On the basis of this piloting, the conversation was refined and a number of adjectives excluded.

It was decided that the final conversation would be two minutes and fifteen seconds in length. Participants would then be required to answer four main questions about both men in turn (thus eight questions in total). Question one involved rating the manner of the man (reading the paper) on four positive and four negative adjectives. Question two involved rating the man's view of the other man on these same adjectives. The Likert type (ordinal) scale with four points, 'not at all,' 'slightly,' 'moderately' and 'very' was used for these questions. The third question involved rating the sound of the man's voice on five items and question four rating whether the man's speech contained certain features (e.g. stutters) on three items. These last two questions (rating para-language) used a Likert type (ordinal) scale with four points, 'never,' 'seldom,' 'often' and 'very often.' These same four questions (i.e. questions five to eight) were then asked about the man (not reading the paper). (See appendix 6.8). It was assumed that the task had reasonable face validity and content validity, to the extent that it consisted of an everyday conversation, in which different interpretations based upon the language and para-language was required.

Administration and scoring

Participants were asked to listen carefully to the conversation and told that it involved a conversation between two men who did not know each other. The participants were then asked to recall as much detail as they could remember about the conversation. The researcher wrote down their responses verbatim. To check that participants had identified basic details of the conversation, they were asked a series of simple questions, such as "Where did the conversation take place?" and "Did either of the two men have anything with them?" Participants were then required to answer the eight questions about both men, as described above. The order of the presentation of the items was counterbalanced.

To score the free recall responses, the entire dialogue was divided into units or 'ideas'. (See appendix 6.8). This process was similar to the scoring procedure used in the AMIPB, which also deals with nominal data. The researcher initially divided the dialogue into provisional 'ideas', which was then refined through discussion with a person not involved in the study. It was decided that sixty-eight 'ideas' existed, each reflecting a theme. The participant obtained one point if the basic 'idea' was recalled and half a point if their response lacked detail or was changed in accuracy. A score of zero was given if the 'idea' was omitted or the response was clearly inaccurate. For example, "...but I find reading makes me feel sick on trains", was an 'idea' and one point was obtained if sick or more generally ill was connected to reading, half a point if reading or ill was mentioned but not linked and zero if there was no mention of reading or ill. This provided a total score of sixty-eight.

To score questions one, two, five and six, the positive items were given a score between 1 for 'not at all' to 4 for 'very'. This was reversed for the negative items. It was not appropriate to reverse the para-language items in questions three, four, seven and eight, as they were all phrased negatively. Each item was given a score between 1 for 'never' and 4 for 'very often'.

2.4.3. Neuropsychological measures of executive function

2.4.3.1. The Hayling Test (Burgess and Shallice, 1996)

The test comprises of two sections. Each section consists of fifteen short sentences where the last word is missing. The sentences are read aloud by the examiner and participants are expected to provide a verbal response. In section one, participants are asked to provide a sensible answer to conclude the sentence and to give the answer as quickly as they can (e.g. "He posted the letter without a.....stamp"). In contrast, section two requires participants to

provide a word that does not fit at the end of the sentence and which is unconnected to the sentence in every way (e.g. " Most cats see very well at.....apples").

The test yields three measures related to executive function. In section one, participants are timed and the sum of the response latencies provides a measure of simple response initiation speed. Section two is designed to be a response suppression task. Two scores are calculated, the sum of the response latencies and an error score. The error score is based on the frequency and nature of the errors. The test manual suggests that participant's who perform poorly on section two are those that respond too slowly or are too impulsive and make errors by finishing the sentences with words which are semantically linked. Those participants who perform well tend to develop strategies to help them cope with the demands of response suppression (e.g. look around the testing room and name objects in view).

2.4.3.2. Trail Making Test (Reitan, 1958)

The Trail Making Test assesses visuo-motor tracking, mental 'set-shifting' and conceptualisation skills. It should be noted that poor performance on this test could also be related to motor slowing, in-coordination and poor motivation (Lezak, 1995).

The test comprises two parts (A and B). Part A requires participants to join together a series of circled numbers in correct numerical order. The numbers are from one to twenty five and presented in random order on the page. They need to complete the task as quickly as they can. In Part B participants are presented with numbers (1-13) and letters (A-L). These are also randomly spread across the page. This time they are required to alternate between numbers and letter in correct ascending order (e.g. 1 to A to 2 to B to 3 to C and so on). Part A and B have samples for participants to practice on prior to the actual tests.

Participants are timed and their score is the time it took in seconds to complete each part. Errors made on part A or B are pointed out as they occur to allow self-correction.

2.4.3.3. Letter Fluency Test (Thurstone and Thurstone, 1962).

Impaired verbal fluency has been associated with damage to frontal and temporal brain areas (e.g. Janowsky et al, 1989; Parks et al, 1988). This impairment refers to problems in the speed and ease of verbal production. The Letter Fluency Test involves asking participants to write down as many words as they can think of beginning with a certain letter (provided once all the instructions are given). They are required to follow three simple rules. Firstly, they are not allowed to use more than one word from the same root. Secondly, words must not include numbers or days of the week. Thirdly, they are not permitted to use names (people or places). Participants are then told that the letter is 's' and they have five minutes in which to do the task.

The total score is the number of words produced, excluding words that break any of the three rules. (Duplicated words are also excluded). The words that break the rules are also summed to yield a total rule break score.

2.4.3.4. Raven's Advanced Progressive Matrices: Set 1 (Raven, 1976)

It has been argued that the Advanced Progressive Matrices (Set 1) provides a test of executive function, particularly due to its novel format (Philips, 1997). The test is quick and easy to administer and comprises of twelve visual pattern matching and analogy problems. These are arranged in order of increasing complexity and multiple-choice answers are provided. Each item contains a non-representational pattern problem with a part missing. Participants need to

point out which of eight pictured inserts contain the correct pattern. There is no time limit in which to complete the test. The number of correctly solved problems provides a raw score.

2.4.3.5. The Modified Six Elements Test (Wilson et al 1996)

The Modified Six Elements Test is part of the British Assessment of Dysexecutive Syndrome (BADS, Wilson et al, 1996), which is a battery of tests aimed at predicting everyday problems arising from Dysexecutive Syndrome. This particular test was designed to make demands on an individual's ability to plan, organise and monitor their behaviour. Performance is considered to be associated with prospective memory, which refers to the ability to carry out an intended action at a future time.

The test consists of three types of task, with each type containing two tasks: dictation (A and B), picture naming (A and B) and arithmetic (A and B). Participants are told that they have ten minutes in which to attempt at least something from all six tasks. They are told that they can do the tasks in any order, as long as they do not break a specific rule. The rule is that they are not to move between parts A and B (or B to A) on the same type of task. Participants are provided with a timer to allow them to plan their activities. Trial two yields a profile score that is based on the number of tasks attempted, the number of rule-breaks and the length of time spent on any one of the six tasks.

2.4.3.6. The Dysexecutive Questionnaire (DEX; Wilson et al 1996)

The DEX is also part of the BADS and is a questionnaire designed to measure particular problems associated with Dysexecutive Syndrome. It comprises twenty self report items, falling within four broad areas: emotional or personality changes (e.g. euphoria), motivational changes (e.g. apathy), cognitive changes (e.g. abstract thinking difficulties) and behavioural

changes (e.g. aggression). Participants are required to indicate how often they experience each of the problems using a five-point scale, anchored by 0 (never) and 4 (very often). The scores from the twenty items are summed to yield a total score.

The DEX is routinely administered to the significant others of brain injured respondents as they have been found to underestimate their difficulties. In this study, the DEX was given to significant others of all participants (including Controls), in order to assess for differences in accuracy of self-report ratings between groups.

2.4.4. Neuropsychological measure of anterior attentional processes

2.4.4.1. Test of Everyday Attention (TEA, Robertson et al, 1994)

In the absence of readily available measures of sub-types of attention (Robertson et al, 1994), the TEA was designed to measure two central systems of attention (see Posner and Peterson, 1990). These refer to selective and vigilance systems. The TEA also attempts to measure different aspects of the selection system, including attentional switching and divided attention. A particular strength of the TEA is that it uses relatively familiar everyday materials, thus improving the ecological validity of the test.

There are eight sub-tests of the TEA and the entire test takes about one hour to complete. It was decided in this study to use four of the sub-tests only. The selected sub-tests were: Elevator counting, Elevator counting with distraction, Telephone search, Telephone search while counting. There were two main reasons for omitting sub-tests. Firstly, the sub-tests selected were reported to measure a range of attentional sub-systems (namely sustaining attention, auditory selective attention and auditory-verbal working memory). This was considered an adequate measurement of attentional processes for the purposes of this study.

Secondly, it was felt that administering the entire battery would increase the likelihood of participant fatigue.

The Elevator counting sub-test

This test is based on a procedure devised by Wilkins et al (1987). The version used in the TEA is a variation of this procedure devised by Brooks et al (1988) and is considered an established measure of sustained attention sensitive to right frontal lesions. The sub-test involves a simple counting procedure, such that participants need to count seven strings of tones presented on a tape recorder. The number of tones in each string ranges from a minimum of three to a maximum of fourteen and the time delay between each tone varies. Participants are asked to pretend they are in an elevator whose floor indicator is not functioning and they need to establish which floor they have arrived at by counting the tones. At the end of the tones a voice on the tape says 'how many?' Participants then provide an answer. Two practice items are provided at the beginning so that subjects are familiar with the tones. Participants obtain one point for each correctly counted string (excluding the practice strings), yielding a maximum score of seven. The test manual provides raw score interpretation criteria (seven 'normal', six 'doubtful', five or less 'definitely abnormal').

The Elevator counting with distraction sub-test

This test was devised to measure auditory selective attention (and loads on a factor of auditory-verbal working memory) (see Robertson et al, 1994). The sub-test is similar to the Elevator counting sub-test. It differs in that participants need to count strings of tones with the same pitch as before in addition to not counting a distracting tone (which is a higher pitch). The task begins with two examples to demonstrate the difference between the two tones and to

allow the participant practice in counting. Participants obtain one point for each correctly counted string (excluding the practice items) yielding a maximum score of ten.

The Telephone search sub-test

This test was constructed to measure selective attention. Participants are told to imagine that they are away on holiday at a friend's house and need to contact a particular service (i.e. plumbers). They are presented with a simulated telephone directory page and told that they need to search for key symbols. Alongside each entry are two symbols (stars, squares, circles or crosses), which indicate a rating of the service. They are told that guaranteed plumbers are those that always have identical symbols (e.g. two stars). They need to circle these identical symbols as quickly and as accurately as they can. Participants obtain one point for each correctly detected pairs of symbols (excluding false positives). A time-per-target score is then calculated by dividing the total time by the number of correctly identified symbols.

The Telephone search while counting sub-test

This test was designed to measure divided attention and has been found to be associated with the ability to sustain attention. It is similar to the Telephone search sub-test, in that participants are required to search for identical symbols in a telephone directory. However, this time participants search for a different service (i.e. restaurants) and complete another task at the same time. This involves counting strings of tones presented on a tape recorder. Participants are told to work as quickly and as accurately as they can and to put equal effort into each of the two simultaneous tasks. They are provided with an example of the tones prior to starting. This test yields a 'dual task decrement' (or divided attention) measure by combining the score on this sub-test and the score on the Telephone search sub-test. This reflects how much slower the participant was compared to the single task, corrected for accuracy. Participants obtain one

point for each correctly detected pairs of symbols (excluding false positives). The total time is then divided by the number of correctly identified symbols, which yields a time-per-target score. The numbers of strings of tones correctly counted is then divided by the number of strings of tones attempted, to obtain the proportion of tone-strings correctly counted. The time-per-target score is then divided by the proportion of tone-strings correctly counted obtaining a time-per-target score weighted for accuracy of tone counting. The time-per-target score from the Telephone search sub-test is then subtracted from the time-per-target score weighted for accuracy, yielding a 'dual task decrement' score.

2.4.5. Neuropsychological measure of memory

2.4.5.1. Story recall (AMIPB, Coughlan and Hollows, 1985).

This test requires the participant to recall the details of a story, both immediately and after 30 minutes delay. The story is read to the participant prior to the immediate recall only. Their responses are recorded verbatim. The test provides scoring procedures in which the details of the story are divided into twenty-eight 'ideas'. Each idea is scored separately, whereby two points are obtained if the response is consistent with the basic 'idea' and one point if the response is inaccurate but only changes the 'idea' a little. If the idea is omitted entirely, no points are given. Example responses are provided to guide the scoring process. The maximum score is fifty-six.

2.4.6. Theory of mind measures

2.4.6.1. Story Comprehension task (Channon and Crawford, 2000)

The Story Comprehension task was designed to assess high level theory of mind in adults by requiring participants to infer the thoughts of another person which are the opposite to what they actually say or do. The test consists of twelve short stories (vignettes) presented one at a time in a fixed randomised order. Each story is printed on a single page and participants are asked to read each one in turn. There is no time limit and in order to reduce memory constraints each story is left in front of the participant. After each story the participant is asked to explain the speech or actions of a main character. The text itself does not explicitly provide a reason for the characters speech or actions. Furthermore, the last sentence of each vignette provides information to ensure that the story cannot be understood adequately using a literal interpretation. Participants are allowed a single neutral prompt (e.g. 'Can you give me a little more information?') if their responses are unclear.

The vignettes include examples of sarcasm, threat, lie, white lie, pretence, misunderstanding and dare. An example of one vignette is: "Harriet's daughter Lara likes playing with her friends after school, but she has been told to be home by 5 o'clock. Sometimes Lara is late and then Harriet worries that something has happened to her. This evening, Harriet tells Lara "if you are not back by 5 you won't get any dinner." The participant is then asked why they thought Harriet said what she did.

