The usefulness of neuropsychological test scores in predicting social recovery in closed head injury patients.

Steven Donaghy
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THE USEFULNESS OF NEUROPSYCHOLOGICAL TEST SCORES IN
PREDICTING SOCIAL RECOVERY IN CLOSED HEAD INJURY PATIENTS

by

Steven Donaghy

B. A. University of Western Ontario, 1985

A Thesis
Submitted to the Faculty of Graduate Studies
through the Department of Psychology
in Partial Fulfillment of the
Requirements for the Degree
of Master of Arts at the
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ABSTRACT

This study examined the usefulness of neuropsychological test scores, the MMPI, GCS Scores, and education in predicting the long-term social recovery of closed head injury patients. It was hypothesised (1) that improvement in test scores would be seen over time, (2) that summary measures of neuropsychological impairment and of reasoning ability would be the best predictors of recovery, and (3) that more accurate predictions would be made from test scores obtained more than one year after injury than from test scores obtained less than one year after injury.

Fifty seven former head injury patients (mean time since injury = 4 years 4 months) and 55 of their relatives/friends returned questionnaires designed to measure the patients' current functioning. The first hypothesis was supported since significant improvement in test performance over time was found for 12 of 13 tests. However, the other hypotheses were generally not supported. One exception was that the reasoning summary score was the best predictor of later work adjustment. The best overall predictor of long-term social recovery was a measure of psychopathology derived from the MMPI. Another good predictor was a summary score of motor impairment. The implications of these findings were discussed in terms of the importance of examining multiple factors in predicting long-term social recovery.
ACKNOWLEDGEMENTS

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both in Guelph and in Windsor, thanks for the interest and support over the years! I would especially like to express my love and appreciation to my parents and to my brother. They have been a continuous source of strength, support and encouragement over the years. This thesis is dedicated to them.

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Chapter I

Introduction

A closed head injury (CHI) is a cranial injury in which the three membranes covering the brain (i.e., the meninges) remain intact (Gilroy & Holliday, 1982). In recent years the quality of outcome after CHI has become of increasing concern as advances in neurosurgical management are reducing mortality and increasing the number of survivors suffering disability (Timming, Orrison, & Mikula, 1982). Such survivors are often left with physical and neuropsychological deficits requiring a long and difficult multidisciplinary rehabilitation program. An important challenge to health care professionals working with CHI patients is to identify those factors that influence or predict the eventual outcome of those patients. If successful, this would enable one to predict the long-term prognosis of these patients and improve methods of patient management (Klonoff, Costa, & Snow, 1986).

Unfortunately at present the relationship between early factors and eventual outcome is for the most part poorly understood. In the first section of the following literature review some of the reasons for this are examined.
First, some general methodological problems involved in doing research on social recovery are listed. Next, the relative usefulness of various commonly used outcome measures is discussed. In the second section the qualities of good measures of social adjustment are examined. First, some desirable features of outcome measures are posited. Next, some advantages/disadvantages associated with using different information sources are discussed. Finally, the scales that will be used to measure outcome in the present investigation are described. Although there are difficulties involved in conducting research in this field, some statements can be made regarding the usefulness of various demographic, physical, and psychological variables in predicting outcome. In the final section of this review, the purpose of the present investigation, the general design, and the hypotheses that were tested are outlined.

The Measurement of Outcome

General Methodological Issues

Investigations of outcome after head injury are generally subject to criticism on various methodological grounds. If one surveys the field as a whole this is hardly surprising, given that (a) vague terms are often used to describe patient's health (Jennett & Bond, 1975) and social adjustment (Katz & Lyerly, 1963), (b) the assessment of
brain damage is complicated by a combination of both mental and physical sequelae and by the prolonged time scale during which recovery continues (Jennett & Bond, 1975), and (c) controversy surrounds discussions of the effects of early management, late rehabilitation, the reliability of prognosis and various other factors related to outcome after head injury (Jennett et al., 1977). Thus Livingston, Brooks and Bond (1985a) make a valid point when they note that at present no method for comprehensive assessment of patient outcome exists.

Quite aside from such ubiquitous concerns are a number of more specific methodological concerns associated with doing research in this area. These concerns are listed below. Since many of these are dealt with in association with specific issues in the text of the following literature review, they will only be discussed briefly here.

1. Most normative samples for traditional assessment devices consist of students, psychiatric patients, and normal adults. Comparing the performance of medically-ill patients to these samples may thus be inappropriate because the validity of their use with medically-ill patients has not been established (Lamping, 1985).

2. Many assessment devices have inadequate content validity for use with medically-ill populations. For example, some items in tests devised for psychiatric populations (e.g., those asking about hallucinations) may foster poor test-
taking attitudes. Furthermore, many adjustment measures do not tap important domains that are often affected by medical-illness (e.g., social functioning, social contacts) (Lamping, 1985).

3. Many assessment devices adopt a unidimensional conceptualization of behavior and ignore the multiple factors that can affect adjustment. (Lamping, 1985).

4. Many measures are insensitive to change. This is problematic because the ability to assess and predict change is crucial in understanding how people adjust and adapt to illness and is vital in designing interventions (Lamping, 1985).

5. Most social adjustment scales are applicable only to adult populations and many include overlapping and unspecified concepts (Weismann, Sholomskas, & John, 1981)

6. Control groups are rarely used and when they are they tend to be used inappropriately (McKinlay & Brooks, 1984). They also tend to vary between limb trauma patients, paraplegics and patients. Such variation between studies renders comparison of studies problematic (Livingston et al., 1985a).

7. Many authors fail to clearly differentiate the source of their information. This is important to do because the accounts of patients and of relatives have been found to differ systematically, with patients typically admitting
fewer personality changes than are reported by relatives (McKinlay & Brooks, 1984).

8. Comparison of studies is often difficult due to the use of heterogeneous and poorly described study samples and the employment of varying entry criteria (such as different measures of severity) (Levin et al., 1982; McKinlay, Brooks, Martinage, & Marshall, 1981; Oddy, Humphrey, & Uttley, 1978a; Tamas, Dacey, & Winn, 1985; Thomsen, 1984).

9. Despite the importance of the relationship between age at injury and recovery, most authors make no attempt to limit the age distribution in the study (Oddy et al., 1978a). When authors do not limit age, the effects of head injury are confounded with age-related degenerative changes (Klonoff et al., 1986).

10. Follow-up contacts are made at widely varying intervals within studies (Oddy et al., 1978a; Thomsen, 1984).

The Definition of Outcome

Levin, Benton, and Grossman (1982) discuss five reasons why the assessment of outcome of CHI patients is of importance: to provide prognostic information, to assess the efficacy of different treatments, to document CHI's significance as a public health problem due to its drain on public resources, to provide information on the morbidity of CHI and to provide information regarding the planning of rehabilitation facilities and allocation of resources. Thus,
although the focus of the present investigation will be the prognosis of eventual outcome, it is evident that the adequate measurement of outcome can have far more wide-ranging uses than this. However, with respect to prediction, it is evident that definition of outcome is the necessary first step in the prediction of outcome (Jennett & Bond, 1975).

Unfortunately, outcome is a multidimensional concept so the definition of it has tended to vary according to the specific purposes of different investigations. Jennett and Bond (1975) thus note that the most confusing aspect about outcome research is the wide range of terms used. For example, the above authors discussed six papers on outcome after CHI and found only one term that appeared more than once, "the rather vague word 'recovery'" (p.481). What outcome studies tend to do is to describe the outcome of their patients in terms of a small number of exclusive categories, some of which inevitably include patients with wide-ranging disabilities. The comparison of studies and the relative contribution of different factors (social, physical, psychological) to eventual outcome is thus rendered problematic.

However, one can think of outcome in general as being "the global term used to indicate the adequacy with which a patient's lifestyle is resumed" (Levin et al., 1982, p.63) with possible outcomes ranging from death to complete
resumption of premorbid lifestyle with no lasting sequelae. Given such a wide ranging definition it is hardly surprising that research on recovery after head injury has tended to vary widely between investigators in terms of outcome measures employed. Despite such variation, certain outcome measures do get used more often than others. Not surprisingly, some of these adopt a very narrow definition of outcome while others adopt quite a broad definition of outcome. Four of the most widely used types of outcome measures are mortality rates, return to work, the Glasgow Outcome Scale, and measures that tap multiple dimensions of social recovery. The usefulness of each of these as a measure of outcome is discussed in turn below. This discussion is arranged such that the measure with the narrowest definition of outcome (mortality rates) is examined first with the definitions getting progressively broader for the three measures that follow.

The Usefulness of Different Outcome Measures

I. Mortality Rates. The early prediction of the probability of death versus survival has been an issue of ongoing interest in the medically-oriented outcome literature. Tamas et al. (1985) suggest that it is because mortality is the easiest and most reliable outcome measure that it has so often been used to compare. Typically measures of severity and age at time of injury are found to
be the best predictor variables, with the likelihood of survival decreasing with increasing severity of injury and increasing age. For example, Levin et al. (1982) compare outcome from a number of different studies and conclude that patients with head injuries of sufficient severity to obtain a score of 8 or less on the Glasgow Coma Scale (GCS) have a 50-70% chance of survival with the probability of death increasing exponentially as a function of age at time of injury. Similarly—in a review of 19 studies conducted since 1968 that used the GCS as an index of severity, Tamas et al. (1985) also concluded that mortality increases with age and severity.

The use of mortality as the primary outcome variable is problematic for several reasons. Tamas et al. (1985) note that sole use of mortality rates may introduce major errors into interpretation because there is a wide distribution in age- and GCS-associated mortality rates across studies. In addition, Jennett and Bond (1975) suggest that the measurement of mortality is not as straightforward as it might appear to be since agreement must be reached on the conditions that should be met before ascribing death primarily to brain damage. More specifically, since closed head injuries are usually associated with other major injuries and complications, one must be careful to ensure that the death is indeed due primarily to the closed head injury. And finally, Jennett
and Bond (1975) also pragmatically suggest that "success should be measured less by the fact of survival and more by the quality of survival" (p.481). It is this issue of quality of survival, ill-defined as it may be, that is of more interest in attempts to measure and predict outcome after closed head injuries.

II. Return to Work. Return to work has been the dominant outcome measure used in studies of social recovery after head injury (Oddy et al., 1978a); it is typically considered a measure of social reintegration (Jennett & Bond, 1975). A consistent relationship between return to work and severity of injury has been reported in the literature with this relationship holding with various indices of severity. For example, extended lengths of unconsciousness (Gilchrist & Wilkinson, 1979), extended durations of post traumatic amnesia (Bond, 1975; Oddy et al., 1978a; Oddy & Humphrey, 1980; Van Zomeren & Van Den Burg, 1985), and GCS scores of 8 or less (Levin, Grossman, Rose, & Teasdale, 1979) are all associated with poorer prognosis for return to work. In addition (as will be discussed in more detail later), performance on various neuropsychological tests has been found to correlate positively with return to work (Drudge, Williams, & Kessler, 1984), to discriminate between employed and unemployed former patients (Heaton, Chelune, & Lehman, 1978), to
correlate with employment status, income and job skills (Newnan, Heaton, & Lehman, 1978), and to be a good predictor of future occupational status (Wild, Posthuma, & Bowman, 1985).

As is the case with almost every facet of outcome, a relationship between increasing levels of physical disability—poor prognosis for return to work has been reported (Bond, 1975; Oddy & Humphrey, 1980). However, like other facets of recovery, the prognosis for return to work is even poorer when it is associated with lasting emotional sequelae and personality disturbances (Bruckner & Randle, 1972; Gilchrist & Wilkinson, 1979; Prigatano, Fordyce, Zeiner, Roueché, Pepping, & Wood, 1984; Weddell, Oddy, & Jenkins, 1980). Although adequate statistics are not available, present estimates suggest that only about one-third of severe CHI patients return to work (Prigatano et al., 1984). In addition, a substantial proportion of those who do return to work are employed in lower status or part-time positions (Bruckner & Randle, 1972; Oddy et al., 1978a). When the pattern of return to work in the years following head injury is examined, it is generally found that the majority of patients who eventually return to work do so within the first two years (Levin et al., 1979; Oddy & Humphrey, 1980). However, Oddy, Coughlan, Tyerman, and Jenkins (1985) did report that a minority of patients who were working at a lower capacity (than premorbidly) at two
years post injury were able to return to their former vocational level by seven years post injury.

Despite the popularity and the consistent findings associated with the use of return to work as an outcome measure, many authors feel that return to work should not be used as the only outcome measure of recovery. There are several convincing arguments that support this view. Return to work is a relatively crude measure and may be an unrealistic index of recovery since both returning to work and failure to return to work may be related to factors other than health (e.g., the economy, employer generosity) (Jennett & Bond, 1975; Jennett, Snoek, Bond, & Brooks, 1981; Oddy & Humphrey, 1980; Van Zomeren & Van Den Burg, 1985).

Moreover, Weddell et al. (1980) suggest that whether or not a person can return to work is affected by two relatively independent factors. They report that return to work is related both to (a) neurophysical status and (b) personality change. Neurophysical status and personality change are not related to each other. Thus examination of the overall measure of return to work does not tell one about the relative contributions of physical and mental factors.

However, the most important reason not to rely solely on return to work as an outcome measure is because defining social reintegration only in terms of return to work ignores other important facets of recovery. For example, Oddy et
al. (1978a) found that one third of their sample did not return to work and one third did not resume leisure activities after head injury. Since the people in the third that did not return to work were not the same as those who did not resume leisure activities, Oddy et al. (1978a) argue that return to work is not an adequate outcome variable on its own and that other aspects of patient's functioning should also be explored (e.g., family life, social and leisure activities).

III. The Glasgow Outcome Scale. In developing the Glasgow Outcome Scale (GOS) Jennett and Bond (1975) were responding to a perceived need to develop a scale that would clearly define outcome into a number of mutually exclusive categories on the basis of more dimensions than are typically used. The GOS was thus devised as a measure that would categorize head injury patients into one of five categories on the basis of their physical and economic dependence and their social reintegration (Levin et al., 1982).

The categories describe by Jennett and Bond are:
1. Death: This must be ascribable to primary brain damage.
2. Persistent vegetative state: This indicates patients who show no evidence of meaningful responsiveness (e.g., cannot utter words or obey simple commands).
3. Severe disability: This is used to describe patients who are conscious but are dependent on others to the extent that they cannot function independently through a 24-hour period on their own.

4. Moderate disability: This is used to describe patients who are disabled but independent in that they are able to look after themselves, use transportation and return to certain kinds of work, but some previous activities are no longer possible.

5. Good recovery: Indicates that the patient is able to resume normal occupational and social activities although there may be minor physical or mental deficits.

The five scales are most often used separately but they can be combined into two groups or even subcategorized to form as many as eight categories (Jennett et al., 1981). The GOS was adopted for world-wide use for a five year period in order to facilitate comparison between centers. A close correspondence in terms of percentages of people in different outcome categories was generally reported (Jennett & Bond, 1975; Jennett, Teasdale, Braakman, Minderhoud, & Knill-Jones, 1976). This correspondence is closest for the more severe categories. Designation of outcome for the moderate disability and good recovery categories tends to vary between centers (Levin et al., 1982). In addition, the GOS is reported to have good inter-
rater reliability (Jennett & Bond, 1975; Jennett et al., 1981).

The GOS was designed to be a primary outcome measure to be used in conjunction with the Glasgow Coma Scale (GCS) (Gennarelli et al., 1982; Layton, 1987) such that together the two measures could form a predictive system in which early GCS scores could be used to predict later outcome, as measured by the GOS (Jennett & Bond, 1975). Some support for such a predictive system has been reported in that severe GCS ratings have been found to be predictive of poorer GOS ratings while mild GCS ratings have been found to be predictive of better GOS ratings (Jennett et al., 1977; Livingston et al., 1985a). Outcome predictions in patients who receive intermediate GCS scores (5, 6, or 7) tend to be less accurate (Young, Rapp, Norton, Haack, Tibbs, & Bean, 1981). As for the stability of GOS ratings, it is unusual for patients to change to another GOS category later than six months post injury, with approximately two-thirds of patients being in their final outcome category at three months post injury and over 90% being in their final outcome category at six months post injury (Jennett et al., 1976; Jennett et al., 1977; Jennett et al., 1981).

Although the GOS is clearly an improvement over mortality rates and return to work as a measure of outcome, and although it is quite popular and reliable, it is still not an ideal measure of outcome. Jennett et al. (1976)
suggest that attempts to rate psychological and neurological deficits are cumbersome and are liable to overestimate the functional deficits of patients. They thus argue that the advantage of this scale is that it indicates degree of disability without analyzing the factors contributing to the handicap. However, the lack of analysis of specific factors has also been cited as being the major weakness of the scale (Klonoof et al., 1986; Layton, 1987; Rimel, 1981). When one derives only a single score this tells one nothing about impairment within the specific dimensions that are used to compute this score.

**IV. Multidimensional Measures of Outcome.** In recent years the tendency has been for authors to use measures that do indeed tap different dimensions of recovery. Even in doing so many authors still adopt too narrow a viewpoint in that they conceptualize recovery as only having two broad components, a physical one and a mental one, and they tend to focus primarily on the physical component (Jennett & Bond, 1975). There are several compelling reasons why such an approach should not be adopted. Although most head injury patients are left with a combination of both mental and physical sequelae, one will sometimes encounter head-injured patients who are left with only mental sequelae; however, it is unusual to encounter patients who are left with only physical sequelae (Jennett & Bond, 1975; Jennett

A more important reason not to focus exclusively on physical sequelae is the fact that two of the most consistently reported findings in the literature are that cognitive and personality changes are the most frequently reported sequelae of CHI and that it is these changes, not physical disabilities, that are primarily responsible for disruption of lifestyle after head injury (Bond, 1975; Jennett & Bond, 1975; Levin & Grossman, 1978; Oddy et al., 1978a; Oddy et al., 1985; Weddell et al., 1980). In fact, of the studies currently reviewed, only two (Klonoff et al., 1986; Oddy & Humphrey, 1980) reported that one facet of recovery (return to work) was more influenced by physical disability than by personality and cognitive deficits. Thus, there is much evidence to suggest that to focus primarily on the physical sequelae of CHI is inappropriate.

As a result of such findings, authors now tend to examine more components (and, in turn, subcomponents) of recovery than had previously been the case. Although the number of components and terminology used to describe them vary between authors, most would agree with Bond (1975) who suggests three indices of outcome that should be rated independently (although some overlap exists): neurophysiological, mental, and social. Neurophysiological indices are designed to measure cumulative neurological and physical deficits.
Mental indices are designed to measure the extent of any memory defect, change in personality, and symptoms of mental illness. And, social indices are designed to measure changes in work status, leisure activities, family life, sexual behavior, and the development of criminality or alcohol abuse. Various other terms that have been used instead of Bond's (1975) are: physical (Klonoff & Costa, no date; Levin et al., 1982) instead of neurophysical; emotional (Klonoff & Costa, no date), cognitive (Jellinek, Torkelson, & Harvey, 1982; Newton & Johnson, 1985), and behavioral (Newton & Johnson, 1985) instead of mental; and psychosocial (Klonoff & Costa, no date; Levin et al., 1982; Newton & Johnson, 1985) instead of social.

The neurophysical and mental measures can generally be said to tap the physical and mental components of recovery discussed above. It is the work on social recovery after CHI and the interaction between areas that therefore has produced many of the newer findings in this field. In particular, the effect of head injury on the resumption of leisure activities, the resumption of social activities, return to work; and family life has been of interest. Since return to work was discussed in a previous section the present discussion will be confined to the affects of CHI on leisure activities, social activities, and family life.

A decrease in leisure activities (e.g., outside interests and hobbies) has been associated with physical
disability (Oddy et al., 1978a), mental disability (Bond, 1975), and severity of injury (Bond, 1975; Oddy et al., 1978a; Oddy & Humphrey, 1980). In an initial study, Oddy et al. (1978a) found that a decrease in leisure activities was also typical of a group of control patients who had traumatic limb fractures. They thus suggest that it is the disruption of normal life associated with any serious injury which is responsible for this decrease in leisure activities at six months. In a follow-up study in which these same patients were seen again at 12- and 24-months post injury, Oddy and Humphrey (1980) found that this decrease in leisure activities remained only for the head injury group and that it was not related to physical disability at these times. Similarly, Weddell et al. (1980) found that a group of head injury patients who had been injured approximately two years prior to contact engaged in fewer leisure activities than did controls. Oddy et al. (1985) contacted this same group of patients seven years after injury and found that they still engaged in fewer leisure activities than did controls. Thus a decrease in leisure activities appears to be one of the social sequelae of CHI.

A decrease in social activities (e.g., making and receiving visits, number of social outings, number of friends and acquaintances) is reported after closed head injury. This decrease is also associated with increased durations of post traumatic amnesia (Oddy et al., 1978a;
Oddy & Humphrey, 1980) but, interestingly, it is not associated with physical disability (Newton & Johnson, 1985; Oddy et al., 1978a; Oddy & Humphrey, 1980). At present, then, it is consistently concluded that social adjustment is a common problem for people who have experienced severe closed head injuries and that people who have received such injuries are a lonely and isolated group (Newton & Johnson, 1985). This is especially the case for those who are unemployed (Oddy et al., 1985).

The effects of head injury on family life are generally quite consistent. Weddell et al. (1980) suggest that the two findings which are most often reported are (1) cognitive and personality changes are more disruptive to family life than are physical disabilities and (2) parents withstand the stress better than do spouses. Although both of these findings are often reported, the finding that parents withstand stress better than do spouses is not as consistently reported (e.g., Oddy et al., 1978b) report no differences between parents and spouses in depression scores). In contrast, disruption of family life as a result of personality changes is a highly reliable finding (e.g., Livingston et al., 1985a; Oddy et al., 1978b).
Outcome Measures to be Used

Qualities of Good Measures

Despite the fact that a number of scales have been
designed specifically to measure social adjustment, the
assessment of social adjustment has not been highly
developed (Weismann et al., 1981). This is largely due to
many of the methodological considerations involved in the
assessment of adjustment that are discussed above. The
stunted development of social adjustment assessment is also
largely due to some of the difficulties involved in dealing
with such an ill-defined concept as adjustment. These
difficulties are no different today than they were when Katz
and Lyerly (1963) discussed some of the issues involved in
designing a good measure of social adjustment.

The definition of adjustment was a major concern of
Katz and Lyerly (1963). They noted that an operational
definition of adjustment must be derived in such a way that
it is readily accepted but does not just conform to some
current fad in psychological theory or health care. Katz
and Lyerly (1963) determined that the dictionary definition
was the clearest and most satisfying. The dictionary
defined adjustment as "bringing into proper relation
behavior to circumstances or oneself to one's environment;
to free from differences or discrepancies, to bring to a
satisfactory state so that parties are agreed" (Katz &
Lyerly, 1963, p.506). They later defined more specific terms relating to adjustment (adequate social functioning, social adjustment, personal adjustment, and social behavior). The Katz Adjustment Scale was designed to conform to these definitions and to a number of methodological considerations.

At present, it is these methodological considerations that are of interest because they are still relevant when evaluating scales said to measure social adjustment. Katz and Lyerly's (1963) first consideration was one discussed in detail above: Namely, because adjustment is a multifaceted concept, an adequate scale should attempt to develop a profile of scores that will tap the separate facets. Next they suggest that, because adjustment affects both the person experiencing difficulties and those people in the social environment with whom he has contact, scales should be administered to both the patient and a significant other. Next, they note that a measure should be objective so that results can be generalized across studies that use the same populations. They also suggest that, for a scale to be widely applicable, it must be possible for the lay person to administer it. Next, they suggest that a scale should be able to differentiate the actual behavior of the patient from the expected behavior of the patient. And finally they suggest that a scale should be able to describe behavior in the community.
By these criteria, the scales chosen for use in the present investigation can be said to be good measures of adjustment. The Katz Adjustment Scale was chosen as the measure to be used by a close relative to rate the patient's adjustment. The other scale used was the Psychosocial Adjustment to Illness Scale. This was used as a self-rating of adjustment by the patient. This scale meets the above criteria, with one exception: It does not provide a way in which expected behavior can be separated from actual behavior. However, such separation is rarely reported in the literature so failure to meet this criterion is not a major shortcoming of this scale. Both scales are considered to be relatively good measures of social adjustment, even though there are some methodological problems associated with their use with head injured populations. The scales, and the associated problems and advantages of using them, are discussed below in more detail in the methodology section.

The Advantages/Disadvantages of Different Information Sources.

Because of concern regarding the reliability of self-ratings by patients regarding their own adjustment, many authors advocate the use of a close relative as a source of information in addition to, or instead of, the patient (Heaton, & Pendleton, 1981; Hogarty, Katz, & Chase, 1971;
Katz & Lyerly, 1963; Wild et al., 1985). Indeed, McKinlay and associates have been consistent opponents of the sole use of patient reports as measures of adjustment since they feel that many head injury patients may have a lack of insight into their problems, may be unwilling to admit changes in personality, or may underestimate the significance or consequences of such changes (Brooks & McKinlay, 1983; McKinlay et al., 1981; McKinlay & Brooks, 1984).

There is some support for this position. In an unpublished study (discussed in Heaton & Pendleton, 1981), Heaton, Chelune, and Lehman (1981) found that the complaints of disability in a heterogeneous group of patients were more related to their emotional status (as measured by the MMPI) than to actual abilities (as measured by their performance on a battery of neuropsychological tests). They thus conclude that asking patients about their disability may not be a reliable method in which to gather data. Similarly, Wild et al. (1985) found a negative correlation between severity of injury and the number and severity of reported problems. They argue that this relationship supports the suggestion of previous researchers that more severely head injured patients complain less about changes in their day-to-day efficiency than do less severely injured patients. Finally, McKinlay and Brooks (1984) asked both the patient and a close relative to rate the patient's adjustment and
found that their accounts systematically differed. When they examined the accounts according to different areas of deficit, they found the most frequent agreement regarding the patient's physical functioning and the least regarding the patient's emotional functioning. However, in contrast to Wild et al. (1985), they suggest that the differing accounts were most likely related to the patient's unwillingness to admit personality changes rather than to severity of disability, since they found no significant correlations between the extent of disagreement and extent of cognitive impairment.

There are also problems associated with the use of close relatives to rate patients, the most obvious of which is that such ratings may be subject to bias due to the relative's relationship with the patient (Heaton & Pendleton, 1981; Hogarty et al., 1971; Katz & Lyerly, 1963). However, in recent years much of the research that examines ratings by close relatives has been concerned with more subtle issues regarding the influence of the relative's functioning on the ratings that they give.

