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ASSESSING PROBLEMS IN DAILY FUNCTIONING IN HEAD-INJURED ADULTS

by

Susanne R. Schibler

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Name: Susanne R. Schibler

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Examining Committee:

Chairman: Dr. Paul Bakan

Dr. Geoffrey D. Carr
Senior Supervisor

Dr. Marilyn L. Bowman

Dr. Margaret J. Kendrick
Lion's Gate Hospital, Vancouver, B.C.

Dr. David J. Crockett
External Examiner
University of British Columbia
and University Hospital, Vancouver, B.C.

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Title of Thesis/Project/Extended Essay

Assessing Problems in Daily Functioning in Head-Injured Adults

Author: ______________________
(signature)

Susanne R. Schibler
(name)

August 4, 1989
(date)

ABSTRACT

The present study centers around the development and initial validation of the Simon Fraser University (SFU) Index of Neuropsychological Functioning; a self-report inventory designed to assess problems in daily functioning experienced by neurologically impaired adults. The SFU Index was administered to head-injured patients, non-head-injured control subjects and a "significant other" living with each subject. Head-injured patients were significantly more impaired in daily functioning than control subjects, as rated by themselves and by their "significant others". The impairment ratings provided by head-injured subjects did not differ from those provided by their "significant others". Ten SFU Index items were designed to assess malingering via subjects' endorsement of unlikely sequelae of head-injury. Head-injured patients and their "significant others" endorsed these items on a substantially lower basis than the remaining items. The relationship between the SFU Index and neuropsychological test scores and demographic variables was investigated by identifying those variables that best predicted patient and "significant other" ratings of subjects' problems in daily functioning.

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Last but not least, I would like to thank the participants in the present study. The cooperation of the head-injured men and their relatives, who willingly contributed their time and effort to the present study, is especially appreciated.

DEDICATION

To my brother Christian

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CHAPTER I

INTRODUCTION

> "Hope has been both my foe and my ally. As my foe, it has enabled me to unrealistically plan my life, dreaming of lifestyles which had little if any feasibility... Positively, my hope has allowed me to accomplish feats which were deemed impossible by those in authority. Where does determination leave off and unreality begin?" (Dann, 1984)[1]

Traditionally, "recovery" from traumatic head-injury was equated with the preservation of the patient's life, and with the absence of grossly incapacitating physical or mental deficits. There has been, however, a growing awareness of the detrimental effects of even minor neurological insult on virtually every aspect of the victim's life. The present study centers around the development of the Simon Fraser University (SFU) Index of Neuropsychological Functioning, a measure designed to systematically assess problems in daily functioning experienced by neurologically impaired adults. The following review briefly provides a historical context for the present study, followed by a discussion of a number of important issues in modern neuropsychology.

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[1] Ms. Dann suffered a head-injury in a motor vehicle accident fifteen years prior to publishing her account of the emotional turmoil that accompanies traumatic head-injury.

From Diagnosis to Description: The Shift in Emphasis in Clinical Neuropsychology

A recent shift in emphasis in clinical neuropsychology, resulting in the increased importance accorded to patients' everyday functioning, high-lights the need for a tool to delineate patients' problems in daily functioning.

Rourke (1982) conceptualized the evolution of clinical neuropsychology over the last 45 years in terms of three paradigms: the static, cognitive and dynamic phases. During the 'static' phase, characterizing the field between 1945 and the mid 1960s, brain damage was conceptualized as an all-or-none phenomenon (Hartlage, 1987; Lezak, 1983). The primary tasks of clinicians centered around the differentiation between 'organic' and 'functional' deficits and the establishment of "fixed relationships between well-documented lesions and supposedly reliable and easily understood psychological measures" (Rourke, 1982, p.2). Empirical interests were focused on the development and validation of single-function measures that discriminated between brain-damaged and non-brain-damaged examinees (Costa, 1983; Hartlage, 1987; Lezak, 1983; Mapou, 1988; Rourke, 1982)

According to Lezak (1983), the static phase of clinical neuropsychology typifies the initial status of any clinical science: Prior to creating its own niche in the health care field, neuropsychology needed to gain credibility vis a vis the more established fields of medicine, neurology and clinical psychology. This was accomplished by demonstrating the ability of neuropsychological tests to replicate medical-diagnostic findings (Crockett, Clark & Klonoff, 1981) and resulted in a large body of literature attesting to the discriminative validity of neuropsychological tests (see Heaton, Baade & Johnson, 1978; Heaton & Crowley, 1981; and Spreen & Benton, 1965; for reviews of the literature concerned with the discriminative validity of neuropsychological measures).

The 'cognitive' phase in the evolution of clinical neuropsychology witnessed a growing interest in the "psychology" of neuropsychology (Boll, 1985; Rourke, 1982). Whereas attention had been focused primarily on the brain during the 'static' phase, the emphasis now shifted toward the description of the psychological abilities required for successful test performance (Rourke, 1982). Although the complexity of cerebral trauma was yet to be fully appreciated, increasing attention was accorded to the extent and nature of cognitive impairment resulting from brain damage (Lezak, 1983; Prigatano, 1986a).

It is only recently that clinical neuropsychology has moved toward a 'dynamic' model that simultaneously recognizes the complexity of neurological insult and its functional manifestations (Rourke, 1982). The integration of the two sides of the brain-behavior relationship, as well as the advances made in medical neurodiagnosis, have led to the extension of clinical neuropsychology beyond the replication of medical findings (Brooker, 1984; Costa, 1983; Crockett et al., 1981; Hartlage, 1987; Heaton & Pendleton). Although neuropsychologists are still consulted for diagnostic purposes, their unique contribution to patients' "medical work-up" (Brooker, 1984) has shifted toward the description of behavioral strengths and weaknesses attributable to cerebral lesions (Brooker, 1984; Chelune & Moehle, 1986; Costa, 1983; Hartlage, 1987; Lezak, 1985; MacNeill Horton, Jr., & Puente, 1986; Mapou, 1988; Rourke, 1982).

The new focus in clinical neuropsychology on the whole individual and his environment, rather than only on his brain (Boll, 1985; Chelune & Moehle, 1986; Rourke, 1982), has enhanced the usefulness of neuropsychological assessment significantly. In addition to its ongoing use as a diagnostic tool, neuropsychological assessment is now performed to establish relationships between cognitive impairment and brain damage (Crockett et al., 1981; Lezak, 1983), to plan and evaluate treatment programs (Brooker, 1984; Crockett et al., 1981; Lezak, 1983; Wolfe, 1987), to provide management recommendations and coping strategies for patients and their families (Brooker, 1984; Lezak, 1983; Wolfe, 1987) and to predict the degree of expected recovery and eventual level of adjustment following brain damage (Brooker, 1984; Crockett et al., 1981).

The shift from a purely diagnostic toward a more descriptive focus has a number of implications in terms of both neuropsychological research and clinical application. First, there has been a growing interest in the quality of daily living of neurologically impaired patients. Second, there have been attempts to identify the factors that add to the complexity of predicting long-term recovery from cerebral trauma. Third, the usefulness of neuropsychological measures is no longer evaluated on the sole basis of descriminative validity. Emphasis is now placed on investigating the efficacy of neuropsychological measures to predict problems in daily functioning. Fourth, the nature of the formal neuropsychological evaluation has been criticized in terms of its limited applicability to real-life behavior. The remainder of this review addresses these issues with respect to head-injury.

Long-Term Consequences of Traumatic Head-Injury

Given that the SFU Index of Neuropsychological Functioning centers on the assessment of those daily functioning problems that are attributable to head-injury, the following sections will address the effects of traumatic head-injury and the complex nature of the recovery process.

Cognitive-Perceptual Sequelae of Head-Injury

The long-term cognitive-perceptual consequences of head-injury can be classified into six broad categories of dysfunction (Prigatano & Fordyce, 1986). One area of disturbance concerns attention and concentration, manifested in terms of increased distractibility and impaired selective attention and shifting of attention (Prigatano & Fordyce, 1986). A second problem area involves the executive functions, including goal formulation, planning, initiation and effective performance of purposive behavior (Lezak, 1982, 1983, 1985). Deficient executive functioning results from impaired abstract thinking and problem-solving, impulsive or perseverative responding, the inability to self-monitor ongoing behavior and organically-based deficiencies in motivation (Lezak, 1982, 1983; Prigatano & Fordyce, 1986). A third area of dysfunction involves disturbances in judgment and perception. Head-injured patients' social functioning, for example, is frequently compromised by their low threshold for environmental stimulation, their misinterpretation of interpersonal cues, and their inappropriate behavior in social situations (Prigatano & Fordyce, 1986). A fourth problem area involves memory and new learning. Although remote memories are frequently left intact following head-injury, the storage and recall of more recent memories are typically impaired. A fifth area of dysfunction concerns the slowing of information processing and of psychomotor functioning (Prigatano & Fordyce, 1986). A last area of dysfunction involves linguistic disturbances. Commonly observed communication deficits following head-injury include non-fluent, qualitatively impoverished output; poor word generation and speech initiation; impaired repetition, naming, reading and writing skills; and non-aphasic deficits such as talkativeness or tangentiality of speech (Prigatano & Fordyce, 1986; Prigatano, Roueche & Fordyce, 1986; Stuss & Benson, 1984).

Emotional, Personality and Psychosocial Sequelae of Head-Injury

Given the recent emphasis on everyday functioning in neuropsychology, the last decade has witnessed a proliferation of sequential assessment studies tracing post-head-injury adjustment in terms of daily functioning ability. Those studies assessing head-injured patients' functioning shortly after the injury typically report a high prevalence of psychosomatic symptoms (Keshavan, Channabasavanna & Reddy, 1981; E. Miller, 1979). As the injury-assessment interval increases and the natural recovery of the brain takes place, however, these deficits lessen and psychosocial, emotional and personality disturbances become more prevalent.

In a seven-month follow-up study, a sample of severely head-injured patients reported a number of emotional problems, including irritability, anxiety and aggression (Tyerman & Humphrey, 1984). Reported personality changes ranged from the negative (bitterness, frustration) to the neutral (cautiousness, seriousness) and the positive (increased maturity and understanding). Psychosocial complaints centered around the inability to resume work, leisure activities and interpersonal relationships.

McKinlay, Brooks and their colleagues have described post-injury functioning in severely head-injured patients on the basis of relatives' reports. During the first post-trauma year, language and self-care difficulties reportedly decreased (McKinlay & Brooks, 1984; McKinlay, Brooks, Bond, Martinage & Marshall, 1981) while emotional and behavioral functioning were rated as more impaired. Among the specific complaints voiced by relatives were mood swings, displays of bad temper, social withdrawal, impatience, depression and child-like behavior (McKinlay et al., 1981). Even those patients whose relatives reported no personality changes exhibited impaired emotional control and reduced energy and enthusiasm at the end of the first post-trauma year. Injury severity, as measured by the length of post-traumatic amnesia (PTA), emerged as a good predictor of the likelihood of personality change, but not of its extent (Brooks & McKinlay, 1983).

Given the primarily negative emotional and behavioral changes observed in post-head-injury patients, it is not surprising that the quality of their interpersonal relationships frequently deteriorates over time. In a two-year follow-up of severely head-injured subjects (Weddell, Oddy & Jenkins, 1980), relatives rated the patients as having fewer interests and hobbies, having fewer close friends and being more lonely and bored. While patient irritability was positively related to family conflict, employment was inversely associated with psychosocial and neuropsychological impairment (Weddell et al., 1980). Another follow-up study (Oddy & Humphrey, 1980) found that severely head-injured patients had reduced contact with close friends six months after the injury. At the end of the first post-trauma year, patients' relationships with their siblings were strained, and spouses expressed diminished feelings of affection toward patients. Furthermore, patients received fewer visits and participated in fewer leisure activities. Two years post-injury, a trend towards having fewer friends emerged, suggesting ongoing difficulties with interpersonal relationships. In this study, neither social contact nor participation in leisure activities were related to patients' physical disabilities (e.g., the loss of a limb). The psychosocial variables were, however, associated with neuropsychological test performance, illustrating the impact of cognitive impairment on everyday functioning. Return to work was influenced by both physical disability and by premorbid personality factors such as nervousness and suspiciousness (Oddy & Humphrey, 1980).

Long-term follow-up studies suggest that recovery of psychosocial and emotional functioning remains incomplete for many patients. Five years post-injury, relatives still rated patients as being negativistic, withdrawn, suspicious and confused (Newton & Johnson, 1985). Another five-year follow-up (Brooks, Campsie, Symington, Beattie and McKinlay, 1986), reported that little improvement had taken place over the last three years, and that patients' threats of violence, concentration problems and dependence had increased (Brooks et al., 1986). In a sample of head-injured patients studied by Lezak (1987) anger, reduced social contact, difficulties at work or in school and reduced participation in leisure activities remained major problem areas five years after the injury. While physical impairment generally showed no association with emotional or social functioning in this study, physical mobility and the intactness of speech were related to independent living skills (Lezak, 1987). Similarly, independence in daily living was inversely related to psychological distress in another head-injured patient sample (Jellinek, Torkelson & Harvey, 1982). In a seven-year follow-up, loss of temper, lack of interests, social isolation and immature behavior were the most consistently reported remaining difficulties (Oddy, Coughlan, Tyerman & Jenkins, 1985). As long as 10 to 15 years following head-injury, patients were characterized by increased irritability, restlessness, aspontaneity, tiredness and decreased social contact (Thomsen, 1984).