Channon and Crawford developed a scoring system, with written guidelines. The system classifies answers on the basis of accurate interpretation of the characters words or actions. Correct answers would indicate clearly that the words of the main character were not supposed to be taken literally. For example, the correct answer for the vignette above could include "it's a threat to get her back on time". Participants score a point for each vignette, which are then summed to provide a total score. Channon and Crawford (2000) found inter-rater reliability between two blind independent raters to be 93% for the classification of responses as correct versus incorrect.

2.4.6.2. *Strange stories* (Happé, 1998)

This task was designed to assess advanced theory of mind. The task consists of a series of written stories, which require inferences beyond the information stated. There are two types of story. Firstly, there are eight theory of mind (or mentalising) stories. These stories require inferences about people's mental states, including their motivations and intentions. Secondly, there are eight physical (control) stories, which although require inferences about an implicit element, do not invite consideration of mental states.

An example of a theory of mind story is: Brian is always hungry. Today at school it is his favourite meal, sausages and beans. He is a very greedy boy and he would like to have more sausages than anybody else, even though his mother would have made him a lovely meal when he gets home. But everyone is allowed two sausages and no more. When it is Brian's turn to get served, he says, "Oh, please can I have four sausages because I won't be having any dinner when I get home!" Participants are required to read each story and then answer a question, which invites an inference to be made. In the case of this story the question is: "Why does Brian say this?"

Scoring guidelines are provided for the task. The scoring system classifies each story as either correct (two points), partially correct (one point) or incorrect (no points), which is based upon the level of inferential understanding. For example, in the story above, two points are obtained if the response mentions the intention to mislead or pursued, one point if Brian is referred to simply as greedy and no points if reference to an irrelevant fact is made. Therefore, the maximum score is sixteen. The mentalising stories are also scored in terms of their use of mental state language, including words such as thinks, knows, pretends and lies. This provides an additional score out of eight.

3. RESULTS

3.1. Analysis of data

The computerized statistical package SPSS version 8 was used to analyse the data.

Initially, the data were inspected for skewness of distribution and outliers, as these can violate the assumptions of normality and linearity underlying parametric tests.

The degree of skewness was calculated for each variable (within each group) and compared against the standard error of skewness obtained using Tabachnick and Fidell's (1983) formula to see whether it differentiated significantly from zero. The standard error of skewness is as follows:

$$S_s = \sqrt{6/n} = 6/17 = 0.59$$

Where n is the number of cases. The probability of obtaining a skewness value of this size is

$$Z = \frac{S - 0}{S_s}$$

Where S is the value for skewness. At the 1% level, a Z value in the excess of ± 2.58 would lead to rejection of the assumption of normality. Entering this into the table.

$$S = \pm 2.58 \times S_s = \pm 2.58 \times 0.59 = \pm 1.53$$

Therefore, a criterion of ± 1.53 was used for the present data as a cut-off point for normality. Positive skewness was detected for one of the measures of attention in the TBI group (Elevator Counting raw score), two measures of executive function in the TBI group (the Hayling Test A and B, and the Trail Making Test A and B) and the Strange stories task (mentalising and physical stories) in the TBI group.

The data were also checked for outliers using a standardised score (\pm or 3 standard deviations from the mean) as the cut-off point for continuous variables (Tabachnick and Fidell, 1983). Standardised scores were calculated for each variable (within each group) in order to identify those that might contain values outside these limits. Outliers were found in one of the measures of attention in the control group (Elevator Counting raw score), three measures of executive function in the TBI group (Trail Making A, Six Elements Test rule break, Verbal Fluency rule break) and the Strange stories task (mentalising and physical stories) in the TBI group. It was expected that the Six Elements and Verbal fluency rule break (error) scores would not be normally distributed due to ceiling effects and should therefore be treated non-parametrically.

The positively skewed variables were transformed logarithmically (for both groups). Transformation reduced skewness to an acceptable level and dealt the outliers for the Hayling A and B, Trail Making A and B and the Strange stories task (mentalising and physical stories). Thus, it was appropriate to perform parametric tests on these transformed scores. For the Elevator Counting raw score transformations did not reduce skewness to an acceptable level and it was therefore necessary to treat this variable non-parametrically.

Therefore, all variables in this study, except Elevator Counting, Six Elements rule break and Verbal Fluency rule break were analysed using parametric tests. A significance level of 5% was adopted throughout.

3.2. TBI and Control group performance on the social interpretation measures

3.2.1. Do the TBI and Control group differ significantly on the pragmatic judgment task?

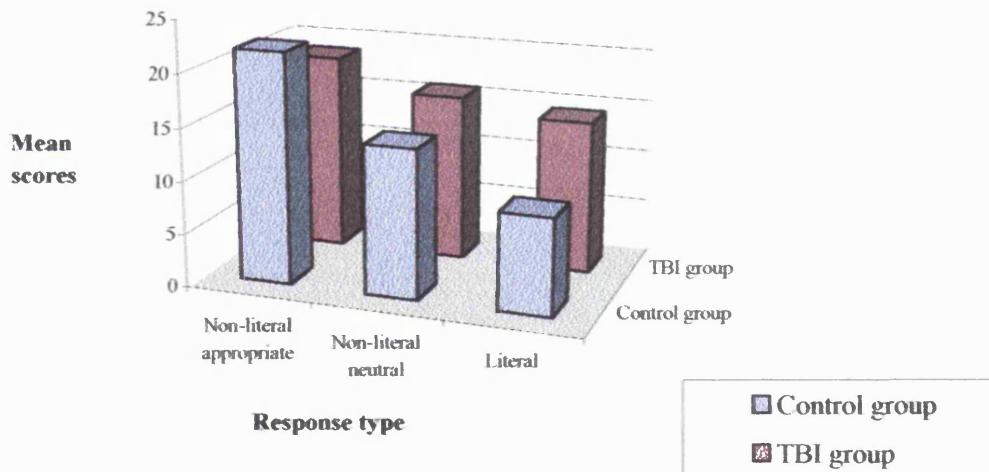
To explore mean group differences on the pragmatic judgment task, analysis of variance (ANOVA) was performed with one between-subjects factor (group: TBI and Control) and one within-subjects factor (response type: 'non-literal appropriate', 'non-literal neutral', 'literal'). There was a significant group by response type interaction effect ($F = 25.59$, $df = 2, 32$, $p = .0001$). There was also a significant main effect of group ($F = 4.68$, $df = 1,32$, $p = .038$) and a significant main effect of response type ($F = 104.60$, $df = 2,32$, $p = .0001$). In order to explore these results further for the two groups, three post-hoc paired samples t-tests were performed, comparing each pair of response types. A significance level of $\alpha/3 = 0.02$ was used.

Table 3.1. shows that both the TBI and Control group rated the 'non-literal appropriate' response as significantly more appropriate than the 'non-literal neutral' and 'literal' responses. However, the TBI group in contrast to the Control group did not rate the 'non-literal neutral' response as significantly more appropriate than the 'literal' response. (See Figure 1.).

Table 3.1. Mean group scores for the response types on the pragmatic judgment task

Type of response	TBI (n=17)		t value	sig	Control (n=17)	
	Mean (sd)				Mean (sd)	t value
non-literal appropriate	18.82 (2.70)		3.13	.007	21.94 (2.33)	11.32 .0001
non-literal neutral	15.89 (3.08)				14.06 (2.54)	
non-literal appropriate	18.82 (2.70)		3.61	.002	21.94 (2.33)	16.39 .0001
literal	14.53 (2.93)				9.12 (2.76)	
non-literal neutral	15.89 (3.08)		1.54	.143	14.06 (2.54)	13.78 .0001
literal	14.53 (2.93)				9.12 (2.76)	

NB The task consisted of 6 items, each containing the 3 response types. Each response type was rated between 1 (not very appropriate) to 4 (very appropriate).

Figure 1. Pragmatic judgment task: Mean scores for the TBI and Control group for each response type

It was considered useful to examine to what extent the 'non-literal appropriate' response type was rated highest (i.e. most appropriate), compared to the other response types. Effectively, this would be equivalent to a correct score for the task. This was calculated in each group by giving a score of 1 if the 'non-literal appropriate' was rated highest, a score of 0 if it was rated lowest, a score of .5 if it was rated joint first and a score of .3 if it was rated equal to the other two response types. This provided a total 'non-literal appropriate correct' score. To examine

mean group differences between this score, independent samples t-tests were performed. (See Table 3.2).

Table 3.2. Mean group scores for the ‘non-literal appropriate correct’ variable on the pragmatic judgment task

Type of response	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)	t value	sig
non-literal appropriate correct	3.26 (1.12)	5.10 (0.65)	5.87	.0001

Table 3.2. shows that the ‘non-literal appropriate’ response was rated the highest response type significantly more often in the Control group compared to the TBI group.

3.2.2. Do the TBI and Control group differ significantly on the social skill judgment task?

To explore mean group differences on the social skill judgment task, ANOVA was performed with one between-subjects factor (group: TBI and Control) and one within-subjects factor (response type: ‘skilled’, ‘neutral’, ‘unskilled’). There was a significant group by response type interaction ($F = 18.94$, $df = 2, 32$, $p = .0001$). There was no significant main effect of group ($F = 1.27$, $df = 1, 32$, $p = .268$). However, there was a significant main effect of response type ($F = 55.65$, $df = 2, 32$, $p = .0001$). In order to explore these results further for each group, three post-hoc paired samples t-tests were performed, comparing each pair of response types. A significance level of $\alpha / 3 = 0.02$ was used.

It can be seen from Table 3.3. that both the TBI and Control group rated the ‘skilled’ response as significantly more skilled than the ‘neutral’ response. However, the TBI group in contrast to the Control group did not rate the ‘skilled’ response as significantly more skilled than the

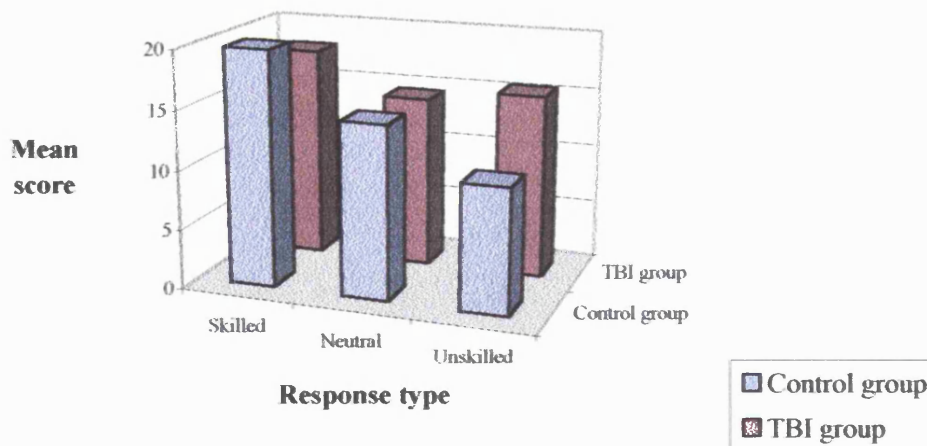
‘unskilled’ response or rate the ‘neutral’ response as significantly more skilled than the ‘unskilled’ response. (See Figure 2.).

Table 3.3. Mean group scores for the response types on the social skill judgment task

Type of response	TBI (n=17)		Control (n=17)	
	Mean (sd)	t value sig	Mean (sd)	t value sig
skilled	18.00 (2.96)	6.16 .0001	19.88 (2.55)	9.36 .0001
neutral	14.52 (2.98)		14.65 (4.36)	
skilled	18.00 (2.96)	2.37 .031	19.88 (2.55)	13.54 .0001
unskilled	15.53 (3.66)		10.53 (2.58)	
neutral	14.52 (2.98)	1.05 .309	14.65 (4.36)	4.23 .001
unskilled	15.53 (3.66)		10.53 (2.58)	

NB The task consisted of 6 items, each containing the 3 response types. Each response type was rated between 1 (not at all socially skilled) to 4 (very socially appropriate).

Figure 2. Social skill judgment task: Mean scores for the TBI and Control group for each response type



Similar to the pragmatic judgment task, it was considered useful to examine to what extent the ‘skilled’ response type was rated highest (i.e. most skilled), compared to the other response types. This would also be equivalent to a correct score for the task. A total ‘skilled correct’ score for each group was calculated adopting the same scoring criteria as in the pragmatic

judgment task. To examine mean group differences between this score, independent samples t-tests were performed. (See Table 3.4.).

Table 3.4. Mean Group scores for the ‘skilled correct’ variable on the social skill judgment task

Type of response	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)	t value	sig
skilled correct	3.04 (1.34)	4.46 (0.64)	3.79	.001

Table 3.4. shows that the ‘skilled’ response was rated the highest response type significantly more often in the Control group compared to the TBI group.

3.2.3. Do the TBI and Control group differ significantly on the conversation judgment task?

The analysis considered the free recall responses and judgments about the conversation separately.

3.2.3.1. Free recall

To examine mean group differences between the free recall scores, an independent samples t-test was performed. (See Table 3.5.). This showed that the TBI group recalled significantly less detail compared to the Control group on the conversation task.

Table 3.5. Mean group scores for the free recall on the conversation judgment task

Conversation Judgment task	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)	t value	sig
Free recall score	9.13 (4.56)	19.06 (5.23)	5.90	.0001

NB Maximum free recall score was 68

3.2.3.2. Judgments

All participants were able to give satisfactory answers to the questions which intended to check that they identified basic details of the conversation. For example, all participants knew that the conversation took place on a train and that one man had a newspaper with him. Therefore, it was accepted that all participants had a sufficient grasp of the conversation to make judgments about the two characters.

To analyse the responses, the data were organised and labelled in the following way. The task required participants (P) firstly to answer questions one to four about the manner of the man reading the newspaper (A) and then questions five to eight about the manner of the man not reading the newspaper (B). Therefore, P rating A involved: question one P rating A (on four positive and four negative adjectives), question two P rating A/B i.e. what P thought A thought of B (on four positive and four negative adjectives), question three P rating As (on five para-language items about speech sound) and question four P rating Af (on three para-language items about whether the speech contained certain features). This was reversed in questions five to eight where P rated B (i.e. P-B, P-B/A, P-Bs, P-Bf). To perform individual t-tests on these eight questions (i.e. 48 analyses) would involve a rather high possibility of Type 1 error.