There are indications that the relative's personality has an influence on their reports of patient changes. Increasing severity of patient's injury has been found to be related to increased ratings of subjective burden on the part of the relative (McKinlay et al., 1981; Livingston et al., 1985a) and an increased likelihood that the relative
will rate the patient as having experienced personality changes (Brooks & McKinlay, 1983). However, one cannot conclude that these ratings are only reflective of the more severe patient injuries since the relationship between subjective burden and severity weakens over time but the level of stress experienced by the relative remains unchanged (McKinlay et al., 1981; Oddy et al., 1978a). In addition, some relatives who reported low subjective burden rated the patients as having experienced many personality changes while some relatives who reported high subjective burden reported few personality changes (Brooks & McKinlay, 1983). It thus appears that factors within the relative, as well as those within the patient, influence relative's rating of the patient's functioning.

McKinlay and Brooks (1984) did examine the influence of relative's personality on patient ratings. They administered a 15-item version of Eysenck's personality scale to close relatives of head injury patients and found that relatives with higher neuroticism scores reported more patient differences. Since there was no way to be sure if it was the relative's higher neuroticism that influenced their ratings of the patient or if it was the greater number of changes in the patients that resulted in higher neuroticism scores, McKinlay and Brooks (1984) suggest that there is a need for caution in drawing causal inferences:
one should not simply assume relative ratings are only reflective of patient changes.

Given that information from both the patient and from a close relative can be of use in assessing the patient's social recovery, but that information from both of these sources is suspect for the reasons discussed above, one can argue that the best course is to obtain ratings both from a relative and from the patient. Katz and Lyerly (1963) suggest that to do so is advisable because it "protects against the expected inadequacies of relying solely on either informant" (p.509). In the present investigation, information regarding the patient's adjustment will therefore be obtained both from a relative, via the Katz Adjustment Scale - Relative's Form, and from the patient, via the Psychosocial Adjustment to Illness Scale - Self-Report Form.

Variables Related to the Prediction of Outcome of CHI

Age

It is a well-established finding that recovery from head injury is inversely proportional to age (Oddy et al., 1978a). This relationship holds regardless of the outcome measure employed. Increasing age at the time of injury is associated with increasing mortality rates (Heiskanen & Sipponen, 1970), poorer prognosis for return to work.
(Gilchrist & Wilkinson, 1979), poorer outcomes on the GOS (Jennett et al., 1976), and poorer 'quality of survival' ratings (Pazzaglia et al., 1975).

The best outcomes are reported for patients who are under 20 years of age at the time of injury and the worst for patients who are over age 60 at the time of injury (Heiskanen & Sipponen, 1970; Jennett et al., 1976; Pazzaglia et al., 1975; Timming et al., 1982). The age of 40 years has been reported to be an important cutoff point with respect to both mortality and return to work. Approximately 50% of those head injured patients who die as a result of their injury are 40 or over at the time of injury (Pazzaglia et al., 1975) while an age at injury of over 40 years is associated with persistent unemployment (Bruckner & Randle, 1978). However, Jennett et al. (1976) suggest that age may be less closely related to outcome in the 20- to 60-year-old age range than is often claimed because they found no differences between successive decades with respect to percentage of people in the five GOS categories.

Litigation

Because head injured patients are often involved in claims for compensation, such claims are sometimes introduced to account for the sequelae of head injury (Dikmen & Reitan, no date). Of the studies that are currently reviewed, only three examined this variable. Oddy
et al. (1978a) found no statistical association between claims for damage and time to return to work. Mckinlay et al. (1981) found no significant differences between the number of complaints of patients who consistently expressed the view that they had ground for compensation and the number of complaints of patients who consistently expressed the view that they had grounds for compensation and the number of complaints of patients who did not feel that they had grounds for compensation. And, Mckinlay and Brooks (1984) reviewed several studies that examined the effect of claims for compensation and found no evidence to suggest that a relationship between litigation and patient symptoms exists. Thus, it appears that, in severely head injured populations, it is rare for patients to exaggerate symptoms because of claims for compensation.

Type of Lesion

Several authors have examined the relationship between type of lesion and outcome. Pazzaglia et al. (1975) examined the relationship between lesion type, level of injury, and outcome after head injury. Not surprisingly, they found that surgical lesions generally involved a less favorable prognosis than non-surgical lesions. When they further examined outcomes associated with the surgical lesions they found that they could establish a scale of decreasing severity. Subdural haematomas were associated
with the worst outcome, followed by lacerations and contusions and acute extradural haematomas. When they examined the relationship between level of injury and outcome Pazzaglia et al. (1975) found that the more caudal the level of the injury was the worse the outcome was. They thus found that recovery was above average in diencephalic and uncal syndromes, usually unfavorable in mesencephalic syndromes, and that a bad outcome was always associated with Bulbopontine syndromes. By combining their findings on the effects of age, lesion type, and level of injury, Pazzaglia et al. (1975) formed a predictive system for outcome. For example, they found that the best prognosis was associated with those patients who were under the age of 40, had diencephalic or uncal syndromes, and non-surgical lesions, and the least favorable prognosis was associated with those patients who were over the age of 40, had Bulbopontine syndromes, and surgical lesions.

Gennarelli et al. (1982) examined the relationship between severity and lesion type. They divided their patients (1) according to GCS scores into serious (GCS scores 6 to 8) and more serious (GCS 3 to 5) groups and (2) by type of lesion. Outcome was measured at 3 months using the GCS. Severity of injury was found to affect outcome regardless of the lesion type in that patients with GCS scores of 3, 4, or 5 always had worse outcomes than those with GCS scores of 6, 7, or 8. Of the lesion types,
subdural haematomas and diffuse lesions with comas greater than 24 hours were associated with the worst outcomes.

What was particularly interesting about this study was the interaction between severity and lesion type. Gennarelli et al. (1982) found that for equivalent levels of injury severity there are some lesions that are associated with a good prognosis and some that are associated with a poor prognosis. For example, the mortality rate in patients who suffered an epidural haematoma and had a GCS score of 3 to 5 was approximately 35% while the mortality rate in patients who suffered a subdural haematoma but who also had a GCS of 3 to 5 was approximately 73%. Gennarelli et al. (1982) thus question the "unstated hypothesis" (p.32) that severity of injury is the sole determinant of the type of outcome and argue that other factors, such as lesion type, should also be considered.

Severity of Injury

Severity of injury clearly has the greatest prognostic significance of the various neurological variables (Levin et al., 1982) and is the most widely accepted indicator of brain damage (Jennett et al., 1977). Generally, one can think of severity as referring to impaired consciousness (Teasdale & Jennett, 1974) and depth and duration of coma as being the best indicators of severity (Jennett et al., 1977). Unfortunately, there is an abundance of terms by
which impairment of consciousness can be described and there has been no general agreement about what terms to use and how to interpret them (Teasdale & Jennett, 1974). However, investigations with head injured populations have typically used one of three indices of severity: length of coma (a.k.a. length of unconsciousness), length of post-traumatic amnesia, and Glasgow Coma Scale ratings.

Length of Coma. There is a large body of literature that indicates that length of coma (LOC) is related to recovery. Patients who have longer comas are reported to have poorer prognoses than those with shorter comas (Dye, Saxon, & Milby, 1981; Oddy et al., 1978a). For example, increasing LOCs have been associated with poorer performances on neuropsychological tests (Dye et al., 1981), higher mortality rates (Gilchrist & Wilkinson, 1979), a poorer prognosis for return to work (Gilchrist & Wilkinson, 1979), and a poorer prognosis for independence in activities of daily life (Timming et al., 1982).

Unfortunately, the definition of coma tends to vary between studies that use LOC as an index of severity. Typically, definitions include an inability to voluntarily obey simple commands (e.g., Dye et al., 1981; Heiskanen & Sipponen, 1970), inability to communicate either verbally or nonverbally (e.g., Heiskanen & Sipponen, 1970; Levin & Grossman, 1978; Timming et al., 1982), and/or a state of unresponsiveness to the environment (e.g., Gilchrist &
Wilkinson, 1979; Pazzaglia et al., 1975). The major problem involved in using LOC as an index of severity is therefore that no general consensus has been reached with respect to what constitutes (1) a coma and (2) the termination of a coma (Teasdale & Jennett, 1974).

Post Traumatic Amnesia. The definition of post-traumatic amnesia (PTA) also tends to vary between authors. However, a definition of PTA as being "the time before the return of continuous day-to-day memory after the accident" (Oddy et al., 1978a, p.612) does appear to be a representative one. There is much evidence that suggests that longer durations of PTA are associated with poorer outcomes in head injured populations. Bond (1975) found that longer durations of PTA are associated with greater degrees of mental, physical and social disability. Brooks and McKinlay (1983) found that duration of PTA is a good predictor of the presence. Duration of PTA is a good predictor of the presence of personality change but not the magnitude of personality change. Oddy et al. (1978a) found that longer durations of PTA are associated with poorer prognosis for return to work, fewer leisure activities, and less social contact. Mandleberg (1976) found that rate of cognitive recovery is related to duration of PTA. Drudge et al. (1984) report that duration of PTA has been found to correlate with neuropsychological recovery.
The use of PTA as a measure of severity is also problematic for several reasons. First, although the above definition of PTA is widely accepted, it has not been accepted by all. For example, Eames and Wood (1985) suggest that PTA should not be rated only on the basis of memory performance because many head injury patients have persisting severe memory disorders. Comparison is thus difficult because varying definitions of PTA are employed. Second, duration of PTA is typically rated retrospectively and the reliability of such ratings has been questioned (Klonoff et al., 1986). Third, there is no general agreement in the literature regarding what duration of PTA should be regarded as severe. Many authors adopt the Russell (1971) classification of severity in which a duration of PTA greater than seven days is taken to indicate a very severe injury (e.g., Jennett et al., 1977; Oddy et al., 1978a; Thomsen, 1984). However, many authors classify patients as having a severe injury if they have a duration of PTA greater than 48 hours (e.g., Livingston et al., 1985b; McKinlay et al., 1981). And fourth, there are indications that the Russell dichotomy may be in need of revision. Van Zomeren and Van Den Burg (1985) examined the Russell dichotomy of severe versus very severe concussions and concluded that, although the one week cutoff is a reasonable one in indicating very severe injuries, a better cutoff for very severe injuries is 13 days.
The Glasgow Coma Scale. The Glasgow Coma Scale (GCS) was developed in order to provide a reliable system for describing impaired consciousness that could be applied consistently by clinicians (Teasdale & Jennett, 1974). Rimel (1981) provides an excellent description of the GCS. She writes:

The Glasgow Coma Scale relates 'consciousness' to motor responses, verbal responses and eye opening. In each of the three test categories, the examiners determine the best response the patient can make to a set of standardized stimuli. An increasing number of points are assigned to responses indicative of increasing degrees of arousal. The scores range between 3 and 15 with 15 considered normal and 3 indicating the most severely depressed level of consciousness. The three categories (verbal, motor response, eye opening) are totalled to calculate the score. Coma is defined by Teasdale and Jennett (1974) as 1) no response to command, 2) no comprehensible verbal response and 3) no eye opening. According to these criteria, all scores of seven or less, but no scores of nine or more, constitute coma (Rimel, 1981, p.138).

There is some support for the reliability of this measure. Teasdale and Jennett (1974) report a disagreement rate of 20% when several doctors and nurses were simply asked whether patients were unconscious or not. In contrast, they report that "disagreements were rare" (p.83) when these same observers rated the same patients using the GCS. Jennett et al. (1977) report a close correspondence between centers in three countries (Scotland, the Netherlands, and the United States) in terms of percentages of people who obtain various GCS scores. They note that the
use of this scale has identified remarkably similar patient populations in distinctly different countries and argue that such concordance supports the reliability of the GCS.

The GCS has been adopted worldwide as a measure of severity after head injury (Tamas et al., 1985). Studies to date suggest that the GCS is a valid predictor of mortality and morbidity (Layton, 1987). Choi, Ward and Becker (1983) found that accurate predictions of outcome (using the GOS) could be made within the first 24 hours after injury based on GCS scores, age and oculocephalic response. Klonoff et al. (1986) found that the GCS scores were important predictors of post-injury quality of life. And Tamas et al. (1985) reviewed 19 studies that used the GCS and found that mortality rates decrease in a stepwise fashion in relation to GCS scores; that is, more people who obtain ratings of 3 die than do people who obtain ratings of 4, more people who obtain ratings of 4 die than do people who obtain ratings of 5, and so on.

In an attempt to further validate the GCS, Layton (1987) examined the relationship between severity of injury and neuropsychological test performance. Patients were divided into severe (GCS score 3-8), moderate (GCS score 9-12), and mild (GCS score 13-15) groups based on ratings six hours post injury. Because he was interested in examining the validity of GCS rating in the acute stages of injury, Layton (1987) conducted the neuropsychological examination
as soon as possible after injury. The mean time after injury for the examination was 6.4 days in the mild group, 14.7 days in the moderate, and 36.7 in the severe. Layton (1987) arranged the neuropsychological tests in his battery into eight "conceptually meaningful" (p.4) composite groups and compared the composite scores (1) of the severe group with the composite scores of the moderate and mild groups combined and (2) of the moderate group with those of the mild group. A total of 16 comparisons were thus made. Fifteen of these comparisons were statistically significant. Because neuropsychological test performance soon after injury was able to discriminate between these three groups, Layton (1987) suggests that the GCS categories of severe, moderate, and mild are valid.

The main area of contention with respect to use of the GCS appears to be which GCS rating should be used for admission to a study (Tamas et al., 1985). Jennett et al. (1976) argue that the scores six hours after admission should be used because they feel that brain damage may appear to be more serious than it really is in the first few hours after admission. In contrast, in their review Tamas et al. (1985) concluded that studies that used GCS scores on admission made more accurate predictions of outcome than studies that used scores at six hours. However, most investigators agree that the most accurate predictions are made by using serial GCS scores (Levin et al., 1982). For
example, a consistent finding is that patients whose GCS scores improve within the first 24 hours after injury have a much better prognosis than do patients whose GCS scores fall within the first 24 hours after injury.

The GCS was used as an index of severity in the present study. Given the retrospective nature of this study, GCS scores were considered to be the best index of severity of injury, as LOC and PTA data were not considered to be as reliable. In addition, GCS scores were available for most of the patients used in this study whereas other measures of severity were not as consistently recorded.

Neuropsychological Predictors

Introduction. Several studies that examine the usefulness of neuropsychological test scores for predicting everyday functioning have been conducted. Many of these studies employ heterogeneous subject samples (e.g., Heaton et al., 1978; Heaton & Pendleton, 1981; Newman et al., 1978) or specific patient populations (e.g., McSweeney, Grant, Heaton, Prigatano, & Adams, 1985). Generalizing the results of these studies specifically to head injured populations is thus problematic. In addition, because various different tests have been employed as 'neuropsychological' predictors, the definition of what constitutes neuropsychological impairment varies between studies.
In order to more clearly focus the following
discussion, only those studies that (1) use head injured
patients as subjects and (2) primarily use tests in the
Halstead-Reitan Neuropsychological Test Battery (HRNTB) as
measures of neuropsychological functioning will be
discussed. Klonoff et al. (1986) is an exception in that
these authors do not employ the HRNTB. However, this study
is discussed because the present investigation was similar
to it in several important ways. As in Klonoff et al.
(1986), the present investigator employed both patient’s and
relative’s ratings of adjustment, examined the
correspondence between these different information sources,
examined the relationship between neuropsychological test
scores and ratings of adjustment, and used the KAS-R as the
relative’s rating. However, unlike Klonoff et al. (1986),
the present investigation primarily used tests from the
HRNTB, used the PAIS-SR (instead of the Sickness Impact
Profile) as a patient rating of social adjustment, primarily
used severe (instead of mild) head injury patients as
subjects, and used neuropsychological test scores as
predictors (rather than as correlates) of adjustment.

Review of Studies. Dikmen and Reitan (no date) were
interested in evaluating the emotional reactions of a group
of head injured patients over an 18-month period. Emotional
reactions were measured by the MMPI. Dikmen and Reitan (no
date) classified patients into either (1) impaired or (2)
normal/mild groups on the basis of their scores on the HRNTB at discharge. These same patients were then tested again at 12- and 18-months post injury. The neuropsychological test performances of both groups of patients improved in each successive testing. Nonetheless, the test performances of the impaired patients were still inferior to those of the normal/mild patients at both follow-ups.

Scores on several MMPI scales (Depression, Hypochondriasis, Psychasthenia, Schizophrenia) also dropped significantly in both groups in each successive testing. Dikman and Reitan (no date) suggest that this progressive drop indicates "that feelings of anxiety, somatic complaints and strange experiences that patients complain of soon after their head injuries tend to subside over time" (Dikmen & Reitan, no date, p.6). Although the scale scores of both groups decreased over time, differences between the MMPI profiles of the impaired and mild/normal groups were found at all testings. At first testing, the impaired group had significantly higher scores on the L, K, Depression, Hypochondriasis, and Hysteria scales and a lower score on the Mania scale. This pattern was observed at both 12- and 18-months. Dikmen and Reitan (no date) interpret these differences as suggesting that patients with more serious ability losses are more depressed, have a greater number of somatic complaints, and have less energy than less impaired patients. No explanation was posited for the elevated L and
K scale scores. Dixmen and Reitan (no date) thus conclude that the MMPI is a good measure of emotional functioning since it is sensitive both to the acute/chronicity dimension of injury and to severity of injury, as measured by the HRNTB.

Drudge et al. (1984) evaluated the neuropsychological sequelae of severe CHI over time. They conducted two complete neuropsychological examinations of the same patients. The mean interval between injury and the first testing was 2.6 months and the mean interval between injury and the second testing was 11.5 months. In addition, they also administered the HRNTB and the WAIS to a group of neurologically normal patients who presented with "a variety of symptoms which were believed to be psychogenically based and/or precipitated" (Drudge et al., 1984, p. 260). These patients served as a control group.

When the two head injury groups' testings were compared, significant improvements were found in all neuropsychological test scores except for Speech-Sounds Perception, grip strength with the dominant hand, and tactile form recognition. In addition, significant improvement was noted on all of the WAIS scales except for digit span. When the scores of the head injury group were compared to those of the control group, it was found that the control group's performance was superior to the head injury group's performances at both testings. This was
especially the case when the control group's performances were compared to the CHI group's first testing. However, significant differences were still noted at 12 months between the control and head injury groups on 9 of the 15 Halstead-Reitan measures and on 9 of the 14 WAIS measures. Drudge et al. (1984) thus conclude that, although some global recovery of function occurs in CHI patients within the first 12 months after injury, the prognosis for full recovery within this time is not particularly good.

Dye et al. (1981) examined the neuropsychological test performance of head injury patients who had experienced comatosis. They hypothesized (1) that comatosis would lead to subsequent neuropsychological deficits and (2) that greater lengths of coma would be associated with greater neuropsychological deficits. To test the first hypothesis, they compared the performance of their overall group of head injury patients to the performance of a control group of traumatic injury patients. Support for this hypothesis was obtained when they found significant differences between groups for all but two (Speech-Sounds Perception and Verbal IQ) of the neuropsychological measures. Dye et al. (1981) therefore concluded that their hypothesis that comatosis would lead to subsequent neuropsychological deficits was supported.

To test their second hypothesis, Dye et al. (1981) divided their head injury patients into short (less than 48
hours) and long (greater than 48 hours) coma groups. Significant differences between the two coma groups were obtained on finger tapping, the Tactual Performance Test's (TPT) location and memory components, the Halstead Impairment Index, and Parts A and B of the Trail Making Test. In addition, more group differences were reported between the long coma group and controls than between the short coma group and controls. Dye et al. (1981) thus conclude that these findings support the hypothesis that long periods of coma are followed by poorer subsequent neuropsychological test performance than are short periods of coma.

The findings of Heaton and associates (Heaton et al., 1978; Heaton & Pendleton, 1981; McSweeny et al., 1985; Newnan et al., 1978) indicate that neuropsychological assessments have clinical utility for predicting (1) chances of competitive employment and (2) satisfactory psychosocial adjustment. However, as was noted above, these authors used heterogeneous patient samples. Wild et al. (1985) were interested in replicating the findings of these authors using a more homogeneous group of head injured patients.

At the time of testing most subjects were more than one year post injury. Wild et al. (1985) thus suggest that it can be assumed that the greatest gains in cognitive functioning have already occurred and that the test results represent residual neuropsychological deficits. Thirty-four
variables were selected as potential predictors. One of these was a summary variable referred to as "Keytests", which consisted of the Halstead Impairment Index, The Category test, TPT location, and Trails B. Other predictors included Estimated (premorbid) Full Scale IQ (FSIQ), and the 13 MMPI scales. The dependent variables were employment status and daily life efficiency (i.e., how well a person is able to cope with daily life situations).

The most important predictors of occupational status were Keytests, estimated FSIQ, finger tapping scores and the male/female (Mf) and Social Introversion (Si) scales from the MMPI. The most important predictor variables for daily life efficiency were severity of trauma, actual (as opposed to estimated) FSIQ and the Depression scale from the MMPI. Wild et al. (1985) thus concluded (1) that neuropsychological measures (i.e., KEYTESTS) are useful predictors of occupational status, (2) that neuropsychological measures are not useful predictors of daily life efficiency and, (3) that severity of trauma and the resulting cognitive (i.e., WAIS-R) deficits are useful predictors of later daily life efficiency. It should be noted that this distinction between neuropsychological measures and cognitive deficits is somewhat artificial since the WAIS-R is typically one of the measures included in a neuropsychological test battery. As such, it is possible
that neuropsychological measures, taken in this more general sense, are related to daily life efficiency.

Fordyce et al. (1983) note that the cognitive functioning of head injury patients typically improves over time but that emotional functioning often deteriorates. They thus hypothesized that a group of severe head injury patients referred for neuropsychological testing more than six months after injury (referred to as the chronic group) would exhibit greater emotional distress than a group of severe head injury patients tested six months or less after injury (referred to as the acute group). Fordyce et al. (1983) used the MMPI as a self-report measure of emotional functioning and the KAS-R as a relative-report measure of emotional functioning. As predicted, the MMPI and KAS-R profiles of the chronic group indicated that patients in this group were experiencing more emotional distress than were patients in the acute group. More specifically, significant differences were reported between groups on the K, Psychasthenia, Schizophrenia, and Social Introversion scales of the MMPI and on the General Psychopathology, Bizarreness, and Withdrawal and Retardation scales of the KAS-R. These differences were not in evidence when an Analysis of Covariance was performed using LOC as a covariate. Surprisingly, no significant differences were found between groups on any of the neuropsychological measures.
Fordyce et al. (1983) suggest that two components of emotional distress emerged from these findings. One was a generalized emotional distress component which, Fordyce et al. (1983) suggest, is similar to the general maladjustment factor that is extracted from factor analytic studies of the MMPI. This was indicated by the elevations on the K, Psychasthenia, and Schizophrenia scales of the MMPI and by the elevation of the General Psychopathology Scale of the KAS-R. The other was a social introversion component. This was indicated by the elevation on the Social Introversion scale of the MMPI and the Withdrawal and Retardation Scale of the KAS-R. Fordyce et al. (1983) conclude that these findings support the hypothesis that emotional functioning in head injury patients is more likely to deteriorate over time than is cognitive functioning.

And finally, Klonoff et al. (1986) were interested in the relationship between neuropsychological impairment and quality of life (QOL) after head injury. They identified a number of (1) premorbid (2) injury-related, and (3) post-injury variables that have been reported to be good predictors of outcome after closed head injury and used them as possible a priori predictors of QOL. In addition, Klonoff et al. (1986) described a wide battery of neuropsychological tests that are primarily measures of "information processing, language, memory, executive functions," and motor performance" (p.473). These tests
were also used as possible a priori predictors of QOL. The KAS-R was used as the QOL questionnaire to be filled out by relatives. The MMPI and Sickness Impact Profile (SIP) were used as patient QOL questionnaires. These questionnaires were used as criterion variables.

Klonoff et al. (1986) identified patients who had experienced head injuries two to four years prior to their investigation. These patients were then given the battery of neuropsychological tests, the SIP, and the MMPI. In addition, a close relative was asked to complete the KAS-R. Klonoff et al. (1986) note that these cannot be considered to be either 'predictor' or 'criterion' variables since this data was collected after injury. They thus caution that the relationship between the predictor variables and criterion variables should be regarded as correlational, not as causative. This is especially the case since they used canonical correlations to examine the relationship between their predictor variables and (1) the SIP, MMPI and return to work data and (2) the KAS-R.

Three canonical variates were identified. Two of these were derived from canonical correlations between the predictor variables and patient ratings of QOL. The third was derived from a canonical correlation between the predictor variables and the relatives' ratings of patient QOL. The first canonical variate indicated that a relationship exists between the predictor variables of motor
performance and initial GCS scores and the criterion variables of physical well-being and social role functioning. Klonoff et al. (1986) interpret this relationship to mean that degree of motor dysfunction relates to those aspects of QOL that involve activities of daily living and social role functioning. This canonical variate thus represents the affects of physical dysfunctions on post-injury quality of life. Canonical variate 3 supported this finding. Since canonical variate 1 was identified using patient criterion variables and canonical variate 3 was identified using relative criterion variables, Klonoff et al. (1986) suggest that the affect of motor dysfunction on QOL is a reliable finding. Canonical variate 2 indicated that a relationship exists between memory and constructional ability and psychosocial dysfunction. They interpreted this to suggest that impairment of higher-order cognitive skills relates to psychosocial dysfunction. Klonoff et al. (1986) conclude evidence exists to support the affects of both physical and cognitive deficits on QOL.

**Purpose, Design, and Hypotheses**

The purpose of the present investigation is to further examine the usefulness of neuropsychological test scores in predicting social recovery after closed head injuries. The subjects consisted of former head injury patients who have been administered at least one partial Neurocognitive
Assessment (NCAs). A NCA refers to an abbreviated battery of neuropsychological tests that was designed to tap five areas of functioning: communication, memory, visuospatial and psychomotor skills, and reasoning. However, the Communication and Memory factors were not included in analyses (as is discussed in the Methodology section). Subjects who were administered two NCAs were administered the first during the first year post-injury and the second one or more years post-injury. The age at the time of injury was limited to between 16 and 39, as per the recommendation of Oddy and associates. This restriction was imposed in order to minimize the possible confounding effects of normal age-related degenerative changes. Since Rimel (1981) reports that the majority of patients who experience CNS trauma are under 22 years of age, the sample was still representative of the majority of people who experience closed head injuries.

Subjects who met these criteria were contacted and asked to complete the Psychosocial Adjustment to Illness Scale - Self Report (PAIS-SR). In addition, the person whom the patient has the most contact with in day-to-day life was asked to complete the Katz Adjustment Scale - Relative's Form (KAS-R).