On one hand, it is difficult to obtain a global picture of post-head-injury functioning on the basis of the findings of individual follow-up studies. The generalization and integration of these findings is hampered by differences in research design, patient and control groups, measures of cognitive ability and everyday adjustment and injury-assessment intervals. On the other hand, the diversity within this body of research enhances the value of repeatedly observed trends. Not only do the differences in methodology subject these common findings to a more stringent test of generalizability, but they also provide a crude 'time-line' that describes issues in post-head-injury functioning at various stages of recovery.

Long-term Course of Recovery Following Traumatic Head-Injury

Recovery of function following traumatic head-injury is generally conceptualized as a logarhythmic function, with rapid gains occuring in the early post-trauma stages and improvement slowing thereafter. Stage models divide the recovery process into a number of relatively distinct phases (Bond, 1979; Cripe,1987). During the first stage, the length of which varies as a function of injury severity (Bond, 1979; Cripe, 1987), patients range from a barely arousable to a completely unconscious state (Cripe, 1987) and most higher-level cognitive functioning remains "shut down" (Cripe, 1987). At the second stage, consciousness is regained and problems in the basic cognitive functions (e.g., attention, concentration and memory) first become evident (Bond, 1979; Cripe, 1987). The end of this stage is heralded by the clearing of disorientation and of post-traumatic amnesia (Bond, 1979; Cripe, 1987). The third recovery stage, which lasts until about six months after the injury (Brooks, Deelman, Van Zomeren, Van Dongen, Van Harskamp & Aughton, 1984; Cripe, 1987; Dikmen, Reitan & Temkin, 1983; Lezak, 1979; W.G. Miller, 1986) is characterized by rapid cognitive improvement paralleling the natural recovery of the brain (Bond, 1979). The last stage consists of the slowing and subsequent plateauing of improvement (Brooks et al., 1984; Cripe, 1987; E. Miller, 1979; W.G. Miller, 1986). It is at this stage that deficits in higher-level cognitive, executive, emotional and psychosocial functioning are first recognized by patients and their "significant others" (Bond, 1979; Cripe, 1987).

Factors Affecting Long-term Outcome

Injury Severity

Eventual outcome following traumatic head-injury has been associated with patient characteristics such as age, premorbid intellectual functioning, occupational and educational attainment, socio-economic status and premorbid psychological adjustment (Boll, 1985; Klonoff, Costa & Snow, 1986; E. Miller, 1979; W.G. Miller, 1986; Oddy & Humphrey, 1980). The most frequently used predictor of patients' eventual adjustment, however, is injury severity as measured by the length of post-traumatic and retroactive amnesia or the length and depth of coma (Lezak, 1983; E. Miller, 1979).

Levin and Grossman (1978), for example, found that patients of differing injury-severity grades remained 100% distinguishable in terms of their emotional, cognitive and psychosocial functioning ten months after the injury. In an 18-month follow-up, severely head-injured patients consistently differed from their less severely injured counterparts in terms of higher-level cognitive functions such as concept formation, problem-solving and abstract and flexible reasoning (Dikmen, Reitan & Temkin, 1983). Less consistent differences were obtained for the more basic cognitive functions, including attention, concentration, and incidental memory. No injury-severity-related differences were found for motor strength and speed (Dikmen et al., 1983). The authors proposed a 'deficit-proportional' model of recovery, in which more severely injured patients are expected to show a greater degree of both improvement and residual impairment than less severely injured patients (Dikmen et al., 1983).

Although injury severity tends to accurately predict patient functioning during the early post-trauma stages (E. Miller, 1979), outcome becomes increasingly multi-determined as the time since the injury increases. The relationship between relatives' reports of patient adjustment and the length of patients' PTA, for example, decreased drastically over a five-year post-injury period (Brooks et al., 1986). Similarly, relatives' ratings of the burden they experienced as a result of patients' neurologically impaired status was strongly related to the length of patients' PTA at three months, but not one year post-injury (McKinlay et al., 1981).

The Layered Emergence of Head-Injury Sequelae

The recovery process following traumatic head-injury is complicated by the appearance of increasingly complex deficits as the time since the injury increases (Brook et al., 1984; Cripe, 1987; Dikmen et al., 1983; Lezak, 1978, 1979). Deficits in the higher-level functions may be "masked" by the presence of more visible or grossly incapacitating sequelae in the early stages of recovery (Cripe, 1987; Lezak, 1978; McKinlay & Brooks, 1984). It is, for example, difficult to detect impairment in executive and interpersonal functioning in patients who are disoriented, aphasic and amnestic. Lezak (1979) noted differential rates of onset, rate and extent of recovery in learning and memory functions of various complexities. Over a three-year assessment period, only simple measures of immediate memory span and verbal learning showed consistent improvement in a sample of head-injured patients. An actual deterioration in performance was observed in some of the more complex functions sampled (Lezak, 1979).

Such instances of "secondary regression" (Lezak, 1979) are frequently observed in the emotional and psychosocial realms of functioning (Brooks, Hosie, Bond, Jennett & Aughton, 1986; Brooks & McKinlay, 1983; McKinlay et al., 1981; McKinlay & Brooks, 1984; Thomsen, 1984). On one hand, these findings may suggest that the changes following head-injury do not necessarily occur in the direction of improvement (Lezak, 1979). On the other hand, they may reflect a bias in the reports provided by patients and relatives. Subtle deficits may not be considered worth reporting as long as more obviously disabling problems persist (McKinlay & Brooks,1984). Once the more visible consequences of head-injury have disappeared, however, higher-level impairment emerges as a major contributor to the debasement of patients' and relatives' daily living situations.

From Denial to Awareness of Deficit

One factor that contributes to the layered symptom emergence in head-injured patients is the shift toward increased awareness of loss of function. While typically recognizing the degree of their physical impairment, head-injured patients tend to initially underestimate their cognitive deficits relative to the estimates of relatives and health care professionals (Deaton, 1986; Fordyce & Roueche, 1986; Nockleby & Deaton, 1987; Prigatano, 1986a). Awareness of deficit follows the clearing of cognitive confusion, and tends to be accompanied by growing emotional distress (Fordyce & Roueche, 1986; Fordyce, Roueche & Prigatano, 1983; Nockleby & Deaton, 1987; Prigatano, 1986a; Roueche & Fordyce, 1983).

Although inaccurate self-appraisal may be a direct result of cerebral damage, psychogenically-based factors may also reinforce the denial of deficit (Deaton, 1986; Fordyce & Roueche, 1986; Prigatano, 1986a; Rosen, 1986; Roueche & Fordyce, 1983). Specifically, denial serves as a defense mechanism that protects the head-injured patient from the dispair that accompanies full awareness of mental and physical loss. Other "advantages" of denial include increased motivation to recover to a performance level that exceeds professional expectations and the preservation of self-esteem and hope for the future. Disadvantages of denial include the premature withdrawal from rehabilitation, the premature attempt to resume a pre-injury life-style and conflict with those holding more realistic views regarding patient impairment (Deaton, 1986; Nockleby & Deaton, 1987; Roueche & Fordyce, 1983).

The Emergence of Secondary Deficits

Personality, emotional and psychosocial changes in head-injured patients can be classified into those resulting directly from cerebral damage, those reflecting premorbid characterological styles and those constituting psychogenically-based reactions to head-trauma (Prigatano, 1986b). Few symptoms observed in head-injured patients, however, clearly fit one category of this classification. The symptoms associated with the post-concussional syndrome, for example, may reflect both organically-based problems or psychological stress reactions (E. Miller, 1979). Similarly, post-traumatic depression, anxiety, irritability and anger may be direct consequences of brain damage or reactions to physical and mental losses (Lezak, 1988; McKinlay & Brooks, 1984; Newman, 1984; Newton & Johnson, 1985; Parsons & Prigatano, 1978; Prigatano, 1986a). In one sample of head-injured subjects, for example, a higher incidence of depression was found in those patients that had longer injury-assessment intervals and more intact cognitive-perceptual functions (Atteberry-Bennett, Barth, Loyd & Lawrence, 1986).

Psychosocial and interpersonal functioning may also deteriorate as a result of secondary consequences of head-injury (Newman, 1984; Newton & Johnson, 1985). Direct sequelae of cerebral damage such as impaired attention, distorted perception and rigid thinking, may impair patients' social interaction skills and lead to inappropriate social behavior. This secondary consequence may in turn give rise to feelings of inadequacy, resentment and subsequent social withdrawal.

The Efficacy of Neuropsychological Measures to Assess Problems in Daily Functioning

Although initially greeted with optimism, the use of neuropsychological tests to predict everyday functioning has recently been criticized (e.g., Chelune & Moehle, 1986; Heaton & Pendleton, 1981). The following review traces this shift in order to justify the need for alternative methods to evaluate problems in daily functioning.

As early as the 1960s, neuropsychological screening batteries, intelligence tests and personality inventories were shown to differentiate between unemployed and employed epileptic patients (Dennerll, Rodin, Gonzalez, Schwartz & Lin, 1966; Schwartz, Dennerll & Lin, 1968). More recently, these types of measures have been associated with employment status (Dikmen & Morgan, 1981; Dodrill & Clemmons, 1984; Heaton, Chelune & Lehman, 1978; Newman, Heaton & Lehman, 1978), level of occupational attainment (Dikmen & Morgan, 1981; Newman et al., 1978), vocational success (Webster, 1979) and hourly wage (Newman et al., 1978). Neuropsychological testing has also been shown to accurately predict problems in independent living, academic success and perceived quality of life (see Chelune & Moehle, 1986; and Heaton & Pendleton, 1981; for reviews of this literature).

Studies assessing the relationship of neuropsychological measures to such broadly based areas as quality of life typically find that specific tests best predict adjustment in relatively circumscribed areas of functioning. Measures tapping motor and psychomotor abilities, for example, have been associated with physical mobility, capability for self-care, and adjustment in the home, at work, and in interpersonal relationships (Klonoff et al., 1986; McSweeney, Grant, Heaton, Prigatano & Adams, 1985). Simlarly, aphasia tests have shown relationsips to patients' abilities to communicate with others (McSweeney et al., 1985).

Despite the promising conclusions regarding the efficacy of neuropsychological measures to predict certain areas of daily functioning (Chelune & Moehle, 1986; Heaton & Pendleton, 1981), the research in this area has several short-comings.

The representativeness of these studies has been criticized on three grounds (Chelune & Moehle, 1986; Heaton & Pendleton, 1981). First, the same set of neuropsychological measures are typically subjected to the test of applicability to daily functioning (Heaton & Pendleton, 1981). Specifically, the Wechsler Scales and Halstead-Reitan Neuropsychological Test Battery tend to be selected as the representatives of neuropsychological assessment. While this choice may be justified by the frequent use of these measures in clinical settings, it is made at the expense of a large number of alternative tests that might have direct applicability to daily functioning. Second, a large portion of studies is conducted with subject groups that differ from those clients that are typically referred for neuropsychological assessment (Chelune & Moehle, 1986; Heaton & Pendleton, 1981). Preferred research populations are epileptics, schizophrenics and the mentally retarded (see Chelune & Moehle, 1986; Heaton & Pendleton, 1981), while traumatically brain-injured patients are underrepresented. Third, everyday functioning tends to be operationalized in terms of global and/or objectively verifiable criteria such as independent living and vocational status, thus neglecting the complex nature of daily living (Boll, 1985; Heaton & Pendleton, 1981).

One notable exception is a study that assessed the relationship between neuropsychological measures and driving performance in brain-damaged subjects (Sivak, Olson, Kewman, Won & Henson, 1981). Measures of cognitive-perceptual skills were administered to neurologically impaired, orthopaedically handicapped and normal control subjects. Driving ability was assessed in closed-track and in-traffic situations. Brain-damaged subjects were impaired in terms of both cognitive-perceptual functioning and driving performance, while orthopaedically impaired subjects resembled normal control subjects. The best neuropsychological test predictors of driving ability differed for brain-damaged and non-brain-damaged subjects, suggesting that different underlying cognitive-perceptual skills are the primary determinants of driving ability for the two groups (Sivak et al., 1981).

Limitations of the Formal Neuropsycholgical Evaluation

The efficacy of neuropsychological measures to detect problems in daily functioning is further complicated by the nature of the neuropsychological evaluation.

The main rationale underlying the (neuro)psychological evaluation is the assumption that the assessment process is an ecologically valid procedure. Specifically, it is assumed that the behavior observed in the testing situation represents a valid sample of the examinee's typical mode of functioning. Furthermore, it is assumed that the deficits observed during (neuro)psychological testing reflect the examinee's difficulties in everyday living (Chelune & Moehle, 1986; Heaton & Heaton, 1981; Heaton & Pendleton, 1981; Lezak, 1983).

Given that the issues of test validity and reliability are given high priority in neuropsychological assessment, the issues of representativeness and applicability to everyday living have traditionally been neglected. In the formal neuropsychological evaluation, examinees are typically required to perform a number of highly specific tasks that may have limited applicability to day-to-day living (Lezak, 1983). The lack of a perfect correspondence between the tasks performed in the test situation and in day-to-day living does not necessarily invalidate generalizations and predictions. Neuropsychological tests, for example, effectively uncover real-life deficits in cognitive functions such as short-term memory and visuo-spatial construction.

Recently, however, the efficacy of the neuropsychological evaluation to detect more subtle and complex problems in daily functioning has been questioned (Lezak, 1978, 1982, 1983, 1985; Prigatano, 1986a) and the issue of ecological validity has received considerable attention. As Lezak has stated, "we increasingly come to appreciate that the brain functions we study are always the functions of <u>somebody's</u> brain and that that somebody has a life outside of our examining rooms and laboratories (Lezak, 1982, p. 295).

