The Relationship between Selected Work Behaviors and Closed Head Injury

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Each year approximately 30,000 to 50,000 individuals suffer a traumatic brain injury (TBI) serious enough to limit their ability to return to their pre-injury lifestyle. A large portion of these individuals are men in their early adult years who are primary wage earners and, additionally, are in the process of establishing primary career tracks. The consequences of the injury, although not negatively impacting on their life expectancy, pose barriers to obtaining and maintaining employment. A persistent problem for rehabilitation specialists is predicting job performance following a TBI. Existing instruments were not available to assess behavioral changes resulting from the injury.

Thirty-four TBI patients comprised the sample for the study. The Categories and Trails B subtests of the Halstead-Reitan Neuropsychological Test Battery (HRNTB) was used to determine severity of the TBI. A new instrument, the Vocational Scaling System (VSS), was administered to the subjects following a minimum of 4 weeks in a job placement. The Vocational Scaling System (VSS) was
developed to evaluate work related behavior in an on-the-job setting. It was constructed to provide a simple, objective and easily administered tool that would numerically measure six work-related behaviors that were negatively affected by a TBI.

The interrelationships between the VSS behavioral measurements, and the Categories and Trails B tests from the HRNTB became the focus for the present study. The relationships between individual behaviors that comprise the VSS and their sensitivity to severity of injury was also examined.

The results showed that the category Independence is the behavior most sensitive to the severity of injury. Additionally, Independence appears to measure a category of skills and abilities that is related to each of the other behavioral areas evaluated by the VSS. Finally, the structure of the VSS was reviewed and recommendations were made to modify or eliminate specific questions, and to increase the number of questions in some behavioral categories.
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The relationship between selected work behaviors and closed head injury

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The Problem

Each year a significant number of Americans experience some form of head injury. Estimates of the frequency of these injuries vary from 700,000 (McMahon & Growick, 1988) to 3 million per year (U.S. Department of Education, 1981). A majority of these incidences are minor and have minimal impact on an individual's life style following the initial recovery period. However, between 30,000 and 50,000 individuals yearly suffer an injury severe enough to limit their ability to return to their pre-injury life style. The cost for treatment of traumatic brain injury (TBI) during 1980 was estimated to be over $4 billion (National Institute of Handicapped Research, 1981). Included in the estimate were direct costs of medical treatment, lost wages, and costs related to support services needed to help TBI individuals return to their previous life styles. Since the life span of TBI individuals is usually not negatively impacted by the injury and many are young adults, a need exists for specialized programs that can meet the treatment goals of this population.
The present study was undertaken to expand the current knowledge base related to the effects of a traumatic brain injury (TBI) on specific work behaviors. More specifically, it studied the relationship between six discrete work relevant behaviors and the severity of TBI as measured by the Categories test and Trails B, subtests of the Halstead-Reitan Neuropsychological Test Battery (HRNTB) (Reitan & Wolfson, 1985). In addition, the study identified the relationship between the six selected behaviors as they are measured by a vocational rating scale, an assessment instrument developed by Hope Rehabilitation Network staff for use in traumatic brain injury programs.

Until recently, research studies and medical treatment have been directed towards the more acute medical aspects of the TBI individual's disability (Long & Webb, 1983). These programs and research projects have been directed at assessing and addressing the short term medical problems of this population. Limited attempts have been made to identify, evaluate, and develop treatment approaches and techniques necessary to remediate the long term permanent medical, cognitive, and emotional consequences of TBI which pose barriers to establishing and maintaining an independent lifestyle.

The National Institute of Handicapped Research (NIHR), a federal agency, has funded two studies on the effects of severe head injuries. One of these studies
(Ben-Yishay et al., 1982), at the New York University Medical Center, identified four problems TBI individuals presented to the rehabilitation process. The study examined:

the specific effects of intra-personal disturbances in the areas of neuropsychological, cognitive, and "self" functions, on four major behavioral domains of a patient's life: (a) daily life functions; (b) work abilities and potential for earning a living; (c) capacity for "intimacy," i.e. the ability to "relate" to and form adequate interpersonal relations with people; and (d) his "social repertoire" of behaviors and capacity to "belong" to a small reference group. (p. 6)

Ben-Yishay et al. (1982) concluded that no single behavior of head injured individuals can adequately exhibit the extent of brain dysfunction, and that no single test or evaluation tool could measure all the parameters of a patient's cognitive and physical deficits which result from a head injury. Additionally, they found that the type of instruments needed to adequately assess and describe the residual effects of a head injury are not currently available within the rehabilitation professional's assessment domain.

Hope Rehabilitation Network (HRN), a private non-profit vocational rehabilitation facility located in Grand Rapids, Michigan, has been providing specialized rehabilitation services to brain damaged individuals since 1982. HRN personnel have developed a program directed at increasing the ability of head injured individuals to
function more independently within their community and live in the least possible restrictive environment. One important component of this program assesses work abilities and the potential for earning a living. During the beginnings of the program, HRN staff were unable to identify an existing measurement instrument to rate specific work behaviors that fit the special needs of the TBI population that they served. In response to this, HRN developed its own Vocational Scaling System (VSS) to measure, rate, and record specific behaviors which assess job performance in a work setting (see Appendix A).