There were three hypotheses associated with this study:
1. Studies that have conducted serial neuropsychological testings have found that neuropsychological test performance improves in successive testings of the same patient (Dikmen & Reitan, no date; Drudge et al. 1984). The first hypothesis of this study was therefore that the neuropsychological test performances of the patients at the second testing would be significantly better than those at the first.

2. Summary measures of impairment (the Halstead Impairment Index, the Average Impairment Rating, 'key tests') have been reported to be good predictors of recovery (Drudge et al., 1984; Dye et al., 1981; Wild et al., 1985). The second hypothesis of this study was therefore that, at both testings, a summary rating of neuropsychological impairment would be a better predictor of social recovery, as measured by summary scores from the KAS-R and PAIS-SR, than GCS scores, the Personality factor of the NCA, or the number of years of formal education completed by the patient premorbidly.

3. The third hypothesis consists of a set of three hypotheses. These all relate to the indications in the literature that (1) initial severity of head injury (Wild et al., 1985) and impairments in motor skills (Klonoff et al., 1986) are particularly related to difficulties in performing activities of daily life and (2) that impairment of higher-order cognitive skills is particularly related to
psychosocial dysfunctions (Klonoff et al., 1986; Wild et al., 1985).

3a. The PAIS-SR was selected for use in the present study specifically because it was designed to measure psychosocial adjustment. As such, the ability to perform daily life activities is not a major focus of this scale. Hypothesis 3a was therefore that, at both testings, the Reasoning factor of the NCA would predict the PAIS-SR summary score better than would the other NCA factors, GCS scores, or number of years of formal education.

3b. Return to work and the resumption of social and leisure activities have been reported to be particularly affected by disruption of higher-order cognitive skills. Hypothesis 3b was therefore that, at both testings, the Reasoning factor of the NCA would best predict scores on the vocational environment and social environment scales of the PAIS-SR since these scales are, respectively, designed to measure occupational adjustment and social and leisure activities.

3c. Residual impairment in higher-order cognitive skills has been found to be particularly related to psychosocial dysfunctions. Hypothesis 3c was therefore that the reasoning scores at the time of the second assessment would be more related to the PAIS-SR total, vocational environment, and social environment scores than would the reasoning scores at the time of the first assessment.
Chapter II
Methodology

Subjects

The subjects in this study were selected from head injury patients who had been seen at Chedoke Hospital in Hamilton, Ontario. Several criteria were specified for inclusion into the study: An age-at-onset of between 16 and 39 years, an initial assessment within the first year after injury, a full testing on at least one of two NCA factors that were used as predictor variables in this study (i.e., the Visuospatial and Psychomotor factor, and the Reasoning factor), and no premorbid psychiatric history or history of drug abuse.

Out of a potential sample of 194 head injury patients, 94 fulfilled these criteria. Since the centile groups to which the patients were assigned for Testing One (as is described in detail below) were based on this Overall sample, these 94 patients will be referred to as the "Overall" sample. A subsample of the Overall sample was also identified. This subsample consists of those patients from the Overall sample who returned the questionnaires and is referred to as the "Study" subsample.
In addition, two other subsamples were identified to test the hypotheses associated with Testing Two. The first consists of those patients from the Overall sample who (1) underwent a second assessment 12 or more months after injury and (2) underwent two full testings on at least one of the two NCA factors which were used as predictor variables in this study. These patients are thus referred to as forming the "Retest" subsample. The final subsample identified consisted of those subjects in the Retest subsample who returned the questionnaires.

At this point it would be advisable to clearly specify what exactly the nomenclature used in the present investigation is referring to. The reading of this chapter, and the following chapters, could potentially be confusing because (1) four samples were identified to be used in the analyses, and (2) data from two different assessments were used in the various analyses. In order to facilitate the reading of this document a summary of the explanations for various terms that are used is presented in Table 1 and a breakdown of where the various samples were derived from is presented in Figure 1.

Insert Table 1 and Figure 1 about here
<table>
<thead>
<tr>
<th>Term</th>
<th>Explanation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing One</td>
<td>The assessment that occurred within the first year after onset.</td>
</tr>
<tr>
<td>Data from Testing One</td>
<td>The GCS score on admission, the number of years of formal education, and the neuropsychological and MMPI data obtained during Testing One.</td>
</tr>
<tr>
<td>Testing Two</td>
<td>The assessment that occurred more than one year after onset.</td>
</tr>
<tr>
<td>Data from Testing Two</td>
<td>The GCS score on admission, and the neuropsychological and MMPI data obtained during Testing Two.</td>
</tr>
<tr>
<td>Overall sample</td>
<td>All of the closed head injury patients assessed at Chedoke Hospital who met the criteria of the present investigation.</td>
</tr>
<tr>
<td>Study subsample</td>
<td>All of the patients from the Overall sample who returned the questionnaires.</td>
</tr>
<tr>
<td>Retest subsample</td>
<td>The patients from the Overall sample who were tested twice: Once within the first year after onset and once more than one year after onset.</td>
</tr>
<tr>
<td>Study2 subsample</td>
<td>All of the patients from the Retest subsample who returned the questionnaires.</td>
</tr>
</tbody>
</table>
Figure 1

A Breakdown of Where the Overall sample, and the Study, Retest, and Study2 subsamples were Derived from.

Closed Head Injury Patients Assessed at Chedoke Hospital (n=194)

→ The Overall Sample (n=94)

→ The Study Subsample (n=57)

→ The Retest Subsample (n=53)

→ The Study2 Subsample (n=36)
Descriptive statistics for the Overall sample and for the Study, Retest, and Study2 subsamples are presented in Table 2. It is evident from this table that the Overall sample and the Study, Retest, and Study2 subsamples all consist primarily of men who have a high school education and who have sustained severe head injuries in their early twenties. Given that one of the criteria for inclusion into the study was an age-of-onset of between 16 and 39 years, it is not surprising that the patients in this study tended to be young at the time of injury. However, since only 26 of the original 194 head injury patients (13.4%) were excluded from the study because they did not fulfill the age-at-onset criterion (8 were too young and 18 were too old), this sample is considered to be fairly representative of the population of patients who sustain head injuries. Indeed, the Overall sample of the present study is demographically very similar to a large sample of head trauma patients described by Rimel (1981). In this sample, 69% of the head injury patients were male, 62% of the patients were under 29 years of age at the time of injury, and unemployed people and "blue collar" (p.136) workers comprised two of the three groups of people who are most affected by head traumas. The third group consisted of retired people.
Table 2

Descriptive Statistics for Subjects in the Overall sample and in the Study, Retest, and Study2 Subsamples

<table>
<thead>
<tr>
<th>Variable</th>
<th>na</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall sample (69 men, 25 women)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-at-onset (years)</td>
<td>91</td>
<td>23.97</td>
<td>5.9</td>
<td>16.58-38.75</td>
</tr>
<tr>
<td>Years Since Injury</td>
<td>92</td>
<td>4.64</td>
<td>2.14</td>
<td>-1.17-10.25</td>
</tr>
<tr>
<td>Months Between Injury and first testing</td>
<td>92</td>
<td>3.82</td>
<td>2.61</td>
<td>1-11</td>
</tr>
<tr>
<td>GCS score on admission</td>
<td>67</td>
<td>6.09</td>
<td>2.23</td>
<td>3-15</td>
</tr>
<tr>
<td>Years of Formal Education</td>
<td>88</td>
<td>11.88</td>
<td>2.12</td>
<td>8-17</td>
</tr>
</tbody>
</table>

| Study subsample (44 men, 13 women)            |    |       |     |               |
| Age-at-onset (years)                          | 54 | 24.03 | 5.58| 16.92-38.75   |
| Years Since Injury                            | 55 | 4.34  | 2.06| 1.17-8.83     |
| Months Between Injury and first testing       | 55 | 3.85  | 2.36| 1-10          |
| GCS score on admission                        | 41 | 6.51  | 2.53| 3-15          |
| Years of Formal Education                     | 55 | 11.85 | 1.96| 8-17          |

\textit{Note:} The number of patients used to calculate the descriptive statistics varies because full data sets were not available for many of the subjects.
Table 2 (continued)

<table>
<thead>
<tr>
<th>Variable</th>
<th>n</th>
<th>M</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Retest subsample (38 men, 15 women)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-at-onset (years)</td>
<td>53</td>
<td>24.56</td>
<td>5.92</td>
<td>16.83-37.75</td>
</tr>
<tr>
<td>Years Since Injury</td>
<td>53</td>
<td>4.14</td>
<td>1.98</td>
<td>1.17-8.00</td>
</tr>
<tr>
<td>Months Between Injury and first testing</td>
<td>53</td>
<td>4.38</td>
<td>2.8</td>
<td>1-11</td>
</tr>
<tr>
<td>Months Between Injury and second testing</td>
<td>53</td>
<td>14.74</td>
<td>3.7</td>
<td>12-26</td>
</tr>
<tr>
<td>GCS score on admission</td>
<td>39</td>
<td>5.94</td>
<td>2.19</td>
<td>3-15</td>
</tr>
<tr>
<td>Years of Formal Education</td>
<td>51</td>
<td>11.88</td>
<td>2.12</td>
<td>8-17</td>
</tr>
<tr>
<td><strong>Study2 subsample (29 men, 7 women)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Age-at-onset (years)</td>
<td>36</td>
<td>24.57</td>
<td>5.8</td>
<td>16.92-38.75</td>
</tr>
<tr>
<td>Years Since Injury</td>
<td>36</td>
<td>3.9</td>
<td>1.87</td>
<td>1.17-8.90</td>
</tr>
<tr>
<td>Months Between Injury and first testing</td>
<td>36</td>
<td>3.97</td>
<td>2.35</td>
<td>1-10</td>
</tr>
<tr>
<td>Months Between Injury and second testing</td>
<td>36</td>
<td>14.31</td>
<td>3.24</td>
<td>12-25</td>
</tr>
<tr>
<td>GCS score on admission</td>
<td>28</td>
<td>6.21</td>
<td>2.44</td>
<td>3-15</td>
</tr>
<tr>
<td>Years of Formal Education</td>
<td>35</td>
<td>11.66</td>
<td>1.94</td>
<td>8-17</td>
</tr>
</tbody>
</table>
Seventy-six of the 94 patients in the Overall sample were located and contacted by phone. Eight were sent packages of material without contacting them by phone first because they either had unpublished numbers, lived in another country, or their relatives were unwilling to divulge their phone numbers. There were 10 patients whom we were unable to locate. Letters that explained the purpose of the study and asked that they contact Chedoke Hospital were sent to the last address on file for these 10 patients in the hope that their mail would get forwarded and they would contact the hospital.

Fifty-one of the 76 people contacted by phone returned both questionnaires while one person returned only the KAS-R and one person returned only the PAIS-R. Three of the people who were sent packages without being contacted personally returned both questionnaires while one returned only the PAIS-SR. Of the letters which were sent to former patients' last known addresses, six were returned with messages that those people no longer lived there and no responses were obtained from the remaining four. Therefore, of the 84 sets of questionnaires mailed out, a total of 54 were returned with both questionnaires completed, two were returned with only the PAIS-SR completed, and one was returned with only the KAS-R completed. An overall return rate of 67.86% was thus obtained from those people to whom questionnaires were sent.
As can be seen in Table 3, the majority of the KAS-Rs that were returned were completed by either the patients' wives (24.1%) or mothers (33.33%). Fathers constituted the next largest single group of respondents (11.11%). The people in the "Other Relative" category consisted of three husbands, two sisters, and one brother-in-law, one grandmother, and one daughter. The people in the "Significant Other" category included one boyfriend, one girlfriend, and one fiancee.

Materials

The Katz Adjustment Scale. Despite the problems associated with relative's ratings, they are nonetheless considered to be of value because a relative is in a particularly advantageous position to report on the patient's adjustment (Katz & Lyerly, 1963) and day-to-day problems (Wild et al., 1985). Katz and Lyerly (1963) recognized the dilemma posed by the possible bias of a relative on the one hand and the value of a relative as an informant on the other hand and attempted to circumvent this dilemma when they designed the Katz Adjustment Scale - Relative's Form (KAS-R). They state:
Table 3
The Relationship of the People Who Completed the KAS-R to the Patient

<table>
<thead>
<tr>
<th>Relation to Patient</th>
<th>n</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Wife</td>
<td>13</td>
</tr>
<tr>
<td>2. Mother</td>
<td>15</td>
</tr>
<tr>
<td>3. Father</td>
<td>6</td>
</tr>
<tr>
<td>4. Other Relative</td>
<td>6</td>
</tr>
<tr>
<td>5. Significant Other</td>
<td>3</td>
</tr>
<tr>
<td>6. Friend</td>
<td>5</td>
</tr>
<tr>
<td>7. Health Care Worker</td>
<td>2</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>55</strong></td>
</tr>
</tbody>
</table>
One methodological question to consider in this research concerns areas in which relatives can provide dependable information. Consequently, many areas of behavior relevant to the general concept of adjustment were included (in the KAS-R). In addition, in order to minimize the extent to which the relative’s involvement would interfere with his reporting, the items were designed to focus on specific behaviors and to avoid placing the relative in the position of judging the patient. The little experience that we have in dealing with this problem indicates that relatives will report it if a patient “has trouble sleeping”, if he “gets into fights”, “speaks to people who aren’t there”, but that few relatives will report a patient as “unfriendly” or “not generous” (Katz & Lyerly, 1963, p.510).

The KAS-R consists of 127 items that were originally written to conform to a number of hypothetical clusters (e.g., depression, belligerence, withdrawal) as a method of lending direction to test construction. These items were designed to tap two major areas of behavior: psychiatric symptoms and social behavior. In an initial validation study, Katz and Lyerly (1963) were interested in examining whether or not the KAS-R could discriminate between carefully selected extreme groups in the community. The subjects consisted of 19 ex-hospitalized schizophrenic patients (average time after discharge from the hospital was approximately 2 to 2 1/2 years) who were rated by the clinical staff in terms of their adjustment to the community: nine were rated as well-adjusted and ten as poorly adjusted. Relatives of the patients were given the KAS-R and their ratings of the patient were compared with those of the clinical staff. Significant point-biserial
correlations were obtained for both ratings of psychopathology and social behavior which, they suggest, argue in favor of using relatives as reporters. Later research extended these findings to include patients of varying levels of adjustment. The KAS-R thus appears to be valid for distinguishing psychiatric patients' behavior at various levels of adjustment (Hogarty et al., 1971).

In a follow-up study, Katz and Lyerly (1963) gave the KAS-R to the relatives of 100 schizophrenic patients, the responses of whom were subjected to a cluster analysis that was aimed at providing a set of clusters that would be internally consistent and relatively independent of each other. They found that 12 clusters emerged. They named them as follows: Belligerence, verbal expansiveness, negativism, helplessness, suspiciousness, anxiety, withdrawal and retardation, general psychopathology, nervousness, confusion, bizarreness, and hyperactivity (later a thirteenth "stability" cluster was formed Hogarty et al., 1971). To examine the internal consistency of these clusters, Katz and Lyerly (1963) then administered the KAS-R to the relatives of 404 acute schizophrenic patients from nine other hospitals and found comparable internal consistency coefficients in the two samples and similar intercorrelations of the clusters across the two samples. They thus conclude that the pattern of relationships among clusters is highly stable.
Hogarty et al. (1971) were later interested in developing norms for nonpatients in order to examine whether the norms vary as a function of social and demographic variables. Their sample consisted of 450 people (221 male, 229 female) aged 15 and over who did not have a history of psychiatric treatment. It should be noted that their sample cannot be considered to be representative of the population in general since it was drawn exclusively from one county in the United States, and the population was 98% white, and was 88% Protestant. The normative sample is broken down according to sex, age, marital status, and social class. Means and standard deviations on all 13 of the subscales are presented for each of the categories of this breakdown. In addition, Hogarty et al. (1971) present means and standard deviations for a typical psychiatric patient sample.

Although there was generally very little variability in the scores of the standardization sample, Hogarty et al. (1971) did find that certain patterns of behavior were more characteristic of certain population segments. For example, more symptomatic behavior was reported for women than for men and adolescents tended to rate as higher on negativism and lower on stability than were older subjects. The authors thus note that one should be aware of such differences in psychiatric samples before making too much of small differences in psychiatric populations.
Although the KAS-R was developed for use with psychiatric populations and although norms for brain-injured populations are not yet available, the KAS-R is increasingly being used as a measure of the social adjustment of head injury patients. Its use with these patients is thus subject to several of the methodological criticisms outlined in the first section of this paper. Despite this fact, the KAS-R's growing use with this population, its psychometric properties, the dearth of scales that do have norms for head injured populations, and its multidimensional orientation make it one of the best scales available for use in obtaining relative's ratings of social adjustment. In addition, authors who have used the KAS-R with head injured populations have compared their results to the norms of Hogarty et al. (1971). For all of the above reasons the KAS-R was considered by the present author to be an appropriate scale for use with a head injured population.

The KAS-R has been used in studies of head injury patients for various purposes. Newton and Johnson (1985) compared a sample of 11 head injury patients with the norms presented by Hogarty et al. (1971) and found that the head injury group had significantly poorer adjustment than did the general population. In addition, they were more confused but less anxious, nervous, hyperactive and showed less psychopathology than did a psychiatric sample.
A trend has been reported for relatives to rate patients as being more impaired on the KAS-R 12 months after injury than 6 months after injury. One possible explanation for this trend is that ratings become worse as patients move from the acute to chronic phases of injury because they become more emotionally disturbed as they realize that their deficits will remain (Fordyce et al., 1983). Another possible explanation is that the relatives become more depressed when the personality changes fail to resolve (Oddy et al., 1978b). However, there is some suggestion that rehabilitation can reverse this trend since Prigatano et al. (1984) found a significant improvement in KAS-R scores in head injury patients who had undergone rehabilitation as compared to those who had not. In addition, they reported that those patients who underwent rehabilitation but showed no improvement were more deviant in their pre-rehabilitation KAS-R scores than were those patients who showed improvement. This suggests that the KAS-R might be of use in identifying patients who will benefit from rehabilitation.

Finally, Klonoff and associates have used the KAS-R as an inventory of quality of life as reported by relatives. Klonoff and Costa (no date) examined the differences in quality of life between four groups of head injury patients: Patients with frontal lobe damage in the context of a diffuse injury, patients with posterior damage but no
frontal lobe damage, patients with normal CT scans, and patients with mild injuries in which no CT scans were taken. The patients with frontal lobe damage showed the most impairment both on a self-report inventory of quality of life (the Sickness Impact Profile) and on the KAS-R. Klonoff and Costa (no date) also report that "a modest relationship between neuropsychological tests thought to reflect frontal lobe dysfunction and quality of life, as measured by the KAS" (p.4) was found. In addition, as was discussed in detail previously, Klonoff et al. (1986) found that KAS-R scores were related to the extent of motor dysfunction and initial severity of injury in a group of head injured patients. It thus appears that the KAS-R is sensitive to at least some aspects of differences in quality of life in head injured patients.

In the present investigation, a variation of the instructions suggested by Katz and Lyerly (1963) was attached to the KAS-R and sent to the respondent. The following instructions were sent to the relative/friend of male patients (a female version was also available):

THIS FORM IS DESIGNED TO GIVE US SOME IDEA OF HOW YOUR RELATIVE/FRIEND IS FROM DAY TO DAY AND HOW WELL HE HAS BEEN GETTING ALONG. IT WILL ALSO GIVE US SOME IDEA ABOUT HIS BEHAVIOR AND HOW HE GETS ALONG WITH OTHER PEOPLE. PLEASE BASE YOUR CHOICES ON HIS BEHAVIOR IN THE PAST 30 DAYS, INCLUDING TODAY. PLEASE ANSWER ALL THE QUESTIONS. WHEN YOU FINISH PLEASE CHECK AGAIN TO MAKE SURE YOU HAVE COMPLETED ALL THE ITEMS.
The KAS-R was scored based on the original article by Katz and Lyerly (1963) in which 12 clusters were described. In addition, the later "Stability" cluster described by Hogarty et al. (1971) was also included. Respondents rate the 127 items of the KAS-R as occurring "Almost Never", "Sometimes", "Often", and "Almost Always". Scores of one, two, three, and four, respectively, are assigned to these different ratings. The number of items per cluster varies from three to 24, with the mean number of items-per-cluster being 6.62 and the mode number of items-per-cluster being four. Thus, for the various clusters the range for the lowest possible scores attainable is from three to 24 while the range for the highest possible scores attainable is from 12 to 96.

In the 12 clusters originally described by Katz and Lyerly (1963), high scores indicate greater difficulties in adjustment that do low scores. However, in the thirteenth "Stability" cluster described by Hogarty et al. (1971), lower scores indicate greater difficulties in adjustment. The stability cluster contains nine items. Thus scores for this cluster range from between 1 and 9, with nine indicating the least "stability". Because both analyses and interpretation are facilitated by scoring all 13 clusters in the same direction (higher scores indicating greater impairment), the scores on the stability cluster were transformed by subtracting them from 45. In so doing, lower
scores on the stability factor then also indicated fewer
difficulties in adjustment than did higher scores.

Twelve respondents did not complete all of the items
in the KAS-R. Six of these 12 respondents omitted one item
and two omitted two items. The remaining four respondents
omitted three, four, 11, and 23 items, respectively. Since
Katz and Lyerly (1963) do not specify a procedure for
assigning missing data values, a conservative approach was
adopted in which it was decided that it was better to err in
favour of the patient and assume that "Almost Never" (or
"Almost Always" in the case of the Stability cluster) was
the desired choice. Thus omitted items were assigned scores
of one (or four if they were in the stability cluster).

Since only the total score from the KAS-R was used in
the analyses, it was felt that assignment of missing data
values to four items or less would not unduly influence
their total score or the results. However, the KAS-Rs
which 11 and 23 items were omitted were also included in the
analyses. Although assignment of missing data values in
these instances undoubtedly had an effect on the total KAS-R
scores, these two KAS-Rs were retained because, even with
the conservative approach to the assignment of missing
values, their total scores were among the highest obtained.
This suggests that these two respondents perceived their
relatives as having severe adjustment problems but that they
were unwilling to discuss these difficulties at length. The KAS-R is included in Appendix A.

The Psychosocial Adjustment to Illness Scale. Although, prior to the development of the Psychosocial Adjustment to Illness Scale (PAIS) (Derogatis, 1975) some scales designed to measure adjustment to medical illness did include some items on psychosocial adjustment, few focussed on it. The value of the PAIS is that it is designed to focus specifically on a patient's psychosocial adjustment to medical illness (Morrow, Chiarello, & Derogatis, 1978). The PAIS was originally designed to be administered in a semi-structured interview format (Derogatis, 1975) but later a self-report version of the PAIS, the PAIS-self-report (PAIS-SR), was developed (Derogatis & Lopez, 1983).

Both versions consist of 46 questions that are divided into seven sections, each of which is designed to measure a different domain of psychosocial adjustment, (Morrow et al., 1978). The sections are:
1. Health care orientation: This relates to attitudes towards physicians and treatment.
2. Vocational environment: This assesses disruption in job performance, satisfaction, and adjustment that is attributable to the illness.
3. Domestic environment: This assesses illness-induced difficulties that arise primarily in the home.
4. Sexual relationships: This assesses shift in quality of sexual behavior or relationships due to illness.

5. Extended family relationships: This reflects difficulties in relationships with the extended family due to illness.

6. Social environment: This assesses the degree to which illness has impaired the patient's social and leisure activities.

7. Psychological distress: This assesses the degree to which psychological difficulties have arisen in association with the illness.

Morrow et al. (1978) examined the inter-rater reliability and construct and criterion validity of the PAIS using a sample of 37 patients who had Hodgkin's disease. They obtained an inter-rater reliability coefficient of .83 for the total score and reliability coefficients for the seven sections that ranged from .33 to .82. They conclude that the PAIS can be considered to be a reliable instrument with one exception: The extended family section. It was considered to be problematic because a non-significant and low coefficient of agreement of .33 was obtained.

When the scores from the seven domains were intercorrelated, the correlation coefficients ranged from 0.00 to .33 indicating that the seven domains are relatively independent of each other in terms of their assessment of social adjustment. Furthermore, all of the domains but two
(extended family relationships and vocational environment) showed a statistically significant contribution to the total score. The authors thus suggest the findings (1) that the domains are relatively independent of each other and (2) that they contribute to the total score, support the construct validity of this measure. With respect to criterion validity, Morrow et al. (1978) gave the subjects a written questionnaire to complete that posed questions about activities of daily life that are relevant to each of the domains (e.g., the number of sick days in the preceding two weeks as related to the health care orientation domain) and obtained significant correlations (in the predicted directions) between the PAIS and the ratings. They thus conclude the implications of these findings are that "the PAIS can be administered with an acceptable degree of reliability and with an initial measure of confidence in its validity" (Morrow et al., 1978, p.39).

Kaplan De-Nour (1982) later conducted a study that examined the usefulness of the PAIS in measuring the adjustment of a group of 102 chronic hemodialysis patients. He found that the patients reported a higher rate of problems than would have been expected from the literature and suggested that this indicates that patients are willing to admit to problems. However, he also suggest that patients are less willing to admit problems regarding psychological distress and relationships than problems in
other more functional domains. In contrast to Morrow et al. (1978), Kaplan De-Nour (1982) found that the seven sections of the PAIS did significantly intercorrelate with each other. He suggests that it is not surprising that different aspects of adjustment are related to each other because strong relationships between different aspects of adjustment have been reported previously. Kaplan De-Nour (1982) also found a strong relationship between physicians' ratings of the patients and the patients' ratings of themselves which further supports the criterion validity of the measure. He concludes that the PAIS is useful for (a) gathering meaningful information that is related to physicians' assessments, (b) differentiating patients at different levels of adjustment, and (c) as such, it meets the requirements of a questionnaire that can measure the adjustment of this group of hemodialysis patients.

Two reviews of adjustment scales have also given generally favorable reports on the PAIS. In their review, Weisman et al. (1981) discuss an unpublished factor-analytic study by Derogatis (1981) that supported the dimensional structure of the PAIS and that demonstrated high discriminative validity in distinguishing males who tested positive and negative for lung cancer. They note that the PAIS has problems with both reliability and validity in the extended family domain and that data on its applicability to
patients with other disabilities is needed. However, they conclude that, on the whole, it is a promising scale.

In a more recent review, Lamping (1985) also examined the PAIS. The fact that the PAIS was reviewed at all in this article speaks for its potential as a measure of adjustment to illness since Lamping (1985) only discussed measures that fulfilled her criteria for potentially valid and useful measures to be used in health psychology. She noted that its positive features are as follows: (1) it is specifically designed to measure psychosocial adjustment to medical illness, (2) it has norms for various patient groups, (3) it has both interview and self-report formats, (4) it is multidimensional, and (5) it gives scores for adjustment at global, domain, and discrete-item levels. The major limitation of the PAIS reported by Lamping (1985) is that its relationship to social desirability has not been explored.