In terms of the sensitivity of neuropsychological assessment to subtle deficits, follow-up studies with mildly head-injured patients often find a discrepancy between neuropsychological test performance and patients' subjective reports. In one series of studies, mildly-injured patients appeared to have made remarkable recoveries psychometrically. Their subjective reports, however, suggested difficulties with memory and concentration, difficulties with the resumption of daily activities and impaired psychosocial and emotional functioning (Dikmen, McLean & Temkin, 1986; McLean, Temkin, Dikmen & Wyler, 1983). Although these findings do not identify the source of the discrepancy in estimated patient impairment, they illustrate that patients' subjective reports are not necessarily commensurate with the degrees of deficit indicated by their objective test profiles.

In terms of the ability of neuropsychological testing to detect problems in more complex functioning, the highly standardized nature of neuropsychological assessment is problematic (Lezak, 1978, 1983, 1985; Prigatano, 1986b). First, the quantification of behavior in terms of abstract test scores results in performance estimates that are far removed from the examinees' original behavior and that deemphasize qualitative, observational data (Brooker, 1982; Heaton & Heaton, 1981, Lezak, 1983). Furthermore, neuropsychological assessment may not be sensitive to those all-encompassing control functions that concern the regulation and execution of ongoing behavior.

The Difficulty of Assessing the Executive Functions

The executive functions described by Lezak (1982, 1983, 1985) exemplify one aspect of daily functioning that is not as amenable to structured neuropsychological assessment as the cognitive functions.

The executive functions can be divided into four steps that are required for the performance of a complex behavioral sequence: formulating a long-term goal, planning the actions required to achieve this goal, carrying out goal-directed actions, and effectively delivering purposive behavior (Lezak, 1982, 1983, 1985). The executive functions differ from the cognitive functions on two important dimensions. First, whereas cognitive functioning is concerned with what or how much skill and intellectual knowledge an examinee possesses, executive functioning emphasizes how or whether a task is performed. Second, whereas cognitive functioning involves highly specific skills, executive functioning encompasses virtually all aspects of behavior (Lezak, 1982, 1983, 1985). The abilities underlying executive functioning include conceptualizing one's long-term abstract needs, making decisions, initiating and maintaining complex behavioral sequences, thinking and behaving flexibly and regulating one's behavior (Lezak, 1982, 1983).

Given the immediate relevance of these abilities to all domains of everyday functioning, it is not surprising that defective executive functioning severely reduces the quality of patients' lives. As a result of the supramodal (Lezak, 1982) nature of these abilities, however, they are difficult to pinpoint in the highly structured neuropsychological evaluation (Lezak, 1982, 1983, 1985). In order to gain information regarding the intactness of the executive functions, the experimenter finds himself in the difficult situation of having to "structure a situation in which the patient can show whether and how well he can make structure for himself" (Lezak, 1983, p.508). Lezak's (1982) Tinkertoy test presents an attempt to circumvent this "paradox" by providing the examinee with a minimally-structured task involving the execution of a complex behavioral sequence.

<u>The Use of Questionnaires to assess Problems in Daily Functioning</u>

Given the limitations of neuropsychological testing to detect subtle and complex aspects of impaired daily functioning, the use of self-report or third-person-report inventories has become wide-spread. Existing questionnaires and checklists range from global indices of outcome (e.g., Glasgow Outcome Scale, Jennett & Bond, 1975) to detailed profiles of adjustment in various domains of everyday functioning.

In terms of the latter category, the Katz Adjustment Scales (Katz & Lyerly, 1963) are most widely used. The KAS-R was designed to obtain ratings of patients' everyday adjustment on the basis of "significant other" reports. A parallel form exists for patient self-ratings. Both the self-report and "significant other" forms require respondents to rate both patient adjustment and their satisfaction thereof (Katz & Lyerly, 1963).

A number of features contribute to the usefulness of the Katz Adjustment Scales in the assessment of post-head-injury impairment in daily functioning. First, adjustment ratings can be obtained on the basis of both patient and relative reports, thus providing more confidence in profiles of reported impairment. Second, the requirement of both adjustment and "satisfaction with adjustment" ratings supply an indirect estimate of pre-injury functioning. Third, the KAS-R samples psychiatric, psychosocial, personality, emotional and motivational adjustment. All of these domains represent problematic areas for head-injured patients. A major short-coming of the KAS-R is its neglect of the higher cognitive and executive functions.

Lezak's (1987) Portland Adaptability Inventory (PAI) taps difficulties in three domains related to daily functioning: temperament and emotionality, activities and social behavior and physical capabilities. Given the emphasis Lezak places on higher-level cognitive and executive functioning, it is surprising that these domains are only represented in terms of items relating to patients' abilities to initiate behavior. A further disadvantage of the PAI is its higher weighting of third-person ratings or objectively verifiable events. While this bias may reduce inaccuracy due to patients' distorted perceptions of impairment, it also eliminates the benefit of subjective experience.

The Patient's Assessment of Own Functioning Inventory (Heaton, Chelune & Lehman, 1981, see Lezak, 1983) incorporates many desirable features for the assessment of everyday functioning in head-injured patients. First, it covers many of the domains that tend to be problematic for head-injured patients. Memory, language and communication, the use of hands, sensory-perceptual functioning, higher-level cognitive and intellectual functioning, vocational and recreational functioning are all represented in this inventory. Notably absent, however, are emotional and psychosocial functioning. A second advantage of the PAOFI is its conceptual simplicity. One item designed to assess sustained attention, for example, questions respondents about their difficulties in "following a conversation while other people are talking". A third advantage is the Relative's Assessment of Patient Functioning Inventory, designed to obtain "significant other" ratings. Instead of rating sensory-perceptual functioning, relatives rate personality changes in the patient. One short-coming of the PAOFI is the absence of a pre-injury estimate of everyday functioning. Respondents rate the absolute frequency of deficits, rather than their relative increase since the injury.

A promising measure of everyday memory functioning developed by Sunderland, Harris and Gleave (1984), includes 35 memory problems commonly experienced by head-injured patients. This instrument also contains rarely endorsed 'floor' items to detect malingering or random responding. An initial validation study showed an association of "significant other" ratings with patients' neurological impairment profiles. No such relationship was obtained in the case of patient self-ratings. The authors suspected that patients had underestimated their problems in daily functioning, possibly as a result of the complex format of the questionnaire. The requirement of patients to estimate the frequency of occurence of each memory problem (e.g. "once a week", "more than once a week") may have placed too great a demand on the cognitive apparatus of the head-injured respondents. The authors suggested the use of pre/post injury or above/below average ratings as more appropriate answer choices (Sunderland et al., 1984).

The Present Study

Despite the increasing appreciation of the benefit of self-ratings and third-party reports in neuropsychological assessment, the existing scales all suffer from certain limitations. The present study centers on the development and initial validation of a self-report inventory that assesses head-injured patients' problems in daily functioning and that avoids the short-comings of the presently available scales. Item construction of the Simon Fraser University (SFU) Index of Neuropsychological Functioning was guided by three sources. First, the literature concerned with the long-term consequences of traumatic head-injury was consulted (e.g., Brooks, Campsie, Symington, Beattie & McKinlay, 1986; Brooks & McKinlay, 1983; Lezak, 1982; McKinlay, Brooks, Bond, Martinage & Marshall, 1981;, Prigatano, 1986a, 1986b; Weddell, Oddy & Jenkins, 1980). Second, the content areas covered by the KAS-R (Katz & Lyerly, 1963), Patient's Assessment of Own Functioning Inventory (Heaton et al., 1981, see Lezak, 1983) and Portland Adaptability Inventory (Lezak, 1987) served as a starting base. Third, those problems that were commonly observed and reported in the author's clinical work with head-injured subjects were incorporated into the SFU Index.

Self-ratings of problems in daily functioning were obtained from head-injured patients and non-head-injured control subjects. "Significant other" ratings were provided by an adult in daily contact with each subject. The following hypotheses were investigated:

1. It was expected that head-injured subjects would obtain significantly higher scores on the SFU Index than control subjects, indicating a higher degree of impairment in daily functioning.

2. Given the well-documented tendency of head-injured patients to underestimate non-physical deficits, it was expected that the impairment ratings provided by "significant others" would significantly exceed those provided by head-injured patients.

3. It was also expected that the discrepancy between subject and "significant other" ratings would be significantly larger for the head-injured patient group than for the control subject group.

4. Ten items were designed to assess malingering or random responding via the endorsement of highly unlikely

'neuropsychological symptoms'. It was expected that these items would be endorsed on a significantly lower basis by head-injured patients and their "significant others" than actual problems in daily functioning. Given that control subjects and their "significant others" were expected to endorse a minimal level of impaired daily functioning, no such discrepancy was expected to occur in their case.

In order to explore the relationship of the SFU Index to standardized neuropsychological measures, a number of tests that are routinely used to assess higher-level cognitive functioning were also adminstered to the head-injured patients. Those tests that, in combination or by themselves, emerged as powerful predictors of problems in daily functioning, as measured by the SFU Index, were identified. Given the high predictor-to-subject ratio, this portion of the present study is intended as a pilot project designed to guide future research.

CHAPTER II

METHOD

Subjects

The subjects included 22 males with documented histories of mild to severe traumatic head injury. The subjects were recruited from those patients referred for neuropsychological assessment to the Workers' Compensation Board of British Columbia (n=12), to the G. F. Strong Rehabilitation Centre in Vancouver, B.C. (n=7) and to a private psychological firm (Posthuma, Wydra & Wild), in Vancouver, B.C. (n=3).

The control subject group consisted of 22 males who did not have previous histories of head-injury or psychiatric difficulties. Control subjects were recruited from the pool of telephone volunteers at Lifeline Crisis Centre in Coquitlam, B.C., (n=8) and from the tenants of two apartment complexes in Burnaby, B.C. (n=14). Table 1 presents a summary of head-injured patient and control subjects' demographic characteristics.

In addition to patient and control subjects, an adult who was living with each subject at the time of testing was asked to participate in the present study. For head-injured subjects, this "significant other" must have lived with the

Table 1

Subject Demographic Characteristics

	Patient (n=22)	Control (n=22)
Age at Testing:*		
Mean	39/03	38/07
SD	14/09	12/05
Range	19/11-62/06	21/04-68/07
Age at Injury:		
Mean	35/11	--
SD	14/00	--
Range	15/07-57/04	--
Time Since Injury:		
Mean	3/03	--
SD	3/07	--
Range	00/05-17/01	--
Education:		
Mean	11.09	13.18
SD	1.85	1.50
Range	8-15	10-17

*Note: Age at Testing, Age at Injury and Time Since Injury are presented as years/months.

Table 1 (continued)

	Patient (n=22)	Control (n=22)
Estimated Premorbid Full-Scale IQ:*		
Mean	99.82	106.32
SD	5.58	4.61
Range	91.02-109.39	97.46-118.19
Estimated Premorbid Verbal IQ:		
Mean	99.05	106.30
SD	5.98	4.75
Range	89.25-109.53	97.14-118.56
Estimated Premorbid Non-Verbal IQ:		
Mean	100.11	105.18
SD	4.34	3.57
Range	93.51-107.53	98.49-114.36

*Note: The regression equations for premorbid IQ estimation (Barona, Chastain & Reynolds, 1984) are:

FSIQ = 54.96 + 0.47(age) + 1.76(sex) + 4.71(race) + 5.02(educational level) + 1.89(occupational level) + 0.59(geographic region)

VIQ = 54.23 + 0.49(age) + 1.92(sex) + 4.24(race) + 5.25(ed) + 1.89(occ) + 1.24(urban/rural residence)

PIQ = 61.58 + 0.31(age) + 1.09(sex) + 4.95(race) + 3.75(ed) + 1.54(occ) + 0.82(geographic region) subject for at least one year prior to the injury. For control subjects, the "significant other" must have lived with the subject for at least one year prior to testing. Fourteen wives, three girl-friends, three parents and two siblings served as "significant others" for the head-injured patients. Nineteen wives, two siblings and one room-mate fulfilled this role for the control subjects.

Neuropsychological Measures

Wechsler Adult Intelligence Scale - Revised

The WAIS-R (Wechsler, 1981) provides a global index of intellectual functioning and separate indexes of verbal-conceptual and non-verbal, visuo-spatial functioning. The validity and reliability of the WAIS-R have been well-documented (Wechsler, 1981). A brief description of the five WAIS-R subtests that were administered to head-injured patients follows.

Digit Span requires subjects to repeat sequences of random numbers read by the experimenter. In the second part, number sequences are repeated in the reverse order. Both parts of the Digit Span subtest assess immediate short-term auditory memory, sequencing, attention and concentration (Kaufman, 1979; Ogdon, 1977). The second part further requires the ability to simultaneously remember and mentally manipulate the auditory material (Lezak, 1983).

Comprehension consists of 13 open-ended questions measuring awareness of societal conventions, common-sense decision-making and the ability to apply past experiences to new situations (Kaufman, 1979; Lezak, 1983; Ogdon, 1977). Three additional items require the interpretation of proverbs. In younger subjects, performance on these items depends on the intactness of abstract reasoning skills. In older subjects, performance is affected by the ability to recall and apply previously acquired material (Lezak, 1983).