Therefore, it was decided to consider six variables by collapsing the questions and items in the following way: P-A and P-B (adding up all the ratings on adjectives in question one and

question five respectively), P-A/B and P-B/A (adding up all the ratings on adjectives in question two and question six respectively), P-Asf and P-Bsf (adding up all the ratings to items in questions three and four and questions seven and eight respectively). Hence this resulted in the six variables P-A, P-B, P-A/B, P-B/A, P-Asf and P-Bsf. It was acknowledged that by combining items, it would not be possible to ascertain which specific items contributed to any observed differences.

The variables P-A, P-A/B, P-B and P-B/A were initially analysed. This would examine group differences in judgments about the manner of the characters. ANOVA was performed with one between-subjects factor (group: TBI and Control) and two within-subjects factors ('character': A or B and 'other': A/B and B/A), with total ratings on adjectives in questions one, two, five and six, entered as dependent variables.

There was no significant interaction effect between group, 'character' and 'other' ($F = .10$, $df = 1,32$, $p = .752$). There was also no significant interaction effect between group and 'character' ($F = 1.07$, $df = 1,32$, $p = .310$) and no significant interaction between group and 'other' ($F = 1.05$, $df = 1,32$, $p = .314$). As expected, there was a significant interaction effect between 'character' and 'other' ($F = 39.15$, $df = 1,32$, $p = .0001$). There was no significant main effect of group ($F = .01$, $df = 1,32$, $p = .929$), indicating that the TBI and Control groups did not significantly differ in their ratings across 'character' and 'other'. However, there was a main effect of 'character' ($F = 8.06$, $df = 1,32$, $p = .008$), showing that across groups, the character reading the newspaper was rated significantly differently to the character not reading the newspaper. Inspection of the mean scores showed that judgments were in the expected direction. The manner of the man reading the newspaper was judged more positively than the manner of the man not reading the newspaper. (See Table 3.6.).

There was no significant main effect of 'other' ($F = 1.31$, $df = 1,32$, $p = .261$), indicating that across the groups there was no difference between participants ratings about what they thought the man reading the newspaper thought of the other man. Furthermore, there was no difference between participants' ratings about what they thought the man not reading the newspaper thought of the other man.

To examine group differences in judgments concerning para-language, the variables P-Asf and P-Bsf were then analysed. ANOVA was performed with one between-subjects factor (Group: TBI and Control) and one within-subjects factor ('character': A or B), with total ratings to items in questions three, four, seven and eight entered as dependent variables. There was a significant interaction effect between group and 'character' ($F = 21.87$, $df = 1,32$, $p = .0001$). There was no significant main effect of group ($F = .31$, $df = 1,32$, $p = .579$). Hence, the TBI and Control did not differ in their ratings of para-language across both characters. There was also no main effect of 'character' ($F = 1.81$, $df = 1,32$, $p = .118$), showing that across groups the para-language ratings for the man reading the newspaper were not significantly different to the man not reading the newspaper. In order to explore the results further, post-hoc independent samples t-test were performed (See Table 3.7.). This showed that the TBI group rated para-language in the man reading the newspaper as occurring significantly less often, compared to the Control group. In contrast, there was no significant difference between groups in the rating of para-language in the man not reading the newspaper.

Table 3.6. Mean group scores for the manner ratings on the conversation judgment task

Manner rating:	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)
Participant rating man reading the newspaper (P-A)	22.95 (3.85)	23.47 (3.57)
Participant rating man not reading the newspaper (P-B)	17.24 (5.37)	18.00 (2.85)
Participant rating what the man reading the newspaper thought of the other man (P-A/B)	18.47 (5.12)	17.06 (2.49)
Participant rating what the man not reading the newspaper thought of the other man (P-B/A)	21.53 (6.18)	21.29 (3.41)

NB The maximum score for each variable is 32.

Table 3.7. Mean group scores for the para-language ratings on the conversation judgment task

Para-language rating	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)	t value	sig
Participant rating man reading newspaper (P-Asf)	13.88 (3.33)	16.53 (2.50)	2.62	.013
Participant rating man not reading newspaper (P-Bsf)	15.41 (3.34)	13.76 (2.39)	1.66	.108

NB The maximum score for each variable is 32.

3.2.4. Is there a relationship between the performance on the three social interpretation tasks?

Correlations were performed between the three social interpretation measures in the TBI and Control group. (See Tables 3.8 and 3.9.). To limit the number of correlations, the ‘non-literal appropriate correct’ score and the ‘skilled correct’ score were used for the pragmatic judgment task and social skill judgment task respectively. In addition to this, a ‘difference’ score was calculated for each of these tasks. In the pragmatic judgment task the ‘literal’ responses were subtracted from the ‘non-literal appropriate’ responses. The ‘unskilled’ responses were subtracted from the ‘skilled’ responses in the social skill judgment task. These ‘difference’ scores provided a measure of judgment sensitivity between the respective response types. A higher score reflected a greater degree of differentiation in participant rating.

Tables 3.8. and 3.9. show that there were few significant correlations between the social interpretation tasks in the TBI or Control group. Significant correlations within the pragmatic judgment task and social skill judgment task were in the expected direction. In relation to the conversation judgment task no specific predictions about the direction of the correlations were made.

Table 3.8. Correlations between the three social interpretation measures in the TBI group

	Pragmatic judgment task		Social skill judgment task		Conversation judgment task					
	correct(nla)	diff	correct (sk)	diff	P-A	P-B	P-A/B	P-B/A	P-Asf	P-Bsf
<u>Pragmatic Judgment task</u>										
correct(nla)										
diff		.662**								
<u>Social skill Judgment task</u>										
correct(sk)			.332	.442						
diff			.129	.402						
<u>Conversation Judgment task</u>										
P-A					-.388	-.403	-.511	-.196		
P-B					-.072	-.537*	-.450	-.534*	.470*	
P-A/B					-.011	.490*	-.149	-.487*	-.123	.443
P-B/A					-.421	-.560*	-.181	-.534*	.240	.170
P-Asf					-.257	-.166	-.084	.061	-.260	.230
P-Bsf					-.120	-.199	.210	-.017	-.312	-.094

** Correlation significant at the 0.01 level (2-tailed) * Correlation significant at the 0.05 level (2-tailed)
 NB Pragmatic judgment task: diff= nla-nln, correct(nla)= rating non-literal appropriate as highest response type; Social skill judgment task: diff= sk-un, correct(sk)= rating skilled as highest response type; Conversation judgment task: rec= recall, P-A= participant rating manner of man with newspaper, P-B= participant rating manner of man without newspaper, P-A/B= participant rating what A thought of B, P B/A= participant rating what B thought of A, P-Asf= participant rating para-languauge A, P-Bsf= participant rating para-language B.

Table 3.9. Correlations between the three social interpretation measures in the Control group

	Pragmatic judgment task correct(nla) diff		Social skill judgment task correct(sk) diff		Conversation judgment task					
					P-A	P-B	P-A/B	P-B/A	P-Asf	P-Bsf
<u>Pragmatic Judgment task</u>										
correct(nla)										
diff		.713**								
<u>Social skill Judgment task</u>										
correct(sk)	.008	-.111								
diff	-.360	-.083	.320							
<u>Conversation Judgment task</u>										
P-A	.098	.456	-.129	.234						
P-B	-.322	-.345	-.446	.234	.027					
P-A/B	.043	-.163	-.316	.176	.008	.528*				
P-B/A	.050	.228	-.186	.405	.572*	-.137	.120			
P-Asf	.088	-.138	.253	-.092	-.764**	-.042	-.083	-.427		
P-Bsf	.020	-.074	-.572*	-.427	-.351	.498	.392	-.346	.270	

** Correlation significant at the 0.01 level (2-tailed) * Correlation significant at the 0.05 level (2-tailed)
 NB Pragmatic judgment task: diff= nla-nln, correct(nla)= rating non-literal appropriate as highest response type; Social skill judgment task: diff= sk-un, correct(sk)= rating skilled as highest response type; Conversation judgment task: rec= recall, P-A= participant rating manner of man with newspaper, P-B= participant rating manner of man without newspaper, P-A/B= participant rating what A thought of B, P B/A= participant rating what B thought of A, P-Asf= participant rating para-language A, P-Bsf= participant rating para-language B.

3.3. TBI and Control group performance on the neuropsychological measures

3.3.1. Do the TBI and Control groups differ significantly on measures of attention and executive function?

To examine mean group differences on the measures of attention and executive function, independent sample t-tests were performed on all measures (except Elevator Counting, Six Elements rule break and Verbal Fluency rule break, where Mann-Whitney tests were used). (See Table 3.10.) The results showed that the TBI group obtained scores that were significantly different from the Control group on all measures of attention and executive function, except the Letter Fluency test and the Elevator counting (sustained attention) sub-test. Inspection of the means show that, overall, the TBI group obtained a score that reflected a poorer performance than the Control group.

ANOVA was performed for the Hayling and Trail-Making tests as these both involved two related tasks. For the Hayling test, there was one between-subjects factor (group: TBI or Control) and one within-subjects factor (Part A or B). There was a significant group by task interaction effect, a significant main effect of group and a significant main effect of task. Post-hoc independent samples t-tests showed that the TBI group took significantly longer to complete Part A and Part B, compared to the Control group. The group difference was greater on Part B. Also, independent samples t-test analysis of the Hayling test error score (Part B) showed that the TBI group made significantly more errors compared to the Control group.

For the Trail-Making test, there was one between-subjects factor (group: TBI or Control) and one within-subjects factor (Part: A or B). There was no significant group by task interaction. A

significant main effect of group was found, showing that the TBI group was significantly slower than the Control group across tasks. Also, a significant main effect of task indicated that across groups, participants were slower to complete Part B than Part A.

Table 3.10. Mean group scores for the measures of attention and executive function

Type of measure	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)	t value	sig
Attention:				
<u>Sustained attention</u>				
Elevator counting	6.65 (0.70)	6.94 (0.24)	1.48	.375 (z- score)
<u>Selective attention</u>				
Elevator counting with distraction	9.12 (0.10)	6.71 (3.44)	2.78	.012
Telephone search	5.18 (1.57)	2.93 (0.32)	5.81	.0001
<u>Dual task</u>				
Telephone search while counting	4.44 (5.41)	.30 (0.91)	3.11	.006
Executive function:				
<u>Hayling Test</u> (grp x task: F = 10.43, p= .003, grp:F= 51.65, p=.0001, task: F= 48.10, p=.0001)				
Time A	1.47 (0.20)	1.26 (5.41)	3.96	.0001
Time B	1.89 (0.29)	1.42 (6.29)	6.49	.0001
Error score B	5.76 (5.03)	1.59 (1.42)	3.29	.004
<u>Six Elements Test</u>				
Profile score	2.53 (1.18)	4.00 (0.00)	5.14	.0001
Rule break	0.18 (1.18)	0.00 (0.00)	1.44	.563 (z- score)
<u>Trail-making</u> (grp x task: F= .672, p=.148, grp: F= 20.09, p=.0001, task: F= 180.69, p=.0001)				
Time A	1.75 (.27)	1.47 (.14)		
Time B	2.09 (.26)	1.77 (.10)		
<u>Letter Fluency</u>				
Total score	28.65 (11.60)	33.18 (6.24)	1.47	.154
Rule break	0.76 (1.09)	0.18 (0.53)	1.96	.131 (z- score)
<u>Ravens</u>				
Total score	6.59 (2.67)	9.00 (1.58)	3.20	.003

3.3.1.1 Do the TBI and Control group differ significantly on the dysexecutive questionnaire (DEX)?

To examine mean group differences on the DEX, independent samples t-tests were performed. (See Table 3.11.). As expected the self and relative DEX ratings were significantly higher in the TBI group, compared to the Control group.

Table 3.11. Mean group scores for the DEX

Type of measure	TBI Mean (sd)	Control (n=17) Mean (sd)	t value	sig
DEX				
Self rating	31.60 (15.44) n=15	8.24 (4.49)	5.65	.0001
Relative rating	32.38 (14.14) n=13	6.29 (2.69)	6.56	.0001

NB The self and relative rating maximum score was 80.

NB Two participants and four relatives in the TBI group failed to return questionnaires.

3.3.2. Do the TBI and Control group differ significantly on the memory measure?

To examine mean group difference on the Story recall test (AMIPB) ANOVA was performed. (See Table 3.12.). There was one between-subjects factor (group: TBI or Control) and one within-subjects factor (Recall: Immediate and Delayed). There was no significant group by task interaction effect. There was a significant main effect of group and a significant main effect of task. Inspection of the means showed that the TBI performed more poorly across both tasks compared to the Control group. Also, across groups, performance was better on the immediate compared to the delayed recall.

Table 3.12. Mean group scores for the measure of memory function

Type of measure	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)
AMIPB (grp x task: F= 2.01, p= .166, grp: F= 5.54, p= .025, task: F= 16.15, p= .0001)		
Immediate recall	30.76 (9.36)	37.12 (7.16)
Delayed recall	26.59 (13.00)	35.12 (7.24)

3.4. TBI and Control group performance on the theory-of-mind-type social comprehension tasks

3.4.1. Do the TBI and Control group differ significantly on the Story Comprehension task?

To examine mean group difference on the Story Comprehension task, an independent samples t-test was performed. (See Table 3.13.). The results showed that the TBI group performed significantly more poorly on this task, compared to the Control group.