Overall, it appears that authors are agreed that the PAIS is a potentially valuable instrument that has acceptable reliability and validity but which still has problems, especially regarding its extended family domain and the possibility of the social desirability factor. These problems, the issue that norms are lacking for head injured populations and the lack of information on the PAIS-SR all question the decision to use the PAIS-SR in the present study. However, its potential usefulness, its
orientation toward general medical (rather than psychiatric) illness, its multidimensional nature, and the fact that it is relatively short are all features that led to the decision to include it in the present investigation. Since this is one of the first studies to use the PAIS with head-injured patients, its use is also of interest because this study, in effect, constitutes an exploratory investigation of its use with these patients.

In the present study, the instructions included in the PAIS-SR booklet were sent to the patients. Briefly, these instructions indicate that the questions concern the effects that their illness has had on various areas of life, that in answering the questions they should refer to the last 30 days, and that they should leave blank those questions that do not apply to them (e.g., those that assume that they have a steady sexual partner when they do not) but that they should try to answer as many questions as they possibly can. The full instructions are included in Appendix A.

The questions are scored on a four-point scale (zero to three) in which a score of zero indicates no difficulties and a score of three indicates marked difficulties (Derogatis & Lopez, 1983). The number of items per scale ranges from five to eight, with the mean number of items-per-scale being 6.57 and the mode number being six. Thus the lowest possible score on all scales is zero while the highest possible scores range from 15 to 24.
Thirty-two of the 56 subjects who returned the PAIS-SR omitted at least one item. As can be seen in Table 4, items were most often omitted from the Domestic Environment and Sexual Relationships subscales. The most common explanation given for why subjects omitted items (1) on the former subscale was because the subjects lived alone, and (2) on the latter subscale was because they had no current sexual partner. With respect to hypothesis three in the present study, it is of interest to note that nine subjects omitted items from the Vocational Environment subscale and that two subjects omitted this scale entirely. The most common explanation given was that subjects who were not working omitted items that asked about their present work behaviour (e.g., items two and three) because they felt that these items were not applicable.

The majority of subjects omitted only one item on any given subscale (see Table 4). In such cases, corrections for missing data were made in accordance with the PAIS-SR manual suggestion that "the integer value (i.e., rounded to the nearest whole number) of the average of item scores present for the domain is assigned to any missing items from that domain" (Derogatis & Lopez, 1983, p.21). Since the manual does not give a procedure for scoring subscales when more
Table 4

Description of Missing Data on the PAIS-SR

<table>
<thead>
<tr>
<th>Subscale</th>
<th>1 item</th>
<th>2 items</th>
<th>3 items</th>
<th>4 items</th>
<th>All items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Health Care Orientation</td>
<td>4</td>
<td>2</td>
<td>1</td>
<td>1</td>
<td>6</td>
</tr>
<tr>
<td>Vocational Environment</td>
<td>5</td>
<td>2</td>
<td>0</td>
<td>2</td>
<td>2</td>
</tr>
<tr>
<td>Domestic Environment</td>
<td>10</td>
<td>5</td>
<td>1</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Sexual Relationships</td>
<td>8</td>
<td>8</td>
<td>0</td>
<td>0</td>
<td>5</td>
</tr>
<tr>
<td>Extended Family Relations</td>
<td>2</td>
<td>1</td>
<td>0</td>
<td>1</td>
<td>0</td>
</tr>
<tr>
<td>Social Environment</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Psychological Distress</td>
<td>2</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
than one item is omitted, a conservative approach was again adopted and the items were scored as "zero". Two subjects omitted the Vocational Environment subscale entirely, four omitted the Sexual Relationships subscale, and one omitted the Social Environment subscale. For these subjects, the total PAIS-SR score was computed based on the scales that were completed (as is discussed below).

In the PAIS-SR manual, Derogatis and Lopez (1983) state:

Analyses randomly deleting items from completed tests have shown that up to 20% (approximately 9) of the items may be deleted from the scale without markedly affecting the PAIS Total Score if a correction is made. Similarly, on any of the 7 primary domain scores, deletion of any one item appears to have little impact on the respondent's score on that dimension if a correction is applied (p. 20).

No subject in the present investigation had more than eight missing values included in the calculation of the Total Score. Thus the use of a summary score (which was derived from the Total Score, as is discussed below) as a dependent variable in the present investigation is justifiable by these standards.

The Vocational Environment and Social Environment subscales were also used as dependent variables. All of the subjects included in the analyses in which the Social Environment subscale was the dependent variable completed all the items on this subscale. Thus the use of it as a dependent variable was justifiable. Nine subjects omitted
more than one item on the Vocational Environment subscale. As was mentioned previously, unemployed subjects tended to omit items on the Vocational Environment subscale because they felt that the items were not applicable. Thus the conservative approach to the assignment of missing data adopted in the present investigation most likely had the effect of underestimating the difficulties in vocational adjustment that these subjects were experiencing. The PAIS-SR is also included in Appendix A.

The Neurocognitive Assessment

The Neurocognitive Assessment (NCA) was assembled at Chedoke Hospital to serve as an abbreviated test battery that would tap five major areas of functioning. Before describing the factors, a word of caution is in order. Although the five factors are given names according to what the tests can generally be considered to measure, this does not mean that the tests do not tap other abilities. For example, although the Trail Making Test is included in the reasoning factor, to successfully complete this test one must have intact visuospatial and psychomotor abilities. Thus this test could also be considered to tap ability measured by the psychomotor factor. Similarly, the Digit Symbol subtest of the WAIS-R is commonly considered to be the WAIS-R subtest that is the most sensitive to brain damage. As such, one could argue that this test could also
be included in the reasoning factor, instead of the psychomotor factor, because the reasoning factor is presumably the one which should be the most sensitive to impairment of higher-order cognitive functions. One should therefore be aware of the fact that overlap between factors exists and that the factor names are not meant to be taken literally.

The five factors of the NCA are:

1. Factor A is a Communication Factor. It typically consists of the Aphasia Screening Test. For reasons discussed below, this factor was not included in the analyses.

2. Factor B is designed to measure both verbal and figural memory and it is therefore a Memory Factor. The tests used to tap verbal memory are the Sentence Memory Test, the Digit Span Subtest from the WAIS-R, and the Babcock-Levy Story Recall Test. The test used to tap figural memory is the Benton Visual Retention Test (BVRT). Both Form A, which is designed to measure immediate memory figures, and Form B, which is designed to measure delayed memory for figures, of the BVRT are administered.

3. Factor C is a Visuospatial and Psychomotor Abilities Factor. The Picture Completion and Block Design subtests from the WAIS-R are used to measure visuospatial abilities. The Grooved Pegboard Test and the Digit Symbol subtest from the WAIS-R are used to measure psychomotor abilities.
4. Factor D is a Personality Factor. This typically consists of the MMPI.

5. Factor E is a Reasoning Factor. The tests used here are the Category Test and Parts A and B of the Trail Making Test.

Procedure

Contacting the Subjects. Head injury patients were originally identified by examination of their files in the Psychology Department at Chedoke Hospital in Hamilton. Ninety-five patients who met the inclusion criteria specified above were targeted as being potential subjects. However, one of these subjects had to be eliminated at a later time, despite the fact that he had already been contacted by phone, because examination of his medical file indicated that he suffered a mild, rather than severe, closed head injury.

Whenever possible, initial contact with potential subjects was made over the telephone. The subjects were (1) briefly told about the project, (2) informed that a package of material was to be mailed to them, (3) requested to fill out the questionnaires and return them, (4) told that they would be contacted again by phone in order to address any difficulties that they might have with the questionnaires, (5) asked if they had any questions, and (6) thanked for their time.
The subjects were then mailed a package of material that included a letter that explained the purpose of the project and a request for their participation, letters of consent for both the patient and the person who filled out the KAS-R, the PAIS-SR, and an addressed and stamped envelope in which they returned the consent forms and questionnaires. Those patients who had not returned the material within two-to-three weeks were contacted again by phone. At this time, any questions they had regarding the study were answered. If necessary, interviews were conducted in order to aid the patients in filling out the questionnaires, and they were again urged to fill out the questionnaires and return them.

Patients who did return the questionnaires were sent thank-you letters. Patients who still did not return the questionnaires after approximately one month were sent letters which again asked them to fill out and return the questionnaires. In addition, these letters also said that they should just return the blank questionnaires if they were not going to complete them so that we would know their intentions either way. The letters (1) of consent, (2) explaining the study, (3) thanking the subjects, (4) urging the subjects to return the questionnaires, and (5) of feedback are appended in Appendix B.

**Obtaining Glasgow Coma Scale Scores.** Whenever possible, GCS scores on admission were obtained through
examination of the patients' medical files at Hamilton General Hospital, the hospital in Hamilton that handles acute care of head injury patients. Twenty-seven patients who qualified for inclusion in the present study were transferred to Chedoke via hospitals other than Hamilton General Hospital. No GCS information was thus available for these patients.

Hamilton General Hospital had files on the remaining 67 patients. GCS scores for 59 of these patients were obtained directly from their files. The remaining eight patients did not have GCS scores recorded in their files. However, descriptions of their conditions on admission, in terms GCS variables (eye opening, verbal responsiveness, and motor responsiveness) or—in terms of loss of consciousness, were recorded and GCS scores were estimated based on these descriptions. These estimates were made by Dr. Scott Garner, the physician in charge of the head injury team at Chedoke Hospital.

**Number of Years of Formal Education.** It was decided to include a measure of premorbid Socio-Economic attainment as a predictor variable. Three measures which are often used are (1) occupational status, (2) income, and (3) educational level. Typically, these three measures are highly correlated, with one well-accepted opinion being that occupational status is an intervening variable which links education to income (Blishen, 1971).
For the purposes of the present study, the question was which one of these three variables should be used as an index of premorbid Socio-Economic attainment. Originally, occupational status was chosen. The most common method of rating occupational status in Canada is by the use of Blishen's Index for Occupations in Canada (Blishen, 1971). Unfortunately, using this was not feasible in the present study. There were two main reasons for this. First, ratings of premorbid occupation were only available for approximately two-thirds of the subjects selected for inclusion into this study. Second, and most important, approximately one-third of these people were students at the time of injury and there is no rating for "Student" in Blishen's Index. Similarly, there were no records available on the subjects' premorbid income and this measure would be a misleading measure of premorbid Socio-Economic attainment in a sample of subjects that contained so many students.

The number of years of formal education attained before the accident was thus chosen as the most appropriate measure of premorbid Socio-Economic attainment. This was available for the majority of the subjects from their files in the Psychology department at Chedoke.

Reduction of the Number of Variables. There were 51 variables that could have potentially been used in the analyses for the present study. Fourteen neuropsychological test scores, 13 MMPI scale scores, the
number of years of formal education, the GCS score, 14 KAS-R scores (13 subscale scores and a summary score), and eight PAIS-SR scores (seven subscale scores and a summary score). Because the use of all of these variables would have resulted in an unacceptably low subject-to-variable ratio, it was necessary to reduce the number of variables included in the analyses.

Several steps were taken to accomplish this. First, summary scores for the PAIS-SR and the KAS-R were computed. There are seven subscales in the PAIS-SR and 13 subscales in the KAS-R. It was not appropriate to use total scores as summary scores for these scales because several subjects did not complete all of the subscales. Average scores were therefore used as summary scores for these scales. For subjects who completed all the measures, the average scores were computed for the PAIS-SR and KAS-R by summing the subscale raw scores and dividing by the total number of subscales. For the remaining subjects the average score was computed by summing the subscale raw scores and dividing by the number of subscales completed.

Second, a summary score was derived for the MMPI. This score consisted of the number of scaled scores which were greater than or equal to 70; that is, the number of scores which were more than two standard deviations above the mean of the standardization sample of the MMPI. This score was interpreted as being a gross measure of
psychopathology. Since the MMPI (ordinarily) contains 10 clinical scales and three validity scales, the MMPI score could range from zero to 13.

Third, the Communication Factor from the NCA (i.e., the Aphasia Screening Test) was not included in the analyses. Although systems for scoring the Aphasia Screening Test have been described (e.g., Russell et al., 1970), there are no scoring standards that are consistently used with this test (Lezak, 1983). In addition, Reitan and Wolfson (1985) suggest that the results of the Aphasia Screening Test should not be scored, but rather that a pathognomonic sign approach should be used in interpreting this test. However, they note that such a pathognomonic sign approach necessarily produces many false negatives, which suggests that meaningful conclusions can only be drawn when deficits in performance occur. As such, it was felt that the use of a single Aphasia Screening Test score as a predictor variable would have both questionable reliability and validity.

Fourth, a summary index of neuropsychological impairment was computed to serve as an overall measure of impairment on all of the NCA tests taken by any particular subject. Because the various tests in the NCA yield scores using different scales (e.g., seconds-to-complete versus number of errors), it was necessary to convert all of the neuropsychological test scores to a common scale in order to
compute this overall index. The issue at hand was therefore what common scale to use.

One option was to convert the raw scores to standard scores based on published norms. Such norms tend to be collected from various geographical regions, at different times, using different subjects. In addition, with the exception of the WAIS-R subtests, there are several sets of norms for most of the neuropsychological tests used in the present investigation, so the question arises as to which set to use since none appear to be widely adopted. Interpretation of the results using published norms would have thus been problematic because one cannot assume that these samples (1) are comparable to each other or (2) are generalizable to the population from which the sample of patients used in the present study was drawn. The option of converting to standard scores based on published norms was therefore rejected.

Because of these problems associated with the use of published norms, it was decided that the use of ipistive statistics (i.e., statistics derived from subjects in the present investigations) would be the best approach to take. Having decided this, the issue again became what common scale to use. One option was to convert the raw scores to standard scores based on means and standard deviations from the Overall sample. However, this did not prove to be feasible because the T score distributions of the tests used
in the NCA were not all normal. As Russell (1987) recently stated, this renders interpretation of standard scores problematic because the same standard score can reflect differing amounts of impairment between different tests.

For example, in the Study subsample the T score at the 75th centile varied between 60.85 for the Digit Span Subtest of the WAIS-R and 50.04 for the Grooved Pegboard Test with the dominant hand. Thus T scores which reflected an identical amount of impairment, relative to the Overall sample, differed by as much as one standard deviation between tests.

Because of these problems, an "Average Centile Score" (ACS) was settled on as being the best summary index of neuropsychological impairment. Each subject was classified into one of four groups for each test that he/she was administered. Group one consisted of those subjects whose score placed them at or below the 25th centile for that test. The subjects in this group thus constituted the subjects who were the least impaired relative to the rest of the sample. Groups two, three, and four consisted of those subjects whose score placed them between the 26th and 50th, 51st and 75th, and 76th and 100th centiles, respectively. The subjects in the latter group thus constituted the subjects who were the most impaired relative to the rest of the sample.
The ACS for Testing One was computed based on each subject's performance relative to all of the subjects in the Overall sample and the ACS for Testing Two was computed based on each subject's performance relative to all of the subjects in the Retest subsample. However, the analyses for Testing One were computed based on data from the Study subsample and the analyses for Testing Two were computed based on data from the Study2 subsample. The reason that data from the Study and Study2 subsamples were not used to compute the Average Centile scores was because it was felt that to do so would "overfit" the data to the subjects who returned the questionnaires. Thus it was felt that computing the Average Centile Scores based on data from the Overall sample and Retest subsample provided measures of impairment which were the most representative of the levels of impairment in the population of potential subjects.

The main disadvantage associated with using ipsitive centile scores is that categorization of otherwise continuous variables reduces variance and therefore potentially attenuates the predictive power of the neuropsychological tests. Another disadvantage was that it limited the generalizability of the results of the present study to different samples. The main advantage was that one can be sure that subjects in the same centile groups have similar amounts of impairment in the different tests relative to the rest of the subjects in the sample. This
made the results were more interpretable and meaningful for the subjects in the present study.

The fifth step taken to reduce the number of variables involved computing factor scores for individual NCA factors. The Visuospatial and Psychomotor abilities factor score (hereafter referred to as the "Motor" factor score) and the Reasoning factor score were computed by summing the centile scores of the tests in each factor and dividing by the number of tests.

Originally, the intention was also to compute a factor score for the Memory factor; however, the Memory factor was not included in the analyses because four of the five tests which comprise it were not administered to more than 35% of the sample. Because a complete data matrix was required to perform the multiple regressions used in the analyses, it was necessary to estimate scores for missing values. To do so for the Memory Factor would have required the estimation of so many missing values that the results would have had questionable reliability. However, it should be noted that, when available, the tests in the Memory factor were included in the computation of the ACS. Since the ACS was intended to comprise an overall measure of neuropsychological impairment, it was felt that this would best be accomplished by using all the NCA data available for each subject.

**Estimation of Missing Data.** As was alluded to above, a complete data matrix is necessary to perform the
"Regress" procedure when using the SAS statistical package.
It was therefore necessary to estimate values for missing
data for the independent variables used in the analyses.
(the procedures used for assigning missing data for the
dependent variables were described previously).

Tabachnick and Fidell (1983) discuss several methods
of estimating missing values. They suggest that, whenever
possible, it is best to make educated guesses based on prior
knowledge. If this is not possible then they suggest that
one can insert mean values. However, to do so routinely
will, for any given variable, reduce its correlation with
other variables and, as a consequence, put that variable at
a disadvantage in a prediction equation. A suggested
compromise is to "use certain demographic or classification
attributes for the case to estimate the mean" (Tabachnick &
Fidell, 1983, p. 71). For example, one might assign a female
subject the mean value for female subjects in the sample
rather than the overall mean value if one has reason to
believe that to do so is meaningful. However, if the
researcher cannot reasonably justify the above options, then
insertion of the mean value is most likely the best
approximation of a missing value's score.

The suggestions of Tabachnick and Fidell (1983) were
adopted for the assignment of missing values in the present
investigation. It was necessary to assign values for
missing data for the following variables: Education, GCS
scores, and tests in the Motor and Reasoning factors. The mean education score of the Overall sample (11.875 years) was assigned to those subjects for whom education data was missing. The insertion of the mean value for missing education scores was considered to be justifiable for two reasons. First, education data was available for all but two subjects in the Study sample and thus it was felt that the insertion of mean values was unlikely to disadvantage this variable by reducing its correlation with other variables. Second, no reasonable justification for assignment of different means based on classification variables existed for this variable.

GCS scores were available for only 41 of the 57 subjects in the Study subsample. Therefore, missing GCS values had to be estimated for 28% of the subjects in this subsample. As was indicated previously, assigning the mean value for too many subjects for any given variable puts that variable at a disadvantage in the prediction equation because it reduces its correlation with other variables. Rather than do this to the GCS data, it was decided that a better strategy would be to insert various GCS means according to the classification variable of age-at-onset.

Such a strategy was felt to be justifiable because, as was mentioned in the literature review, age-at-onset has consistently been related to various measures of severity of injury, including GCS scores. Indeed, a weak positive
correlation of 0.2333 (p=.06) was obtained between age-at-onset and GCS scores in the Overall sample, indicating that head injury victims with earlier onsets tend to obtain lower GCS scores. This is readily explainable because, as was also mentioned in the literature review, mortality rate increases with increasing age-at-onset. Thus the most likely explanation for this positive correlation is that people with earlier age-at-onsets are more likely to survive severe head injuries than are those with later age-at-onsets. Missing Glasgow Coma Scale scores were therefore assigned according to the subject's age-at-onset. Subjects were assigned to one of four groups, each of which represented approximately 25% of the Overall sample. The groups were: age-of-onset of between 16-19, 20-24, 25-29 and 30-39. The mean GCS scores for these groups, respectively, were 5.25, 6.57, 6.17, and 6.90.

Due to central nervous system involvement (i.e., hemiparesis or apraxia) or peripheral injuries (i.e., a broken arm), several subjects completed the Grooved Pegboard Test with only one hand. If a subject was unable to complete the test with one hand as a result of CNS damage then the subject was assigned the highest score obtained by a subject in the sample who could complete the test. If a subject was unable to complete the test as a result of a peripheral injury, then the subject was assigned the mean score for the Overall sample. The rationale for such
assignments of scores was that the former subjects' inability to complete the task resulted directly from the closed head injury whereas the latter subjects' inability to complete the task resulted from other injuries sustained in at the time of onset.

Similarly, several subjects were able to complete Part A of the Trail Making Test but were unable to complete Part B. In such instances, it was reasonable to assume that the subject was capable of the motor responses required to complete Part B and it was some other component of the test that resulted in the test not being administered or being discontinued. Subjects who were able to complete only Part A were therefore assigned the highest score obtained by a subject in the sample who could complete the test. The Category Test was also discontinued with several subjects because they could not complete it. These subjects were assigned the highest score obtained by a subject in the sample who could complete the test.

After such missing values were assigned, all of the subjects in the Study subsample had data values for the Trail Making Test. However, missing data values still had to be assigned for the remaining tests in the Motor and Reasoning factors of the NCA. The number of subjects who were missing data varied between these tests: Two were missing data for the Block Design Subtest, three were missing for data the Picture-Completion Subtest and Grooved
Pegboard Test, and 10 were missing data for the Category Test. Thus the Category Test was the only test in the Motor and Memory factors of the NCA for which missing data values had to be estimated for more than 5% of the subjects in the Study subsample. Despite this fact, the Category Test was retained in the analyses because it has been reported to be particularly sensitive to brain damage (Reitan & Wolfson, 1985) and to be a particularly good predictor of later outcome (Heaton & Pendleton, 1981).

Subjects in this study rarely obtained centile scores which placed them in the same centile group in all testings. However, examination of the centile scores indicated that the most impaired people in the sample tended to be quite impaired across all measures while the least impaired tended to be relatively unimpaired across all measures. Thus it was felt that assignment of mean values for missing NCA test data would misrepresent the extreme groups of the distribution. In addition, the use of mean scores would further reduce the variance in the NCA data (in addition to this data being divided into discrete categories). Together such reductions in variance would potentially have had the effect of greatly attenuating the predictive ability of the neuropsychological test data.

Instead of using mean scores as estimates of missing values, it was decided that a more representative missing value estimate would be one which reflected each subject's
individual degree of neuropsychological impairment. Such a value was readily available in the form of the subject's ACS. In order to examine whether or not the ACS was related to the centile scores of the tests in the Motor and Reasoning factors for which missing data had to be estimated, another subsample of the Overall sample was isolated. This subsample consisted of those people in the Overall sample who were given complete Neurocognitive Assessments (n=42) and is referred to as the "Complete" Subsample.

Average Centile Scores were computed for subjects in the Complete Subsample. These scores were then correlated with each subject's centile scores on the relevant tests in the Motor and Reasoning factors. The correlations ranged from a low of 0.51 for the Grooved Pegboard Test with the dominant hand to a high of 0.85 for both Part A of the Trail Making Test and the Block Design Subtest of the WAIS-R, suggesting that the ACS is moderately to strongly related to the centile scores on these tests. Most importantly, a correlation of 0.73 was obtained between the ACS and the Category Test centile score, suggesting that they are positively related. This being the case, it was felt that use of the subject's ACS score as a missing value estimate was justifiable and made more sense than the use of mean scores.
Chapter III
Results
Tests of Assumptions and Subsequent Data Transformations

Before the output from any given multiple regression was interpreted, it was first inspected to ensure that the multiple regression did not grossly violate the assumptions of normality, linearity, and homoscedasticity. In multiple regression these three assumptions are tested by examining a scatterplot of the errors between the predicted and obtained values. If these assumptions are met then the scatterplot "will be nearly rectangular in shape with a concentration of scores along the center" (Tabachnick & Fidell, 1983, p. 93). This indicates that the errors between the predicted and obtained scores are normally distributed about a mean of zero.

The scatterplots originally associated with hypothesis two (discussed below) violated all of these assumptions. In these analyses, the summary PAIS-SR (PSUM) and KAS-R (KSUM) scores were the dependent variables (in two different analyses) and the ACS, GCS score, MMPI centile score (MMPIGRP), and number of years of formal education (ED) were the independent variables. Tests for normality of the distributions of these dependent and independent variables
were then performed. These tests indicated that PSUM, ACS, and MMPIGRP had normal distributions but that the distributions of KSUM, GCS, and ED were all positively skewed.

Both KSUM and GCS had values that were more than three standard deviations above the group means. In accordance with the suggestion of Tabachnick and Fidell (1983), these values were treated as univariate outliers and were recoded and given a value equal to three standard deviations above the mean. In this manner the uniqueness of these outliers was preserved without their unduly influencing which regression line was chosen. However, this had little corrective effect with respect to the assumptions in that both KSUM and GCS remained positively skewed and the scatterplots of the residuals were virtually unchanged.

The next step taken to meet the assumptions of multiple regression involved performing data transformations on the skewed variables. Cohen and Cohen (1983) note that the need for nonlinear transformations may arise "whenever a constant additive change in one variable is associated with other than a constant additive change in another" (p.254). They add that, in several fields, one of which being neuropsychology, "relatively strong theories have been developed that result in the postulation of (generally nonlinear) relationships between dependent and independent variables" (p.255). Thus, transforming data is justifiable
in such fields because the prediction equations are not arbitrary but are "hypothetically descriptive of 'how things work' " (p.255). Tabachnick and Fidell (1983) further add that transformation is undertaken when the distribution is skewed and the group mean is not a good indicator of central tendency. They write "for skewed distributions, then, the median or geometric mean may be more meaningful than the mean itself, as may differences between medians or differences between geometric means" (p.84). Thus, it was felt that ample statistical and theoretical justifications existed for performing data transformations in the present investigation.

Two transformations that can be applied to positively skewed data are square root transformations and logarithmic transformations, with the former transformation being appropriate if a variable has moderate positive skewness and the latter being appropriate if a variable has severe positive skewness (Tabachnick & Fidell, 1983). Because no clear guidelines to differentiate between moderate and severe skewness are known to the present investigator, both of these transformations were applied to all of the positively skewed variables that were used in the analyses. The transformations that best approximated normal distributions were the ones which were adopted.

With respect to the variables in hypothesis two, this resulted in square root transformations being applied to GCS
scores and ED, and a logarithmic transformation being applied to KSUM. These transformed variables are referred to as GCSRT, EDRT, and KSUMLOG, respectively. After the transformations were completed, no gross violations of the assumptions of linearity, normality or homoscedasticity were evident in the scatterplot of the residuals of the predicted scores. It should be noted that, even after transformations, the scatterplots obtained were rarely the rectangular-shaped ideal. However, they were, in all cases, far better approximations of this than were their counterparts which were based on untransformed variables.