Similarities requires subjects to deduce the common properties of the members of 14 word-pairs. This measure assesses verbal concept formation, abstract thinking and the ability to differentiate essential from non-essential details (Kaufman, 1979; Lezak, 1983; Ogdon, 1977; Peck, Stephens & Martinelli, 1987)

Picture Arrangement requires subjects to arrange ten sets of cartoon-like drawings in the most conceptually meaningful manner (Wechsler, 1981). This non-verbal counterpart to the Comprehension subtest (Lezak, 1983) requires planning, sequential thinking and the detection of cause-and-effect relationships in social situations (Kaufman, 1979; Lezak, 1983; Ogdon, 1977; Peck et al., 1987).

Block Design requires subjects to reproduce nine two-dimensional designs from models. This ~~task~~ assesses visuo-spatial analysis and synthesis, and visuomotor coordination (Kaufman, 1979; Ogdon, 1977).

The age-scaled scores (see Wechsler, 1981) for Digit Span, Comprehension, Similarities, Picture Arrangement and Block Design were included as independent scores in the present study.

Trail-Making Test

The Trail-Making Test (Army and Navy Individual Test Battery, 1944, see Lezak, 1983) is widely recognized as a reliable and valid indicator of brain damage (Boll & Reitan, 1973; Greenlief, Margolis & Erker, 1985; Reitan, 1955, 1958; Stuss, Stethem & Poirier, 1987). Part A requires subjects to connect consecutively numbered circles as quickly as possible, and assesses perceptual motor speed, attention and concentration. Part B requires subjects to alternately connect numbers and letters in ascending numerical and alphabetical order, respectively. This part further measures cognitive flexibility and mental tracking of multiple concepts (Lezak, 1983)

For the purpose of the present study, subjects' measured amounts of time to complete parts A and B of the TMT were included as independent scores. Although errors were not directly penalized, their occurence indirectly affected performance by lengthening completion time (see Lezak, 1983).

Booklet Category Test

The Booklet Category Test (DeFilippis & McCampbell, 1979) requires subjects to deduce the underlying principles that govern the relationship between a series of geometric forms (Peck et al., 1987). This measure of abstract thinking and concept formation also contains a learning component, since subjects modify their performance on the basis of ongoing and immediate feedback (Boll, 1981; Reitan, 1979).

Halstead's (1947) original Category Test is a reliable and valid indicator of brain damage (Boll, 1981; Doehring & Reitan, 1962; Filskov & Golstein, 1974; Goldstein & Shelley, 1972; Lezak, 1983; Shaw, 1966). Studies comparing the Halstead Category Test and the portable modification used in the present study indicate high correlations between the two versions of the test (see DeFilippis & McCampbell, 1979).

For the purpose of the present study, subjects' total error scores were calculated.

Wisconsin Card Sorting Test

Despite obvious surface similarities between the Wisconsin Card Sorting Test (Berg, 1948) and the Halstead Category Test, recent studies have recommended their conjoint use to assess different aspects of abstract thinking and concept formation (Bond & Buchtel, 1984; Pendleton & Heaton, 1982; Rothke, 1986). The WCST consists of two packs of 64 cards on which are printed one to four different symbols (triangles, stars, crosses and circles) in one of four colors (red, green, yellow or blue). Subjects are required to place the cards, one at a time, under one of four stimulus cards according to an underlying principle which they must deduce. Ongoing and immediate feed-back regarding the correctness or incorrectness of each placement is provided by the examiner. The WCST has been found to be a valid and reliable discriminator between brain-damaged and non-brain-damaged subjects (Drewe, 1974; Heaton, 1981; Malmo, 1974; Robinson, Heaton, Lehman & Stilson, 1980).

The present study included the WCST Categories Achieved and Perseverative Error scores. The former score reflects the number of completed runs of ten consecutive correct placements, while the latter reflects perseverative tendencies (see Heaton, 1981, for Perseverative Error scoring criteria).

Stroop Color Word Test

Golden's (1975) version of the Stroop Color Word Test (Stroop, 1935) consists of three pages on which are printed five columns of twenty stimuli. On the first page, the words "red", "blue" and "green" are printed in black ink. On the second page, "XXXX" strings are printed in red, blue or green ink. On the third page, the words "red", "blue" and "green" are printed in red, blue or green ink. On this page, a word and the ink it is printed in never match. For example, the word "red" may appear in blue or green, but never in red ink. Subjects read the words as quickly as possible on the first page and name the color of the "XXXX" strings as quickly as possible on the second page. On the third page, subjects name the color of the ink, not the printed word, as quickly as possible.

This measure of "general cognitive efficiency" (Berg, Franzen & Wedding, 1987) requires subjects to select and attend to relevant information, and to filter out interfering material according to changing demands (Golden, 1978). The validity and reliability of the SCWT as a discriminator between brain-damaged and non-impaired subjects have been well-documented (Franzen, Tishelman, Sharp & Friedman, 1987; Golden, 1975, 1976, 1978; Jensen & Rohwer, 1966).

Four SCWT scores were included in the present study. The 'Word','Color' and 'Color-Word' scores were the t-scores based on the number of items completed on the first, second and third pages, respectively. The 'Interference' score, excluding speed factors, is a t-score based on the subtraction of a predicted color-word score (C x W/C + W) from the observed color-word score (Golden, 1978).

Assessment of Daily Functioning: The Simon Fraser University (SFU) Index of Neuropsychological Functioning

SFU Index Content

The Simon Fraser University (SFU) Index of Neuropsychological Functioning is a 68-item inventory that covers five areas of functioning that are related to daily living:

1. **Language & Communication:** (7 items)
   This category assesses linguistic expression and reception, word-finding and tangentiality of speech. Items concerned with reading comprehension and writing skill are also included.

2. **Memory, Attention & Concentration:** (13 items)
   This category is concerned with temporal and spatial orientation, various aspects of attention (sustained

attention, shifting attention), concentration, new learning and memory. Immediate, recent and remote memory functions are assessed.

3. **Executive Functioning & Motivation:** (17 items)
This category assesses the intactness of Lezak's (1982, 1983) four stages of executive functioning: goal formulation and initiation, planning, carrying out goal-directed behavior and effective performance. Additional abilities covered include the speed of information processing, problem-solving, perseverance, self-monitoring and functional independence in everyday living.

4. **Social Activities & Interpersonal Adjustment:** (10 items)
This category is concerned with the appropriateness of behavior in social situations, the frequency of social contact and the quality of interpersonal relationships.

5. **Emotional Functioning:** (11 items)
This category assesses general changes in emotionality and in a number of specific emotions such as anger, anxiety, indifference, sadness, excessive excitability and excessive euphoria.

In addition to the items tapping problems in daily functioning, 10 items were developed to detect malingering or random responding. These items questioned respondents about changes in the occurence of non-existing or highly unlikely "neuropsychological symptoms". One item, for example, asks whether subjects have more difficulty "remembering the faces of males than females". Another item inquires about the frequency of subjects' vision switching "to black and white and then back to color". Appendix A presents a list of the items included in the SFU Index.

Four parallel forms of the SFU Index were developed for use with head-injured patients, non-impaired control subjects and "significant others" of each group. Apart from minor grammatical adaptations, item content remained identical for all forms. The "Subject Form" of the SFU Index requires head-injured respondents to rate current problems in daily functioning relative to pre-injury levels. The focus on relative changes rather than absolute impairment is also emphasized in the instructions preceeding the test items. The "Control Subject Form" requires non-head-injured respondents to rate the occurence of the problems relative to "about a year ago". The "Significant Other" and "Significant Other Control" forms require persons in frequent contact with head-injured and control subjects to rate changes in subjects' daily functioning relative to previous levels (i.e., "prior to the injury" or "about a year ago"). The SFU Index utilizes a five-point rating scale, with answer choices ranging from "No [increase in frequency of occurence]" to "Much More".

SFU Index Scoring

The following SFU Index summary and content area scores were calculated:

1. **SFU Index Total Score:** This score is based on subjects' average endorsement of all 68 items of the SFU Index, including Malingering items, and has a range from 1 to 5.

2. **SFU Index Impairment Score:** This score is similar to the Total score, except for its exclusion of the 10 Malingering items.

3. **Malingering and Random Responding Score:** This score represents subjects' average endorsement of the 10 items which are unlikely to be sequelae of head-injury.

4. **SFU Index Content Area Scores:** Five scores were calculated on the basis of subjects' average endorsement within each area of daily functioning sampled (e.g., Language & Communication).

Procedure

Head-injured subjects were asked to participate in the present study while undergoing neuropsychological evaluation, or prior to a feedback meeting following neuropsychological testing. Patient "significant others" were asked to complete the SFU Index of Neuropsychological Functioning at the time the patient was tested or at home. In the latter case, questionnaires were returned by mail.

Those tests that were added to head-injured subjects' assessments for the present study were administered by the author. Those tests constituting regularly scheduled assessments were administered by trained testers employed by the participating institutions. Demographic and injury-related information was obtained from patients' files.

Control subjects and their "significant others" returned questionnaires by mail. Demographic information and details regarding previous histories of head-injury or psychiatric problems were based on subjects' self-report.

Method of Premorbid IQ Estimation

Subjects' premorbid levels of intellectual functioning were estimated using a demographically based index (Barona, Reynolds & Chastain, 1984) for use with the 1981 Wechsler Adult Intelligence Scale - Revised (Wechsler, 1981). Full-scale, Verbal and Non-Verbal intelligence quotients were calculated. Head-injured subjects' levels of intellectual functioning were estimated on the basis of occupation, residence (urban versus rural), age and level of education at the time of injury. Control subjects' levels of intellectual functioning were based on their demographic characteristics one year ago. This time-frame was chosen to simulate the premorbid estimates calculated for head-injured subjects. Specifically, on the SFU Index head-injured subjects compared present difficulties in daily functioning to those experienced prior to the injury. Control subjects compared current difficulties in daily functioning to those experienced "about a year ago".

Missing Data

Missing data points were estimated by regressing the variable in question on up to two variables selected by step-wise regression. This procedure was applied to estimate missing demographic information for two control subjects, Trail-Making Test scores for one head-injured patient, and missing SFU Index scores for three "significant others". Table 2 summarizes the pattern of missing data for all subject groups.

Table 2

Cases with Missing Data For Each Subject Group

	Patient (n=22)	Control (n=22)	Patient S.O. (n=22)	Control S.O. (n=22)
Personal and Demographic Data	0	2	-	-
Neuropsychological Test Data	1	-	-	-
SFU Index Scores	0	0	3	0

Level of Statistical Significance

Unless otherwise indicated, a probability level of $p<.05$ was considered statistically significant in the present study.

CHAPTER III

RESULTS

Summary and Content Area Scores of the SFU Index of Neuropsychological Functioning

The means and standard deviations for each subject group on the individual SFU Index items are presented in Appendix B. The means and standard deviations for each subject group on the SFU Index Summary and Content Area scores are presented in Table 3.

The Summary scores were subjects' averages on the 68-item Total score (including Malingering items), the 58-item Impairment score (excluding Malingering items) and the 10-item Malingering score. The Content Area scores were subjects' averages on the seven 'Language and Communication' items (Lang scale), the 13 'Memory, Attention and Concentration' items (Memo scale), the 17 'Motivation and Executive Functioning' items (Exmot scale), the 10 'Social Functioning' items (Soc scale) and the 11 'Emotional Functioning' items (Emo scale).

Table 3

Means and Standard Deviations on SFU Index Summary and Content Area Scores

	Tot	Imp	Mal	Lang	Memo	Exmot	Soc	Emo
Patient								
Mean	2.32	2.48	1.47	2.58	2.67	2.40	2.29	2.46
SD	0.79	0.86	0.46	0.85	1.06	0.96	0.88	0.92
Patient "Significant Other"								
Mean	2.42	2.61	1.34	2.75	2.58	2.77	2.21	2.64
SD	0.72	0.82	0.21	0.92	0.92	1.06	0.85	0.90
Control								
Mean	1.23	1.26	1.07	1.17	1.20	1.25	1.26	1.40
SD	0.26	0.29	0.10	0.24	0.29	0.33	0.46	0.57
Control "Significant Other"								
Mean	1.19	1.21	1.05	1.19	1.19	1.23	1.20	1.26
SD	0.23	0.26	0.09	0.33	0.25	0.32	0.31	0.35

Note: Means represent averages on a 5-point scale.

SFU Index of Neuropsychological Functioning Internal Consistency

In order to assess the internal consistency of the SFU Index, reliability coefficients (Cronbach's Alphas) were calculated for the SFU Index Total, Impairment and Content Area scores for all subject groups. Given the low variability observed on the Malingering scale (see Table 3), this portion of the SFU Index was excluded from this analysis. As is revealed by Table 4, extremely high consistency was obtained for all subject groups on those items assessing problems in daily functioning, attesting to the reliability of these SFU Index items.