Table 3.13. Mean group scores for the Story Comprehension task

Type of measure	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)	t value	sig
Story Comprehension task	9.24 (2.11)	11.59 (.62)	4.41	.0001

NB Maximum score is 12

3.4.2. Do the TBI and Control group differ significantly on the Strange stories task?

The mean scores for the TBI and Control on the Strange stories task are shown in Table 3.14. An independent samples t-test showed that the TBI and Control group did not significantly differ in the use of mental state language. To examine mean group differences between the mentalising and physical stories ANOVA was performed, with one between-subjects factor (group: TBI and Control group) and one-within subjects factor (story type: mentalising and physical). There was no significant group by story type interaction. A significant main effect of group was found, indicating that there was a significant difference between the TBI and Control group in their performance across story type. Inspection of the mean scores show that the Control group performed better than the TBI group. However, there was no significant main effect of story type, showing that across groups there was no significant difference between performance on the mentalising and physical stories.

Table 3.14. Mean group scores for the Strange stories task

Type of measure	TBI (n=17) Mean (sd)	Control (n=17) Mean (sd)	t value	sig
Strange stories task:(grp x task: F= 1.62, p=.211, grp: F= 7.61, p=.009, task: F= 2.31, p=.138)				
<u>Story type</u>				
mentalising stories	196.82 (52.31)	219.35 (33.05)		
physical stories	198.76 (52.02)	241.53 (19.05)		
<u>Mental state language</u>	7.12 (1.11)	7.65 (.61)	1.72	.097

3.5. Relationship between performance on the social interpretation tasks and the measures of attention and executive function and theory-of-mind-type social comprehension tasks

Correlations are presented in Tables 3.15. and 3.16. The AMIPB was included in these analyses. Correlations could not be performed on the Six Elements test (profile score) in the Control group, as all responses were at a ceiling level i.e. error free performance.

3.5.1. Is there a relationship between performance on the pragmatic judgment task and the measures of attention and executive function and theory-of-mind-type social comprehension tasks in the TBI and Control group?

Only one significant correlation was found. This was in the expected direction i.e. high scores on both tasks was related to better performance.

3.5.2. Is there a relationship between performance on the social skill judgment task and the measures of attention and executive function measures and theory-of-mind-type social comprehension tasks in the TBI and Control group?

All significant correlations found were in the expected direction, with the exception of the negative correlation between the 'non-literal appropriate correct' score and the Elevator counting sub-test in the TBI group i.e. a high score was related to worse performance on the attention sub-test.

3.5.3. Is there a relationship between performance on the conversation judgment task and the measures of attention and executive function measures and theory-of-mind-type social comprehension tasks in the TBI and Control group?

In relation to the conversation judgment task no specific predictions were made about the direction of the correlations. Relatively few significant correlations were found in both groups.

Table 3.15. Correlations between the three social interpretation tasks and the attention and executive function measures and theory-of-mind-type social comprehension tasks in the TBI group

	TBI group (n=17)									
	Pragmatic judgment task correct(nla) diff		Social skill judgment task correct(sk) diff		Conversation judgment task					
					P-A	P-B	P-A/B	P-B/A	P-Asf	P-Bsf
<u>Sustained attention</u>										
Elevator counting	-.422	-.223	-.579*	-.389	.194	-.394	-.081	.097	-.106	-.113
<u>Selective attention</u>										
Elevator counting with distraction	-.244	-.302	-.068	.118	.206	-.394	-.490*	-.196	-.300	.038
Telephone search	-.080	-.257	.063	-.009	-.205	.117	.587*	.405	-.017	.088
<u>Dual task</u>										
Telephone search while counting	-.047	-.301	.104	.016	.150	.537	.307	.330	.038	-.326
<u>Executive function</u>										
<u>Hayling Test</u>										
Error score B	.086	.082	.043	-.180	.139	.262	.124	.070	-.212	.024
<u>Six Elements Test</u>										
Profile score	.223	.308	.624**	.650*	-.066	-.265	-.395	-.140	.033	-.078
<u>Trail-making</u>										
Time A	-.092	-.220	.364	.299	.187	.105	.288	.302	.064	.186
Time B	-.284	-.465	.264	.117	.113	.225	.351	.463	.036	.142
<u>Letter Fluency</u>										
Total score	-.112	.256	-.041	.337	.331	-.302	-.653*	-.291	-.341	-.135
<u>Ravens</u>										
Total score	-.004	.351	.028	.414	.071	-.348	-.233	.080	-.117	-.223
<u>AMIPB</u>										
Immediate recall	.075	.165	.435	.634*	-.101	-.372	-.313	-.143	.326	.294
Delayed recall	.063	.145	.416	.605*	-.232	-.506*	-.242	-.116	.358	.398
<u>Theory of mind</u>										
<u>Story comprehension</u>										
Strange stories	.376	.663*	.445	.365	-.410	.459	-.424	-.461	.074	.226
<u>Mentalising</u>										
Physical	.111	.238	.419	.497*	-.181	-.476	-.061	-.001	.190	.418
<u>Physical</u>										
	.476	.339	.713**	.474	-.449	.179	.142	-.274	.281	.359

* Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed).

NB Pragmatic judgment task: diff= nla-nln, correct(nla)= rating non-literal appropriate as highest response type; Social skill judgment task: diff= sk-un, correct(sk)= rating skilled as highest response type; Conversation judgment task: rec= recall, P-A= participant rating manner of man with newspaper, P-B= participant rating manner of man without newspaper, P-A/B= participant rating what A thought of B, P B/A= participant rating what B thought of A, P-Asf= participant rating para-language A, P-Bsf= participant rating para-language B.

Table 3.16. Correlations between the three social interpretation tasks, measures of attention and executive function and theory-of-mind-type social comprehension tasks in the Control group

	Control group (n=17)										
	Pragmatic judgment task correct(nla) diff		Social skill judgment task correct(sk) diff		Conversation judgment task	P- A	P- B	P- A/B	P- B/A	P- Asf	P- Bsf
<u>Sustained attention</u>											
Elevator counting	.182	.128	.104	.310	.410	-.282	.286	.412	-.312	-.411	
<u>Selective attention</u>											
Elevator counting with distraction	.259	.131	.563*	.003	.328	-.477	-.337	.163	-.195	-.425	
Telephone search	-.284	-.287	-.040	-.299	.377	.516*	.051	-.491*	.286	.353	
<u>Dual task</u>											
Telephone search while counting	-.022	.049	-.412	-.177	.052	.263	.102	.058	-.203	.290	
<u>Executive function</u>											
<u>Hayling Test</u>											
Error score B	-.236	-.262	.047	.050	-.408	.046	-.279	-.321	.403	.101	
<u>Six Elements Test</u>											
Profile score	-	-	-	-	-	-	-	-	-	-	
<u>Trail-making</u>											
Time A	.121	-.230	.005	-.145	-.867**	-.113	.083	-.265	.661*	.289	
Time B	-.105	-.188	-.158	.031	-.186	.122	-.162	.438	.148	.027	
<u>Letter Fluency</u>											
Total score	-.163	-.211	.091	-.308	-.015	.042	-.209	-.479	-.143	.031	
<u>Ravens</u>											
Total score	-.152	.104	-.096	-.324	.612*	.083	-.244	.095	-.648*	-.076	
<u>AMIPB</u>											
Immediate recall	.034	.158	-.255	.214	.150	-.398	-.148	.736**	-.101	-.076	
Delayed recall	-.087	-.006	-.137	.367	.213	-.082	.011	.731**	-.081	-.048	
<u>Theory of mind</u>											
<u>Story comprehension</u>											
Strange stories	.256	.312	.398	-.044	.120	-.525*	-.496*	-.226	-.024	-.375	
<u>Mentalising</u>											
Mentalising	-.060	.183	.403	-.226	-.015	-.287	-.179	-.062	-.211	-.404	
<u>Physical</u>											
Physical	.237	.072	.144	-.235	-.308	-.483*	-.409	-.013	.342	-.149	

* Correlation is significant at the 0.05 level (2-tailed). **Correlation is significant at the 0.01 level (2-tailed). _ Correlation coefficients could not be computed

NB Pragmatic judgment task: diff= nla-nln, correct(nla)= rating non-literal appropriate as highest response type; Social skill judgment task: diff= sk-un, correct(sk)= rating skilled as highest response type; Conversation judgment task: rec= recall, P-A= participant rating manner of man with newspaper, P-B= participant rating manner of man without newspaper, P-A/B= participant rating what A thought of B, P B/A= participant rating what B thought of A, P-Asf= participant rating para-language A, P-Bsf= participant rating para-language B.

3.6. Relationship between the performance on the theory-of-mind type social comprehension tasks and performance on the measures of attention and executive function

Additional analyses were performed to examine the relationship between performance on the theory-of-mind-type social comprehension tasks and performance on the measures of attention and executive function in both groups. The AMIPB was included in these analyses. (See Table 3.17.). Due to ceiling effects, correlations with the Six elements test (profile score) could not be performed.

Table 3.17. shows that that there were very few significant correlations found in both groups. All significant correlations were in expected direction i.e. better performance on one was related to better performance on the other. The only exception was the significant negative correlation between the physical stories and the Elevator counting sub-test i.e. a better performance was related to a worse performance on the attention sub-test.

Table 3.17. Correlations between the theory-of-mind-type social comprehension tasks and measures of attention and executive function

Type of measure	TBI group (n=17)			Control group (n=17)		
	Story comprehension	Mentalising stories	Physical stories	Story comprehension	Mentalising stories	Physical stories
<u>Sustained attention</u>						
Elevator counting	-.258	-.187	-.546*	-.182	.301	.264
<u>Selective attention</u>						
Elevator counting with distraction	.124	.209	-.197	.551*	.461	.350
Telephone search	-.240	.160	.410	.204	.120	-.053
<u>Dual task</u>						
Telephone search while counting	-.556*	-.557*	.088	-.309	-.406	-.368
<u>Executive function</u>						
<u>Hayling Test</u>						
Error score B	.058	-.103	-.016	.108	-.269	.095
<u>Six Elements Test</u>						
Profile score	.354	.299	.249	_	_	_
<u>Trail-making</u>						
Time A	-.176	.295	.377	-.335	-.125	.457
Time B	-.338	-.038	-.009	.391	-.215	.180
<u>Letter Fluency</u>						
Total score	.165	.259	-.022	.679*	.142	-.169
Rule break	-.324	.304	-.011	.266	.293	-.023
<u>Ravens</u>						
Total score	.112	.298	.027	.086	.414	-.085
<u>AMIPB</u>						
Immediate recall	.324	.633*	.371	-.233	-.093	.397
Delayed recall	.321	.624*	.362	-.481	-.285	.065

* Correlation is significant at the 0.05 level (2-tailed).

_ Correlation coefficients could not be computed

3.7. Overview of the current findings

I shall now provide an overview of the results corresponding to the hypotheses of the study.

- **TBI adults will perform significantly more poorly than healthy controls on three social interpretation measures.**

Pragmatic judgement task

The TBI group did perform significantly more poorly on this task compared to the Control group. The TBI group, in contrast to the Control group, did not rate the 'literal' response as significantly less appropriate than the 'non-literal neutral' response. The TBI group was the same as the Control group, however, in rating the 'non-literal appropriate' response as significantly more appropriate than the 'non-literal neutral' response and 'literal' response.

Social skill judgment task

The TBI group performed significantly more poorly on this task compared to the Control group. The TBI group, in contrast to the Control group, did not rate the 'unskilled' response as significantly less skilled than the 'skilled' response or the 'neutral' response. However, the TBI group was the same as the Control group in rating the 'skilled' response as significantly more skilled than the 'neutral' response.

Conversation judgment task

The results did not fully support the prediction that TBI participants would perform significantly more poorly compared to the Control group on this task. The TBI group did recall significantly less conversational information, compared to the Control group. However, there were no significant differences between the TBI and Control group in rating the manner of both characters and in rating the characters views of each other. In particular, both groups rated the same character as significantly more positive. Also, the TBI and Control group did not significantly differ in their para-linguistic ratings across both characters, although the TBI group did rate the para-language in one character as occurring significantly less often compared to the Control group.

- **TBI adults will perform significantly more poorly than healthy controls on non-social neuropsychological measures of attention and executive functioning**

As predicted, the TBI group performed significantly more poorly compared to the Control group on most of the non-social neuropsychological measures of attention and executive function. The TBI group performed significantly worse on each of the measures of attention (Elevator counting with distraction, Telephone search and Telephone search while counting) and executive function (Hayling test, Six elements test, Trail-making test and Advanced progressive matrices) Furthermore, TBI participants (and relatives) reported more problems than the Control group participants (and relatives) on the DEX. The only measures in which significant group differences were not found were the Elevator counting sub-test (TEA) and the Letter fluency test. The TBI group also performed significantly worse than the Control group on the measure of memory functioning (AMIPB).

- **A significant relationship might exist such that poorer performance on the three social interpretation tasks will be associated with poorer performance on the non-social neuropsychological measures of attention and executive functioning in the TBI adults.**

The results provided little evidence to suggest that performance on the three social interpretation tasks was related to performance on the non-social neuropsychological measures of attention and executive functioning in either the TBI or Control group. Across the three social interpretation tasks, only a few significant correlations were found.

- **TBI adults will perform significantly more poorly than healthy controls on measures of higher-level theory-of-mind-type social comprehension.**

The TBI group did perform significantly more poorly than the Control group on the Story comprehension task. Also, the TBI group performed worse than the Control group across story types on the Strange stories task. However, there was no significant difference between performance on the mentalising and physical stories across both groups.

- **A significant relationship might exist such that poorer performance on the three social interpretation tasks will be associated with poorer performance on the measures of theory-of-mind-type social comprehension in the TBI adults.**

The results provided little evidence to suggest that performance on the social interpretation tasks was related to performance on the theory-of-mind-type social comprehension tasks in the TBI or Control group. There were few significant correlations found, although in the TBI group there was some evidence suggesting that better performance on the Story comprehension and Strange stories task was associated with better performance on the pragmatic judgment and social skill judgment tasks respectively.