The identical procedure as is described above was applied to each multiple regression before it was interpreted. That is, (1) scatterplots of the residuals of the predicted scores were examined, (2) if the assumptions were violated the distribution of each variable involved was examined, (3) univariate outliers were identified and given values equal to three standard deviations above the mean, (4) data transformations were performed, and (5) scatterplots based on the transformed variables were examined and these variables were adopted if they did not grossly violate the assumptions of multiple regression. It was only necessary to perform two further transformations, both of which were on subscales of the PAIS-SR which were used as dependent variables in hypothesis three. Square
root transformations were applied to both the Vocational Environment and Social Environment subscales.

Finally, before the output from any given multiple regression was interpreted each independent variable in the equation was examined for multicollinearity. Tabachnick and Fidell (1983) state "multicollinearity occurs when two variables in an equation show a similar pattern of correlations with the other variables" (p.82). This is problematic because multicollinearity leads to an unstable matrix inversion which, in turn, leads to an unstable multivariate solution (Tabachnick & Fidell, 1983). Variables can be inspected for multicollinearity by examining their tolerances. The range of possible tolerance values is between zero and one, with lower scores indicating increasing multicollinearity.

Only one regression had to be modified in the present investigation because of low tolerance values. This occurred in the analyses for hypothesis three when both the Motor and Reasoning factors were entered as predictors in the same regression. In this case these factors, respectively, had unacceptably low tolerance values of .365 and .359. As a result, the analyses for hypothesis three were conducted without entering both of these variables as predictors in the same equation. The tolerance values for the variables included in the various multiple regressions performed in the present investigation ranged from .795 to
.995 and were considered to be acceptable for inclusion in the analyses.

**Hypothesis Number One**

The first hypothesis stated that the neuropsychological test performances of the patients at Testing Two would be significantly better than those at Testing One. This hypothesis was tested by conducting one-tailed t-tests for correlated samples on the 13 tests which comprise the Memory, Motor, and Reasoning factors of the NCA. These were one-tailed t-tests because the hypothesis predicts improvement in the test scores. Because the use of multiple t-tests increases the risk of making type-I errors (Glass & Hopkins, 1984), a significance level of .01 was preset prior to conducting the tests. All of these tests were based on the raw data from subjects in the Retest Subsample.

As is evident in Table 5, this hypothesis was supported for all measures with the exception of the Sentence Memory Test (t = -2.09, p = .0221). The subjects used in the present study thus demonstrated the statistically significant improvement in neuropsychological test scores that is typically seen in head injury victims.
Table 5

Paired t-tests Comparing Performances on Neuropsychological Test Scores in Testing One With Performances in Testing Two

<table>
<thead>
<tr>
<th>Test</th>
<th>M1</th>
<th>SD</th>
<th>dfb</th>
<th>t</th>
<th>Effect Size</th>
</tr>
</thead>
<tbody>
<tr>
<td>SENM</td>
<td>-0.94</td>
<td>2.71</td>
<td>35</td>
<td>-2.09</td>
<td>-.082</td>
</tr>
<tr>
<td>DSP</td>
<td>-0.90</td>
<td>2.07</td>
<td>51</td>
<td>-3.15**</td>
<td>-.086</td>
</tr>
<tr>
<td>STREC</td>
<td>-3.25</td>
<td>6.56</td>
<td>35</td>
<td>-2.97*</td>
<td>-.117</td>
</tr>
<tr>
<td>BVRT-C</td>
<td>-1.55</td>
<td>1.95</td>
<td>32</td>
<td>-4.54**</td>
<td>-.195</td>
</tr>
<tr>
<td>BVRT-D</td>
<td>-1.34</td>
<td>2.91</td>
<td>31</td>
<td>-2.61*</td>
<td>-.115</td>
</tr>
<tr>
<td>PCOM</td>
<td>-1.77</td>
<td>2.44</td>
<td>50</td>
<td>-5.17**</td>
<td>-.143</td>
</tr>
<tr>
<td>BLDES</td>
<td>-2.50</td>
<td>2.18</td>
<td>49</td>
<td>-8.26**</td>
<td>-.225</td>
</tr>
<tr>
<td>GPT-D</td>
<td>55.80</td>
<td>108.78</td>
<td>49</td>
<td>3.33**</td>
<td>.103</td>
</tr>
<tr>
<td>GPT-ND</td>
<td>40.71</td>
<td>65.66</td>
<td>50</td>
<td>4.43**</td>
<td>.113</td>
</tr>
<tr>
<td>DSYM</td>
<td>-1.63</td>
<td>1.87</td>
<td>50</td>
<td>-6.23**</td>
<td>.173</td>
</tr>
<tr>
<td>CAT</td>
<td>21.12</td>
<td>17.98</td>
<td>41</td>
<td>7.61**</td>
<td>.256</td>
</tr>
<tr>
<td>TMT-A</td>
<td>41.00</td>
<td>91.80</td>
<td>52</td>
<td>3.25**</td>
<td>.087</td>
</tr>
<tr>
<td>TMT-B</td>
<td>138.93</td>
<td>230.69</td>
<td>52</td>
<td>4.38**</td>
<td>.117</td>
</tr>
</tbody>
</table>

Note. Table abbreviations: SENM=The Sentence Memory Test, DSP=the Digit Span Subtest of the WAIS(-R), STREC=the Babcock-Levy Story Recall Test, BVRT-C=the Benton Visual Retention Test-Form C, BVRT-D=the Benton Visual Retention Test-Form D, PCOM=the Picture Completion Subtest of the WAIS(-R), BLDES=the Block Design Subtest of the WAIS(-R), GPT-D=the Grooved Pegboard Test-Dominant Hand, GPT-ND=the Grooved Pegboard Test-Non Dominant Hand, DSYM=the Digit Symbol Subtest of the WAIS(-R), CAT=the Category Test, TMT-A=the Trail Making Test-Part A, and TMT-B=the Trail Making Test-Part B.

aThe mean refers to the mean difference in raw test scores between Testing One and Testing Two.

bThe number of degrees of freedom varies between tests because not all subjects were administered each test twice.

*p<.01. **p<.001
over time (Dikmen & Reitan, no date; Drudge et al., 1984).

However, one cannot infer from these statistically significant differences that the magnitude of improvement between testings was necessarily quite large. Glass and Hopkins (1984) write "a highly statistically significant difference (e.g., p(.001) does not necessarily indicate a large difference in means. If n is large or r is high, even a small difference in means can result in a large t-ratio, and a highly significant difference" (p. 242). They thus suggest that the effect size, rather than the level of statistical significance, should be reported as an indication of the magnitude of the difference between means.

Effect size is simply the difference between the means of two groups expressed in standard deviation units (Glass & Hopkins, 1984). For example, an effect size of 1.0 indicates that the difference between two means is estimated to be one standard deviation. As is evident in Table 5, the effect sizes in the present investigation were generally quite small, ranging from a low of -.082 for the Sentence Memory Test to a high of .256 for the Category Test. When interpreting the results of the present study one should thus remember that the subjects who participated suffered severe injuries and their improvement, although statistically significant, should in no way be taken to indicate that they were exhibiting normal levels of performance at the time of Testing Two.
Hypothesis Number Two

The second hypothesis stated that, at both testings, a summary measure neuropsychological impairment would predict later social recovery better than would GCS scores, number of years of formal education or the Personality factor of the NCA (i.e., the MMPI). As can be seen in Table 6, four

Insert Table 6 about here

multiple regressions were conducted to test this hypothesis with two being conducted using data from Testing One and two being conducted using data from Testing Two. Within each testing, one multiple regression used a summary score from the PAIS-SR as a dependent variable and one used a summary score from the KAS-R as a dependent variable. Because the Study 2 subsample consisted of less than 40 subjects, one predictor variable had to be dropped from the analyses on the data from Testing Two in order to maintain an adequate subject-to-variable ratio. It was decided that the number of years of formal education would be most theoretically justifiable predictor variable to drop because the remaining three variables have been found to be related to recovery in past investigations whereas education has not.
Table 6

Summary of Variables Used in the Multiple Regressions Conducted to Test Hypotheses Two and Three

<table>
<thead>
<tr>
<th></th>
<th>n</th>
<th>Dependent Variable(s)</th>
<th>Predictor Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>MR#1</td>
<td>MR#2</td>
<td>MR#1</td>
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<tr>
<td>---</td>
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<td>------------------------</td>
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<tr>
<td></td>
<td>MR#1</td>
<td>MR#2</td>
<td>MR#1</td>
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<tr>
<td></td>
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<tr>
<td></td>
<td>MR#1</td>
<td>MR#2</td>
<td>MR#1</td>
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</table>

### Hypothesis 2

<table>
<thead>
<tr>
<th>Testing One</th>
<th>55</th>
<th>54</th>
<th>PSUM</th>
<th>KSUMLOG</th>
<th>ACS</th>
<th>GCSRT</th>
<th>EDRT</th>
<th>MMPIGRP</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing Two</td>
<td>34</td>
<td>35</td>
<td>PSUM</td>
<td>KSUMLOG</td>
<td>ACS2</td>
<td>GCSRT</td>
<td>MMPIGRP2</td>
<td>MMPIGRP2</td>
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</table>

### Hypothesis 3a

<table>
<thead>
<tr>
<th>Testing One</th>
<th>55</th>
<th>53</th>
<th>PSUM</th>
<th>RF1</th>
<th>MF1</th>
<th>GCSRT</th>
<th>GCSRT</th>
<th>EDRT</th>
<th>EDRT</th>
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<td>PSUM</td>
<td>RF2</td>
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<td>MMPIGRP2</td>
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### Hypothesis 3b

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<th>Testing One</th>
<th>53</th>
<th>53</th>
<th>VOCRT</th>
<th>RF1</th>
<th>MF1</th>
<th>GCSRT</th>
<th>GCSRT</th>
<th>EDRT</th>
<th>EDRT</th>
<th>MMPIGRP</th>
<th>MMPIGRP</th>
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<tbody>
<tr>
<td></td>
<td>54</td>
<td>54</td>
<td>SOCRT</td>
<td>RF1</td>
<td>MF1</td>
<td>GCSRT</td>
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<td>EDRT</td>
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<td>MMPIGRP</td>
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<td>MR#2</td>
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</tbody>
</table>

**Note.** Table abbreviations: MR=Multiple Regression; PSUM=the summary score from the PAIS-SR; KSUMLOG=the summary score from the KAS-R after a logarithmic transformation; ACS/ACS2= the Average Centile Scores from Testings One and Two, respectively; GCSRT=Glasgow Coma Scale score after a square root transformation; EDRT=the number of years of formal education after a square root transformation; MMPI_GRP/MMPI_GRP2=the MMPI centile group in Testings One and Two, respectively; RF1/RF2=respectively, the average centile scores for those tests which comprise the Reasoning factor in Testings One and Two; MF1/MF2=respectively, the average centile scores for those tests which comprise the Motor factor in Testings One and Two; VOCRT=the raw score associated with the Vocational Environment subscale of the PAIS-SR after a square root transformation; SOCRT=the raw score associated with the Social Environment subscale of the PAIS-SR after a square root transformation.
The results for hypothesis two are presented in Table 7. With respect to the analyses associated with Testing One

Insert Table 7 about here

It should be noted that the regression combination of variables accounted for 19.2% of the variability in PSUM (i.e., R-SQUARE=.1920) and 17.56% of the variability in KSUMLOG and significant \( F \) values were obtained in both of these regressions (\( F_{PSUM} (4,51) = 3.03, p = .0257; F_{KSUMLOG} (4,50) = 2.863, p = .0431 \)). Thus, some support for the utility of this regression combination of variables in predicting later social recovery was obtained. However, it is the relative contribution of the individual variables to the prediction equation, not the overall significance of the model, that is of primary interest with respect the second hypothesis.

The SAS Statistical Package tests the significance of each predictor variable by conducting two-tailed \( t \)-tests on their beta values (labelled "Parameter Estimates" in Table 8). A beta value is similar to a semipartial correlation between a dependent variable and one predictor variable when the other predictor variables have been partialed out (Nie, Hull, Jenkins, Steinbrenner, and Bent, 1975). Given this, the beta value for ACS (for example) is similar to the correlation of ACS with the residuals of the prediction of
Table 7  
Analyses of Variance for the Multiple Regressions Conducted to Test Hypothesis Two  

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F</th>
<th>Prob&gt;F</th>
<th>R-SQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing #1 - Dependent Variable = PSUM</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>MODEL</td>
<td>4</td>
<td>76.869</td>
<td>19.217</td>
<td>3.03</td>
<td>.0257</td>
<td>.1920</td>
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<tr>
<td>ERROR</td>
<td>51</td>
<td>323.514</td>
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<tr>
<td>TOTAL</td>
<td>55</td>
<td>400.383</td>
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<tr>
<td>Testing #1 - Dependent Variable = KSUMLOG</td>
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<tr>
<td>MODEL</td>
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<td>0.0196</td>
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<td>.1756</td>
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<td>ERROR</td>
<td>50</td>
<td>0.3686</td>
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<td>TOTAL</td>
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<td>0.4471</td>
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<tr>
<td>Testing #2 - Dependent Variable = PSUM</td>
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</tr>
<tr>
<td>MODEL</td>
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<td>0.0122</td>
<td>.2930</td>
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<td>214.917</td>
<td>6.933</td>
<td></td>
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<tr>
<td>TOTAL</td>
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<td>303.970</td>
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</tr>
<tr>
<td>Testing #2 - Dependent Variable = KSUMLOG</td>
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<tr>
<td>MODEL</td>
<td>3</td>
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<td>0.0087</td>
<td>1.081</td>
<td>0.3713</td>
<td>.0920</td>
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<tr>
<td>ERROR</td>
<td>32</td>
<td>0.2577</td>
<td>0.0081</td>
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<td>TOTAL</td>
<td>35</td>
<td>0.2838</td>
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</table>
PSUM from GCSRT, EDRT, and MMPI GRP. Since these latter three predictors cannot, by definition, be correlated with their own residuals (Nie et al., 1975), one can see that testing for the significance of beta values is a valid procedure if one wants to determine any given predictor's unique contribution to the variation in the dependent variable.

As is evident in Table 8, MMPI GRP was the only predictor in Testing One for which a significant $t$-value was obtained when PSUM was the dependent variable ($t(51)=2.083, p=.0423$). In this testing none of the predictors yielded significant $t$-values when KSUMLOG was the dependent variable, although the value for MMPI GRP ($t(50)=1.901, p=.0630$) approached significance. It thus appears that MMPI GRP, which can be considered to be a gross measure of psychopathology at the time of the initial assessment, was the predictor which was primarily responsible for the significant $R$ SQUA RE values obtained in association with Testing One. Correspondingly, it appears that degree of psychopathology evidenced at the time of Testing One (as indicated by the number of MMPI scale scores which were greater than 70) is the variable which best predicts later social recovery and that this is true for both relative and
Table 8

Tests of the Significance of the Predictor Variables Used in the Multiple Regressions Conducted to Test Hypothesis Two

| Variable | DF | Parameter Estimate | Std Error | T for HO: Parameter=0 | Prob>|T |
|----------|----|--------------------|-----------|-----------------------|-------|
| Testing #1 - Dependent Variable=PSUM |
| ACS      | 1  | 0.0276             | 0.0198    | 1.393                 | 0.1696|
| GCSRT    | 1  | -0.5861            | 0.9758    | -0.601                | 0.5508|
| EDRT     | 1  | -1.6875            | 1.2969    | -1.301                | 0.1991|
| MMPIGRP  | 1  | 0.0271             | 0.0130    | 2.083                 | 0.0423|
| Testing #1 - Dependent Variable=KSUMLOG |
| ACS      | 1  | 0.0002             | 0.0006    | 0.321                 | 0.7499|
| GCSRT    | 1  | -0.0465            | 0.0333    | -1.454                | 0.1523|
| EDRT     | 1  | -0.0523            | 0.0455    | -1.809                | 0.0764|
| MMPIGRP  | 1  | 0.0008             | 0.0004    | 1.901                 | 0.0630|
| Testing #2 - Dependent Variable=PSUM |
| ACS2     | 1  | 0.0485             | 0.0284    | 1.707                 | 0.0979|
| GCSRT    | 1  | -1.3427            | 1.3313    | -1.009                | 0.3210|
| MMPIGRP2 | 1  | 0.0448             | 0.0169    | 2.634                 | 0.0130|
| Testing #2 - Dependent Variable=KSUMLOG |
| ACS2     | 1  | 0.0012             | 0.0009    | 1.295                 | 0.2046|
| GCSRT    | 1  | -0.0289            | 0.0449    | -0.644                | 0.5244|
| MMPIGRP2 | 1  | 0.0003             | 0.0006    | 0.577                 | 0.5678|
patient ratings of social recovery. In contrast, the t-values obtained for the ACS were non-significant for both multiple regressions associated with Testing One \( (t_{PSUM} = 1.393, p = .1696; t_{KSUMLOG} = .321, p = .7499) \).

Hypothesis two was thus not supported for Testing One since this hypothesis stated that ACS would be the best predictor of later social recovery.

With respect to the analyses of variance associated with Testing Two (see Table 7), it should be noted that the regression combination of variables accounted for 29.3% of the variability in PSUM but only 9.2% of the variability in KSUMLOG and, thus, that only the F value for the former regression was significant \( (F_{PSUM} (3, 31) = 4.282, p = .0122; F_{KSUMLOG} (3, 32) = 1.081, p = .3713) \). Therefore, in contrast to Testing One, support for the utility of the regression model for predicting later social recovery was obtained only when PSUM, a measure based on patient ratings of day-to-day functioning, was the dependent variable. This combination of predictor variables did not predict later social recovery when social recovery was based on relative's ratings (i.e., KSUMLOG).

Given that a non-significant F value was obtained in Testing Two when KSUMLOG was the dependent variable, the non-significant results obtained in t-tests for the beta values were to be expected (see Table 8). Hypothesis two was thus not supported in Testing Two when KSUMLOG was the
dependent variable. More specifically, hypothesis two stated that ACS2 would be the best predictor. Since ACS2 yielded a probability level which was non-significant ($t(32) = 1.295, p = .2046$), hypothesis two was not supported.

As was the case in Testing One, the only significant $t$-value obtained for Testing Two when PSUM was the dependent variable was obtained for the Personality factor of the NCA ($t_{MMPIGRP2} (31) = 2.634, p = .013$). Similarly, it thus appears that MMPIGRP2, which can be considered to be a gross measure of psychopathology at Testing Two, was the predictor which was primarily responsible for the significant $R^2$ value obtained. In contrast, the $t$-value obtained for the ACS2 was non-significant for this regression ($t_{PSUM} (31) = 1.707, p = .0979$). Since hypothesis two stated that ACS2 would be the best predictor, this hypothesis was thus also not supported in this regression.

In summary, hypothesis two, that a summary measure of neuropsychological impairment would be the best predictor of later social recovery at both testings, was not supported. This was the case despite the fact that three of the four regressions yielded significant $F$-values. The only predictor which accounted for a significant amount of the variance in $R^2$ was the Personality factor from the NCA (i.e., the MMPI). This was the case for both regressions conducted for Testing One but only for the regression for Testing Two in which PSUM was the dependent
variable. Thus self-ratings of psychopathology, via the MMPI, appear to be particularly useful for predicting later social recovery, with this being particularly the case (1) when predicting patient's (versus relatives') ratings of social recovery and (2) when the MMPI was administered more than one year after injury.

**Hypothesis Number Three**

**Hypothesis 3a.** Hypothesis three consists of three hypotheses which all relate to indications in head injury patients that (1) severity of injury and impairment in motor skills are related to later difficulty in performing activities of daily life and (2) impairment in reasoning abilities is related to later psychosocial dysfunctions. The first of these three hypotheses, hypothesis 3a, stated that, at both testings, the Reasoning factor of the NCA would predict the PAIS-SR summary score better than would the Motor factor, GCS scores, education, or the MMPI. Four multiple regression were performed to test this hypothesis. In all of these regressions, PSUM was the dependent variable (see Table 6).

With respect to the analyses associated with the Testing One, it is evident from Table 9 that (1) when the

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*Insert Table 9 about here*

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Table 9

Analyses of Variance for the Multiple Regressions Conducted to Test Hypothesis 3a

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob&gt;F</th>
<th>R-SQ</th>
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</thead>
<tbody>
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<td></td>
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<td>MODEL</td>
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<td>.1702</td>
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<td>6.514</td>
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</tr>
<tr>
<td>TOTAL</td>
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<td>400.383</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Testing #1 - NCA Predictor Variable=Motor Factor</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>MODEL</td>
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<td>TOTAL</td>
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</tr>
<tr>
<td>Testing #2 - NCA Predictor Variable=Reasoning Factor</td>
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<td></td>
</tr>
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<td>4.304</td>
<td>0.0119</td>
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<tr>
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<td>303.970</td>
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<tr>
<td>Testing #2 - NCA Predictor Variable=Motor Factor</td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
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<td>79.954</td>
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<td>3.688</td>
<td>0.0222</td>
<td>.2630</td>
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<td>224.017</td>
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</tr>
<tr>
<td>TOTAL</td>
<td>34</td>
<td>303.970</td>
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</tr>
</tbody>
</table>
Reasoning Factor of the NCA was included in the regression model. 17.02% of the variability in PSUM was accounted for. (2) when the Motor Factor of the NCA was included in the model, 25.26% of the variability in PSUM was accounted for, and (3) both of these regressions were significant at the .05 level ($F_{RF1}(4,51) = 2.62, p = .0458; F_{MF1}(4,51) = 4.31, p = .0044$). Inspection of the contributions of the individual predictors revealed that MMPIGRP was the only predictor to contribute significantly to the variation in PSUM in the former regression ($t_{(51)}=2.071, p = .0435$) while both MMPIGRP ($t_{(51)}=2.104, p = .0404$) and $MF1(t_{(51)}=2.497, p = .0158$) contributed significantly to the variation in the latter regression (see Table 10). Hypothesis 3a was thus not supported for Testing One since the amount of variation explained by the Reasoning factor was non-significant ($t_{(51)}=0.743, p = .4606$).

Similar results were obtained in the regressions associated with Testing Two. As can be seen in Table 9, significant $F$ values were obtained both when the model included the Reasoning factor ($F_{RF2}(3,31) = 4.30, p = .0119$) and when the model included the Motor factor ($F_{MF2}(3,31) = 3.69, p = .0222$). Inspection of the contributions of the individual predictors revealed that MMPIGRP2 was the
Table 10
Tests of the Significance of the Predictor Variables Used in the Multiple Regressions Conducted to Test Hypothesis 3a

| Variable | DF | Parameter Estimate | Std Error | $T$ for HO: Parameter=0 | Prob>|T |
|----------|----|--------------------|-----------|-------------------------|-------|
| Testing #1 - Dependent Variable=PSUM

| Variable | DF | Parameter Estimate | Std Error | $T$ for HO: Parameter=0 | Prob>|T |
|----------|----|--------------------|-----------|-------------------------|-------|
| RF1      | 1  | 0.0119             | 0.0161    | 0.743                   | 0.4606 |
| GCSRT    | 1  | -0.7827            | 1.0016    | -0.781                  | 0.4381 |
| EDRT     | 1  | -1.9788            | 1.2901    | -1.534                  | 0.1313 |
| MMPIGRP  | 1  | 0.0282             | 0.0134    | 2.071                   | 0.0435 |

| Variable | DF | Parameter Estimate | Std Error | $T$ for HO: Parameter=0 | Prob>|T |
|----------|----|--------------------|-----------|-------------------------|-------|
| Testing #2 - Dependent Variable=PSUM

| Variable | DF | Parameter Estimate | Std Error | $T$ for HO: Parameter=0 | Prob>|T |
|----------|----|--------------------|-----------|-------------------------|-------|
| RF2      | 1  | 0.0369             | 0.0215    | 1.722                   | 0.0951 |
| GCSRT    | 1  | -1.3930            | 1.3195    | -1.056                  | 0.2993 |
| MMPIGRP2 | 1  | 0.0417             | 0.0172    | 2.423                   | 0.0214 |

| Variable | DF | Parameter Estimate | Std Error | $T$ for HO: Parameter=0 | Prob>|T |
|----------|----|--------------------|-----------|-------------------------|-------|
| Testing #2 - Dependent Variable=PSUM

| Variable | DF | Parameter Estimate | Std Error | $T$ for HO: Parameter=0 | Prob>|T |
|----------|----|--------------------|-----------|-------------------------|-------|
| MF2      | 1  | 0.0304             | 0.0244    | 1.239                   | 0.2245 |
| GCSRT    | 1  | -1.3982            | 1.4025    | -0.997                  | 0.3265 |
| MMPIGRP2 | 1  | 0.0479             | 0.0173    | 2.766                   | 0.0095 |
only predictor to contribute significantly to the variation in \( \text{PSUM} \) in both of the regressions that included the Reasoning factor \( (t_{\text{MMPIGRP2}(31)} = 2.423, p = .0214) \) and the regression that included the Motor factor \( (t_{\text{MMPIGRP2}(31)} = 2.766, p = .0095) \) (see Table 10). Hypothesis 3a was thus also not supported for Testing Two since the amount of variation explained by the Reasoning factor was non-significant \( (r(31) = 1.722, p = .0951) \).

In summary, hypothesis 3a, that the Reasoning factor of the NCA would be the best predictor of later social recovery at both testings, was not supported in either testing. The variables which best predicted social recovery, as measured by the PAIS-SR summary score, were the Motor factor of the NCA and the MMPI at Testing One and the MMPI at Testing Two. The predictive ability of the Motor factor at Testing One, but not at Testing Two, suggests that initially severe deficits in psychomotor and visuospatial abilities (as measured by the tests in the Motor factor) may be related to later social functioning.

Given that the MMPI was the best predictor of the PAIS-R summary score in Hypothesis two, it is not surprising that it was also a good predictor in Hypothesis 3a, since the only difference between the regressions performed to test these hypotheses was the NCA scores that were used. However, it is worth restating that self-ratings of psychopathology, via the MMPI, appear to be particularly
useful for predicting later social recovery, with this being particularly the case when the MMPI was administered more than one year after injury.

Hypothesis 3b. Return to work and resumption of social and leisure activities have been reported to be affected by disruption of higher-order cognitive skills. Hypothesis 3b stated that, at both testings, the Reasoning factor of the NCA would predict scores on the Vocational Environment and Social Environment subscales of the PAIS-SR better than would the Motor factor of the NCA, GCS scores, education, or the MMPI. Eight multiple regressions were conducted to test this hypothesis. In four of these regressions the Vocational Environment subscale was the dependent variable and in four the Social Environment subscale was the dependent variable (see Table 6).