Relationship between SFU Index of Neuropsychological Functioning Summary Scores

The correlation matrices for the SFU Index Summary and Content Area scores are presented in Tables 5 to 8, for patients, patient "significant others", control subjects and control "significant others", respectively. For all subject groups, a perfect positive correlation (r=1.00) was obtained between the SFU Index Total score and Impairment score. Given that the former score includes the items constituting the latter score (Total = Impairment + Malingering; where Malingering is almost a constant due to low variability),

Table 4

Internal Consistency Coefficients for SFU Index Summary and Content Area Scores

	Patient	Patient S.O.	Control	Control S.O.
Total	.9770	.9720	.9362	.9439
Impairment	.9770	.9741	.9371	.9413
Language & Commn	.8237	.8234	.5761	.7537
Memory, Attn & Concn	.9517	.9303	.8064	.8163
Executive & Motivn	.9465	.9541	.8564	.8754
Social	.8823	.8550	.8987	.8391
Emotional	.8730	.8992	.8770	.7424

Table 5

Correlation Matrix of SFU Index Summary and Content Area Scores for Patient Group

	Tot	Imp	Mal	Lang	Memo	Exmot	Soc	Emo
Tot	1.00							
Imp	1.00	1.00						
Mal	0.85	0.82	1.00					
Lang	0.76	0.78	0.47**	1.00				
Memo	0.94	0.94	0.73	0.75	1.00			
Exmot	0.95	0.95	0.77	0.72	0.87	1.00		
Soc	0.95	0.94	0.84	0.68	0.82	0.87	1.00	
Emo	0.85	0.83	0.84	0.42**	0.73	0.74	0.89	1.00

Note: The above correlation coefficients are statistically significant at the $p<.01$ level (uncorrected per-correlation error rates based on two-tailed tests), with the following exceptions:

for ** $p<.05$

Table 6

Correlation Matrix of SFU Index Summary and Content Area Scores for Patient "Significant Other" Group

	Tot	Imp	Mal	Lang	Memo	Exmot	Soc	Emo
Tot	1.00							
Imp	1.00	1.00						
Mal	0.68	0.66	1.00					
Lang	0.88	0.88	0.45**	1.00				
Memo	0.84	0.84	0.68	0.73	1.00			
Exmot	0.95	0.95	0.66	0.82	0.76	1.00		
Soc	0.81	0.82	0.36*	0.74	0.55	0.70	1.00	
Emo	0.82	0.82	0.58	0.62	0.52**	0.73	0.70	1.00

Note: The above correlation coefficients are statistically significant at the $p<.01$ level (uncorrected per-correlation error rates based on two-tailed tests), with the following exceptions:

for ** $p<.05$
* $p>.05$

Table 7

Correlation Matrix of SFU Index Summary and Content Area Scores for Control Subject Group

	Tot	Imp	Mal	Lang	Memo	Exmot	Soc	Emo
Tot	1.00							
Imp	1.00	1.00						
Mal	0.52**	0.47**	1.00					
Lang	0.78	0.78	0.31*	1.00				
Memo	0.55	0.55	0.21*	0.74	1.00			
Exmot	0.82	0.84	0.23*	0.84	0.59	1.00		
Soc	0.82	0.81	0.54	0.37*	0.06*	0.47**	1.00	
Emo	0.85	0.84	0.48	0.40*	0.15*	0.47**	0.94	1.00

Note: The above correlation coefficients are statistically significant at the $p<.01$ level (uncorrected per-correlation error rates based on two-tailed tests), with the following exceptions:

for ** $p<.05$
* $p>.05$

Table 8

<u>Correlation Matrix of SFU Index Summary and Content Area Scores for Control "Significant Other" Group</u>

	Tot	Imp	Mal	Lang	Memo	Exmot	Soc	Emo
Tot	1.00							
Imp	1.00	1.00						
Mal	0.85	0.83	1.00					
Lang	0.81	0.81	0.73	1.00				
Memo	0.90	0.90	0.79	0.73	1.00			
Exmot	0.92	0.91	0.88	0.86	0.83	1.00		
Soc	0.58	0.60	0.26*	0.18*	0.46**	0.24*	1.00	
Emo	0.90	0.91	0.72	0.59	0.68	0.76	0.69	1.00

<u>Note</u>: The above correlation coefficients are statistically significant at the $p<.01$ level (uncorrected per-correlation error rates based on two-tailed tests), with the following exceptions:

for ** $p<.05$
* $p>.05$

this finding is not surprising.

Significant correlations were obtained between the Malingering score and the Impairment score for all subject groups except the control group (see Tables 5 to 8). This illustrates that the endorsement of Malingering items paralleled the endorsement of daily functioning items for some subject groups, most notably patients and control "significant others". For the control "significant others", this tendency is best explained in terms of the low overall endorsement of SFU Index items. Specifically, these respondents showed high agreement that neither actual nor unlikely sequelae of head-injury presented a problem for the control subjects. In terms of the patients, the relatively high degree of parallel responding between Malingering and daily functioning items may reflect a lack of insight into the exact nature of their difficulties, an overly liberal response style or the misinterpretation of certain items.

Visual inspection of subjects' means on the SFU Index (see Table 3), however, reveals that the Malingering score was consistently lower than the lowest Content Area score for all groups. Moreover, for all subject groups except control subjects, the average of the daily functioning items (i.e., Impairment score) exceeded the average of the Malingering items by more than twice the range of the Content Area scores.

A repeated-measures Analysis of Variance (ANOVA) was conducted to further examine the relationship between the relative endorsement of unlikely and actual problems in daily functioning and subject groups. Specifically, it was hypothesized that head-injured patients and their "significant others" would endorse the Malingering items significantly less than the daily functioning items. Given that control subjects and their "significant others" were expected to show a very low level of overall endorsement on the SFU Index, no such discrepancy was expected for these respondents. Group (patient versus control) constituted the between-subject factor. Subject and "significant other" ratings were coded as "self" and "other" ratings, respectively, and constituted the Rating within-subject factor. Subjects' averages on the SFU Index Malingering and Impairment scores constituted the Itemtype within-subject factor. Table 9 summarizes the results of this analysis.

As hypothesized, patients and their "significant others" obtained a significantly larger discrepancy between Malingering and daily functioning items than control subjects and their "significant others" (Itemtype x Group: $F(1, 42) = 61.90$, $p = .0001$). No significant difference was found between subject and "significant other" ratings (Itemype x Rating: $F(1, 42) = 2.42$, $p = .1276$).

Table 9

<u>Analysis of Variance Summary Table for Comparison between SFU Index Malingering & Impairment Scores</u>

	df	MS	F	p
Mean	1	427.91	782.20	.0001
Group	1	29.94	54.73	.0001
Error	42	0.55		
Rating	1	0.01	0.10	.7585
R x G	1	0.01	0.09	.7615
Error	42	0.15		
Itemtype	1	19.11	117.17	.0001
I x G	1	10.09	61.90	.0001
Error	42	0.16		
R x I	1	0.15	2.42	.1276
R x I x G	1	0.23	3.57	.0657
Error	42	0.06		

To summarize, despite some subjects' tendencies to endorse Malingering items proportionally to daily functioning items, the present results indicate that the Malingering scale constitutes a promising method of assessing subjects' exaggeration of deficit. Specifically, patients and their "significant others" endorsed unlikely sequelae of head-injury on a consistently lower basis than commonly observed problems in daily functioning.

Relationship Between SFU Index Content Areas

The correlations between SFU Index content areas ranged from 0.42 to 0.89 for the patient group, from 0.52 to 0.82 for the patient "significant other" group, from 0.06 to 0.94 for the control subject group and from 0.18 to 0.86 for the "significant other" control group (see Tables 5 to 8).

In order to further examine the relationship between the SFU Index content areas, principal component analyses were conducted separately for each subject group. For the patient group, one significant component with an eigenvalue of 4.02 accounted for 80.32% of the variance. For the patient "significant other" group one significant component with an eigenvalue of 3.76 accounted for 75.11% of the variance. Tables 10 and 11 present the unrotated factor loadings, eigenvalues and squared multiple correlations of one content

Table 10

Principal Component Analysis for Patient Group: Unrotated Factor Loadings and Eigenvalue

Content Area	Factor 1
Lang	0.791
Memo	0.934
Exmot	0.942
Soc	0.955
Emo	0.849
Eigenvalue	4.016

Squared Multiple Correlations of Each Content Area with All Other Content Areas

Content Area	R^2
Lang	0.715
Memo	0.818
Exmot	0.838
Soc	0.915
Emo	0.859

Table 11

Principal Components Analysis for Patient Sig. Other Group: Unrotated Factor Loadings and Eigenvalue

Content Area	Factor 1
Lang	0.905
Memo	0.821
Exmot	0.931
Soc	0.849
Emo	0.821
Eigenvalue	3.756

Squared Multiple Correlations of Each Content Area with All Other Content Areas

Content Area	R^2
Lang	0.751
Memo	0.619
Exmot	0.801
Soc	0.639
Emo	0.614

area with all others for the two groups, respectively.

For the control group, two components with eigenvalues of 3.05 and 1.44, accounted for 89.76% of the variance. Similarly, two components with eigenvalues of 3.47 and 1.02 accounted for 89.93% of the variance for the control "significant other" subjects. For both of these groups, the first component resembled that obtained by head-injured patients and their "significant others" and measured a global underlying aspect of impaired daily functioning. An additional dimension of daily living, measuring socio-emotional functioning, also emerged for control subjects and their "significant others". This component appears to measure subjects' feelings of less-than-optimal current psychosocial and affective adjustment, and their realization that they were more satisfied previously.

Tables 12 and 13 presents the unrotated factor loadings, eigenvalues and squared multiple correlations for each content area with all others for the control and control "significant other" groups, respectively.

To summarize, since the SFU Index Content Areas were highly intercorrelated (see Tables 5 to 8 and 10 to 13), they were not further analyzed independently. Given the perfect correlations obtained between the SFU Index Impairment score (excluding Malingering items) and Total

Table 12

<u>Principal Components Analysis for Control Group: Unrotated Factor Loadings and Eigenvalues</u>

Content Area	Factor 1	Factor 2
Lang	0.875	-0.384
Memo	0.644	-0.644
Exmot	0.883	-0.223
Soc	0.723	0.669
Emo	0.751	0.618
<u>Eigenvalue</u>	3.046	1.442

<u>Squared Multiple Correlations of Each Content Area with All Other Content Areas</u>

Content Area	R^2
Lang	0.810
Memo	0.627
Exmot	0.739
Soc	0.896
Emo	0.889

Table 13

Principal Components Analysis for Control Sig. Other Group: Unrotated Factor Loadings and Eigenvalues

Content Area	Factor 1	Factor 2
Lang	0.839	-0.423
Memo	0.903	-0.079
Exmot	0.922	-0.318
Soc	0.563	0.804
Emo	0.886	0.301
Eigenvalue	3.473	1.024

Squared Multiple Correlations of Each Content Area with All Other Content Areas

Content Area	R^2
Lang	0.753
Memo	0.818
Exmot	0.935
Soc	0.792
Emo	0.883

score (including Malingering items), the latter average was also eliminated from further analysis.

Group Differences on SFU Index of Neuropsychological Functioning

For the patient group, the Impairment score averaged 2.48 for self-ratings and 2.61 for ratings provided by "significant others". Control subjects averaged 1.26 for self-ratings and 1.21 for "significant other" ratings (see Table 3).

A two-factor repeated-measures Analysis of Covariance (ANCOVA) was conducted to evaluate the differences between patient and control subjects' reported impairment in daily functioning and between self-ratings and "significant other" ratings for both the patient and control groups. Group (patient versus control) was the between-subject factor. Rating (self versus "significant other") constituted the within-subject factor. Age at testing, education, estimated Verbal and Non-Verbal IQs were included as covariates. Estimated Full-Scale IQ was excluded from analysis as a result of its linear dependencies with other variables.

Table 14 presents a summary of the ANCOVA conducted. Since none of the covariates were significant, the data were reanalyzed using Analysis of Variance (ANOVA). An ANOVA

Table 14

<u>Analysis of Covariance Summary Table for SFU Index Impairment Score</u>

Source	df	MS	F	p
Group	1	21.73	34.14	.0001
Age at Testing	1	0.27	0.42	.5203
Education	1	0.75	1.17	.2854
Est. Verbal IQ	1	0.57	2.47	.1246
Est. Non-Verbal IQ	1	1.19	1.87	.1799
All Covariates	4	0.51	0.80	.5319
Error	38	0.64		
Rating	1	0.04	0.23	.6331
R x G	1	0.18	1.09	.3024
Error	42	0.16		

Table 15

<u>Analysis of Variance Summary Table for SFU Index Impairment Score</u>

	df	MS	F	p
Mean	1	313.93	502.63	.0001
Group	1	37.40	59.88	.0001
Error	42	0.62		
Rating	1	0.04	0.23	.6331
R x G	1	0.18	1.09	.3024
Error	42	0.16		

summary table is presented in Table 15.

The significant Group factor ($F(1, 38) = 34.14$, $p = .0001$) confirmed that head-injured subjects endorsed more problems in daily functioning than non-head-injured subjects on the SFU Index. The Rating factor was not significant ($F(1, 42) = 0.23$, $p = .6331$), indicating that subjects and "significant others" did not differ in terms of their assessments of the subject's problems in daily functioning. No interaction was obtained between the Group and Rating factors ($F(1, 42) = 1.09$, $p = .3024$), suggesting that the minimal discrepancies found between subject and "significant other" ratings did not differ for the patient and control groups.