4. DISCUSSION

The discussion will firstly describe the pattern of results and relate TBI group performance to previous studies. Factors contributing to TBI impairment on the social interpretation tasks will then be considered. I will then identify limitations of the study and directions for future research. The implications of the current findings for rehabilitation and social functioning following TBI will then be discussed. Concluding comments will follow.

4.1. Performance on the social interpretation measures

4.1.1. The pragmatic judgment task

The pragmatic judgment task was constructed in order to examine the extent to which participants differentiated between alternative responses, which varied in their degree of context appropriateness. It was found that the TBI group was impaired in their pragmatic interpretation compared to the Control group. The TBI participants did not rate the 'literal' (i.e. direct) responses as significantly less appropriate than the 'non-literal neutral' (i.e. indirect) responses. This apparent lack of differentiation suggests that the TBI participants had difficulty understanding the role of the direct and indirect speech acts.

It was considered useful to see whether TBI participants would have performed poorly on this task if all the response types were presented together and the participant needed to select the most appropriate. This method of task presentation is more similar to the way pragmatic understanding has been elicited in previous studies. It was found that the TBI group rated the 'non-literal

appropriate' response type as the highest (most appropriate) response type significantly less often than the Control group. Therefore, it seems reasonable to assume that if all the responses were presented at once and the criteria for passing each item was to select the most appropriate response, the TBI group would have still performed significantly worse than the Control group.

These results are consistent with the few previous studies showing impairment in the understanding of direct and indirect speech acts in TBI patients (McDonald and van Sommers, 1993; McDonald, 1992b; McDonald and Pearce, 1996; Bara et al, 1997). However, the current task methodology provided interesting additional information about the extent of difference between the ratings of the alternative responses. The TBI group did rate the 'non-literal appropriate' response as significantly more appropriate than the 'non-literal neutral' and 'literal' responses. Therefore, it appears that the TBI participants were, to some extent, capable of inferring meaning since they recognised that the initial remark warranted an inferred response. I shall illustrate the performance and pattern of impairment by referring to a specific item.

Alison visited her friend (Rachel), as she did every week. On the wall, Alison was surprised to see a new picture, which was obviously an original oil painting. It showed a large elephant. Alison says to Rachel *'Where did it come from?'*

-Rachel says *'It was left to me by my aunt, the one who died recently.'* (Non-literal appropriate)

-Rachel says *'It was painted by Alfred Jones, who's famous for his animal paintings.'* (Non-literal neutral)

-Rachel says *'It is an African elephant.'* (Literal)

Previous studies have often cited the Gricean model of pragmatic functioning (see Grice, 1975) to describe performance. This model suggests that the literal meaning in conversation needs to be

processed initially but then rejected due to its contextual inappropriateness. It is then necessary to identify a more appropriate indirect meaning. The assumption that people are following the 'maxims of conversation' (see Grice, 1975) provides a framework upon which to infer meaning. Applying this model to the above item, it would appear that the correct interpretation of each response is dependent upon the participant appreciating how inadequate it would be to interpret *Alison's* remark literally i.e. inferring that the elephant came from Africa. It is then necessary to recognise and reject the literal response made by *Rachel* and to identify the response with the most appropriate indirect meaning in the context. Inspecting individual scores for this item showed that 94% of the TBI group and 100% of the Control group provided a rating of three or more (with four being very appropriate) for the 'non-literal appropriate' response. Therefore, it can be speculated that both groups judged that information about the aunt was relevant by inferring that Alison was curious to know where Rachel's painting had come from. 76% of the TBI group and 47% of the Control group provided a rating of three or more for the 'non-literal neutral' response, showing that both groups viewed this as less appropriate than the 'non-literal appropriate' response. It is possible that the inferred meaning in this response might have provided more subtle clues regarding appropriateness. Although *Rachel* has appropriately responded in an indirect way, arguably her response does not adequately satisfy *Alison's* curiosity to know where the painting had come from. For example, it appears less relevant in the context to provide information about the painter as opposed to the aunt.

A marked degree of TBI impairment can be found on the 'literal' response in this item. 53% of the TBI group, compared to only 12% of the Control group provided a rating of three or more for the 'literal' response. In fact, two participants in the TBI group rated this response as the highest. Therefore, saying where the elephant actually came from was considered to be an appropriate

response to Alison's question in about half of the participants. This resulted in a lack of differentiation between the 'literal' response and the 'non-literal neutral' response.

The TBI performance on the overall task suggests that they were able to appreciate the initial remark and the 'non-literal appropriate' response well enough to differentiate between this response and the 'literal' and 'neutral' responses. However, their appreciation of the initial remark and the 'literal' response appeared insufficient. In particular, they were unable to adequately differentiate between the 'literal' and 'neutral' response types. Therefore, this pattern of impairment appears to reflect poor inferential sensitivity in the TBI group. This issue will be considered later.

4.1.2. The social skill judgment task

This task was also constructed in order to examine the extent to which participants differentiated between alternative verbal responses. However, the verbal responses varied in their degree of social skill. The results showed that the TBI group was impaired in their ability to interpret the skill of responses compared to the Control group. The pattern of impairment in the TBI group appears, to some extent, to reflect a similar lack of differentiation to that seen in the pragmatic judgment task. The results indicated that they did not rate the 'unskilled' response as significantly less skilled than the 'skilled' response or the 'neutral' response.

The results suggest that the TBI group would have demonstrated impairment on this task if all the response types were presented together and the participant needed to select the most skilled. The TBI group rated the 'skilled' response as the highest response type significantly less often than the Control group. As with the pragmatic judgment task however, a particular benefit of the current

task methodology was in providing additional information concerning the extent of differences between the ratings of alternative responses. The TBI group did rate the 'skilled' response as significantly more skilled than the 'neutral' response. Therefore, the TBI participants did demonstrate to some capacity to differentiate between these two response types.

It was argued that this task, as in the pragmatic judgment task, would require the ability to infer meaning. However, it was considered that performance on this task would also require particular awareness of the intention and interpersonal impact of the responses. Although there have been no previous studies exploring this aspect of social interpretation in TBI patients, the results appear to overlap with a study examining patients with right hemisphere damage. Rehak et al (1992) found that patients demonstrated poor appreciation of remarks which violated the Gricean maxim of 'quantity' i.e. don't say more than you need to. It was speculated that patients might have had difficulty judging the speakers' intention, although this could not be determined by the results. However, it should be noted that due to the heterogeneity of brain damage in the TBI group it is difficult to compare the current findings with studies using patients with right hemisphere lesions (despite the fact that both TBI and right hemisphere damage might involve the frontal lobe).

Nevertheless, this finding in addition to the apparent overlap with performance on the pragmatic judgment task suggests that it might also be fruitful to consider the Gricean model of pragmatic functioning in describing performance here. I shall do this by referring to a specific item:

John and Vicky enter a busy lift. They do not know each other. John's hand accidentally brushes Vicky's skirt.

John says to Vicky *'Oh, I'm sorry.'*

-Vicky says *'OK, don't worry'* and turns away. (Skilled)

-Vicky says nothing. (Neutral)

-Vicky says *'That's never happened to me before.'* (Unskilled)

In this item it would appear that interpretation is affected by judging the intention of John's initial remark. In fact, it seems less important to reject the literal meaning here and to actually appreciate that John does mean what he says i.e. he is sorry. This is likely to affect the extent to which Vicky's responses are inferred as skilled. Similar to the pragmatic judgment task, this inferential process might also be guided by the Gricean 'maxims of conversation'. Inspecting individual scores for this item showed that 82% of the TBI group and 88% of the Control group provided a rating of three or more for the 'skilled' response. Therefore, it could be argued that both groups were able to infer that Vicky's response adequately corresponded to John's remark (i.e. the maxim of 'relevance'), that it was not ambiguous (i.e. the maxim of 'manner') and that she did not say more than she needed to (i.e. the maxim of 'quantity'). 47% of the TBI group and 35% of the Control provided a rating of three or more for the 'neutral' response, showing that both groups viewed this response as less appropriate than the 'skilled' response. It could be argued that this response provided slightly more subtle clues regarding skillfulness. Vicky's response does not appear to fully acknowledge John's intention to apologise but at the same time her silence does not necessarily discount his remark.

A marked degree of TBI impairment was found on the 'unskilled' response on this item. 30% of the TBI group, in contrast to none of the Control group, provided a rating of three or more for the 'unskilled' response. In fact, one participant rated this response as the highest. This resulted in a lack of differentiation between the 'unskilled' response and the 'neutral' and 'skilled' response types. It can be argued that Vicky's 'unskilled' response might have reflected her immediate thoughts about the situation. For example, it is reasonable to assume that a man touching her skirt

in a lift might not have actually happened before and was therefore unusual and surprising. However, to actually verbalise these thoughts appeared to result in a response that was rather irrelevant with regard to John's apology (i.e. breaking the maxim of 'relevance') and is somewhat obscure (i.e. does not follow the maxim of 'manner').

The pattern of TBI performance on the entire task suggests that they were able to appreciate the initial remark (particularly its intention) and the 'skilled' response well enough to differentiate between this response and the 'neutral' response. However, their appreciation of the initial remark and the 'unskilled' response appeared insufficient. They did not adequately differentiate between the 'unskilled' response and the 'skilled' and 'neutral' response types. Therefore, similar to the pragmatic judgment task this appears to reflect poor inferential sensitivity in the TBI group. This will also be considered later.

4.1.3. The conversation judgment task

The conversation judgment task examined both the recall of conversational information in addition to interpretations about the manner and para-linguistic features of the characters involved. The results showed that the TBI group did recall significantly less information compared to the Control group. Interestingly, the amount of information recalled by the Control group was considerably less than the maximum score for the task. Therefore, it does not appear reasonable to expect even Control participants to recall most of the specific details of the conversation (which lasted two minutes and fifteen seconds).

Despite a worse recall of information, the TBI group did not view the manner of the two men as significantly different to the Control group. This involved a direct judgment about each of the

men. The TBI group appreciated that the manner of one character was more positive (e.g. more polite and friendly) and the manner of the other character was more negative (e.g. rude and annoying). (It should be noted that as individual items were collapsed together for the analysis, it is not possible to say whether one group rated certain adjectives higher than any other). Furthermore, the TBI group rated the characters' views of each other as similar to the Control group.

There were some differences in the appreciation of para-linguistic features. The conversation was written so that the man with the newspaper displayed more pauses, stutters and repetitive remarks, compared to the other character. These occurred throughout the conversation. The man also spoke more softly. The TBI group rated the para-language of this character as occurring significantly less often than the Control group (although as noted above, since individual items were collapsed together in the analysis, it is not possible to say whether one group rated certain features higher than any other). Nevertheless, the TBI group appeared to be less sensitive to the presence of these features in the conversation. There were no group differences between para-language ratings of the other character. This latter finding is not surprising as the conversation was written so this character did not convey much para-language. The character only tended to speak more loudly and faster at times, although not throughout.

Overall, it would appear that recalling less information did not markedly affect the ability of TBI participants to judge accurately the manner of the two characters. However, factors contributing to performance on this task will be considered in more detail later. There are no studies in the TBI literature to compare with the current findings, although Hornak et al (1996) did find that patients with frontal lobe damage had less accurate recognition of non-verbal cues such as face perception and tone of voice. This appears to be consistent with the impaired para-language rating found

here. Furthermore, although there is some evidence suggesting that patients with right hemisphere lesions had difficulty deriving the main point or theme in dialogue (e.g. Gardener et al, 1983; Hough, 1990), a later study by Rehak et al (1992) found that patients with right hemisphere lesions had little difficulty judging the overall theme of conversations. This would appear consistent with the current findings. However, as noted earlier, it is difficult to compare the current findings to studies involving this lesion group, due to the heterogeneity of lesions in the TBI group.

4.2. Performance on the non-social neuropsychological measures of attention and executive function

The TBI group demonstrated impairment on most of the neuropsychological measures. This is unsurprising bearing in mind the severity of injury in the TBI group. All of the TBI participants had either a severe or very severe TBI (except two participants with a moderate classification). The research reviewed earlier emphasises that cognitive impairments tend to be a common and persistent problem associated with these levels of severity (e.g. Lezak, 1995).

4.2.1 Anterior attentional functioning

The TBI group did demonstrate significantly worse performance on the TEA sub-tests designed to measure selective and divided attention, compared to the Control group. However, the TBI group did not show significant impairment on the TEA sub-test measuring sustained attention. Previous studies examining sustained attention in TBI patients have produced equivocal evidence, tending to show very little difference in performance between TBI patients and controls (e.g. Manly and

Robertson, 1997). There is some evidence to suggest that TBI patients are impaired in terms of accuracy, speed and consistency of responding, irrespective of whether an overall decline in performance is observed (e.g. Loken et al, 1995). Previous studies examining selective attention also suggest that TBI patients are generally slower and less accurate on tasks requiring the suppression of responses and divided attention (e.g. Ponsford and Kinsella, 1992; Shum et al, 1990).

It is possible that the sustained attention task used in this study might have been too easy to produce the type of impairment reported in these studies. The Elevator counting (sustained attention) sub-test required participants to count tones, which were all the same pitch and presented in relatively short strings (i.e. the maximum was fourteen tones). The interval between the tones did vary but this was quite a brief period of time. In contrast, the Telephone search while counting (divided attention) sub-test, for example, was a timed test where participants needed to accurately identify specific symbols and simultaneously count tones. Therefore, it is possible that the selective attention tasks, in contrast to the sustained attention task, placed greater demands on speed and accuracy. This may account for the difference in TBI group impairment. Furthermore, the processes of sustained and selective attention have recently been explained in terms of executive control (e.g. see Stuss et al, 1995). It is possible that the selective and divided attention tasks used in this study required more executive control via the SAS (see Norman and Shallice, 1980) compared to the sustained attention task. This might be due to their more novel format and the need to inhibit responses. Therefore, it could be assumed that the apparent executive deficits observed in the TBI group was sufficient to only impair performance on the selective attention tasks.