The analyses of variance for the regressions in which the Vocational Environment subscale was the dependent variable are presented in Table 11. It should be noted that significant F values were obtained for the data from Testing One both when the Reasoning factor of the NCA (F (4,49) = 2.68, p = .0424) and the Motor factor of the NCA (F (4,49) = 2.57, p = .0492) were included as predictor variables, and that almost identical levels of significance.
Table 11

Analyses of Variance for the Multiple Regressions Conducted to Predict Scores on the Vocational Environment Subscale of the PAIS-SR

<table>
<thead>
<tr>
<th>Source</th>
<th>DF</th>
<th>Sum of Squares</th>
<th>Mean Square</th>
<th>F Value</th>
<th>Prob&gt;F</th>
<th>R-SQ</th>
</tr>
</thead>
<tbody>
<tr>
<td>Testing #1 - NCA Predictor Variable=Reasoning Factor</td>
<td></td>
<td></td>
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<tr>
<td>MODEL</td>
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<td>2.149</td>
<td>2.68</td>
<td>0.0424</td>
<td>.1795</td>
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<tr>
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</tr>
<tr>
<td>Testing #1 - NCA Predictor Variable=Motor Factor</td>
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</tr>
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<td>2.572</td>
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</tr>
<tr>
<td>TOTAL</td>
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</tr>
<tr>
<td>Testing #2 - NCA Predictor Variable=Reasoning Factor</td>
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<td></td>
</tr>
<tr>
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<td>.4158</td>
</tr>
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</tr>
<tr>
<td>TOTAL</td>
<td>32</td>
<td>28.265</td>
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<td></td>
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<td></td>
</tr>
<tr>
<td>Testing #2 - NCA Predictor Variable=Motor Factor</td>
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<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td>MODEL</td>
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<td>3.4287</td>
<td>5.530</td>
<td>0.004</td>
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<td>17.979</td>
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<td></td>
</tr>
<tr>
<td>TOTAL</td>
<td>32</td>
<td>28.265</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
were obtained in both these regressions. Similarly, significant F values were obtained in both of the regressions for the data from Testing Two and similar levels of significance were obtained in these two regressions (F \text{RF2} (3.29) = 6.88, p = .0012; F \text{MF2} (3.29) = 5.53, p = .004).

Thus, a significant amount of the variation in VOCRT was accounted for in all four regressions. However, the regressions based on scores from Testing Two accounted for more variation in VOCRT than did the regressions based on scores from Testing One (i.e., R-SQUARE: RF1 = .1795; MF1 = .1735; RF2 = .4158; MF2 = .3639).

Tests of the significance of the predictor variables used in these four regressions are presented in Table 12.

Insert Table 12 about here

In the regressions associated with Testing One, the only predictors which contributed significantly to the prediction equations were the Reasoning factor of the NCA in the first regression (t RF1 (49) = 2.754, p = .0082) and the Motor factor of the NCA in the second regression (t MF1 (49) = 2.679, p = .01). In the regressions associated with Testing Two, these two factors still made significant contributions to the prediction equation (t RF2 (29) = 3.0, p = .0055; t MF2 (29) = 2.428, p = .0216). However, in contrast to Testing
Table 12
Tests of the Significance of the Predictor Variables Used in
the Multiple Regressions Conducted to Predict Scores on the
Vocational Environment Subscale of the PAIS-SR

<table>
<thead>
<tr>
<th>Variable</th>
<th>DF</th>
<th>Parameter Estimate</th>
<th>Std Error</th>
<th>T for H0: Parameter=0</th>
<th>Prob&gt;T</th>
</tr>
</thead>
</table>
| Testing #1 - Dependent Variable=VOCRT
| RF1      | 1  | 0.0159             | 0.0058    | 2.754                 | 0.0082 |
| GCSRT    | 1  | 0.0901             | 0.3518    | 0.256                 | 0.7989 |
| EDRT     | 1  | 0.3194             | 0.4647    | 0.687                 | 0.4951 |
| MMPI GRP | 1  | 0.0041             | 0.0048    | 0.854                 | 0.3971 |
| Testing #1 - Dependent Variable=VOCRT
| MF1      | 1  | 0.0168             | 0.0063    | 2.679                 | 0.0100 |
| GCSRT    | 1  | 0.0653             | 0.3537    | 0.242                 | 0.8094 |
| EDRT     | 1  | 0.4053             | 0.4703    | 0.862                 | 0.3930 |
| MMPI GRP | 1  | 0.0057             | 0.0047    | 1.209                 | 0.2326 |
| Testing #2 - Dependent Variable=VOCRT
| RF2      | 1  | 0.0201             | 0.0067    | 3.000                 | 0.0055 |
| GCSRT    | 1  | -0.2007            | 0.3819    | -0.526                | 0.6031 |
| MMPI GRP | 1  | 0.0124             | 0.0049    | 2.504                 | 0.0181 |
| Testing #2 - Dependent Variable=VOCRT
| MF2      | 1  | 0.0182             | 0.0075    | 2.428                 | 0.0216 |
| GCSRT    | 1  | -0.1631            | 0.4141    | -0.394                | 0.6965 |
| MMPI GRP | 1  | 0.0159             | 0.0051    | 3.113                 | 0.0042 |
One, the MMPI also made significant contributions to the prediction equation, both when the model included the Reasoning factor ($t_{MMPIGRP2} (29) = 2.504, p = .0181$) and when the model included the Motor factor ($t_{MMPIGRP2} (29) = 3.113, p = .0042$).

The analyses of variance for the regressions associated with the second part of hypothesis 3b, in which the Social Environment subscale was the dependent variable, are presented in Table 13. One could initially

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Insert Table 13 about here

---

note that a significant $F$ value was obtained for the data from Testing One only when the Motor factor ($F(4.50) = 2.58, p = .0483$) was included as a predictor. The model which included the Reasoning factor yielded a non-significant $F$ value ($F(4.50) = 1.80, p = .1427$). In contrast, significant $F$ values were obtained in both of the regressions for the data from Testing Two ($F_{RF2} (3.30) = 3.43, p = .0295; F_{MF2} (3.30) = 4.13, p = .015$). Thus a significant amount of the variation in SOCRT was accounted for in three of the four regressions. However, as was the case when VOCRT was the dependent variable, regressions based on scores from Testing Two accounted for more variation in SOCRT than did the regressions based on scores from Testing One.
Table 13

Analyses of Variance for the Multiple Regressions Conducted
to Predict Scores on the Social Environment Subscale of
the PAIS-SR

<table>
<thead>
<tr>
<th>Source</th>
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<th>Sum of Squares</th>
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<th>F Value</th>
<th>Prob&gt;F</th>
<th>R-SQ</th>
</tr>
</thead>
<tbody>
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<td>Testing #1 - NCA Predictor Variable=Reasoning Factor</td>
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<td></td>
<td></td>
</tr>
<tr>
<td>MODEL</td>
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<td>ERROR</td>
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<tr>
<td>TOTAL</td>
<td>54</td>
<td>79.739</td>
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<tr>
<td>MODEL</td>
<td>4</td>
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<tr>
<td>TOTAL</td>
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<td>MODEL</td>
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<td>56.781</td>
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</table>
Tests of the significance of the predictor variables used in these four regressions are presented in Table 14.

Insert Table 14 about here

In the regressions associated with Testing One, the MMPI was the only predictor which contributed significantly to the prediction equation which included the Reasoning factor (t MMPIGRP (50) = 2.170, p = .0348) and the prediction equation which included the Motor factor (t MMPIGRP (50) = 1.969, p = .0546). In the regressions associated with Testing Two, the MMPI made significant contributions to the prediction equation which included the Motor factor (t MMPIGRP2 (50) = 2.155, p = .0393) and approached significance in the prediction equation which included the Reasoning factor (t MMPIGRP2 (50) = 1.895, p = .0677). Interestingly, in Testing Two the opposite pattern was observed for the GCS in that it approached significance in the prediction equation which included the Motor factor (t GCSRT (30) = -1.811, p = .0802) and was significant in the prediction equation which included the Reasoning factor (t GCSRT (30) = -2.241, p = .0677). The Reasoning factor was non-significant in both Testing One (t RF1 (50) = -0.342, p = .7339) and in Testing Two (t RF2 (30) = 0.533, p = .5980).
Table 14

Tests of the Significance of the Predictor Variables Used in
the Multiple Regressions Conducted to Predict Scores on the
Social Environment Subscale of the PAIS-SR

| Variable | DF | Parameter Estimate | Std Error | T for H0: Parameter=0 | Prob>|T |
|----------|----|-------------------|-----------|-----------------------|-------|
| RF1 | 1 | -0.0026 | 0.0076 | -0.342 | 0.7339 |
| GCSRT | 1 | -0.7381 | 0.4637 | -1.592 | 0.1177 |
| EDRT | 1 | -0.3529 | 0.6079 | -0.581 | 0.5641 |
| MMPICRP | 1 | 0.0135 | 0.0052 | 2.170 | 0.0348 |

Testing #1 - Dependent Variable=SOCRT

| MF1 | 1 | 0.0134 | 0.0079 | 1.685 | 0.0981 |
| GCSRT | 1 | -0.3793 | 0.4524 | -0.838 | 0.4057 |
| EDRT | 1 | -0.1678 | 0.5970 | -0.281 | 0.7799 |
| MMPICRP | 1 | 0.0116 | 0.0059 | 1.969 | 0.0546 |

Testing #2 - Dependent Variable=SOCRT

| RF2 | 1 | 0.0054 | 0.0101 | 0.533 | 0.5980 |
| GCSRT | 1 | -1.3405 | 0.5980 | -2.241 | 0.0325 |
| MMPICRP | 1 | 0.0147 | 0.0076 | 1.895 | 0.0677 |

Testing #2 - Dependent Variable=SOCRT

| MF2 | 1 | 0.0148 | 0.0108 | 1.364 | 0.1826 |
| GCSRT | 1 | -1.0983 | 0.6066 | -1.811 | 0.0802 |
| MMPICRP | 1 | 0.0162 | 0.0075 | 2.155 | 0.0393 |
In summary, significant F values were obtained in all four regressions in which the Vocational Environment subscale of the PAIS-SR was the dependent variable. More accurate prediction equations were associated with data from Testing Two than with data from Testing One and with regressions in which the Reasoning factor was included as a predictor than in regressions when it was not. Indeed, the Reasoning Factor of the NCA was the best overall predictor in both testings and was a better predictor in Testing Two than in Testing One. Hypothesis 3b was thus supported when the Vocational Environment subscale of the PAIS-SR was used as the dependent variable.

In contrast, significant F values were obtained in only three of the four regressions in which the Social Environment subscale was the dependent variable. The MMPI was the best overall predictor with one exception: The GCS was the best predictor in the regression in Testing Two which included the Reasoning factor of the NCA. However, the Reasoning factor itself did not prove to be a useful predictor in either the regression associated with the data from Testing One or the regression associated with the data from Testing Two. As a result, hypothesis 3b was not supported when the Social Environment subscale of the PAIS-SR was used as the dependent variable.

Hypothesis 3c. This hypothesis was a direct extension of hypotheses 3a and 3b. It stated that the
Reasoning factor score from Testing Two would predict the 
(1) PAIS-SR summary score, (2) Vocational Environment 
subscale score, and (3) Social Environment subscale score 
better than would the Reasoning factor from Testing One. 
The usefulness of RF1 vs. RF2 for predicting these three 
scores can be obtained by contrasting their probability 
levels in Tables 10, 12, and 14. If this hypothesis is 
supported, then RF2 should have a more significant $t$-value 
than RF1.

Since the Reasoning factor only explained a significant amount of the variance when the dependent variable was VOCRT (see Table 12), the usefulness of testing this hypothesis is questionable. Nonetheless, one can briefly note that the $t$-values obtained for RF2 were always larger than those obtained for RF1. Although this was the case when VOCRT was the dependent variable, one should note that the probability levels associated with both Testings One ($p=.0082$) and Two ($p=.0055$) were both very low. Thus, one cannot unequivocally conclude that RF2 is the better predictor. In contrast, a notable difference between the $t$-values of RF1 and RF2 was evident when PSUM was the dependent variable (see Table 10). In this instance the probability level associated with RF2 ($p=.0951$) approached significance whereas the probability level associated with RF1 did not ($p=.4606$). However, the support for hypothesis 3c, if any, must be considered to be weak.
Summary of the Results

A summary of the results is presented in Table 15. It

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Insert Table 15 about here

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is evident from this table that, by-and-large, the hypotheses of this study were not supported. Only
hypothesis one was fully supported and hypothesis ib was
partially supported. Thus, it appears that the ACS and the
Reasoning factor are of limited use for predicting long-term
social recovery.

Two other findings of interest should be noted from
Table 15. First, the Motor factor was a significant
predictor in several regressions. This suggests that
physical factors are of some use in predicting long-term
social recovery. Second, the MMPI was, overall, the best
predictor of social recovery. This suggests that self-
ratings of psychopathology, both in the acute and chronic
stages of recovery, are useful for predicting long-term
social recovery. These findings are discussed in more
detail below.
### Summary of the Results

<table>
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<tr>
<th>Hyp. #</th>
<th>Predicted Results</th>
<th>Obtained Results</th>
<th>Hyp. Upheld</th>
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<tr>
<td>One</td>
<td>NCA test scores would improve significantly between Testing One and Testing Two</td>
<td>Significant improvements found for 12 out of 13 tests</td>
<td>Yes</td>
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<td>Two</td>
<td>The ACS would be the best predictor of PSUM and KSUMLOG at both Testing One and Testing Two</td>
<td>The MMPI was the best predictor of PSUM and KSUMLOG at both Testings</td>
<td>No</td>
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<td>3a</td>
<td>The Reasoning factor would be the best predictor of PSUM at both Testing One and Testing Two</td>
<td>The MMPI and the Motor factor were the best predictors at Testing One and the MMPI was the best predictor at Testing Two</td>
<td>No</td>
</tr>
<tr>
<td>3b</td>
<td>The Reasoning factor would be the best predictor of VOCRT and SOCRT at both Testing One and Testing Two</td>
<td>The Reasoning factor was the best predictor of VOCRT at both Testings. The MMPI was the best predictor of SOCRT at Testing One, and the MMPI and GCS scores were the best predictors at Testing Two</td>
<td>Yes &amp; No</td>
</tr>
<tr>
<td>3c</td>
<td>The Reasoning factor would be a better predictor at Testing Two than at Testing One</td>
<td>A generally weak trend towards the Reasoning factor being a better predictor at Testing Two was noted</td>
<td>?</td>
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</table>
Chapter IV
Discussion

Before beginning a discussion of the results, some cautions regarding their interpretation are in order. These cautions relate primarily to two areas of concern. The first of these areas can be thought of as problems in interpretation relating to data manipulation. In the present study, the analyses were all performed using ipsitive data; that is, data from the present sample only. As was discussed previously, the use of such data was felt to be appropriate because it yielded the most meaningful interpretation for the subjects in the present study. However, the classification of subjects based on ipsitive data could potentially misrepresent the degree of impairment suffered by the subjects and, thus, mislead the reader. Therefore, the reader should be ever aware that the subjects in the present study suffered severe injuries. Even those subjects who were the least impaired relative to the rest of the sample would, on the whole, still be considered impaired relative to normal subjects. This was especially the case at Testing One.

A second problem with respect to data manipulation relates to the fact that missing data values had to be
estimated and used in the analyses. As was mentioned previously, these values were not estimated arbitrarily, but rather they were estimated according to the most justifiable statistical and theoretical criteria. Missing data values had to be estimated for more than five percent of the subjects for only two measures: Estimations were made for 28% of the subjects for GCS scores and 18% of the subjects for the Category Test centile score. One cannot be sure of the accuracy of the missing data estimates. The reliability of the present findings thus awaits future research in which estimation of missing data is not necessary.

The second area of caution, with respect to interpretation of the results, relates to concerns associated with the measures themselves. Two general concerns arise here. First, in order to reduce the number of variables, it was necessary to create summary variables (e.g., ACS, MMPIGRP, PSUM, KSUM) and conduct the analyses using these. The use of such general measures necessarily results in general conclusions. More fine-grained conclusions thus await future research.

Second, the results from Testing One are not strictly comparable to those from Testing Two because education was included as a predictor in the analyses associated with Testing One but not in the analyses associated with Testing Two. When education was included with the predictors
associated with Testing One, its t-value only approached significance once, in the regression to predict KSUMLOG (t = -1.809, p = .0764). Because it was such a poor predictor at Testing One, one could hypothesize that, had it been included with the predictors associated with Testing Two, the number of years of formal education would also have been a poor predictor at Testing Two. Of course, the usefulness of education as a predictor at Testing Two could have been easily tested by including it in the analyses associated with Testing Two. However, education had to be dropped from these analyses in order to maintain an adequate subject-to-variable ratio. Therefore, the usefulness of education as a predictor at Testing Two cannot be determined in the present study.

For the purposes of the present discussion, it should be noted that inclusion of education in the analyses associated with the data from Testing Two would undoubtedly have had the effect of increasing the total sum of squares in these analyses. Thus one cannot be sure what effect, if any, its inclusion would have had on the partitioning of the sum of squares attributable to the predictors in each regression. Some caution must therefore be taken in comparing the relative contribution of the same variables in Testings One and Two.

Due to the concerns mentioned above, conclusions drawn from the results of the present investigation must be
viewed as being general in nature and in need of replication. Given those cautions the discussion will now turn to the interpretation of the results. This will be done in four sections. The first three sections will discuss the results of hypotheses one, two, and three, respectively. In the fourth section general conclusions and suggestions for future research will be made.

Hypothesis Number One

Hypothesis one stated that the neuropsychological test performances of the patients at Testing Two would be significantly better than those at Testing One. This hypothesis was supported for 12 of the 13 tests used in the Neurocognitive Assessment. The only test for which a non-significant improvement between testings was obtained was the Sentence Memory Test. Norms for the Sentence Memory Test have been published with several different normative samples (Carmichael & MacDonald, 1984; Gaddes & Crockett, 1975; Knights & Norwood, 1980; Spreen & Gaddes, 1969). Of the various sets of norms available to the present author, those of Knights and Norwood (1980) are the most stringent: that is, their normative sample obtained the highest mean score on the Sentence Memory Test ($M=18.00$, $SD=2.3$). Even compared to these norms, the subjects in the present study exhibited low-normal performances on this test at both Testing One ($M=16.73$, $SD=3.25$) and Testing Two ($M=17.68$, $SD=2.37$). The most likely explanation for the non-
significant improvement obtained for the Sentence Memory
Test thus appears to be that the subjects were minimally
impaired on it in Testing One and therefore had little room
for improvement.

Two explanations are possible for the overall
improvement in neuropsychological test performance between
Testings One and Two. The first is that the improvements
were due to practice effects and the second is that the
improvements were due to the recovery of functions. Drudge
et al. (1984) argue that the better performances over time
observed in their sample of CHI patients are most likely due
to the recovery process. They cite three justifications to
support this argument. First, research suggests that CHI
patients' most frequent deficits are in memory and learning
abilities, both of which are important to produce practice
effects. Second, these deficits coupled with an average
nine-month intertest interval reduced the likelihood of
incidental learning in their subjects. And third, other
studies have found "little or no change in Halstead-Reitan
test scores over repeated testings with chronic brain-
damaged patients" and that "even with young, normal
subjects, relevant test-retest practice effects were
observed on only a small number of the subtests and over a
much shorter intertest interval" (Drudge et al., 1984,
p.261).
Although practice effects may have played some role in the improvement in neuropsychological test performance observed for the subjects in the present study, it is unlikely that they were solely responsible for the improvements. Much of the improvement can therefore be attributed to the recovery process. The exact extent of which cannot be determined in the present study. For the purposes of the hypothesis one what is important about this finding is that it indicates that the present sample shows the improvement in neuropsychological test performance that is typically seen in CHI patients over time (e.g., Dikmen & Reitan, no date; Drudge et al., 1984). The present sample can thus be considered to be comparable to other CHI samples in this respect.

The present sample is also comparable to other CHI samples in another respect: Although improvement in test performance was seen over time, the subjects were still impaired at Testing Two. This is notable from the generally small effect sizes obtained between Testings One and Two. However, it is of interest to note that the largest effect size (.256) was seen for the Category Test. This is consistent with Reitan and Wolfson's (1985) contention that this test is particularly sensitive to the status of the brain, and that deficits on this measure will be particularly salient under conditions of recent brain damage.
Neuropsychological sequelae were still notable at Testing Two for several tests, the most notable of which being the Digit Symbol subtest of the WAIS-R, the Grooved Pegboard Test, and the Trail Making Test. The subjects in the present study would be considered to be impaired on these three tests regardless of which set published norms (available to the present author) that one choses to use for comparison purposes. For example, in the WAIS-R manual (Wechsler, 1981) the Digit Symbol subtest has a mean scaled score of 10 (SD=3); in the present study the mean scaled score at Testing Two was 6.45 (SD=2.94).

Similarly, the subjects in the present study exhibited impaired performances at Testing Two on the Grooved Pegboard Test (M GPT-D= 96.17, SD= 31.74; M GPT-ND= 146.15, SD= 44.86), in comparison for example to the those of Heaton et al. (1986) (M GPT-D= 61.1, SD= 8.1; M GPT-ND= 65.7, SD=11.0), and on the Trailmaking Test (M TMT-A= 41.96, SD=28.57; M TMT-B= 94.43, SD= 71.61), in comparison for example to Kennedy (1981) (M TMT-A= 16.96, SD=41.31, M TMT-B= 64.53, SD= 17.9). Thus, the conclusion to be made from hypothesis one is that patients who suffer severe head injuries still evidence neuropsychological sequelae more than one year after injury, and that this is the case despite the finding that statistically significant gains are made within this period.
Hypothesis Number Two

The second hypothesis stated that, at both testings, a summary measure of neuropsychological impairment (the Average Centile Score) would be a better predictor of social recovery than would GCS scores, education, or the MMPI. Neither the Average Centile Score from Testing One nor the Average Centile Score from Testing Two contributed significantly to the prediction of social recovery. This was the case regardless of whether the measure of social recovery was derived from patient's ratings (i.e., the PAIS-SR) or from a relative/friend's ratings (i.e., the KAS-R). Hypothesis two was thus not supported.

Several explanations for the finding that the ACS was a non-significant predictor of later social recovery can be posited. The most obvious of these is that overall level of neuropsychological impairment is not predictive of later social recovery and that this is the case regardless of whether testing occurs in the acute period (i.e., within the first year) or in the chronic period (i.e., after the first year) after injury. Alternately, this finding may have resulted from methodological differences between the present study and previous studies.

The studies reviewed by the present author typically measured social recovery (usually via the Glasgow Outcome Scale or return to work) six months and/or 12 months postinjury (e.g., Drudge et al., 1984; Dikmen & Reitan, no
date: Fordyce et al. 1984). In the present study the mean
time between injury and measurement of social recovery (via
the KAS-R and PAIS-SR) was 4.34 years (in the Study
subsample). Thus it is possible that the finding that the
ACS was a non-significant predictor of social recovery
reflects a decreasing efficacy of neuropsychological test
scores in predicting recovery as time passes. Indeed, if
this be the case, this would not be unique to
neuropsychological test scores as predictors. For example,
Grant and Alves (1997) note that it is difficult to predict
later psychosocial functioning from early postinjury status
and that "severity of the initial injury (as measured by
PTA) correlates with the short-term outcome (three months
but this association tends to diminish over time" p.149.

At least two other explanations can be offered to
explain the finding that the ACS was a non-significant
predictor of social recovery: These relate to the use of
the ACS as a predictor variable and the PAIS-SR and KAS-R
summary scores as dependent variables. With respect to the
ACS, it is possible that this measure has questionable
reliability. This may be so for two reasons. First, all of
the NCA tests available for any given subject were used to
calculate their NCA score because it was felt that this would
constitute the most representative measure of
neuropsychological impairment. As a consequence, the number
and composition of tests used to compute the ACS varied
considerably between subjects. Thus, it is possible that this measure was a non-significant predictor because it was not measuring the same dimensions for all of the subjects. Second, as was mentioned previously, the computation of the ACS involved the classification of the subjects into one of four centile groups for each test and then averaging their centile scores. The categorization of previously continuous neuropsychological tests reduced the variability of these tests and possibly attenuated their predictive power.

The second explanation for the lack of the ACS predictive power may relate to outcome measures used. Typically, previous studies which have attempted to predict outcome from a summary measure of neuropsychological impairment (e.g., the Average Impairment Rating, the Haisled Impairment Index, Keytests) have defined outcome in terms of global measures such as work status (Heaton et al., 1981; Newnan et al., 1978; Wild et al., 1985) or the Glasgow Outcome Scale (c.f., Klonoff et al., 1986). When multidimensional outcome measures (e.g., the SIP, the KAS) have been employed, the analyses have typically utilized individual subscales as dependent variables (Klonoff et al., 1986; McSweeney et al., 1985). Thus, the derivation of a summary score from a multidimensional measure and its subsequent use as a dependent variable has not been attempted before. Possibly, then, the use of such a global
measure obfuscates any more fine-grained relationships that may exist.

One cannot be certain which of the above explanations, if any, best explains the negative ACS results. However, until evidence to the contrary is offered, it seems reasonable to accept the first explanation: The ACS does not adequately predict long-term global recovery. In contrast to the ACS, the MMPI centile group score (MMPI GRF) proved to be the best predictor of social recovery at both testings. This score was a significant predictor only in the regression to predict the summary score from the PAIS-SR (PSUM) in the regressions associated with the data from Testing One. However, it did approach significance \( p = .06 \) in the regression to predict the summary score from the PAI (KSUM). Similarly, it was a significant predictor only in the prediction of PSUM in the regressions associated with the data from Testing Two. Finally, MMPI GRF proved to be a better predictor of PSUM at Testing Two than at Testing One.

Several questions arise from these findings. The most obvious is: Why was the MMPI the best early predictor of a long-term social recovery? Findings regarding the usefulness of the MMPI as a predictor and the change in MMPI scores over time have been inconsistent. Frigato and 1987 suggests that the MMPI has limited value in large study studies. He cites two reasons for this opinion. First, i°
has been standardized on psychiatric patients so it is unclear how the pattern of test scores relates to various forms of brain damage. Second, the usefulness of this test depends on the capacity of the patients to be objective in self-reporting. Prigatano (1987) thus argues that its use is questionable with head injury patients since these patients often lack insight.

Several studies (e.g., Klonoff et al., 1986; Newnan et al., 1978) have found the MMPI to be somewhat limited, although certainly not useless, in the prediction of social recovery. In the study by Klonoff et al. (1986), none of the MMPI variables was included in their "predictor" canonical variates. However, Klonoff et al. (1986) used the 400-item version of the MMPI and grouped the scales into three separate composite scores. It is possible that using an abbreviated version of the MMPI and composite scores put the MMPI at a disadvantage as a predictor by reducing its variance. Therefore, its failure to be included as a predictor arguably could have been a result of being put at a disadvantage as a predictor. Newnan et al. (1978) found that the MMPI scales were not sensitive predictors of chronic unemployment. However, they noted that the MMPI was strongly related to employment status in a previous study, and that the MMPI was related to total hours worked in their study. Thus they suggested that the MMPI does have some
role as a personality measure to predict employment stability.