Visual inspection of Appendix B suggests that patient and "significant other" ratings were most discrepant on the 'Motivation and Executive Functioning' items of the SFU Index. Specifically, "significant others" consistently rated patient functioning as more impaired on these items than did the patients themselves. No such discrepancy was observed for control subjects and their "significant others". An ANCOVA was conducted to evaluate whether the discrepancy between subject and "significant other" ratings differed for the patient and control groups. Age at testing, educational level, and estimated premorbid Verbal and Performance IQ served as the covariates. Table 16 provides a summary of

Table 16

Analysis of Covariance Summary Table for SFU Index 'Motivation & Executive Functioning' Score

Source	df	MS	F	p
Group	1	25.80	28.89	.0001
Age at Testing	1	0.83	0.94	.3391
Education	1	1.40	1.57	.2181
Est. Verbal IQ	1	0.69	0.77	.3842
Est. Non-Verbal IQ	1	0.37	0.42	.5216
All Covariates	4	0.51	0.57	.6869
Error	38	0.90		
Rating	1	0.64	2.42	.1275
R x G	1	0.88	3.31	.0759
Error	42	0.27		

Table 17

Analysis of Variance Summary Table for SFU Index 'Motivation & Executive Functioning' Score

	df	MS	F	p
Mean	1	322.06	376.03	.0001
Group	1	39.92	46.61	.0001
Error	42	0.86		
Rating	1	0.64	2.42	.1275
R x G	1	0.88	3.31	.0759
Error	42	0.27		

this analysis. Since none of the covariates were significant, the data were reanalyzed using ANOVA. As is revealed in Table 17, there was a non-significant trend toward a larger discrepancy between self-ratings and "significant other" ratings for the patient group, relative to the control group (R x G: $\underline{F}(1, 42) = 3.31$, $\underline{p} = .0759$).

Descriptive Analysis of Neuropsychological Test Measures

The means and standard deviations for the neuropsychological test measures completed by the patient group are presented in Table 18. In terms of the WAIS-R, patients' age-scaled scores suggest performances falling in the Average range of intellectual functioning (see Wechsler, 1981) for all subtests administered. Furthermore, as is revealed by Table 19, minimal discrepancies were obtained between patients' estimated premorbid IQ scores and obtained prorated IQ scores. On the Digit Span subtest, only 63.6% of the patient sample obtained age-scaled scores below the normative standard of 10, relative to 50% expected in a random sample. On the Comprehension and Similarities subtests, 54.5% and 50% performed below the average, respectively. In terms of the non-verbal subtests, 50% and 45.5% fell below normative standards on Picture Arrangement and Block design, respectively.

Table 18

<u>Means and Standard Deviations for Head-Injured Subjects on Neuropsychological Measures</u>

	Mean	SD
WAIS-R Subtests (age-scaled scores)		
Digit Span	8.32	2.77
Comprehension	9.18	2.81
Similarities	9.73	2.51
Picture Arrangement	9.32	2.98
Block Design	9.96	2.75
Trail-Making Test (seconds)		
Part A	55.41	45.32
Part B	138.23	111.65
Booklet Category Test		
Total Errors	68.41	32.69
Wisconsin Card Sorting Test		
Categories Achieved	4.36	2.01
Perseverative Errors	24.27	22.52
Stroop Color-Word Test (T scores)		
Word	34.50	9.00
Color	35.00	9.22
Color-Word	36.55	9.97
Interference	49.23	7.07

Table 19

<u>Discrepancy Between Estimated Premorbid IQ Scores and Obtained Prorated IQ Scores for Head-Injured Patients</u>

	Full-Scale	Verbal	Performance
Obtained Prorated IQ	97.00	95.00	102.00
Estimated Premorbid IQ	99.82	99.05	100.11
Discrepancy	-2.82	-4.05	1.89

Patients' performance on the Trail-Making Test was evaluated on the basis of Davies' (1968) norms for the 40 to 49 age group. Only 63.6% scored below the 50th percentile on Part A, whereas 72.7% fell below the 50th percentile on Part B. Furthermore, 27.3% and 18.2% performed below the 10th percentile on Parts A and B, respectively. The present patient sample thus did not exhibit gross impairment in terms of perceptual motor speed and attention alone, but was deficient in terms of multiple conceptual tracking and cognitive flexibility.

On the Booklet Category Test, 72.7% of the present patient sample performed in the impaired range, obtaining error scores above Reitan's (undated) cut-off score of 50 errors. On the Wisconsin Card Sorting Test, only 40.9% of the present sample completed less than the 5.4 categories considered normal in non-brain-damaged subjects, and 63.6% obtained more than the normative average of 16 perseverative errors (see Heaton, 1981).

On the Stroop Color-Word Test, 90.9% obtained a Word-score below the 50th percentile and 95.9% and 95.5% fell below the 50th percentile on the Color and Color-Word scores, respectively. Difficulties were least evident on the Interference score, where only 45.5% scored below the 50th percentile.

To summarize, a large portion of the present patient sample did not show gross impairment on those cognitive abilities measured by the WAIS-R subtests, Part A of the Trail-Making Test and the Wisconsin Card Sorting Test. Reduced cognitive efficiency and flexibility, concept formation, new learning and selecting relevant information from the environment, however, emerged as problem areas, as indicated by the poor performances on Part B of the Trail-Making Test, the Booklet Category Test and the Stroop Color-Word test.

Prediction of Problems in Daily Functioning From Neuropsychological Measures

Table 20 presents the correlation matrix for patients' SFU Index Impairment score and Content Area scores, demographic variables and neuropsychological test scores. The intercorrelations for the SFU Index summary and Content Area scores were reported earlier (see Table 5) and are therefore not presented again. It must be emphasized that these correlations are reported for descriptive purposes only, and that their statistical significance was not evaluated.

All-possible-subsets regression analyses were conducted to identify the set of neuropsychological and demographic

Table 20

Correlations Between SFU Index Impairment Score, Content Area Scores, Demographic Variables and Neuropsychological Test Scores for Patient Group

	Imp	Lang	Memo	Exmot	Soc	Emo	Ed	VIQ	PIQ	FSIQ	Age	TSI	Ds	Comp
Ed	-0.12	0.01	-0.28	-0.11	-0.08	-0.03	1.00							
VIQ	-0.18	-0.01	-0.30	-0.19	-0.16	-0.10	0.83	1.00						
PIQ	-0.12	0.05	-0.24	-0.15	-0.10	-0.04	0.80	0.98	1.00					
FSIQ	-0.14	0.02	-0.27	-0.17	-0.13	-0.07	0.83	0.99	0.99	1.00				
Age	0.23	0.05	0.31	0.26	0.16	0.08	-0.33	-0.21	-0.18	-0.18	1.00			
TSI	0.26	0.24	0.32	0.13	0.26	0.32	-0.10	-0.27	-0.22	-0.24	0.29	1.00		
DS	-0.23	-0.18	-0.13	-0.22	-0.28	-0.27	0.15	0.22	0.21	0.21	0.11	0.22	1.00	
Comp	0.19	0.07	0.23	0.18	0.16	0.19	0.13	0.31	0.29	0.31	0.25	0.07	0.39	1.00
Sim	0.11	0.22	0.09	0.06	0.13	0.06	0.42	0.34	0.35	0.35	0.04	0.45	0.53	0.49
PA	0.30	0.17	0.41	0.15	0.26	0.41	-0.18	0.03	0.09	0.04	-0.21	0.15	0.26	0.24
BD	0.05	-0.08	0.14	-0.06	0.11	0.14	0.07	0.05	0.10	0.07	-0.07	0.23	0.38	0.08
TMTA	-0.08	0.11	-0.17	0.10	-0.13	-0.27	0.16	-0.10	-0.13	-0.10	-0.01	-0.14	-0.28	-0.20
TMTB	-0.05	0.17	-0.18	0.12	-0.05	-0.25	0.05	-0.18	-0.17	-0.17	0.01	-0.08	-0.33	-0.40
StW	-0.05	-0.11	0.06	-0.03	-0.18	-0.05	0.09	0.13	0.17	0.16	0.22	0.03	0.32	0.45
StC	-0.11	-0.20	0.06	-0.16	-0.22	-0.03	-0.06	0.08	0.14	0.11	0.27	0.28	0.54	0.47
StCW	-0.21	-0.39	-0.06	-0.32	-0.21	0.05	-0.06	0.18	0.19	0.17	0.03	0.05	0.52	0.35
StInt	-0.11	-0.12	-0.14	-0.21	0.07	0.17	0.02	0.01	0.00	-0.01	-0.53	-0.18	-0.16	-0.21
BCT	0.27	0.28	0.25	0.38	0.23	0.02	-0.15	-0.12	-0.08	-0.09	0.56	-0.15	-0.25	-0.13
WCat	-0.07	-0.26	-0.07	-0.14	-0.03	0.15	0.04	0.11	0.18	0.15	-0.24	0.04	0.23	0.24
WPers	0.09	0.24	0.09	0.14	0.01	-0.04	-0.14	0.06	-0.11	-0.11	0.02	-0.20	-0.03	-0.16

Table 20 (continued)

	Sim	PA	BD	TMTA	TMTB	StW	StC	StCW	StInt	BCT	WCat	WPers
Sim	1.00											
PA	0.18	1.00										
BD	0.47	0.62	1.00									
TMTA	-0.03	-0.72	-0.58	1.00								
TMTB	-0.06	-0.69	-0.51	0.92	1.00							
StW	0.41	0.06	0.09	0.09	-0.10	1.00						
StC	0.43	0.37	0.37	-0.32	-0.44	0.84	1.00					
StCW	0.19	0.58	0.48	-0.75	-0.84	0.44	0.71	1.00				
StInt	-0.27	0.21	0.07	-0.35	-0.38	-0.34	-0.23	0.33	1.00			
BCT	-0.40	-0.47	-0.51	0.32	0.33	-0.05	-0.21	-0.39	-0.25	1.00		
WCat	0.28	0.47	0.43	-0.47	-0.42	0.45	0.58	0.53	-0.04	-0.45	1.00	
WPers	-0.36	-0.01	-0.30	0.16	0.13	-0.36	-0.40	-0.20	0.17	0.15	-0.62	1.00

Codes: SFU Index **Imp**airment, SFU Index **Lang**uage & Communication, SFU Index **Memo**ry, Attention & Concentration, SFU Index **Exe**cutive Functioning & **Mot**ivation, SFU Index **Soc**ial Functioning, SFU Index **Emo**tional Functioning, **Ed**uction, estimated **V**erbal **IQ**, estimated **P**erformance **IQ**, estimated **F**ull **S**cale **IQ**, **Age** at Testing, **T**ime **S**ince **I**njury, **D**igit **Span**, **Comp**rehension, **Sim**ilarities, **P**icture **A**rrangement, **B**lock **D**esign, **T**rail-**M**aking **T**est Part **A**, **T**rail-**M**aking **T**est Part **B**, **St**roop **W**ord score, **St**roop **C**olor score, **St**roop **C**olor-**W**ord score, **St**roop **Int**erference score, **B**ooklet **C**ategory **T**est error score, **W**isconsin Card Sorting Test **Cat**egories Achieved score, **W**isconsin Card Sorting Test **Pers**everative Error score.

variables that most powerfully and parsimoniously predicted patients' problems in daily functioning. Patient self ratings and "significant other" ratings served as the outcome measures in two separate regression analyses. The neuropsychological predictor variables were patients' scores on Digit Span, Comprehension, Similarities, Picture Arrangement, Block Design, the Trail-Making Test (Parts A and B), the Stroop Color Word Test (Word, Color, Color-Word and Interference scores) the Booklet Category Test and the Wisconsin Card Sorting Test (Categories Achieved and Perseverative Errors). The demographic predictor variables included level of education, estimated premorbid Full-Scale, Verbal and Non-Verbal IQs, age at testing and time since injury.

"Best subsets" included the smallest number of predictors that consistently appeared in subsets of increasing size, while accounting for the largest portion of the variance (R^2 adjusted for the number of cases and variables entered).

For the patient group, the best single predictor was the Picture Arrangement (PA) subtest of the WAIS-R, which accounted for 4.87% of the variance. The best subset included Digit Span (DS), Similarities (SIM), Picture Arrangement (PA), the Stroop Color-Word score (STRCW) and the Booklet Category Test Error score (BCT). This combination of variables accounted for 49.58% of the variance and significantly predicted patients' endorsement of problems in daily functioning ($\underline{F}(6,15) = 5.13$, $\underline{p} = .0054$). Table 21 presents the portions of variance accounted for by subsets of increasing size. Table 22 presents the Analysis of Variance summary table for the best subset and the summary statistics for the individual predictors.

The correlations between reported daily functioning and neuropsychological predictors suggest interesting trends. As is revealed in Table 22, poor performance on Digit Span, the Color-Word portion of the Stroop Test and the Booklet Category Test was associated with greater impairment in daily functioning (for DS, βwt.=-.35; for StrCW, βwt.=-.34; for BCT, βwt.=.61). The unexpected associations of better performance on Picture Arrangement (βwt.=.80) and Similarities (βwt.=.46) with greater impairment in daily functioning are difficult to explain.

The Booklet Category Test Total Error score (BCT) emerged as the best predictor of patients' problems in daily functioning as rated by "significant others". This predictor accounted for 8.21% of the variance. The best subset of neuropsychological and demographic predictors included Age at Testing (TESTAGE), Time Since Injury (TSI), Comprehension (COMP), Part B of the Trail-making Test (TMTB), the Stroop Color-Word Test Interference score (STRINT) and the Booklet

Table 21

Variance Accounted For By Subsets of Increasing Size for Patient Ratings

Adj. R^2	Variables entered				
0.0487	PA				
0.2458	PA	BCT			
0.3910	PA	BCT	STRCW		
0.4453	PA	BCT	STRCW	SIM	
0.4958	**PA**	**BCT**	**STRCW**	**SIM**	**DS**

Note: Best Subset is presented in bold print.