The TBI performance on the attentional measures do provide some evidence to suggest that the poor attentional performance in the TBI participants might be related to damage to the frontal lobe. There is some evidence linking the prefrontal cortex to the ability to attend selectively to information (e.g. Bench et al, 1993). However, the heterogeneity of the lesions in the TBI group mean that this should not be assumed.

4.2.2. Executive functioning

The TBI group impairment on most of the measures of executive function was expected. Executive deficits are generally the most frequently disturbed cognition function following TBI (Johnstone et al, 1995). There are problems concerning the reliability and validity of executive tests (see Philips, 1997). Nevertheless, TBI performance on the tests used in this study are suggestive of typical behavioural problems associated with executive deficits. Performance on the Hayling test would suggest that the TBI participants were slower to initiate responses and had less ability to suppress unwanted responses (e.g. see Burgess and Shallice, 1997). It has been suggested that impairment on the Advanced Progressive matrices is associated with poor conceptual and problem solving ability (e.g. see Lezak, 1995). Furthermore, poor performance on the Modified Six Elements test would indicate that the TBI participants had difficulty planning, organising and monitoring their behaviour (e.g. see Wilson et al, 1996). The TBI group also demonstrated impairment across part A and B of the Trail-making test. However, poor performance across both parts of this test tends to indicate a general slowing of psychomotor speed, whereas a specific impairment on part B more typically indicates executive impairment as it involves the ability to switch between alternative stimuli. Finally, the problems reported by the TBI group (and relatives) on the DEX, suggest that they experience difficulties associated with dysexecutive syndrome (see Wilson et al, 1996). These include changes in motivation, behaviour, cognition and personality.

The TBI were not significantly impaired on the Letter fluency test, which is designed to measure the speed and ease of verbal production. However, as noted earlier there is variation in the degree of executive impairment, influenced by factors including injury severity, pre-morbid intelligence and the nature of the task (Shallice and Burgess, 1991). Therefore, a lack of pervasive executive impairment is not completely unexpected.

The impairment shown by the TBI participants on these executive tests do appear suggestive of frontal lobe damage (e.g. Benton, 1991; Shallice and Burgess, 1991). However, as already mentioned the heterogeneity of the lesions in the TBI group limit any conclusions regarding the anatomical bases to these behaviours.

The TBI group also demonstrated significantly worse performance on a test designed to measure immediate and delayed memory recall (AMIPB), compared to the Control group. This finding is consistent with previous studies showing that TBI patients have difficulty retaining new information (e.g. Millis and Ricker, 1994) and problems recalling previously learned material (e.g. Cooke and Kausler, 1995). It was noted earlier that there might be different factors underlying this pattern of impairment. Problems with the storage of new information in TBI patients has been linked to memory difficulties associated with the hippocampus and the medial temporal lobes (e.g. Lezak (1995). In contrast, impairment in the recall of information has been connected to impaired learning strategies and organisation of information, which might be affected by executive deficits (e.g. see Stuss et al, 1994; Shimamura, 1994). However, the role of the frontal lobes and the associated executive and working memory involvement in memory problems remains unclear (Mayes and Daun, 1997).

4.3. Performance on the higher-level theory-of-mind-type social comprehension tasks

It was noted earlier that there have been very few studies directly examining theory of mind in TBI patients, although tasks used to explore pragmatic functioning arguably incorporate this aspect of functioning (e.g. McDonald and Pearce, 1996; Bara et al, 1997). The contribution of theory of mind to performance in the current study needed to be considered, particularly as the comprehension of other people's mental states is likely to affect the interpretation of social information.

The Strange stories task was designed to assess higher-level theory of mind and requires inferences beyond the information stated. There has been no previous research using this task with TBI patients. The TBI group did not significantly differ from the Control group in their ability to use mental state language. They were able to describe the stories using words such as "he thinks," "he knows" and "he's lying." This use of these words are typically associated with first-order theory of mind attributions i.e. the ability to think about another person's thoughts about an objective event. Previous research has shown that TBI are able to adequately perform first-order theory of mind tasks (e.g. Bara et al, 1997; Channon and Beeson, unpublished).

The TBI group did perform significantly worse than the Control group on both the mentalising and physical story types. This suggests impairment with higher-level theory of mind. However, it is important to note that within the TBI group performance was equally poor on both these story types. The mentalising stories require inferences about people's mental states, including their motivations and intentions. The physical stories also require inferences about an implicit element but do not invite consideration of mental states. Therefore, this suggests that the TBI group did not

display a selective theory of mind impairment. In other words, they had difficulty performing both mental state and non-mental state inferences.

The TBI group also performed significantly worse on the Story comprehension task compared to the Control group. This task requires participants to explain the actions and words of characters in stories involving, for example, sarcasm, white lies and threats. To obtain a correct score it is necessary to appreciate implicit information and invoke a non-literal interpretation. The only previous study examining the performance of patients with brain injury on this task was discussed earlier. Channon and Crawford (2000) found that patients with frontal lobe damage failed to make non-literal interpretations and provided incorrect non-literal answers. Patients also gave incorrect answers. This pattern of errors is consistent with the performance of the TBI participants in this study. It is important to note however, that the TBI participants were able to pass some items. This suggests that across the group the failure to make non-literal interpretations should not be viewed as an absolute impairment.

4.4. Explaining the performance on the social interpretation tasks

I shall now attempt to account for the performance of the TBI group on the social interpretation tasks. Initially I will consider general factors that might have contributed to performance on all the tasks. Then I shall examine more specific factors by referring to the conversation judgment task separately to the pragmatic and social skill judgment tasks. The TBI group demonstrated little impairment on the conversation judgment task, performing generally similar to the Control group. In contrast, the TBI group were impaired on the other two tasks and there appeared to be similarities in the nature of the impairment. It might therefore be fruitful to try and provide a joint account of performance on these two tasks.

It is difficult to explain the TBI group impairment in terms of poor motivation. The TBI participants spent a similar length of time on each task as the Control group. They appeared to concentrate well and put a similar level of effort into the tasks. Both groups seemed interested in the tasks, particularly as many participants informally commented that they found them enjoyable to complete. There is no evidence to suggest that the TBI group recalled considerably less conversational information in the conversation task due to difficulties hearing the material. None of the participants reported any hearing impairment and they could all adjust the volume of the conversation to suit their needs. There were also no reported problems with vision that would have reduced the capacity of the TBI participants to read the material. Also, participants who required glasses for reading wore them during testing.

Impairment to syntactic or semantic language processing does not appear to explain poor performance on these tasks. Dysphasic participants were excluded from the study and all participants performed well on a standardised language comprehension test (TROG). It is also difficult to account for performance in terms of impaired visuoperceptual processing or in recognising non-verbal cues. The tasks presumably did not make particular demands on perceptual abilities or provide non-verbal information.

Finally, impairment in emotional functioning does not appear to explain performance. Damasio et al, (1990) noted that brain-injured patients were less able to appreciate emotionally charged stimuli due to an inability to produce somatic states. However, there was no indication that the tasks were associated with high emotional meaning or consequences for the participants.

4.4.1. Factors contributing to performance on the Conversation judgment task

It can be argued that memory impairment contributed to the poor recall of conversational information observed in the TBI group. Certainly, performance on the AMIPB indicated deficits in the immediate retention and recall of information. However, as previously noted, the possible executive involvement in memory functioning suggest that the TBI group might have actually retained a larger amount of the conversational detail but recalled less due to poor retrieval strategies and organisation of information. This account appears consistent with the notion that TBI patients may possess certain information but might not think to use it unless externally cued (eg. Stuss and Gow, 1992). The fact that the TBI group did not generally differ in their overall judgments of manner might indicate that they retained a larger amount of information but used it only when cued to do so in the judgment questions. However, this cannot be determined in the present instance.

As noted, if the TBI group did actually remember less information this does not appear to have affected their judgments. There were no group differences between the TBI and Control group in rating the manner of both characters and in rating the characters' views of each other. Unfortunately, it not possible to ascertain what information participants used to form their judgments. It may be that TBI participants utilised different aspects of the material. Nevertheless, it could be speculated that the conversational material enabled participants to form global judgments which were unaffected by remembering specific details. Therefore, it is possible that the task was not sensitive to specific information markedly affecting the quality of manner judgments. It would appear that the conversation provided bold stereotypes. A number of TBI participants informally commented that the man not reading the newspaper was "clearly an

irritating man". These bold stereotypes might have also helped in rating the characters' views of each other, as the participants already had established a view of each man. It is important to note that the other social interpretation tasks presented much less information and arguably required more subtle judgments. This may account for the lack of TBI impairment on this task, compared to the other two tasks.

The TBI group did rate the para-linguistic features of one character as occurring significantly less often than the Control group. This requires some consideration. It can be argued that this aspect of the task relied more on actual identification of information and less on subjective interpretation. For example, a stutter or soft voice is to some extent either present or not. Presumably, utilising global opinions about the manner of the characters would not necessarily assist this process. For example, knowing that the man was generally "more friendly and likeable" does not necessarily provide information about the extent of stuttering, whereas it might provide clues to whether he was also polite. Therefore, it could be argued that the TBI participants focused on this para-linguistic information less efficiently or when they did they had difficulty retaining and retrieving it. However, this cannot be determined in the present instance, particularly as there were no significant correlations with any of the neuropsychological measures. As noted earlier, a study by Hornak et al (1996) reported that poor appreciation of non-verbal emotional cues (including tone of voice) was associated with ventromedial frontal lobe damage. The result here appears consistent with this study, although it is not possible to specify particular brain structures due to the heterogeneity of lesions in the TBI group.

Overall, the TBI group performed largely similar to the Control group on this task. The poorer recall of conversational information in the TBI group might be due to problems with the storage of information or poor retrieval strategies and organisation of information (associated with executive

impairment). Despite this poorer performance, the TBI group judged the manner of both characters as accurately as the Control group. Whether they arrived at these judgments by utilising similar information as the Control group cannot be determined here. Finally, the presence of some TBI impairment in the accurate judgment of para-language, suggest that they either attended less well to this information or were impaired in their retention and retrieval of it. However, the lack of association between their performance and neuropsychological measures, including attention, executive functioning and memory, limit conclusions that can be drawn.

4.4.2. Factors contributing to performance on the pragmatic judgment task and social skill judgment task

Before discussing the contribution of executive and theory of mind processes to impairment on these tasks, it is necessary to consider the role of memory impairment. Despite poorer TBI group performance on the memory test (AMIPB) very few significant correlations were found between this test and the social tasks. The AMIPB did significantly correlate with the difference score on the social skill judgment task, suggesting that greater differentiation between the ‘skilled’ and ‘unskilled’ response types was associated with better memory performance. However, it can be argued that both these social tasks did not rely heavily on memory functioning. The initial interactions in each item remained continuously on view while participants were judging the response types. Therefore, they were permitted to re-read each interaction if required to avoid reliance on memory alone. It has also been argued in previous research that social knowledge remains largely intact and accessible to patients following TBI (e.g. Saver and Damasio, 1991). Therefore, it is reasonable to assume that impairment in social knowledge did not contribute to the poorer performance, although social knowledge was not directly measured. To what extent social knowledge can be adequately assessed is questionable, however. Finally, the possibility that

participants might have possessed certain knowledge but failed to make adequate use of it in order to guide interpretation should not be ruled out. As previously discussed, this tendency has been explained in terms of poor executive control of behaviour (e.g. Lezak, 1995).

It was noted earlier that the pattern of impairment in the TBI group appeared to reflect a lack of inferential sensitivity. I shall now consider to what extent theory of mind and executive functioning might have contributed to this. An explanation in terms of theory of mind impairment would argue that TBI participants had difficulty adopting the perspectives of the relevant characters. It would appear that understanding the intentions and motivations of each character was important in both tasks. This might explain the poor inferential sensitivity between the 'literal' and 'non-literal neutral' responses and the 'unskilled' and 'neutral' responses. The TBI group were impaired on the Story comprehension task and the Strange stories task, which does suggest that they had difficulty appreciating non-literal interpretations and making accurate mental state judgments. Therefore, a theory of mind explanation would be strengthened if performance on these tasks correlated with performance on the social interpretation tasks. There were some significant correlations found in the TBI group. Better performance on the Story comprehension task was associated with better performance on the pragmatic judgment task. Furthermore, better performance on the mentalising stories (Strange stories task) was associated with greater differentiation between the 'skilled' and 'unskilled' responses on the social skill judgment task. Also, rating the 'skilled' response highest more often was associated with a better physical stories performance.

However, a theory of mind explanation does easily explain the apparent ability of the TBI group to accurately differentiate between the 'non-literal appropriate' and 'literal' responses and the 'skilled' and 'neutral' responses. To do this presumably involved some appreciation of the

intentions and motivations of the characters. Further evidence weakening a theory of mind account is the finding that the TBI group performed equally poorly on the mentalising and physical stories of the Strange stories task. This suggests that they did not display a selective theory of mind impairment. Impairment on the mentalising stories but not the non-mental physical stories would have provided more support for a theory of mind position.

Can an account in terms of executive dysfunction potentially explain the impairment on these social tasks? (Due to the conceptual overlap between executive and attentional functioning, impairment on the measures of attention will also be included in this discussion). Rather than a selective impairment in comprehending mental states, executive dysfunction should produce an enhanced tendency to adopt the most obvious and concrete interpretations. The SAS is activated particularly when specific selection among schema is necessary and when inappropriate schema must be inhibited (Norman and Shallice, 1986). Presumably it is necessary in both these social tasks to consider competing interpretations and use information from different sources. It can be argued that impairment to the SAS would reduce the ability to inhibit responding to pre-potent and habitual information (see Stuss et al, 1995).