At least two studies have used the MMPI as a measure with which to compare patients' emotional functioning in the acute versus chronic stages of recovery. Dikmen and Reitan (no date) compared serial MMPIs of the same head injury patients and found that (1) more (neuropsychologically) severe patients exhibited more psychopathology at all times and (2) all patients exhibited a reduction in emotional distress over time. In contrast, Fordyce et al. (1983) compared the MMPIs of patients tested in the acute phase of recovery (less than six months since onset) to those tested in the chronic phase (more than six months) and found the latter patients to exhibit more emotional distress. Fordyce et al. conclude that, even though cognitive deficits may improve over time, emotional deficits often increase.

When one examines these two studies closely, it becomes apparent that there were many methodological differences which makes them difficult to compare. Dikmen and Reitan (no date) used a longitudinal design, while Fordyce et al. (1983) used a cross-sectional design. Dikmen and Reitan used patients who suffered mild-to-moderate head injuries while Fordyce et al. used patients who suffered severe head injuries. The subjects in the Dikmen and Reitan study exhibited superior neuropsychological performance when they had reached
chronic stage of recovery whereas Fordyce et al. reported no acute-chronic differences in neuropsychological performance. Thus it is likely that the apparently opposite results of these two studies was a reflection of their differing methodologies and study samples.

To summarize, Prigatano (1987) suggests, for various methodological reasons, that the MMPI is of limited usefulness as a predictor. It has also been found to have limited usefulness as a predictor in several studies (Klonoff et al., 1986; Newnan et al., 1978) but these findings are inconclusive. On the other hand, in two studies where it has been reported to be a valuable measure of emotional functioning, opposite findings have been reported (Dikmen & Reitan, no date; Fordyce et al., 1983), presumably because of methodological differences.

To complicate matters further, the present study, which also examined the MMPI over time, is not comparable to either of the two previous studies which have used the MMPI. This is because the present study used a summary MMPI variable (as opposed to profile analysis), had a sample of patients who suffered severe head injuries (as opposed to Dikmen & Reitan, no date), and examined serial testings of the same patients (as opposed to Fordyce et al., 1983). It is evident from the preceding discussion that, depending on one's orientation and the literature that one chooses to review, one could make a case both for and against the
efficacy of the MMPI as a predictor. Given that this is the case, it seems that the best course to adopt, with respect to the MMPI results in the present study, is to consider them to be preliminary, hypothesis-generating, and in need of more fine-grained research. Clearly, more research needs to be done in this area. Suggestions for such research will be made in the concluding section.

With respect to hypothesis two, the MMPI results are suggestive of two possible relationships. First, overall self-ratings of psychopathology are predictive of later ratings of overall social recovery: This was especially the case when the ratings are made more than one year after onset. This supports the suggestion by Forryce et al. (1983) that personality/emotional disturbances may increase over time, even though cognitive disturbances decrease. This may reflect the patients' growing awareness of the severity of their deficits and the relatively permanent nature of them. Indeed, in the present study, a paired t-test indicated that there was a trend towards an increase in the number of MMPI scaled scores over 70 (t = -1.23, p = .224) between Testings One and Two. Therefore, an increase in overall psychopathology, as operationally defined in the present study, occurred over time coincidental with a decrease in overall levels of neuropsychological disability.

The second possible relationship suggested by MMPI results from hypothesis two is that the MMPI predicts
patients' ratings of their recovery better than do relatives' ratings of the patients' recovery. One possible explanation for this is a statistical consideration. Upon examination of the scatterplots associated with the predictions of KSUMLOG, it was obvious that a multivariate outlier existed: that is, one data point was distinctly separate from the other data points in the generally rectangular-shaped plot. No theoretical justification could be found for deleting the outlier from the analyses. To delete it without such a justification in order to (potentially) support one's hypothesis would be considered by many to be a poor research practice (Tabachnick & Fidell, 1983). Thus the outlier was retained in the analyses. For the present purposes, it should be noted that, given the small number of subjects used in the present study, it is quite likely that this one outlier could have had a disproportionate effect on the prediction of the KAS-R summary score.

A second possible explanation for the better predictions of PSUM than KSUMLOG is that both the PAIS-SR and the MMPI are self-ratings. One would expect greater reliability between two self-rating scales than between a self-rating scale and a scale that was completed by someone else (i.e., a friend or relative). On the other hand, perhaps some patients are more willing to admit to psychopathology than are other patients. Thus, a third
possible explanation for the better predictions of PSUM than KSUMLOG is that it is this willingness, not a relationship between early psychopathology and later social recovery, which is reflected in the MMPI results.

Although this third explanation cannot be discontinued in the present study, the correlation between PSUM and KSUM of 0.53 (p<.0001) suggests that both the patient and the relatives/friends perceived similar levels of overall social recovery in the patient. Therefore, it is likely that the patient's ratings have some reliability. Unfortunately, the design of the present study did not permit the examination of whether patients' and relatives' ratings differed systematically and, if so, what was the nature of the differences. Thus, it is left up to future research to more specifically examine this observed relationship between early psychopathology and later social recovery.

**Hypothesis Number Three**

**Hypothesis 13.** This hypothesis stated that at both testings, the Reasoning factor or the NCA would predict the PAIS-SR summary score better than would the Motor factor. GCS scores, education, or the MMPI. Four multiple regressions were conducted to test this hypothesis. two of which included the Reasoning factor as a predictor and two of which included the Motor factor as a predictor. Because the Reasoning and Motor factors were never entered into the same regression equation, due to problems with
multicollinearity), a direct comparison of these factors is not possible. However, indirect comparison is possible since the other predictor variables in the equation were always identical (i.e., GCS scores, the MMPI, and in Testing One, education). Thus, when one compares these factors one is really comparing the contribution of the Reasoning factor relative to the contribution of the Motor factor.

The Reasoning factor did not contribute significantly to the prediction equation in either Testing One or Testing Two. The Motor factor and the MMPI, respectively, proved to be the best and the second best predictors at Testing One while the MMPI was the only significant predictor at Testing Two. Hypothesis 3a was thus not supported.

The main difference between hypothesis two and hypothesis 3a was that hypothesis two predicted global measures of social recovery (PSUM and KSUMLOG) using a global measure of neuropsychological functioning (the ACS), while hypothesis 3a predicted a global measure of social recovery (PSUM) using measures thought to tap specific areas of neuropsychological functioning (the Reasoning andMotor factors of the NCA). As such, one could again argue that the use of a global measure of social recovery as the dependent variable obfuscated more specific relationships and that this is one possible reason why the Reasoning factor was such a poor predictor. In fact, some support for
this explanation is provided by the results of hypothesis 3b (discussed below). However, one cannot argue that specific neuropsychological factors are all of little value in predicting a measure of global social recovery because the Motor factor at Testing One was the best predictor. Thus, the most likely conclusion is that early indications of motor and visuospatial ability deficits (as measured by the Motor factor) predict long-term global social recovery better than do deficits in higher-order reasoning abilities.

This particular conclusion is quite difficult to explain if one attempts to assimilate it with the results of previous studies. In recent years, as was discussed in the literature review of the present study, the trend in the closed head injury literature has been to concentrate on the effects of personality and cognitive disturbances on social outcome and to downplay the effects of physical disabilities (Klonoff et al., 1986). In addition, some of the research examining the effects of personality disturbances on social outcome was also discussed previously in the discussion of the MMPI results. As for cognitive disturbances, the neuropsychologically oriented research has tended to focus more on the usefulness of measures which are sensitive to the integrity of the brain (e.g., the Average Impairment Rating, Halstead's Impairment Index, the Category Test, the Trail Making Test Part B) for predicting recovery than on
the usefulness of measures that tap motor or psychomotor skills (e.g., Finger Tapping, the Grooved Pegboard Test).

There are some indications that such a focus may be inappropriate and that one should also consider the effects of motor dysfunctions on later social recovery. For example, McSweeney et al. (1985) examined the social functioning (as measured by the SIP and KAS) of patients with Chronic Obstructive Pulmonary Disease (COPD) and found that the neuropsychological tests which best predicted performance on activities of daily life and social role performance were motor tests and psychomotor tests which were speeded. They note that similar findings have been reported for psychiatric patients and patients with cerebrovascular disease, and suggest that these "motor" abilities are more important than are emotional disturbances for predicting social recovery in these patients. A similar relationship between recovery and motor tests was also reported by Klonoff et al. (1986) in CHI patients. These authors found that motor dysfunction bore the strongest relationship to those aspects of quality of life which involve activities of daily life and social role functioning (i.e., performance at work and home). They concluded, "although the role of physical disability in outcome is somewhat controversial in the literature, it is felt that the results of the current study raise the possibility that
motor dysfunction is a variable influencing eventual quality of life in CHI patients" (p.481).

A note of caution in interpretation of the efficacy of global neuropsychological "factors" in predicting outcome is in order. McSweeney et al. (1985), Klonoff et al. (1986), and the present study all (to varying degrees) obtained results that can be interpreted to suggest that a "motor" factor was related to social recovery. However, one cannot infer that these findings are directly comparable or that only motor abilities were involved in performing the tests in the motor factors. The reason for this is that the tests which comprised these motor factors varied between the studies. The tests which were included in the motor factor of McSweeney et al. (1985) were the Part B of Trail Making Test, Grip Strength, and the Grooved Pegboard Test with the dominant hand. The tests which were included in the motor factor of Klonoff et al. (1986) were Finger Tapping and Visual Choice Reaction Time (VCRT). And, the tests which were included in the Psychomotor and Visuospatial Abilities factor of the present study were the Picture Completion, Block Design, and Digit Symbol subtests of the WAIS-III, and the Grooved Pegboard Test with each hand (this factor was referred to as the Motor factor throughout the present text because this was less cumbersome than writing its entire factor name each time).
One could argue that Part B of the Trail Making Test and Digit Symbol measure higher-order abilities (e.g., ability to switch set) in addition to having motor components. Indeed, Trails B was one of the tests included in the Reasoning factor in the present study. In addition, Klonoff et al. (1986) note that labelling VCRT as a motor measure was done for the sake of parsimony and that further research with a measure which does not confound motor speed with information processing is needed to support their results. It is therefore evident that the label of any given factor should not be interpreted as reflecting the only ability which that factor measures. Thus, although it is often necessary for statistical reasons and for the sake of parsimony to label groups of tests with global factor labels, one should be ever aware that such labels are somewhat arbitrary and can sometimes lead to confusion in interpretation.

In addition to the usefulness of the motor factor as a predictor, the other major finding of interest in hypothesis 3a was that the MMPI again was a good predictor of overall social recovery and a better predictor at Testing Two. Given that the only difference between hypothesis 3a and hypothesis two was which neuropsychological variable was entered as a predictor of PSUM, it is hardly surprising that the MMPI results obtained for hypothesis 3a were similar to those obtained for hypothesis two. Because the MMPI results
for hypothesis two were discussed in some detail previously, it will suffice to restate the general conclusion: Self-ratings of psychopathology, via the MMPI, appear to be particularly useful for predicting long-term global social recovery. This was particularly the case when the MMPI was administered more than one year after injury.

**Hypothesis 3b.** This hypothesis stated that, at both testings, the Reasoning factor would predict scores on the Vocational Environment and Social Environment subscales of the PAIS-SR better than would the Motor factor, GCS scores, education, or the MMPI. When the Vocational Environment subscale was the dependent variable the Reasoning factor was found to be the best predictor in the analyses associated with both Testing One and Testing Two. Hypothesis 3b was therefore supported when the Vocational Environment subscale was the dependent variable. In contrast, when the Social Environment subscale was the dependent variable, the Reasoning factor was a non-significant predictor in the analyses associated with both Testing One and Testing Two. Hypothesis 3b was therefore not supported when the Social Environment subscale was the dependent variable.

Measures used in previous studies to assess employment status and/or work performance are generally comparable to the Vocational Environment subscale used in the present study. Several neuropsychologically-oriented studies have used work-related variables as outcome measures of social
recovery. For example, Newnan et al. (1978) examined the relationship between neuropsychological test scores and chronic unemployment in heterogeneous groups of subjects who had histories of brain disorders (i.e., epilepsy, CVAs, head injuries, anoxia, and poisoning). These authors found that chronic unemployment was best predicted by those neuropsychological measures which are commonly thought to be the most sensitive to brain damage (e.g., the Average Impairment Rating, the Tactual Performance Test, the Category Test). Heaton et al. (1981) also examined the relationship between chronic unemployment and neuropsychological test scores in a heterogeneous group of subjects. Heaton et al.'s subjects consisted of all patients in a three-year period who were referred for neuropsychological testing. These authors found that the unemployed group performed significantly worse on virtually all of the neuropsychological tests given and evidenced more disturbances on the MMPI. Thus, in heterogeneous groups of subjects there is evidence for the efficacy of neuropsychological test scores for predicting later employment.

The findings of Wild et al. (1985) are more directly relevant to the present study because these authors used only closed head injury patients as subjects in their study. Wild et al. found that the best cluster of predictors of chronic unemployment consisted of a group of
neuropsychological tests (which they referred to as "keytests") that are thought to be particularly sensitive to brain damage. Interestingly, keytests had a higher correlation with employment status than did the Average Impairment Rating, suggesting that tests which have been found to be specifically sensitive to deficits in higher-order cognitive abilities were more sensitive to later employment status than was a measure of overall neuropsychological impairment. The usefulness of the Reasoning Factor in the present study for predicting scores on the Vocational Environment subscale is thus consistent both with previous findings in which heterogeneous groups of patients were used as subjects and previous findings in which CHI patients were used as subjects.

Other findings of interest also emerged in the analyses associated with the first part of hypothesis 3b. Wild et al. (1985) administered the neuropsychological tests to the subjects in their study more than one year after injury and found a relationship between work status and neuropsychological impairment. The present study extends these findings in that this relationship was found both when testing occurred within the first year after onset and when testing occurred more than one year after onset. In addition, the significance levels of the Reasoning factors were very low at both testing (p = .0062 at Testing One vs. p = .0055 at Testing Two). It is thus possible that these so-
called key tests are just as useful as predictors of long-term work adjustment when they are administered in the acute phase of recovery as when they are administered in the chronic phase of recovery.

Additional findings of interest relate to the MMPI results. The MMPI was only a significant predictor at Testing Two; it was not as significant a predictor as was the Reasoning factor, but was a more significant predictor than was the Motor factor. Three interpretations can be made from this pattern of findings. First, acute personality disturbances are not as important as are chronic ones in the prediction of later vocational functioning. Second, deficits in higher-order cognitive skills are more damaging to future work prospects than are personality disturbances. However personality disturbances are more damaging than are disturbances in motor skills. Third, disturbances in motor skills are nonetheless also important predictors of future vocational adjustment. This pattern of results is consistent with previous findings (discussed in the literature review) which suggest that return to work may be influenced by two relatively independent factors: A physical factor (as indicated, by difficulties in activities of daily living) and a mental factor (as indicated by cognitive and/or personality changes) (Bond, 1975; Weddell et al., 1980).
In contrast to the strong support provided for the efficacy of the Reasoning factor for predicting later vocational adjustment, no support was provided for the efficacy of this factor for predicting later social adjustment (i.e., participation in social and leisure activities). Nonetheless, indications that cognitive deficits are related to difficulties in social adjustment are evident in the literature. Bond (1975) reported that mental disability (defined, in this study, by impairments on the WAIS) is related to later social disability (as measured by both return to work and resumption of leisure activities). Oddy and Humphrey (1980) reported that limited social contact was related to poor performance in certain cognitive tests (the Inglis Paired Associate Learning Test and the Logical Memory subtest of the Wechsler Memory Scale). Newton and Johnson (1985) reported a nonsignificant trend in which increased cognitive impairment was related to social performance and suggested that it is possible that some relationship between cognitive impairment and social adjustment exists. And, Klonoff et al. (1986) found that impairment of higher order cognitive skills (memory and constructional ability) was related to psychosocial dysfunction (decreased mental alertness, increased emotional problems, and increased social isolation).
In the present study, no support was provided to suggest that a relationship between impairment of higher-order cognitive skills and decreased social and leisure activities exists. The above studies, which supported this relationship, all defined "cognitive skills" differently from each other and from the present author. It is therefore possible that the discrepant findings reflect the different definitions. On the other hand, the relationship between cognitive status and deficits in social functioning is based on evidence which is more suggestive than conclusive. It is therefore also possible that neuropsychological variables are of little use in predicting this particular area of recovery.

In contrast to neuropsychological test scores, the MMPI was a significant predictor of the Social Environment subscale in the analyses associated with both Testing One and Testing Two. In addition, the Glasgow Coma Scale was also a significant predictor in the analyses based on data from Testing Two. Thus the results of the second part of hypothesis 3b suggest that initial severity of injury and personality disturbances are the best predictors of long-term social recovery as it relates to resumption of social and leisure activities.

The overall findings associated with hypothesis 3b highlight an important point that is increasingly being made in the literature: Social recovery is a multidimensional
concept. The exclusive focus in the present study on the
efficacy of neuropsychological test scores for predicting
all aspects of outcome was likely an inappropriate one.
This is evident from the findings that these scores were
useful for predicting work status but not for predicting
social reintegration. A more reasonable position to adopt
would therefore be one which conceptualizes social recovery
as a dynamic and complicated process which is related to
several different kinds of variables. The relative
importance of these variables in predicting outcome varies
depending on (1) the stage of recovery (i.e., acute versus
chronic), and (2) the aspect of outcome that one wants to
predict.

Hypothesis 3c. This hypothesis stated that the
Reasoning factor score would be a better predictor at
Testing Two than at Testing One. As was noted in the
Results section, the results associated with this hypothesis
are of questionable usefulness because the Reasoning factor
was only a statistically significant predictor in the
analyses in which Vocational Environment was the dependent
variable. However, one can briefly note two points. First,
the Reasoning factor was always a better (although generally
still non-significant) predictor at Testing Two than at
Testing One. As was noted above, in the one analyses to
predict scores on the Vocational Environment subscale, the
Reasoning Factor was a more significant predictor at Testing.
Two than at Testing One. However, it was a very significant predictor at both Testings, thus these findings do not lend strong support to hypothesis 3c. Nonetheless, one can conclude that a trend towards increased predictive ability of the Reasoning factor in the chronic phase of recovery was observed.

The second point that should be noted, with respect to hypothesis 3c, is that a large increase in the significance level of the Reasoning factor did occur in the analyses to predict the summary score of the PAIS-BR (p = .4606 in Testing One vs. p = .0951 in Testing Two). Thus some support was found for the notion that chronic deficits in higher-order cognitive abilities predict long-term social recovery better than do acute deficits. However, given that the above findings are more suggestive than conclusive, support for hypothesis 3c must be considered weak at best and nonexistent at worst.

Conclusions

Three general findings emerged from the present study. The first of these was that neither the ACS nor the Reasoning factor were particularly useful for predicting long-term social recovery. Because the majority of the hypotheses of this study stated that these measures would be the best predictors of social recovery, the hypotheses were generally not supported. Based on the present results one can therefore conclude that both measures of overall
neuropsychological functioning and of higher-order cognitive skills are not useful for predicting social recovery.

One exception to this conclusion should be noted: The Reasoning factor was the best predictor of the Vocational Environment subscale of the PAIS-SR. This finding suggests that cognitive impairment was related to later employment status. Since similar findings have been reported by other authors (Heaton et al., 1981; Klonoff et al., 1986; Newnan et al., 1978), one can conclude that this is a reliable finding. The present study extends this finding in that it was found that cognitive impairments in the acute, as well as in the chronic, phase of recovery were predictive of later work status.

Although the overall findings of the present study suggest that a summary measure of neuropsychological impairment is of limited usefulness for predicting outcome, one cannot unequivocally conclude that this is the case. As was noted in the literature review, several other studies have found summary measures to be useful for predicting outcome (e.g., Drudge et al., 1984; Heaton et al., 1981). In general, these studies tend to use tests from more complete batteries to compute average impairment indices.

In the present study an abbreviated battery was used and, for many subjects, data was not available for all of the tests. Thus it is possible that the hypotheses suggesting that an overall measure of neuropsychological impairment...
would be a good predictor of social recovery could have been more fairly tested if the ACS was derived from a full battery of tests.

Similarly, although the findings of the present study suggest that a summary measure of reasoning abilities is of limited usefulness for predicting outcome, one cannot unequivocally conclude that this is the case. As was noted previously, it is possible that the predictive ability of the neuropsychological test scores was attenuated because, for the purposes of analyses, they were transformed from being continuous variables to being discrete variables by categorizing them into four groups of impairment. It is possible that this categorization particularly disadvantaged those variables which had normal distributions. In tests with skewed distributions there were notable differences in test scores between patients who were the most impaired group and patients in the other groups. In contrast, such differences between groups were not as striking when the underlying distribution was normal. In this respect, it is of interest to note that the raw score distribution of the Category Test was one of the few which was essentially normal. Thus it is possible that the Category Test was particularly at a disadvantage as a predictor and, therefore, that the reasoning factor may have been a better predictor had another method of transformation been performed. In summary, although the findings regarding the
Reasoning factor and the ACS suggest that they are of limited usefulness as predictors, one cannot conclude that this is unequivocally the case because other factors may have contributed to their poor predictive ability.

The second general finding to emerge from the present study relates to the importance of motor impairments in predicting outcome. In recent years the trend in the literature has been to concentrate on the affects that cognitive deficits and personality disturbances have on social recovery and to virtually ignore the affects of physical disabilities. However, it has recently been argued that such an exclusive focus may be inappropriate (Klonoff et al., 1986).

The results of the present study support this argument. The Psychomotor and Visuospatial Abilities factor (at Testing One) was the only neuropsychological variable which contributed significantly to the prediction of the summary score of the PAIS-SR. In addition, this factor (at both testings) also contributed significantly to the prediction of the Vocational Environment subscale of the PAIS-SR. As was discussed in detail above, one should be cautious in interpreting so-called "factor" scores because they rarely tap only the ability labelled by the factor name. Given that the reader is aware of this caution, one can conclude that the findings which support the usefulness of the "Motor" factor for predicting of social recovery
suggest that deficits in motor skills adversely affect social recovery in general and at least one aspect of social recovery (work status) in particular. Closer examination of the relationship between motor impairments and social recovery would thus be desirable in future research.

And finally, the third general finding to emerge from the present study relates to the importance of the MMPI in predicting outcome. The MMPI was a good predictor of both overall recovery and specific aspects of recovery (i.e., work status and social functioning). It tended to be a better predictor when administered in the chronic phase of recovery than when administered in the acute phase. One can thus conclude that the single most important factor in predicting long-term social recovery was self-ratings of psychopathology that were made more than one year after injury.

Although the usefulness of the MMPI for predicting long-term social recovery received strong support in the present study, it is difficult to arrive at specific conclusions and recommendations regarding how the present results can be of much practical use in a clinical setting. The reason for this is because so many summary measures were used as predictors that can only make general conclusions based on the present results. For example, one can only conclude at present that personality disturbances were
related to poor outcomes and that this was especially the case when the disturbances were evident more than one year after injury. This is in many ways an unsatisfying conclusion because it does not address many important questions. For example, it would be of interest to examine such questions as: Are the MMPI profiles in the acute phase similar to those in the chronic phase and, if not, what are the differences?; Do different clusters of personality profiles emerge and, if so, do similar clusters emerge in both the acute and chronic phases?; Do different clusters of profiles on the PAIS-SR and KAS-R emerge?; And, are certain MMPI profiles associated with certain PAIS-SR/KAS-R profiles and, if so, can one predict outcome on an individual basis with the aid of MMPI profiles?