Codes: Picture Arrangement, Booklet Category Test, Stroop Color-Word score, Similarities, Digit Span

Table 22

Analysis of Variance Summary Table for Best Subset of Predictors of SFU Index Patient Ratings

Source	df	MS	F	p
Regression	6	1.91	5.13	.0054
Residual	15	0.37		

Statistics for Variables In Best Subset of Predictors of SFU Index Patient Ratings

Variable	Regr. Coeff. (β)	Stand. Error	Stand. Coeff. (βwt.)	T Stat.	2Tail Sign.	Tol-erance	Regr. Loading
Constant	-0.34						
PA	0.23	0.06	0.80	3.97	.0011	0.59	0.39
BCT	0.02	0.01	0.61	3.21	.0055	0.66	0.35
STRCW	-0.03	0.02	-0.34	-1.55	.1418	0.49	0.26
SIM	0.16	0.07	0.46	2.35	.0323	0.61	0.14
DS	-0.11	0.07	-0.35	-1.64	.1197	0.53	0.29

Codes: **Picture Arrangement, Booklet Category Test, Stroop Color Word score, Similarities, Digit Span,** Category Test Error score. This combination of predictors accounted for 34.82% of the variance and significantly predicted "significant other" ratings of patients' problems in daily functioning ($\underline{F}(6,15) = 3.24$, $\underline{p} = .0303$). Table 23 presents the portions of variance accounted for by subsets of increasing size. Table 24 presents the Analysis of Variance summary table for the best subset and the summary statistics for the individual predictors.

A relationship was obtained between greater reported impairment in daily functioning and longer injury-assessment intervals (βwt.=.36). This finding may suggest that, as recovery proceeds, "significant others" become more aware of patient deficits. Impaired performances on the Booklet Category Test and the Interference score of the Stroop Test were also associated with increased problems in daily functioning (for BCT, βwt.=.98; for StrInt, βwt.=-.57). The associations of more impaired daily functioning with decreasing age (βwt.=-.86), and with better performance on Comprehension and Part B of the Trail-Making Test (for Comp, βwt.=.26; for TMTB, βwt.=-.48) occured contrary to expectations.

Table 23

Variance Accounted For By Subsets of Increasing Size for Patient "Significant Other" Ratings

Adj. R^2	Variables entered					
0.0821	BCT					
0.1080	BCT	COMP				
0.1485	BCT	COMP	TESTAGE			
0.2143	BCT	COMP	TESTAGE	TSI		
0.2470	BCT	COMP	TESTAGE	TSI	STRINT	
0.3482	**BCT**	**COMP**	**TESTAGE**	**TSI**	**STRINT**	**TMTB**

Note: Best Subset is presented in bold print.

Codes: Booklet Category Test, Comprehension, Time Since Injury, Stroop Interference score, Trail-Making Test Part B

Table 24

Analysis of Variance Summary Table for Best Subset of Predictors of SFU Index Patient Sig. Other Ratings

Source	df	MS	F	p
Regression	6	1.34	3.24	.0303
Residual	15	0.41		

Statistics for Variables In Best Subset of Predictors of SFU Index Patient Sig. Other Ratings

Variable	Regr. Coeff. (β)	Stand. Error	Stand. Coeff. (βwt.)	T Stat.	2Tail Sign.	Tol- erance	Regr. Loading
Constant	5.61						
BCT	0.02	0.01	0.98	3.85	.0016	0.45	0.47
COMP	0.08	0.06	0.26	1.33	.2032	0.79	0.28
TESTAGE	0.00	0.00	-0.86	-3.04	.0083	0.36	0.09
TSI	0.01	0.00	0.36	1.85	.0835	0.75	0.12
STRINT	-0.07	0.03	-0.57	-2.46	.0267	0.54	0.33
TMTB	0.00	0.00	-0.48	-2.16	.0477	0.59	0.08

Codes: Booklet Category Test, Comprehension, Time Since Injury, Stroop Interference score, Trail Making Test Part B

CHAPTER IV

DISCUSSION

Recent interest in the ecological validity of neuropsychological testing has uncovered the limited efficacy of neuropsychological assessment to evaluate some of the more subtle and complex aspects of daily functioning. The primary purpose of the present study was to develop and validate a self-report inventory designed to supplement the test data obtained in the neuropsychological evaluation. Specifically, the Simon Fraser University (SFU) Index of Neuropsychological Functioning was designed to sample a broad range of problems in daily functioning, including those all-encompassing executive abilities that tend to be neglected in the assessment situation.

The second purpose of the present study was to investigate the relationship between reported impairment in daily functioning and neuropsychological test performance in the head-injured patients. Those tests that best predicted impaired everyday functioning were identified. Given the large pool of potential predictors and the relatively small sample size, this portion of the present study can only serve as a pilot project intended to guide future research.

SFU Index Content Areas

Although the items of the SFU Index were postulated to fall into five areas of daily functioning, principal component analyses indicated that one component accounted for most of the variance in patient and patient "significant other" ratings. This component measured a general aspect of daily functioning. A similar component was obtained for control subjects and their "significant others". For these subject groups, however, a second component, measuring socio-emotional functioning, was also obtained. It is possible that this factor reflects the perception that current interpersonal and affective functioning are less optimal than they were previously (i.e., about one year ago).

The failure of the present study to empirically validate the Content Areas in the patient group likely results from the wide-spread impairment attributable to traumatic head-injury. It is not surprising that the diffuse nature of brain damage in the present patient sample affected most aspects of daily living, rather than producing isolated deficits in specific realms of functioning (e.g., in memory).

Furthermore, instances of differential Content Area endorsement for individual patients were obscured as a result of statistical averaging. One patient, for example, reported substantial emotional problems, while perceiving himself as coping adequately otherwise. Another patient reported significantly more difficulties with executive and motivational functioning than with language, memory, attention and concentration.

Given that the statistical analysis of the SFU Index has failed to provide validation of the Content Areas, they were not further analyzed. Future research will examine content-specific impairment in patient groups with more focal lesions and more homogenous medical histories (e.g., in terms of the length of the injury-assessment interval).

Group Differences in Reported Impairment of Daily Functioning

As hypothesized, head-injured subjects obtained significantly higher scores on the SFU Index than control subjects, suggesting more impairment in daily functioning. This finding was not affected by group differences in terms of educational attainment, age at testing, and estimated premorbid verbal and non-verbal intellectual functioning.

Contrary to expectation, head-injured patients were equally sensitive to their deficits as their "significant others". Although in some cases subjects reported higher impairment in daily functioning than their "significant others", and vice versa, the two types of informants generally provided very similar estimates of subject impairment.

In terms of statistical utility, the present study thus suggests that the SFU Index is a psychometrically valid and reliable measure of impaired daily functioning in head-injured patients. In terms of clinical utility, the average impairment rating obtained by head-injured patients indicated "slightly" to "somewhat more" difficulties in daily functioning than prior to the injury. Given that some patients endorsed minimal deficits in certain areas of functioning (e.g., Language & Communication), this average suggests substantial problems in other areas. The wealth of information that can be obtained on the basis of patients' patterns of strengths and weaknesses is illustrated in the following case study.

M.S., a 45-year-old former logger appeared to have made an adequate psychometric recovery from severe occipital damage suffered five years earlier. According to his neuropsychological test profile, M.S.'s intellectual functioning was in accordance with his estimated premorbid intelligence level. Only cognitive flexibility, abstract thinking and concept formation, as measured by the Trail-Making Test (Part B), the Wisconsin Card Sorting Test

(Perseverative Error score), and the Booklet Category Test, appeared as residual areas of deficit.

The detrimental effects of these circumscribed residual difficulties on the quality of M.S.'s and his spouse's lives, however, were illustrated by a consideration of their SFU Index profiles. Not only did these profiles corroborate the cognitive deficits detected during the neuropsychological evaluation, but they also indicated problems in executive and motivational functioning (difficulties in planning, initiating and carrying out goal-directed behavior; reduced information-processing speed; difficulties setting goals, solving problems, following instructions, making decisions, completing actions that were started, and noticing and correcting errors), psychosocial functioning (refusal to engage in formerly enjoyed recreational abilities; inability to complete household chores and handle finances; difficulties with close relationships; misunderstandings with friends and family; spending less time with friends, etc.) and emotional functioning (difficulties controlling emotions and feeling more anxious, frightened, sad and discouraged).

Although this patients' neuropsychological test profile revealed highly circumscribed deterioration in only a few areas of cognitive functioning, his SFU Index profile illustrates the wide-spread effects of his deficits on day-to-day living. It is for this type of case that the SFU Index will hopefully be most useful in supplementing the test data obtained on the basis of neuropsychological assessment.

Malingering and Random Responding Items

The present study suggests that the Malingering scale of the SFU Index, consisting of highly unlikely sequelae of head-injury, is a promising method to evaluate subjects' exaggeration of deficit. As hypothesized, patients and their "significant others" endorsed the Malingering items on a consistently lower basis than those items describing actual problems in daily functioning. Furthermore, the average of these items was lower than the lowest Content Area score for all subject groups.

Correlational analyses suggested that some patients endorsed the Malingering items proportionally to the remaining items. Specifically, as more impairment in daily functioning was indicated, more unlikely neuropsychological symptoms were also endorsed.

It is possible that some patients did attempt to inflate their impairment ratings. It is, however, more likely that the wide-spread changes experienced by these patients caused them to view some Malingering symptoms as plausible symptoms of head-injury. Given that even control subjects endorsed some of these items, the current version of the SFU Index probably contains some Malingering items that are easily misinterpreted by subjects. During the course of testing, for example, one head-injured subject informed the examiner that he had never experienced "words flipping upside-down when reading", but that letters tended to "get reversed". He then proceeded to rate himself as having "Somewhat More" difficulties with the symptom, indicating that he reinterpreted this item to describe an experience he had actually had. Similarly, subjects might have interpreted the item refering to greater difficulties "remembering the faces of males than females" as measuring problems with facial memory in general.

Future research with the Malingering items will therefore commence with the elimination of potentially ambiguous items. Given that the control group had no motivator to exaggerate impairment (e.g., compensation evaluations), those items endorsed by non-impaired subjects will be deleted. Additional items will be constructed and validated on control groups that are asked to respond accurately or to malinger. Since some patients endorsed the Malingering items proportionally to the remaining items (although at a much lower level), normative ratios will be established to determine the degree of endorsement of

Malingering items that is normal for a given amount of genuine impairment.

Prediction of Problems in Daily Functioning from Neuropsychological Measures

The relationship between the SFU Index and neuropsychological test scores and demographic variables was investigated by identifying those variables that best predicted reported problems in daily functioning. The potential neuropsychological predictors included patients' scores on the WAIS-R Digit Span, Comprehension, Similarities, Picture Arrangement and Block Design subtests, the Trail-Making Test (Parts A & B), the Booklet Category Test, the Wisconsin Card Sorting Test and the Stroop Color-Word Test. Demographic variables that have been associated with post-head-injury functioning (Boll, 1985; Klonoff et al., 1986; E. Miller, 1979; W.G. Miller, 1986; Oddy & Humphrey, 1980) were also included as potential predictors. These included level of education, estimated premorbid verbal and non-verbal intellectual level (see Barona, Reynolds & Chastain, 1984, for the estimation procedure), age at testing and the length of the injury-assessment interval. Separate regression analyses were performed for patient and "significant other" ratings of impairment in daily functioning.

For the patient group, a combination of six neuropsychological test scores significantly predicted patients' own ratings of impaired functioning. Poor performances on Digit Span, the Color-Word portion of the Stroop Test, and the Booklet Category Test were associated with high degrees of impaired daily functioning.

The best predictor of "significant other" ratings of patient impairment was the Booklet Category Test Error score. The best subset of predictors included four neuropsychological and two demographic variables and significantly predicted "significant others'" ratings of patient impairment. Daily functioning was rated as more impaired in those patients that had longer injury-assessment intervals and that performed poorly on the Booklet Category Test and the Stroop Interference score.

To summarize, reported impairment in daily functioning was associated with deficiencies in sustained attention, concentration, short-term memory, abstract thinking, concept formation and planning. Not surprisingly, these are the higher-level cognitive functions that are required for successful performance in virtually all aspects of daily functioning. Furthermore, in accordance with the literature, the impairment of these functions typically does not become apparent until the later stages of recovery.

Future Research Directions

In conclusion, the findings of the present study suggest that the SFU Index of Neuropsychological Functioning is a valid and reliable tool to measure the problems in daily functioning encountered by head-injured adults. Future research will commence with the refinement of the SFU Index, as indicated throughout the preceeding sections. Specifically, those items that did not differentiate between head-injured patients and control subjects in the present study will be eliminated. Additional items will be developed and evaluated in terms of their discriminative validity. Two aims of this stage of test construction entail the refinement of the Malingering and Random Responding scale and the attainment of higher discrimination between specific realms of daily functioning. A heterotrait-heteromethod approach will then be taken to establish the construct validity of the SFU Index. Specifically, its specificity to neurological impairment and its applicability to various forms thereof, will be established. Cross-validation and concurrent or predictive validation will then commence.