There does not appear to be any evidence to suggest that the TBI participants were unable simply to refrain from endorsing high ratings across all items. The TBI participants were able to adequately differentiate between response types demonstrating an ability to produce higher and lower ratings. Therefore, it seems important to consider to what extent specific response types reflected a pre-potent or habitual response. It would appear that the poor differentiation in the TBI group stemmed particularly from impaired appreciation of the 'literal' and 'unskilled' response types. In considering the 'literal' response it was argued earlier that it is necessary to firstly reject the literal interpretation and then identify a more appropriate indirect meaning. Therefore,

Rachel's comment that it was an African elephant does reflect an obvious initial interpretation, which might come to mind in a relatively automatic and habitual way. It is necessary to inhibit this thought to then be able to consider more appropriate (indirect) interpretations. Furthermore, the 'unskilled' response also appears to reflect an initial immediate thought about the situation. It can be assumed that Vicky does not frequently have her skirt touched in a lift and therefore her immediate thought might well be "that's never happened to me before". Many of the other 'unskilled' responses in the social skill judgment task do appear to reflect immediate and automatic thoughts about the initial remark. For example, one item involved a person saying that he had just been to the doctors. The unskilled response was "Oh dear, what's wrong with you?" It is likely this would be an initial thought possibly driven by curiosity. However, since the two men do not know each other it is arguably more polite and less intrusive to produce the 'skilled' response "Oh, I'm sorry". In a further item, the 'unskilled' response involved an abrupt and blunt reply to a rude remark. The remark "I wouldn't buy a dress that colour", was followed by the 'unskilled' response "Oh, but I've got the figure to wear it". It is reasonable to assume that the rude remark would trigger immediate conflict and irritation, which would need to be inhibited in order to produce a more assertive and skilled reply.

Therefore, an account in terms of executive dysfunction suggests that the TBI impairment is due to poor inhibitory control of pre-potent and habitual interpretations. In other words, the 'literal' and 'unskilled' responses reflected initial thoughts and feelings triggered by the immediate aspects of the situation. It would appear that these interpretations were too 'tempting' to the TBI group. They were unable to exert sufficient inhibitory control to appreciate that they were not appropriate or skilled in the context.

This executive account can also explain the finding that the TBI group could adequately differentiate between the 'non-literal appropriate' and 'literal' responses and the 'skilled' and 'neutral' responses. It can be argued that the 'non-literal appropriate' and 'skilled' responses did not strongly allude to and trigger a pre-potent and habitual interpretation. These responses did appear to provide subtle and less reactive replies to the initial remarks. Therefore, an executive account can accommodate the apparent ability of the TBI group to infer meaning but explain why they could not do this as well as the Control group. It is important to emphasise that since the TBI group did differentiate between certain response types this implies that they could, to some extent, appreciate the social context and the intentions of the characters.

There are no previous studies examining judgment of social skill in TBI patients. The impairment on the pragmatic judgment task does reflect a bias towards more literal interpretations reported in previous TBI studies (e.g. McDonald and van Sommers, 1993; McDonald and Pearce, 1996). In these studies impairment was associated with poor conceptual ability, although the executive contribution was not extensively examined. It is evident that impaired performance on the neuropsychological measures of executive function would add weight to an executive explanation here. Impairment in attentional functioning would also provide support. As noted, the TBI group did perform significantly worse than the Control group on most of the measures of executive function and attention. Poor performance on these tests provides some evidence for deficits in conceptual ability and inhibitory control. However, stronger evidence favouring an executive contribution would have been provided if TBI group performance on the pragmatic judgment and social skill judgment tasks were associated with performance on the tests of executive and attentional functioning. Unfortunately, very few significant correlations were found and these were confined to the social skill judgment task. Better performance on the Six elements test was associated with rating the 'skilled' response highest more often and greater differentiation between

the 'skilled' and 'unskilled' responses. This test is purported to tap the ability to plan and monitor behaviour effectively. However, it is difficult to draw conclusions without further correlational support.

Therefore, the correlational data adds little support for an executive contribution. This is despite the fact that conceptually, executive dysfunction appears to explain the pattern of TBI impairment on these two social interpretation tasks reasonably well. It should not be ruled out that both executive and theory of mind impairment contributed to the poorer TBI group performance. It was noted that the results of the Strange stories task suggested that the TBI group did not display a selective theory of mind impairment due to difficulties with mental state and non-mental state inferences. However, potentially a selective theory of mind impairment could explain the poor performance on the mentalising stories and a generalised executive impairment could account for the poor performance on the physical stories. However, to what extent executive functioning and theory of mind are separable processes is unclear. As mentioned earlier this issue is currently being debated in the autism literature (e.g. see Bishop, 1993). Also, in the recent study by Channon and Crawford (2000) it was argued that impaired performance on the Story comprehension task in patients with frontal lobe damage could be more readily explained by a generalised executive impairment, rather than a selective theory of mind deficit. They found a close correlation between the story comprehension task and measures of executive function. Surprisingly, there were no significant correlations between this task and the executive measures in this study. Nevertheless, a generalised executive impairment appears to provide a more parsimonious account of the TBI group impairment on the pragmatic judgment and social skill judgment tasks.

4.5. Limitations of the study and directions for future research

It is important to note that this study involved a small sample size. Therefore, generalizations of the findings to the wider TBI population may not be valid. Also, the small sample size was combined with a relatively large number of measures, which is known to increase the probability of finding significant results purely by chance. The design of the study also precludes any causal explanations of the findings. The heterogeneity of lesions in the TBI group mean that it is not possible to address questions concerning functional localisation, despite the fact that TBI often involves damage to the frontal lobe. Furthermore, limitations associated with the classification of TBI severity suggest caution in attributing the findings to a particular level of TBI severity. These methodological weaknesses indicate that it would be important for further research to be conducted with larger samples, smaller numbers of measures and tighter experimental design to confirm some of these findings.

There are a number of limitations and issues regarding the social interpretation tasks. The tasks did not attempt to measure interpretation of visual non-verbal information, such as body language or appearance. This is clearly an important source of information in the appreciation of social situations and might usefully be considered in future research. It was considered particularly important in this study to construct real-life-type tasks. This provided a more ecologically valid measure of performance since the material reflected real life situations that people might encounter either personally or through others. However, there are many ways in which these tasks might differ to real life social situations. For example, in real life people do not have to imagine the social situation. This means that interpretation and behaviour will often be motivated by a particular personal need. Presumably, in hypothetical tasks this would influence judgments to a much lesser extent.

The social tasks were exploratory and little is known about their reliability or validity. There are a number of issues concerning reliability. Inter-rater agreement was not carried out when the free recall was scored on the conversation judgment task. This will be important to do if the task is developed for clinical use, particularly as this will assess how good the rating system was. For example, did the 'themes' adequately reflect the dialogue and how reliably could the recall be categorised and scored? The internal consistency of the pragmatic judgment and social skill judgment tasks should be given particular attention. This will provide some support to say that the items in each response type were measuring similar things or whether certain responses should be refined or removed. Ideally, to assess issues of internal consistency it would be useful to generate more items and administer the tasks to a larger sample.

It was noted earlier that the tasks did appear to have reasonable face and content validity. It would be useful, however, to alter the content of the conversation judgment task in particular, as the task did not appear to sensitively differentiate between interpretations. To understand more about the extent of possible differences in interpretation, it might be helpful to provide less clear stereotypes and include greater subtlety and ambiguity in the material. The fact that the social tasks did not correlate very well with each other does raise the question as to whether they were measuring overlapping aspects of verbal social interpretation. The lack of correlation between the pragmatic and social skill judgment tasks was particularly surprising, as the similar pattern of impairment across these tasks seemed to indicate that they might be measuring related aspects of interpretation. There were also few significant correlations between the social tasks and the measures of theory of mind, attention and executive function. These correlational findings suggest that it might be important for further research to consider other validity issues. In terms of the criterion validity of the tasks it would be interesting, for example, to consider whether

performance is related to others indicators of poor social interpretation. This might include using observations from the relatives of TBI patients. Whether this can be reliably assessed is questionable, however. There is also the complex issue concerning the construct validity of the tasks. It is reasonable to assume that the interpretation of verbal social information is a complex and multidimensional process. It was acknowledged earlier that the tasks probably reflected overlapping aspects of this process and it was likely that multiple cognitive functions would contribute to task performance. These issues await further study and consideration.

4.6. Implications of the findings for rehabilitation and social functioning following TBI

The limitations of the study need to be acknowledged in considering possible implications for rehabilitation and social functioning. Therefore, I shall tentatively raise a number of issues. It is widely reported that TBI patients have considerable problems in social functioning, which appear to manifest in family life, relationships and vocational settings. Previous studies have suggested that poor social decision-making and executive impairment might contribute to these social difficulties (e.g. Shallice and Burgess, 1991; Dimitrov et al, 1996; Channon and Crawford, 1999). This study indicates that it might also be important to consider that poor interpretation of social information also contributes to these problems in social functioning. Furthermore, although the findings are inconclusive, it seems likely that executive impairment might also be important here.

The pattern of TBI impairment in this study suggests that TBI patients are able to successfully interpret the overall gist of interactions and generally appreciate people's intentions and motivations. However, they may fail to identify certain aspects of speech, including pauses and tone. Furthermore, they appear to be less accurate in performing more subtle judgments. This

seems to reflect poorer inferential ability, which might be exacerbated when less information is available and when more obvious interpretations need to be inhibited. Therefore, this apparent lack of inferential sensitivity might cause varying degrees of success in interpretation, depending upon the context and the nature of what was said.

This pattern of impairment highlights possible targets for intervention. There may be scope in providing specific training to improve interpretation of more subtle aspects of information and also inhibitory control. This could involve encouraging greater attention to specific aspects of social information, role-playing situations to identify when immediate thoughts and feelings might not be appropriate and improving awareness of the affect responses might have on other people. It appears important to encourage family members and carers to be involved in developing specific management skills. This might also include encouraging relatives themselves to provide, where possible, clear and sufficient information during interactions. This might enable TBI patients to appreciate situations more accurately. Eslinger (1998) notes that family involvement is probably the critical element in the longer-term management and outcome in TBI.

Finally, the results suggest that an important role for the neuropsychologist will be to identify the nature of the cognitive impairment (particularly deficits in executive functioning) and offer intervention advice. It is unfortunate that a recent study in this country reported that less than 5% of patients admitted to general hospital with severe TBI had been seen by a clinical psychologist (Murphy et al, 1990). It appears at present that many TBI patients and their families have to rely on charitable organisations such as Headway for longer-term community support in the absence of adequate statutory provision. Thus, it seems very important that access to rehabilitation services for the TBI population is urgently addressed in the UK.

4.7. Concluding comments

As predicted the TBI group performed more poorly than the Control group on real-life-type tasks designed to measure the interpretation of verbal social information. The TBI group also performed worse on the neuropsychological measures of attention and executive function and measures of theory-of-mind-type social comprehension.

The TBI group performance on the pragmatic judgment and social skill judgment tasks indicated that they were unable to differentiate adequately between the 'literal' and 'non-literal neutral' responses and the 'unskilled' and 'neutral' responses. However, they demonstrated some inferential capacity by differentiating between the 'non-literal appropriate' and 'literal' responses and the 'skilled' and 'neutral' responses. It was argued that their performance reflected poor inferential sensitivity and might be linked to a generalised impairment in executive functioning. This was explained in terms of impaired inhibitory control and a tendency to rate the 'literal' and 'unskilled' responses as more appropriate as they reflected more strongly pre-potent and habitual interpretations. Unfortunately, there were few significant correlations to support this executive explanation. However, this account was considered preferable to an explanation in terms of theory of mind. The results suggested that the TBI group did not demonstrate a selective theory of mind impairment.

TBI group performance on the conversation judgment task showed that despite recalling significantly less conversational information than the Control group, they accurately judged the manner of the characters. It was argued that the task involved less subtle interpretation than the other two social tasks. In particular, the material appeared to provide bold stereotypes, which could be used to inform interpretations. There was some indication that the TBI group was less

sensitive to the presence of para-linguistic information. Whether this was due to poor attention or impaired retention or retrieval of information is not known, particularly as there were no significant correlations with any of the neuropsychological measures.

Overall, the findings suggest that there is a need for further research examining the interpretation of social information in TBI patients. To what extent the impairment observed in this study contributes to difficulties in everyday social functioning awaits further elucidation. The nature of the impairment highlights a number of possible intervention strategies, which might enable TBI patients to interpret social information more successfully.

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6. APPENDICES

UNIVERSITY COLLEGE LONDON MEDICAL SCHOOL



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25 May 1995

Please reply to: Mrs Vanessa Revill
Committee Secretary
Joint UCL/UCLH Committee on the
Ethics of Human Research: Committee Alpha
(address as above)

Dr Shelley Channon
Head of Neuropsychology Services
Sub-Department of Clinical Health Psychology
Department of Psychology
UCL

Dear Dr Channon,

Joint UCL/UCLH Committee on the Ethics of Human Research: Committee Alpha

No: 95/2953

Title: Memory and executive function in patients with focal brain dysfunction

I am writing to let you know that I am now able to give the above project Chairman's Approval. You may therefore go ahead with your study.

Please note that it is important that you notify the Committee of any adverse events or changes (name of investigator etc) relating to this project. You should also notify the Committee on completion of the project, or indeed if the project is abandoned. Please quote the above number in any correspondence.

Yours sincerely,

Professor M Hobsley
Chairman

6.2. Information sheet



**Subdepartment of Clinical Health Psychology
University College London, Gower Street, London WC1E 6BT**

**Dr. Shelley Channon
Director of Project**

**Researcher: 0171-391 1786
Mike Watts**

INFORMATION SHEET

You are being invited to take part in a study concerned with the ways in which people learn, remember and solve social problems. We are asking some healthy people to take part in the study to compare with the nature and extent of difficulties in memory and reasoning in people of different ages and in those who have suffered injury or illness, which involved the brain. This work has relevance for everyday living where social functioning plays an important role.

All proposals for research using human subjects are reviewed by an ethics committee before they can proceed. This proposal was reviewed by the joint UCL/UCLH Committees on the Ethics of Human Research.