These are obviously ambitious questions which would be difficult to address. However, answers to such questions may well provide a better understanding of the dynamics of personality change after head injury and its relation to long term recovery. Indeed, it appears that the future of research and rehabilitation in the area of head injury must inevitably attempt to address such specific questions and apply them to the individual patient. The efforts of health care professionals are now increasingly being directed towards maximizing the surviving patient's quality of life. Such efforts would undoubtedly be aided by a better understanding of the relationships between numerous
variables (e.g., neuropsychological, demographic, medical, personality) and various aspects of social recovery (e.g., return to work, social functioning, family relationships). Although research on the prediction of social recovery is complicated and often subject to ambiguity in interpretation, it is well worth conducting if it can aid in such a better understanding.
APPENDIX A

THE SCALES:

I. THE KATZ ADJUSTMENT SCALE

II. THE PSYCHOSOCIAL ADJUSTMENT TO ILLNESS SCALE
<table>
<thead>
<tr>
<th></th>
<th>ALMOST NEVER</th>
<th>SOMETIMES</th>
<th>OFTEN</th>
<th>ALMOST ALWAYS</th>
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<tbody>
<tr>
<td>1.</td>
<td>Has trouble sleeping</td>
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<td>2.</td>
<td>Gets very self-critical, starts to blame himself for things</td>
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<td>3.</td>
<td>Cries easily</td>
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<td>4.</td>
<td>Feels lonely</td>
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<td>5.</td>
<td>Acts as if he has no interest in things</td>
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<td>6.</td>
<td>Is restless</td>
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<td>7.</td>
<td>Has periods where he can't stop moving, or doing something</td>
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<td>8.</td>
<td>Just sits</td>
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<td>9.</td>
<td>Acts as if he doesn't have much energy</td>
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<td>10.</td>
<td>Looks worn out</td>
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<td>11.</td>
<td>Feelings get hurt easily</td>
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<td>12.</td>
<td>Feels that people don't care about him</td>
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<td>13.</td>
<td>Does the same thing over and over again without reason</td>
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<td>14.</td>
<td>Passes out</td>
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<td>15.</td>
<td>Gets very sad, blue</td>
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<td>16.</td>
<td>Tries too hard</td>
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<td></td>
<td>ALMOST NEVER</td>
<td>SOMETIMES</td>
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<td>17. Needs to do things very slowly to do them right</td>
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<td>18. Has strange fears</td>
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<tr>
<td>19. Afraid something terrible is going to happen</td>
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<tr>
<td>20. Gets nervous easily</td>
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<tr>
<td>21. Jittery</td>
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<td>22. Worries or frets</td>
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<td>23. Gets sudden fright for no reason</td>
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<td>24. Has bad dreams</td>
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<td>25. Acts as if he sees people or things that aren't there</td>
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<tr>
<td>26. Does strange things without reason</td>
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<tr>
<td>27. Attempts suicide</td>
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<tr>
<td>28. Gets angry and breaks things</td>
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<td>29. Talks to himself</td>
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<td>30. Acts as if he has no control over his emotions</td>
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<td>31. Laughs or cries at strange times</td>
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<td>32. Has mood changes without reason</td>
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<td>33. Has temper tantrums</td>
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<td>34. Gets very excited for no reason</td>
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<td>35. Gets very happy for no reason</td>
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<td>ALMOST NEVER</td>
<td>SOMETIMES</td>
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<td>36. Acts as if he doesn't care about other people's feelings</td>
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<td>37. Thinks only of himself</td>
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<tr>
<td>38. Shows his feelings</td>
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<tr>
<td>39. Generous</td>
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<td>40. Thinks people are talking about him</td>
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<td>41. Complains of headaches, stomach trouble, other physical ailments</td>
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<tr>
<td>42. Bossy</td>
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<td>43. Acts as if he's suspicious of people</td>
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<tr>
<td>44. Argues</td>
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<td>45. Gets into fights with people</td>
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<td>46. Is cooperative</td>
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<td>47. Does the opposite of what he is asked</td>
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<td>48. Stubborn</td>
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<td>49. Answers when talked to</td>
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<td>50. Curses at people</td>
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<td>51. Deliberately upsets routine</td>
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<td>52. Resentful</td>
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<td>53. Envious of other people</td>
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<td>54. Friendly</td>
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<td>ALMOST NEVER</td>
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<td>55.</td>
<td>Gets annoyed easily</td>
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<td>56.</td>
<td>Critical of other people</td>
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<td>57.</td>
<td>Pleasant</td>
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<td>58.</td>
<td>Gets along well with people</td>
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<td>59.</td>
<td>Lies</td>
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<td>60.</td>
<td>Gets into trouble with law</td>
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<td>61.</td>
<td>Gets drunk</td>
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<td>62.</td>
<td>Is dependable</td>
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<td>63.</td>
<td>Is responsible</td>
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<td>64.</td>
<td>Doesn't argue (talk) back</td>
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<td>65.</td>
<td>Obedient</td>
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<td>66.</td>
<td>Shows good judgement</td>
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<td>67.</td>
<td>Stays away from people</td>
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<td>68.</td>
<td>Takes drugs other than recommended by hospital or clinic</td>
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<td>69.</td>
<td>Shy</td>
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<td>70.</td>
<td>Quiet</td>
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<td>71.</td>
<td>Prefers to be alone</td>
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<td>72.</td>
<td>Needs a lot of attention</td>
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<td>73.</td>
<td>Behaviour is childish</td>
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<td>74.</td>
<td>Acts helpless</td>
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<td>75.</td>
<td>Is independent</td>
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<td>ALMOST NEVER</td>
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<td>76. Moves about very slowly</td>
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<td>77. Moves about in a hurried way</td>
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<td>78. Clumsy: keeps bumping into things or dropping things</td>
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<td>79. Very quick to react to something you say or do</td>
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<td>80. Very slow to react</td>
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<tr>
<td>81. Gets into peculiar positions</td>
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<td>82. Makes peculiar movements</td>
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<tr>
<td>83. Hands tremble</td>
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<td>84. Will stay in one position for a long period</td>
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<td>85. Loses track of day, month or year</td>
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<td>86. Forgets his address or other places he knows well</td>
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<tr>
<td>87. Remembers the names of people he knows well</td>
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<td>88. Acts as if he doesn't know where he is</td>
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<td>89. Remembers important things</td>
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<td>90. Acts as if he's confused about things, in a daze</td>
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<td>91. Acts as if he can't get certain thoughts out of his mind</td>
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<td>92. Acts as if he can't concentrate on one thing</td>
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<td>93. Acts as if he can't make decisions</td>
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<td>ALMOST NEVER</td>
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<td>94. Talks without making sense</td>
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<td>95. Hard to understand his words</td>
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<td>96. Speaks clearly</td>
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<td>97. Refuses to speak at all for periods of time</td>
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<td>98. Speaks so low you cannot hear him</td>
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<td>99. Speaks very loudly</td>
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<td>100. Shouts or yells for no reason</td>
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<td>101. Speaks very fast</td>
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<td>102. Speaks very slowly</td>
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<td>103. Acts as if he wants to speak but can't</td>
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<td>104. Keeps repeating the same idea</td>
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<td>105. Keeps changing from one subject to another for no reason</td>
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<td>106. Talks too much</td>
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<td>107. Says that people are talking about him</td>
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<td>108. Says that people are trying to make him do or think things he doesn't want to</td>
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<td>109. Talks as if he committed the worst sins</td>
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<td>110. Talks about how angry he is at certain people</td>
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<td>111. Talks about people or things he's very afraid of</td>
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<td>KATZ ADJUSTMENT SCALE (continued)</td>
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<tr>
<td>112. Threatens to injure certain people</td>
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<td>113. Threatens to tell people off</td>
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<td>114. Says he is afraid that he will injure somebody</td>
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<td>115. Says he is afraid that he will not be able to control himself</td>
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<td>116. Talks about strange things that are going on inside his body</td>
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<td>117. Says how bad or useless he is</td>
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<td>118. Brags about how good he is</td>
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<td>119. Says the same thing over and over again</td>
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<td>120. Complains about people and things in general</td>
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<td>121. Talks about big plans he has for the future</td>
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<td>122. Says or acts as if people are after him</td>
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<td>123. Says that something terrible is going to happen</td>
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<td>124. Believes in strange things</td>
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<td>125. Talks about suicide</td>
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<td>126. Talks about strange sexual ideas</td>
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<td>127. Gives advice without being asked</td>
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<td>Box</td>
<td>Question</td>
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<td>PT. ID. NO.</td>
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<td>STD. NO.</td>
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<td>RX CD.</td>
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<td>7</td>
<td>Med. Dept.</td>
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<td>8</td>
<td>Visst CD.</td>
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<td>9</td>
<td>Soc. Stat.</td>
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<td>10</td>
<td>Tech.</td>
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**INSTRUCTIONS**

The present form contains a set of questions concerning the effects that your recent illness (or the illness of your spouse, child, etc.) has had on you. We are interested in knowing what effects it has had on your relationships and performance at home and on your job, as well as on family and personal relationships. Other questions deal with its effects on your social and leisure-time activities, and how you have felt emotionally.

In answering each question, please put a check mark (✓) in the box alongside the answer that best describes your experience. Please answer all the questions and try not to skip any. If none of the answers to a question match your experience exactly, please choose the answer that comes closest to the experience you have had.

The time we would like you to refer to is the past 30 days, including today. Answer each question in terms of what your experience has been like during this time. In the event you are presently a patient in the hospital (or a hospitalized patient's relative), please report your experiences for the 30 days before entering the hospital.

Some questions on the form assume that you are married or have a steady partner you are close to. Other questions ask about family relationships. If these questions do not apply to you because you are unmarried, or you have no family or partner, please leave them blank. Try to answer all the questions that do apply to you, however.

Section II asks questions about your job performance. If you have either full-time or substantial part-time employment, please answer in terms of your job. If you are primarily a student, answer in terms of your school work. If you are a housewife, answer as though housework, neighbors, etc. are your work environment.

We appreciate the time you have taken to do this form. Please check again to make sure you have completed all the items. If you have any questions about the form, please ask. If you are responding by mail, please write them in the space provided below. Please return the form as soon as you have completed it.

Thank You
SECTION I

1. Which of the following statements best describes your usual attitude about taking care of your health?
   a) I am very concerned and pay close attention to my personal health.
   b) Most of the time I pay attention to my health care needs.
   c) Usually, I try to take care of health matters but sometimes I just don't get around to it.
   d) Health care is something that I just don't worry too much about.

2. Your present illness probably requires some special attention and care on your part. Would you please
   select the statement below that best describes your reaction.
   a) I do things pretty much the way I always have done them and I don't worry or take any special
      considerations for my illness.
   b) I try to do all the things I am supposed to do to take care of myself, but lots of times I forget
      or I am too tired or busy.
   c) I do a pretty good job taking care of my present illness.
   d) I pay close attention to all the needs of my present illness and do everything I can to take care
      of myself.

3. In general, how do you feel about the quality of medical care available today and the doctors who provide it?
   a) Medical care has never been better, and the doctors who give it are doing an excellent job.
   b) The quality of medical care available is very good, but there are some areas that could stand
      improvement.
   c) Medical care and doctors are just not of the same quality they once were.
   d) I don't have much faith in doctors and medical care today.

4. During your present illness you have received treatment from both doctors and medical staff. How do you feel
   about them and the treatment you have received from them?
   a) I am very unhappy with the treatment I have received and don't think the staff has done all they
      could have for me.
   b) I have not been impressed with the treatment I have received, but I think it is probably the best
      they can do.
   c) The treatment has been pretty good on the whole, although there have been a few problems.
   d) The treatment and the treatment staff have been excellent.

5. When they are ill, different people expect different things about their illness, and have different attitudes
   about being ill. Could you please check the statement below which comes closest to describing your feelings.
   a) I am sure that I am going to overcome the illness and its problems quickly and get back to being my
      old self.
   b) My illness has caused some problems for me, but I feel I will overcome then fairly soon, and get
      back to the way I was before.
   c) My illness has really put a great strain on me, both physically and mentally, but I am trying very
      hard to overcome it, and feel sure that I will be back to my old self once of these days.
   d) I feel worn out and very weak from my illness and there are times when I don't know if I am really
      ever going to be able to overcome it.

6. Being ill can be a confusing experience, and some patients feel that they do not receive enough information and
   detail from their doctors and the medical staff about their illnesses. Please select a statement below which
   best describes your feelings about this matter.
   a) My doctor and the medical staff have told me very little about my illness even though I have asked
      more than once.
   b) I do have some information about my illness but I feel I would like to know more.
   c) I have a pretty fair understanding about my illness and feel that if I want to know more I can
      always get the information.
   d) I have been given a very complete picture of my illness and my doctor and the medical staff have
      given me all the details I wish to have.

7. In an illness such as yours, people have different ideas about their treatment and what to expect from it.
   Please select one of the statements below which best describes what you expect about your treatment.
   a) I believe my doctors and medical staff are quite able to direct my treatment and feel it is the
      best treatment I could receive.
   b) I have trust in my doctor's direction of my treatment; however, sometimes I have doubts about it.
   c) I don't like certain parts of my treatment which are very unpleasant, but my doctors tell me I
      should go through it anyway.
   d) In many ways I think my treatment is worse than the illness, and I am not sure if it is worth going
      through it.
(8) In an illness such as yours patients are given different amounts of information about their treatment. Please select a statement from those below which best describes information you have been given about your treatment.

   a) I have been told almost nothing about my treatment and feel left out about it.
   b) I have some information about my treatment but not as much as I would like to have.
   c) My information concerning treatment is pretty complete, but there are one or two things I still want to know.
   d) I feel my information concerning treatment is very complete and up-to-date.

SECTION II

(1) Has your illness interfered with your ability to do your job (school) work?

   a) No problems with my job
   b) Some problems, but only minor ones
   c) Some serious problems
   d) Illness has totally prevented me from doing my job

(2) How well do you physically perform your job (studies) now?

   a) Poorly
   b) Not too well
   c) Adequately
   d) Very well

(3) During the past 30 days, have you lost any time at work (school) due to your illness?

   a) 3 days or less
   b) 1 week
   c) 2 weeks
   d) More than 2 weeks

(4) Is your job (school) as important to you now as it was before your illness?

   a) Little or no importance to me now
   b) A lot less important
   c) Slightly less important
   d) Equal or greater importance than before

(5) Have you had to change your goals concerning your job (education) as a result of your illness?

   a) My goals are unchanged
   b) There has been a slight change in my goals
   c) My goals have changed quite a bit
   d) I have changed my goals completely

(6) Have you noticed any increase in problems with your co-workers (students, neighbors) since your illness?

   a) A great increase in problems
   b) A moderate increase in problems
   c) A slight increase in problems
   d) None

SECTION III

(1) How would you describe your relationship with your husband or wife (partner, if not married) since your illness?

   a) Good
   b) Fair
   c) Poor
   d) Very poor

(2) How would you describe your general relationships with the other people you live with (e.g., children, parents, aunts, etc.)?

   a) Very poor
   b) Poor
   c) Fair
   d) Good
(3) How much has your illness interfered with your work and duties around the house?
   a) Not at all
   b) Slight problems, easily overcome
   c) Moderate problems, not all of which can be overcome
   d) Severe difficulties with household duties

(4) In those areas where your illness has caused problems with your household work, how has the family shifted duties to help you out?
   a) The family has not been able to help but at all
   b) The family has tried to help but many things are left undone
   c) The family has done well except for a few minor things
   d) No problems

(5) Has your illness resulted in a decrease in communication between you and members of your family?
   a) No decrease in communication
   b) A slight decrease in communication
   c) Communication has decreased, and I feel somewhat withdrawn from them
   d) Communication has decreased a lot, and I feel very alone

(6) Some people with an illness like yours feel they need help from other people (friends, neighbors, family etc.) to get things done from day-to-day. Do you feel you need such help and is there anyone to provide it?
   a) I really need help but seldom is anyone around to help
   b) I get some help, but I can't count on it all the time
   c) I don't get all the help I need all of the time, but most of the time help is there when I need it
   d) I don't feel I need such help, or the help I need is available from my family or friends

(7) Have you experienced any physical disability with your illness?
   a) No physical disability
   b) A slight physical disability
   c) A moderate physical disability
   d) A severe physical disability

(8) An illness such as yours can sometimes cause a drain on the family's finances; are you having any difficulties meeting the financial demands of your illness?
   a) Severe financial hardship
   b) Moderate financial problems
   c) A slight financial drain
   d) No money problems

SECTION IV

(1) Sometimes having an illness can cause problems in a relationship. Has your illness led to any problems with your husband or wife (partner, if not married)?
   a) There has been no change in our relationship
   b) We are a little less close since my illness
   c) We are definitely less close since my illness
   d) We have had serious problems or a break in our relationship since my illness

(2) Sometimes when people are ill they report a loss of interest in sexual activities. Have you experienced less sexual interest since your illness?
   a) Absolutely no sexual interest since illness
   b) A marked loss of sexual interest
   c) A slight loss of sexual interest
   d) No loss of sexual interest

(3) Illness sometimes causes a decrease in sexual activity. Have you experienced any decrease in the frequency of your sexual activities?
   a) No decrease in sexual activities
   b) Slight decrease in sexual activities
   c) Marked decrease in sexual activities
   d) Sexual activities have stopped

(4) Has there been any change in the pleasure or satisfaction you normally experience from sex?
   a) Sexual pleasure and satisfaction have stopped
   b) A marked loss of sexual pleasure or satisfaction
   c) A slight loss of sexual pleasure or satisfaction
   d) No change in sexual satisfaction
(5) Sometimes an illness will cause an interference in a person's ability to perform sexual activities even though they are still interested in sex. Has this happened to you, and if so, to what degree?

[ ] a) No change in my ability to have sex
[ ] b) Slight problems with my sexual performance
[ ] c) Constant sexual performance problems
[ ] d) Totally unable to perform sexually

(5) Sometimes an illness will interfere with a couple's normal sexual relationship and cause arguments or problems between them. Have you and your partner had any arguments like this, and if so, to what degree?

[ ] a) Constant arguments
[ ] b) Frequent arguments
[ ] c) Some arguments
[ ] d) No arguments

SECTION V

(1) Have you had as much contact as usual (either personally or by telephone) with members of your family outside your household since your illness?

[ ] a) Contact is the same or greater since illness
[ ] b) Contact is slightly less
[ ] c) Contact is markedly less
[ ] d) No contact since illness

(2) Have you remained as interested in getting together with these members of your family since your illness?

[ ] a) Little or no interest in getting together with them
[ ] b) Interest is a lot less than before
[ ] c) Interest is slightly less
[ ] d) Interest is the same or greater since illness

(3) Sometimes, when people are ill, they are forced to depend on members of the family outside their household for physical help. Do you need physical help from them, and do they supply the help you need?

[ ] a) I need no help, or they give me all the help I need
[ ] b) Their help is enough, except for some minor things
[ ] c) They give me some help but not enough
[ ] d) They give me little or no help even though I need a great deal

(4) Some people socialize a great deal with members of their family outside their immediate household. Do you do much socializing with these family members, and has your illness reduced such socializing?

[ ] a) Socializing with them has been pretty much eliminated
[ ] b) Socializing with them has been reduced significantly
[ ] c) Socializing with them has been reduced somewhat
[ ] d) Little or no socializing, or slight or no effect of illness

(5) In general, how have you been getting along with these members of your family recently?

[ ] a) Good
[ ] b) Fair
[ ] c) Poor
[ ] d) Very poor

SECTION VI

(1) Are you still as interested in your leisure time activities and hobbies as you were prior to your illness?

[ ] a) Same level of interest as previously
[ ] b) Slightly less interest than before
[ ] c) Significantly less interest than before
[ ] d) Little or no interest remaining

(2) How about actual participation? Are you still actively involved in doing those activities?

[ ] a) Little or no participation at present
[ ] b) Participation reduced significantly
[ ] c) Participation reduced slightly
[ ] d) Participation remains unchanged
(3) Are you as interested in leisure time activities with your family (i.e., playing cards & games, taking trips, going swimming, etc.) as you were prior to your illness?
   a) Same level of interest as previously
   b) Slightly less interest than before
   c) Significantly less interest than before
   d) Little or no interest remaining

(4) Do you still participate in those activities to the same degree you once did?
   a) Little or no participation at present
   b) Participation reduced significantly
   c) Participation reduced slightly
   d) Participation remains unchanged

(5) Have you maintained your interest in social activities since your illness (e.g., social clubs, church groups, going to the movies, etc.)?
   a) Same level of interest as previously
   b) Slightly less interest than before
   c) Significantly less interest than before
   d) Little or no interest remaining

(6) How about participation? Do you still go out with your friends and do those things?
   a) Little or no participation at present
   b) Participation reduced significantly
   c) Participation reduced slightly
   d) Participation remains unchanged

SECTION VII

(1) Recently, have you felt afraid, tense, nervous, or anxious?
   a) Not at all
   b) A little bit
   c) Quite a bit
   d) Extremely

(2) Recently, have you felt sad, depressed, lost interest in things, or felt hopeless?
   a) Extremely
   b) Quite a bit
   c) A little bit
   d) Not at all

(3) Recently, have you felt angry, irritable, or had difficulty controlling your temper?
   a) Not at all
   b) A little bit
   c) Quite a bit
   d) Extremely

(4) Recently, have you blamed yourself for things, felt guilty, or felt like you have let people down?
   a) Extremely
   b) Quite a bit
   c) A little bit
   d) Not at all

(5) Recently, have you worried much about your illness or other matters?
   a) Not at all
   b) A little bit
   c) Quite a bit
   d) Extremely

(6) Recently, have you been feeling down on yourself or less valuable as a person?
   a) Extremely
   b) Quite a bit
   c) A little bit
   d) Not at all

(7) Recently, have you been concerned that your illness has caused changes in the way you look that make you less attractive?
   a) Not at all
   b) A little bit
   c) Quite a bit
   d) Extremely
APPENDIX B

THE LETTERS TO THE PARTICIPANTS:

I. THE LETTER INTRODUCING THE STUDY
II. THE HEAD INJURY VICTIM’S LETTER OF CONSENT
III. THE RELATIVE/FRIEND’S LETTER OF CONSENT
IV. THE THANK YOU LETTER
V. THE FOLLOW-UP LETTER
VI. THE FEEDBACK LETTER
August 21 1987

Mr. John Smith
100 Smith St.
SMITHVILLE, Ontario
A0A 0A0

Dear Mr. Smith:

My name is Steve Donaghy. I am a student working under the supervision of Dr. Alan Finlayson at Chedoke Hospital in Hamilton. We are now involved in a project that is designed to help us better understand the problems associated with head injury. As a past head injury victim you are in the position to help in this project.

When you were a patient at Chedoke you were given some neuropsychological tests. We are interested in studying the relationship between these tests and later ability to perform activities of daily life. We have enclosed a questionnaire for you to fill out that asks questions about the effects that your illness (that is, head injury) has had on these activities. We would greatly appreciate it if you would take a few minutes and complete this questionnaire.

In addition, we realize that head injuries also effect the lives of those people who have close contact with head injury victims. As such, we are interested in their opinions. We have therefore also enclosed a questionnaire (the Katz Adjustment Scale) for the relative/friend who has the most contact with you to fill out. We would appreciate it if you would pass that questionnaire and this letter on to the person who has the most contact with you.

We have also enclosed (1) a self-addressed and stamped envelope and (2) letters of consent for you and your relative/friend. Would you and your relative/friend please sign the consent forms and return them and the questionnaires as soon as possible. If I do not hear from you soon I will contact you in order to answer any questions that you might have. Also, if you have any questions please feel free to contact me at Chedoke.
I thank you and your relative/friend in advance for taking the time and trouble to fill out these questionnaires. By participating in this study you may help us to better understand the problems associated with head injury and to better help future head injury victims and their families. Your participation is therefore very valuable and very much appreciated. Thank you again.

Sincerely,

Steve Donaghy

(416) 521-2100 Extension 7537
HEAD INJURY VICTIM'S CONSENT FORM

I understand that I am being asked to participate in a Research Project, the aim of which is to learn more about the relationship between neuropsychological test scores shortly after head injury and later ability to perform activities of daily life.

I understand that this project is being conducted by Steve Donaghy as part of his Master's Thesis in Clinical Neuropsychology, under the guidance of Dr. M. Alan J. Finlayson, Department of Psychology, Chedoke-McMaster Hospitals.

I understand that participation in this project will involve filling out questionnaires which ask questions about my ability to perform activities of daily life.

I understand that this project will be of no direct benefit to me but that it may be of benefit to future head injury victims and their families.

I understand that I can refuse to participate or can withdraw from the study at any time and, if I do so, it will in no way affect my further care in this hospital.

I have been assured that complete confidentiality will be maintained on all medical records and test scores, and that no names will be published in the Research Data.

I therefore agree to participate in this Study.

_________________________________  __________________________
Name (print)                Signature

_________________________________
Date

Principle Investigator: Steve Donaghy, Honors B.A.
Telephone: (416) 521-2100, Extension 7537.
RELATIVE/FRIEND'S CONSENT FORM

I understand that I am being asked to participate in a Research Project, the aim of which is to learn more about the relationship between neuropsychological test scores shortly after head injury and later ability to perform activities of daily life.

I understand that this project is being conducted by Steve Donaghy as part of his Master's Thesis in Clinical Neuropsychology, under the guidance of Dr. M. Alan J. Finlayson, Department of Psychology, Chedoke-McMaster Hospitals.

I understand that participation in this project will involve filling out questionnaires which ask questions about the ability of my relative/friend to perform activities of daily life.

I understand that this project will be of no direct benefit to me but that it may be of benefit to future head injury victims and their families.

I understand that I can refuse to participate or can withdraw from the study at any time and, if I do so, it will in no way affect my relative/friend's further care in this hospital.

I have been assured that complete confidentiality will be maintained on all medical records and test scores, and that no names will be published in the Research Data.

I therefore agree to participate in this Study.

______________________________  __________________________
Name (print)                     Signature

______________________________  __________________________
Relation to Head Injury Victim    Date

Principle Investigator: Steve Donaghy, Honors B.A.

Telephone: (416) 521-2100, Extension 7537
Mr. John Smith
100 Smith St.
SMITHVILLE, Ontario
AOA OAO

Dear Mr. Smith:

On behalf of Dr. Finlayson and myself, I would like to thank you and your wife for your recent help in our search to better understand the long-term effects of head injury. Since this is an ongoing project, we do not expect the results to be available for some months. If you are interested in obtaining a short summary of the results, please contact Chêdoke in mid-to-late December. A summary should be ready at that time and I would be glad to forward it to you.

Once again, we thank you both for your time and help in this endeavour.

Yours Sincerely,

Steve Donaghy
September 30, 1987

Mr. John Smith  
100 Smith St. 
SMITHVILLE, Ontario 
AOA 0AO

Dear Mr. Smith:

Last month I wrote to you on behalf of Dr. Finlayson and myself requesting your assistance in our search to better understand the long-term effects of head injury. We forwarded you two brief questionnaires and asked that you and the person that you spend the most time with complete them and return them to us.

As of today, I have not received your questionnaires. If you plan to complete the questionnaires, this letter simply serves as a reminder to please to do so as soon as possible. I would urge you to do this within the next few days since a full Postal strike is possible at any time. If you do not plan to complete the questionnaires, I would appreciate it if you would return the blank questionnaires to me as soon as possible so that I will be aware of your intentions either way.

Once again, we thank you for your time and continue to hope that you will help us in this endeavour.

Yours Sincerely,

Steve Donaghy
February 4 1988

Mr. John Smith
100 Smith St.
SMITHVILLE, Ontario
AOA OAO

Dear Mr. Smith:

My name is Steve Donaghy. I am the student who was working with Dr. Finlayson on the study that you participated in last fall. Here is the short summary of the results that I promised to send you.

What we wanted to do in this study was to see if any of the tests that were given to the patients when they were at Chedoke were related to how they are doing in present day-to-day life. A total of 84 former head injury patients who were seen at Chedoke Hospital, and their families, were located and asked to participate in the study. Fifty seven of these people agreed to participate in the study and sent back at least one of the two questionnaires. Forty four of the ex-patients who returned the questionnaires were men and 13 were women. The average time between injury and contact from us was approximately 4 years 4 months.

There were basically four findings of interest. First, as a group, those people who were tested more than once showed significant improvements between the first and second testings. Second, people who had problems on the tests of abstract reasoning were more likely to report that they were having difficulties in work adjustment. Third, people who initially had the most physical problems tended to report that they were having general difficulties in adjusting to day-to-day life. And fourth, people who initially reported that they were having a lot of emotional/personality difficulties tended to report that they were still having difficulties.
A couple of words of caution about these results are in order. First, these results are based on group findings so they do not necessarily apply to you as an individual. And second, the focus of the study tended to be on identifying areas in which people were having difficulties. Therefore, you should not get the impression that all of the ex-patients in the study reported that they were having difficulties in day-to-day life—this was clearly not the case.

On behalf of Dr. Finlayson and myself, I would like to thank you once again for your participation in this project. It was very much appreciated. We wish you all the best in the future.

Sincerely,

Steve Donaghy
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VITA AUCTORIS

Steve Donaghy was born on July 10, 1962 in Paisley, Scotland. On June 10, 1966 he immigrated to Canada along with his parents, James and Beatrice, and his older brother, James. He began high school in 1976 at John F. Ross High School in Guelph. In 1981 he finished high school, began undergraduate work at the University of Western Ontario, and became a Canadian citizen. In June of 1985 he graduated from Western with a Honors Bachelor of Arts degree. In September of that year he enrolled in the Doctoral programme in Human Clinical Neuropsychology at the University of Windsor. He obtained his Master of Arts degree in 1988 and is currently at the University of Windsor working towards completion of the requirements for a Ph.D degree.