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APPENDIX A

SFU INDEX OF NEUROPSYCHOLOGICAL FUNCTIONING[1]

Language & Communication

1. Do you have more difficulties speaking clearly and fluently than you did prior to your injury?
2. Do you have more difficulties expressing your ideas ~~to~~ someone than you did prior to your injury (e.g., in a discussion)?
3. Compared to before your injury, do you find yourself losing track of what you are thinking or saying more often?
4. Do you have more difficulties thinking of a particular word or name than you did prior to your injury?
5. Do you have more difficulties understanding what people say to you than you did prior to your injury?
6. **Compared to before your injury, do you more often know the meaning of a word one minute and not know it the next minute?**
7. Do you have more difficulties understanding what you read than you did prior to your injury?
8. **Compared to before your injury, do words more often flip upside-down when you are reading?**
9. Do you have more difficulties writing than you did prior to your injury?
10. **Compared to before your injury, does your vision more often switch to "black and white" and then back to color?**

Memory, Attention & Concentration

11. Compared to before your injury, do you get lost more often when you are going somewhere?
12. Compared to before your injury, do you lose track of the time more often?
13. Compared to before your injury, do you have more difficulties paying attention to someone who is talking to you?

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[1]Malingering items are presented in bold print.

14. Compared to before your injury, do you more often get the feeling that one of your hands wants to do one thing, while the other wants to do something else?

15. Compared to before your injury, do you have more difficulties concentrating on only one thing, when many things are going on around you (e.g., conversations)?

16. Compared to before your injury, do you have more difficulties shifting your attention back and forth when two important things are going on around you (e.g., conversations)?

17. Compared to before your injury, do you have more difficulties holding things in your memory for about one minute (e.g., a phone number)?

18. Compared to before your injury, do you have more difficulties remembering what someone said to you a minute ago?

19. Compared to before your injury, do you have more difficulties remembering the faces of females than males?

20. Compared to before your injury, do you have more difficulties remembering what you did a few days ago?

21. Do you have more difficulties remembering things from early in your life (e.g., childhood) than you did prior to your injury?

22. Compared to before your injury, do you more often remember important things about your past at specific times of the day only?

23. Do you more often get lost in places that you knew well prior to your injury?

24. Compared to before your injury, do you have more difficulties remembering something you have just learned (e.g., a person's name)?

25. Compared to before your injury, do you confuse hot and cold more often?

26. Compared to before your injury, do you have more difficulties remembering things you are supposed to do (e.g., errands, appointments)?

27. Compared to before your injury, do you more often forget to finish something you have started (e.g., leaving water boiling)?

Executive Functioning & Motivation

28. **Does food taste more sour than it did prior to your injury?**

29. Compared to before your injury, do you have more difficulties starting to do something without being told to do it?

30. Compared to before your injury, do you have to do things more slowly to do them right?

31. Do you have more difficulties setting a goal for yourself than you did prior to your injury?

32. Do you have more difficulties making decisions than you did prior to your injury?

33. Do you have more difficulties following instructions than you did prior to your injury?

34. Compared to before your injury, do you have more difficulties planning the things you need to do to get a job done?

35. Compared to before your injury, do you have more difficulties solving problems that come up in your life?

36. Compared to before your injury, do you have more difficulties completing something you started?

37. Compared to before your injury, do you have more difficulties stopping an activity and starting another one?

38. Compared to before your injury, do you have more difficulties trying out different ways of doing a certain thing?

39. Compared to before your injury, do you more often say that you will do something but never get around to doing it?

40. Compared to before your injury, do you have more difficulties noticing and correcting a mistake you have made in something you are working on?

41. Do you have more difficulties caring about the way you look than you did prior to your injury?

42. Do you have more difficulties taking care of yourself without anyone's help than you did prior to your injury?

43. Do you have more difficulties getting involved in doing household chores than you did prior to your injury (e.g., shopping, gardening, working around the house)?

44. Do you have more difficulties handling money than you did prior to your injury?

45. Do you have more difficulties getting involved in activities you enjoyed prior to your injury (e.g., sports, reading, writing letters and other hobbies)?

46. Do you have more difficulties telling the difference between singing and ordinary speech than you did prior to your injury?

Social Activities and Interpersonal Functioning

47. Do you have more difficulties getting along with other people than you did prior to your injury?

48. Compared to before your injury, do you find it more difficult to enjoy spending time with your friends?

49. Compared to before your injury, do you avoid social activities and prefer to be alone more often?

50. Compared to before your injury, do you have more misunderstandings and arguments with your friends and family?

51. Do you have more difficulties making friends than you did prior to your injury?

52. Compared to before your injury, do you more often feel that people do not enjoy your company?

53. Do you have more difficulties being with a group of people (e.g., at a party) than you did prior to your injury?

54. Compared to before your injury, do you have more difficulties understanding people's reactions to things or situations?

55. Compared to before your injury, do you have more difficulties understanding people's reactions to things you have said or done?

56. Compared to before your injury, are close relationships more difficult?

Emotional Functioning

57. Do you have more difficulties controlling your emotions than you did prior to your injury?
58. Do you experience more mood changes than you did prior to your injury?
59. Do you show your feelings more easily than you did prior to your injury?
60. Do you lose your temper more easily than you did prior to your injury (i.e., do you have a "shorter fuse")?
61. Do you get more anxious or nervous than you did prior to your injury?
62. **Compared to before your injury, do you more often switch beween feeling anxious and calm very quickly (i.e., within a minute)?**
63. Do you get frightened more easily than you did prior to your injury?
64. Do you find it more difficult to care about what goes on in your life than you did prior to your injury?
65. Do you find it more difficult to care about what goes on in other people's lives than you did prior to your injury?
66. Do you feel more sad and discouraged than you did prior to your injury?
67. Compared to before your injury, do you get very excited for no reason more often?
68. Compared to before your injury, do you get very happy for no reason more often?

APPENDIX B

Means and Standard Deviations for SFU Index Items for All Subject Groups

Item	Area	Content	Patient		Patient S.O.		Control		Control S.O.	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
6	Maling	know meaning of word one minute, not next minute	1.91	0.87	1.73	1.08	1.18	0.66	1.00	0.00
8	Maling	words flip upside-down when reading	1.05	0.21	1.27	0.94	1.05	0.21	1.00	0.00
10	Maling	vision switching to black/white, back to color	1.41	0.85	1.00	0.00	1.00	0.00	1.05	0.21
14	Maling	hands doing different things	1.36	0.85	1.36	0.79	1.00	0.00	1.00	0.00
19	Maling	remembering faces of females vs. males	1.64	1.22	1.82	0.66	1.05	0.21	1.00	0.00
22	Maling	remember things about past at specific times	1.73	1.16	1.23	0.53	1.14	0.47	1.05	0.21
25	Maling	confuse hot and cold	1.18	0.50	1.14	0.64	1.00	0.00	1.00	0.00
28	Maling	food taste sour	1.18	0.50	1.36	0.85	1.05	0.21	1.05	0.21
46	Maling	differentiating singing from speech	1.18	0.50	1.27	0.70	1.00	0.00	1.00	0.00
62	Maling	from anxious to calm very quickly	2.05	1.43	1.91	0.92	1.23	0.61	1.32	0.78
1	Lang	speaking clearly & fluently	2.46	1.14	2.59	1.18	1.82	0.50	1.09	0.29
2	Lang	expressing ideas	2.64	1.18	3.05	1.17	1.09	0.29	1.14	0.35
3	Lang	lose track of what thinking/saying	2.86	1.21	2.86	1.21	1.27	0.70	1.32	0.65
4	Lang	thinking of word/name	3.05	1.17	3.14	1.17	1.55	0.74	1.27	0.70
5	Lang	understanding what people say	2.05	1.21	2.32	1.21	1.05	0.21	1.18	0.40
7	Lang	understanding what is read	2.36	1.22	2.41	1.50	1.05	0.21	1.09	0.29
9	Lang	writing	2.73	1.52	2.86	1.67	1.00	0.00	1.23	0.69
11	Memo	get lost when going somewhere	2.14	1.28	1.77	0.97	1.00	0.00	1.00	0.00
12	Memo	lose track of time	1.91	1.15	2.18	1.26	1.18	0.50	1.18	0.40
13	Memo	paying attention to someone talking	2.50	1.26	2.27	1.12	1.23	0.53	1.14	0.35
15	Memo	concentrating on only one thing	3.09	1.44	2.96	1.25	1.32	0.48	1.23	0.69

Appendix B (continued)

Item	Area	Content	Patient		Patient S.O.		Control		Control S.O.	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
16	Memo	shifting attention	2.86	1.49	2.91	1.31	1.32	0.57	1.27	0.55
17	Memo	holding things in memory for 1 min.	3.14	1.36	3.09	1.44	1.05	0.21	1.27	0.46
18	Memo	remembering what someone said 1 min. ago	3.09	1.31	3.05	1.36	1.23	0.53	1.27	0.63
20	Memo	remembering what done a few days ago	3.18	1.30	3.27	1.35	1.41	0.91	1.27	0.55
21	Memo	remembering things from early in life	2.14	1.17	1.59	0.85	1.18	0.50	1.05	0.21
23	Memo	get lost in places well known	1.96	1.29	1.41	0.73	1.00	0.00	1.00	0.00
24	Memo	remembering something just learned	3.18	1.22	3.14	1.36	1.27	0.46	1.00	0.00
26	Memo	remembering things supposed to do	2.77	1.34	3.14	1.32	1.36	0.79	1.36	0.66
27	Memo	forget to finish something started	2.55	1.47	2.41	1.44	1.14	0.64	1.36	0.66
29	Exmot	starting something without being told	1.91	1.15	2.68	1.21	1.27	0.55	1.46	0.86
30	Exmot	do things more slowly to do right	2.77	1.27	3.05	1.36	1.23	0.53	1.14	0.64
31	Exmot	setting a goal	2.55	1.47	2.86	1.42	1.27	0.70	1.50	0.80
32	Exmot	making decisions	2.41	1.44	3.18	1.33	1.18	0.40	1.41	0.80
33	Exmot	following instructions	2.55	1.22	2.86	1.42	1.05	0.21	1.09	0.29
34	Exmot	planning things to get job done	2.59	1.30	2.91	1.41	1.14	0.35	1.18	0.66
35	Exmot	solving problems	2.46	1.34	3.09	1.34	1.32	0.57	1.23	0.53
36	Exmot	completing something started	2.36	1.36	2.82	1.44	1.27	0.55	1.36	0.73
37	Exmot	stopping activity, starting another	1.82	1.26	2.46	1.34	1.18	0.50	1.09	0.29
38	Exmot	trying different ways of doing something	2.23	1.31	2.41	1.47	1.09	0.29	1.14	0.35
39	Exmot	says will do something, never gets to it	2.77	1.31	3.36	1.29	1.64	0.95	1.55	0.86
40	Exmot	noticing and correcting mistakes	2.46	1.50	2.55	1.37	1.09	0.29	1.09	0.29
41	Exmot	caring about appearance	2.09	1.38	2.00	1.16	1.32	0.95	1.00	0.00
42	Exmot	taking care of self without help	2.09	1.31	2.14	1.25	1.14	0.35	1.00	0.00
43	Exmot	involved in house chores	2.32	1.49	2.91	1.69	1.32	0.57	1.23	0.53
44	Exmot	handling money	2.09	1.31	2.46	1.63	1.18	0.50	1.14	0.35

Appendix B (continued)

Item	Area	Content	Patient		Patient S.O.		Control		Control S.O.	
			Mean	SD	Mean	SD	Mean	SD	Mean	SD
45	Exmot	involved in previously enjoyed activities	2.91	1.41	3.23	1.48	1.64	1.00	1.23	0.43
47	Soc	getting along with others	2.18	1.37	2.68	1.43	1.14	0.47	1.09	0.43
48	Soc	enjoying time with friends	2.64	1.47	2.64	1.29	1.27	0.46	1.27	0.63
49	Soc	avoiding social activities	2.96	1.46	2.18	1.44	1.32	0.72	1.36	0.79
50	Soc	misunderstandings and arguments	2.64	1.26	2.86	1.28	1.50	0.86	1.36	0.58
51	Soc	making friends	1.82	1.14	1.68	0.95	1.05	0.21	1.05	0.21
52	Soc	feel people don't enjoy company	1.86	0.94	1.82	0.80	1.27	0.77	1.14	0.35
53	Soc	being with a group of people	2.50	1.41	2.64	1.43	1.05	0.21	1.05	0.21
54	Soc	understanding reactions	1.96	1.09	2.14	1.08	1.23	0.43	1.23	0.43
55	Soc	understanding people's reactions to own behavior	2.09	0.97	2.14	1.08	1.27	0.46	1.27	0.55
56	Soc	close relationships	2.05	1.17	2.05	1.29	1.50	1.10	1.14	0.35
57	Emo	controlling emotions	2.68	1.32	2.91	1.23	1.46	0.96	1.32	0.78
58	Emo	mood changes	3.05	1.25	3.09	1.31	1.50	0.96	1.32	0.48
59	Emo	show feelings easily	2.46	1.22	2.67	1.11	1.77	0.11	1.68	0.13
60	Emo	lose temper	2.77	1.51	3.19	1.40	1.36	0.79	1.36	0.58
61	Emo	anxious or nervous	2.96	1.62	3.27	1.32	1.46	0.96	1.14	0.35
63	Emo	frightened	2.00	1.41	2.14	1.17	1.14	0.35	1.00	0.00
64	Emo	care about what goes on in own life	2.50	1.50	2.36	1.36	1.32	0.57	1.14	0.47
65	Emo	care about what goes on in others' lives	2.46	1.41	2.27	1.12	1.32	0.65	1.23	0.53
66	Emo	sad and discouraged	2.77	1.51	3.09	1.44	1.55	1.01	1.27	0.63
67	Emo	excited for no reason	2.00	1.51	2.23	1.41	1.36	0.95	1.09	0.29
68	Emo	happy for no reason	1.46	0.67	1.36	0.66	1.18	0.66	1.14	0.47