You will be given a series of psychological tests, which measure aspects of learning, memory and problem-solving. These will be arranged to suit your convenience and you will be able to take breaks if you feel tired. Due to the nature of the study, we cannot provide you with precise details of the tests, so that this does not influence the findings. You will be asked a series of questions concerned with the way you are feeling and any difficulties you have been having, and asked to fill out a set of questionnaires. The study does not include any blood tests or any other medical procedures.

You will be asked to sign a consent form and any information given will be treated in strict confidence. You do not have to take part in this study if you do not want to. If you decide to take part you may withdraw at any time without giving a reason.

6.3. Consent form



**Subdepartment of Clinical Health Psychology
University College London, Gower Street, London WC1E 6BT**

**Dr. Shelley Channon
Director of Project**

**Researcher: 0171-391 1786
Mike Watts**

CONSENT FORM

Memory and problem solving study

Director of project: Dr Shelley Channon

To be completed by volunteer:

Delete as necessary

Have you read the information sheet about the study? Yes/No

Have you had the opportunity to ask questions about the study? Yes/No

Have you received satisfactory answers to all your questions? Yes/No

Have you received enough information about the study? Yes/No

Which researcher have you spoken to about this study?

Do you understand that you are free to withdraw at any time without giving a reason and without affecting you future care? Yes/No

Do you agree to take part in the study? Yes/No

Signature of volunteer
Name
Date
Address

Signature of researcher
Name
Date

6.4. Access to medical records consent form



**Subdepartment of Clinical Health Psychology
University College London, Gower Street, London WC1E 6BT**

**Dr. Shelley Channon
Director of Project**

**Researcher: 0171-391 1786
Mike Watts**

Memory and problem solving study

Director of project: Dr Shelley Channon

I,, hereby give my consent for Dr. Shelley Channon of University College London to access my medical records, including any investigations such as brain scans, E.E.G's and psychological reports, for the purposes of research.

Signature of volunteer
Name
Date
Address
.....
.....

Signature of researcher
Name
Date

6.5. Consent form to contact significant others

I.....hereby give my consent for Mike Watts (the researcher) of University College London to approach the person I have nominated below in relation to this study. I understand that this would involve them being asked to rate me on questionnaires, which I have been shown. I understand that they will be asked to fill out the questionnaires without my help and that their responses will be treated confidentially by the researcher (i.e. they will be used for research purposes only and not shown to me by the researcher).

I would like to nominate the following:

Name
Address

They are my(Partner, mother, friend, carer etc)

Signed:

Name:

Witness:

6.6. Pragmatic judgment task

Instructions

You will be asked to read a series of short conversations between two people. The conversation involves the first person asking a question. The second person then makes a response.

Your task is to judge how appropriate the second person's response is in the context. You will be shown, in turn, three possible responses. I would like you to rate the appropriateness of each response using the scale in front of you.

1	2	3	4
Not at all			Very
Appropriate			Appropriate

1. Tony is driving with some friends. They are driving through a town they don't know. Pete is looking at a road map. Pete looks out of the car window and points at the building and says to Tony *'Can you see the castle?'*

- 1a Emma says *'Yes, I can see it clearly.'* (Literal)
- 1b Emma says *'Yes, isn't it quaint.'* (Non-literal neutral)
- 1c Emma says *'Yes, here it is on the map.'* (Non-literal appropriate)

2. Mary comes in from work looking tired and joins Tim in the lounge. Mary says to Tim *'Would you be able to pass me that book on the shelf?'*

- 2a Tim says *'Yes, it's not very heavy.'* (Literal)
- 2b Tim says *'Yes, of course. You look tired.'* (Non-literal appropriate)
- 2c Tim says *'Yes, of course. It looks very interesting.'* (Non-literal neutral)

3. Fiona was walking to school when she came across a blue school bag lying at the side of the path. It was slightly dirty with a broken handle. At the school gates, Fiona comes across a friend (Jane). Fiona says to Jane *'Look at this bag I found.'*

- 3a Jane says *'Yes, the bag is broken.'* (Non-literal neutral)
- 3b Jane says *'Yes, I can see it.'* (Literal)
- 3c Jane says *'Yes, our friend, John, has a blue bag.'* (Non-literal appropriate)

4. Alison visited her friend (Rachel), as she did every week. On the wall, Allison was surprised to see a new picture, which was obviously an original oil painting. It showed a large elephant. Alison says to Rachel *'Where did it come from?'*

- 4a Rachel says *'It was painted by Alfred Jones, who's famous for his animal paintings.'* (Non-literal neutral)
- 4b Rachel says *'It was left to me by my aunt, the one who died recently.'* (Non-literal appropriate)
- 4c Rachel says *'It is an African elephant.'* (Literal)

5. Laura meets Cara. Cara says *'How are things.'* Laura says *'I'm a bit stuck, actually. I've just heard from Sally that she's got to go abroad for work. She was meant to be doing the cooking for the club dinner a week on Saturday. Are you available?'*

- 5a Cara says *'Yes, I'd love to help.'* (Non-literal appropriate)
- 5b Cara says *'Yes, I'm free until this evening.'* (Literal)
- 5c Cara says *'Yes, I'd love to come to the dinner.'* (Non-literal neutral)

6. Helen, Vicky and Mark are sitting in their office canteen. Mark goes outside to have a cigarette. Helen then says to Vicky *'Mark has suggested going round some pubs tonight, to celebrate his birthday. Would you like to go out with him?'*

6a Vicky says *'No thanks, I've already got a boyfriend.'* (Non-literal neutral)

6b Vicky says *'Yes, I'd love to come for a drink.'* (Non-literal appropriate)

6c Vicky says *'Yes, I'll join him outside.'* (Literal)

6.7. Social skill judgment task

Instructions

You will be asked to read a series of short conversations between two people. Your task is to rate how socially skilled you think their remarks are in the social context, using the scale below.

1	2	3	4
Not at all			Very
Socially Skilled			Socially Skilled

If you are not sure how socially skilled a remark was, then choose a point on the scale that is closest to what you feel.

1. Lisa and Jane are in a clothing shop. They are standing next to each other in a changing room. They do not know each other. Jane has just tried on a dress.

Lisa says to Jane *'I wouldn't buy a dress that colour'*

1a Jane says *'Oh, but I've got the figure to wear it.'* (Neutral)

1b Jane says *'Oh, right.'* (Skilled)

1c Jane says *'Oh right, but I find this colour suits me.'* (Unskilled)

2. Jack and Dave are in a crowded bar, trying to get served. They do not know each other.

Jack says to Dave *'They could do with more bar staff.'*

2a Dave says *'I guess so.'* (Neutral)

2b Dave says *'Yes, it's too much for just one barman, isn't it?'* (Skilled)

2c Dave says *'James was saying the same thing to me earlier.'* (Unskilled)

3. Steve and Peter are sitting next to each other on a bus. They do not know each other. Peter is reading a newspaper.

Steve says to Peter *'I've just been to the doctor's.'*

3a Peter continues to read the newspaper. (Neutral)

3b Peter says *'Oh dear, what's wrong with you?'* (Unskilled)

3c Peter says *'Oh, I'm sorry.'* and continues to read the newspaper. (Skilled)

4. Jeff and Linda are in a long queue, waiting to buy tickets for the London Dungeons. They hear another American couple, Guy and Sue, talking in front of them. The two couples do not know each other.

Jeff says to Guy *'I recognise that accent. Where are you from?'*

4a Guy says *'I live in New York but I originally come from Atlanta. How about you?'* (Skilled)

4b Guy says *'I live in New York. I've just moved to 5th Avenue, Apartment 33. It's a really great apartment, with 5 rooms.'* (Unskilled)

4c Guy says *'New York.'* And continues to talk to his wife. (Neutral)

5. John and Vicky enter a busy lift. They do not know each other. John's hand accidentally brushes Vicky's skirt.

John says to Vicky *'Oh, I'm sorry.'*

5a Vicky says *'That's never happened to me before.'* (Unskilled)

5b Vicky says *'OK, don't worry'* and turns away. (Skilled)

5c Vicky says nothing. (Neutral)

6. Jason and Emma are sitting on nearby tables in a café, eating lunch. They do not know each other.

Jason says to Emma *'I don't know anyone in this café.'*

6a Emma says *'Nor do I. Still, it's nice to have time to myself sometimes.'* (Skilled)

6b Emma says *'Ah huh'* and then continues to eat her lunch. (Neutral)

6c Emma says *'Do you mind, I'm eating.'* (Unskilled)

6.8 Judgment of language and para-language in real-life-type conversation task

Conversation dialogue

I can't believe this train has stopped for so long. I'm going to be late again. Yeah this always seems to happen. Do you know this is the third time this week? Is it? Yeah I think it's disgusting. I keep meaning to complain but then you know it won't make any difference. Erm guess so. I'm going to be really late now. Yeah I'm glad I've got my newspaper to read. Suppose so but I find reading makes me feel really sick on trains. I guess it doesn't make you feel sick? No not at all. That's lucky. Anything interesting in the paper today? Oh you know just the usual news. Those papers are so big I can hardly see you it covers most of you. It must take you ages to read it. Yeah. I can see on the back page the government are talking about family values. Err are they. Actually I'm on my way to visit my parents this morning. They are going to be so annoyed that I'm late. They hate waiting. Oh right. But then they get annoyed at everything always arguing about things you know. Yeah I suppose parents do argue sometimes. Well I expect we'll start moving soon. You think parents argue sometimes. My parents argue most of the time in fact it makes me feel completely fed-up to be around them. Thank goodness I'm only staying with them for a few days. Oh right. Don't you argue with your parents then? Um er not really ar ohh at last the train is moving again. Hooray. I've been thinking while I've been sat here how funny it is that most people on trains look really bored. May be I should talk louder to see if anyone will join in with our conversation. Ohh arh arh Oh I don't think so. I think I'll just read my paper. Can you see that bloke over there the one with the ridiculous hat on? He's just been staring out of the window for ages. Ermm. And there's that large woman on the seat over there who keeps falling asleep. Oh I suppose she does look very tired though. Erm. It's my stop. Oh er Oh right I wish I was getting off. Bye. Oh bye. See you.

Instructions

Please listen carefully to the following conversation.

The conversation is between two people, who are sitting next to each other. They do not know each other.

After you have listened to the conversation, you will be required to answer some questions about it.

Instructions

Can you please tell me as much detail as you can remember about the conversation?

Instructions

Please answer the following questions about the conversation.

- 1) Where did the conversation take place?
- 2) Is there anyone nearby the two men?
- 3) Do either of the two men have anything with them?
- 4) Was the train moving?

Instructions

Please answer the following questions about the two men. Answer each question, in turn, by ticking one box on the rating scale provided.

1) The man reading the newspaper: did you, personally, think he was

Not at all Slightly Moderately Very

- Polite
- Rude
- Sarcastic
- Likeable
- Annoying
- Friendly
- Interesting
- Abrupt

2) The man reading the newspaper: did he think the other man was

Not at all Slightly Moderately Very

- Polite
- Rude
- Sarcastic
- Likeable
- Annoying
- Friendly
- Interesting
- Abrupt

3) The man reading the newspaper: how often did you, personally, think his speech sounded

Never Seldom Often Very often

- Too loud
- Too soft
- Too flat
- Too slow
- Too fast

4) The man reading the newspaper: how often did you, personally, think his speech contained

Never Seldom Often Very often

**Stutters
Pauses
Repetitive
remarks**

5) **The man not reading the newspaper: did you, personally, think he was**

Not at all Slightly Moderately Very

**Polite
Rude
Sarcastic
Likeable
Annoying
Friendly
Interesting
Abrupt**

6) **The man not reading the newspaper: did he think the other man was**

Not at all Slightly Moderately Very

**Polite
Rude
Sarcastic
Likeable
Annoying
Friendly
Interesting
Abrupt**

7) **The man not reading the newspaper: how often did you, personally, think his speech sounded**

Never Seldom Often Very often

**Too loud
Too soft
Too flat
Too slow
Too fast**

8) **The man not reading the newspaper: how often did you, personally, think his speech contained**

Never Seldom Often Very often

Stutters

**Pauses
Repetitive
remarks**

Conversation scoring

I can't believe
this train
has stopped for so long
I'm going to be late again.
Yeah this always seems to happen.
Do you know this is the third time
this week.
Is it? Yeah I think it's disgusting.
I keep meaning
to complain
but then you know it won't make any difference.
Erm guess so. I'm going to be really late now.
Yeah I'm glad I've got my newspaper to read
Suppose so but I find reading makes me feel really sick on trains.
I guess it doesn't make you feel sick?
No not at all.
That's lucky.
Anything interesting in the paper today?
Oh you know just the usual news.
Those papers are so big
I can hardly see you
it covers most of you.
It must take you ages to read it. Yeah.
I can see on the back page
the government
are talking about family values. Err are they.
Actually I'm on my way to visit
my parents
this morning.
They are going to be so annoyed
that I'm late.
They hate waiting. Oh right.
But then they get annoyed at everything
always arguing about things you know.
Yeah I suppose parents do argue sometimes.
Well I expect we'll start moving soon.
You think parents argue sometimes.
My parents argue most of the time
in fact it makes me feel completely fed-up
to be around them.
Thank goodness I'm only staying with them

for a few days
Oh right. Don't you argue with your parents then?
Um er not really
ar ohh at last the train is moving again.
Hooray.
I've been thinking while I've been sat here
how funny it is
that most people on trains
look really bored.
May be I should talk louder
to see if anyone will join in
with our conversation.
Ohh arh arh Oh I don't think so.
I think I'll just read my paper.
Can you see that bloke over there
the one with the ridiculous hat on.
He's just been staring out of the window
for ages.
Erm. And there's that large woman
on the seat over there
who keeps falling asleep.
Oh I suppose she does look very tired though.
Erm. It's my stop.
Oh er Oh right I wish I was getting off.
Bye.
Oh bye.
See you.