The severity of a traumatic brain injury and the resulting cognitive deficits play a significant role in determining the post-injury employability of TBI individuals. The more severe the injury the less chance the injured individual has for obtaining and maintaining employment (Fraser, Dilkmen, McLean, Miller, & Temkin, 1988). Neuropsychological test batteries have been constructed to be sensitive to and to measure the severity of head injuries. The Halstead-Reitan Neuropsychological Test Battery is the most commonly used test and is a reliable and valid measure of brain dysfunction. Of its subtests, the three most sensitive measures of brain dysfunction are: (1) Tactical Performance Test (TPT) localization score, (2) Category test, and (3) Trails B (Reitan & Wolfson, 1986). Each of these subtests produces
a rating that indicates the severity of cognitive impairment.

The present study examined the relationship between the subscores and total score of the VSS and the impairment rating obtained from two of the three most sensitive tests of brain impairment from the Halstead-Reitan Neuropsychological Test Battery. These comparisons, in conjunction with determining the relationships between the individual subtests of the VSS, may lead to a more effective and efficient assessment of work performance and may lead to a greater determination of job performance and specific behavioral barriers confronting a TBI individual.

In summary, the problem addressed in the study was to determine the relationships between the specific behaviors measured by the VSS and severity of brain impairment as measured by two subtests of the HRNTB. This study added to the current knowledge of information about TBI effects on employability and work potential by determining the relationship between the severity of the TBI specific work behaviors measured by the VSS. Finally, it provided important information related to the structure of the VSS so that it can be modified and improved to more effectively measure job performance.
Theoretical Framework

Efforts directed towards the reintegration of brain injured individuals into the world of work began in earnest during World War II when army hospitals specifically established centers for head injured individuals. These early approaches provided neurological, psychological, and vocational evaluations geared towards retraining. The early efforts were unsophisticated and consisted primarily of occupational therapy (Reitan & Wolfson, 1988). Early psychological assessment of brain functions were not developed to the extent that they adequately assessed cognitive functions; therefore, these initial attempts at cognitive retraining were not directed towards addressing specific deficits. The lack of specificity, however, changed with the establishment of a new approach to the study of brain functions called "neuropsychology."

Halstead (1947), in his book, Brain and Intelligence, and Luria (1970), in his published statement of his theory of brain-behavior relationships, "The Functional Organization of the Brain," offered systematic approaches to evaluate cognitive deficits and their relationships. Both Halstead and Luria depended upon the observation of behavior and psychological performance of individual subjects with cerebral damage as bases for their theories of neuropsychology. However, there are significant differences between their theories. Halstead believed in a
standardized and replicable approach for collecting and reporting data. Halstead viewed the process of standardized administration of specific tests as primary. These data were then utilized to generate a quantitative score that could be analyzed and interpreted. Luria proposed a clinical approach using his observations of specific deficits to develop a procedure that included many specified tasks to evaluate individual deficits and their relationships. Luria, however, disagreed with efforts to describe performance in quantitative scores and described performance with a subjective analysis of the results.

Both Halstead (1947) and Luria (1970) developed standardized test procedures which provided data about the abilities and deficits of individual subjects. These test batteries, following refinement and modification, became the Halstead-Reitan Neuropsychological Test Battery and the Luria Neuropsychological Battery, respectively. Each was based upon the theories of its author and offered a framework whereby brain-behavior relationships could be explored in a more objective fashion.

Since about 1980, there has been a significant increase in the efforts of the private sector and nongovernmental agencies to return TBI individuals to competitive employment. This has been due largely to two motivating factors: (1) The survival rate among people with head injuries has increased four-fold in the preceding 20
years; and (2) the National Head Injury Foundation, a national network of research, training, and treatment facilities, has evolved to meet the special needs of this population. These factors have stimulated an increased awareness of and the ability to serve the needs of the TBI population.

Other factors that have had an influence on the development and implementation of specialized vocational services for the TBI population have been the age of many of the victims and societal changes in the perception of the handicapped population. Typically many of the individuals with head injury are young adults with near normal life expectancies. This population group is growing; and with continued improvement and advances in medical treatment systems, more individuals will recover from their injuries to the point where vocational reintegration is a possibility.

Additionally, society, through increased awareness, has started to view people with disabilities as a resource rather than a liability. Legislative acts at both the state and federal levels have discouraged discrimination due to handicap and have encouraged a greater advocacy on the part of all disabled groups for services and employment opportunities. These efforts and the financial support available through special grants and research projects have precipitated an increase in the number of
special programs available for the TBI population.

The effects of the TBI on work behaviors is dependent upon the severity of the injury with certain work behaviors being more affected than others. There is general consensus in the literature that the more severe the TBI, the less likely that the injured individual will return to work (Humphrey & Oddy, 1980). However, there is some disagreement in the research findings as to why types of residual deficits, i.e., cognitive or physical, have the greatest impact on employability. Studies have varied in their determination of whether physical residual deficits can be used as prognostic indicators of return to work potential. Research has described physical deficits as obvious possible predictors of ability to work (Brooks, McKinlay, Symington, Beattie, & Campsie, 1986); however, there has been little supportive evidence that they are important predictors of return to work potential (Brooks, McKinlay, Symington, Beattie, & Campsie, 1987).

Cognitive outcome, on the other hand, has been shown to be a major predictor of return to work potential (Weddell, Oddy, & Jenkins, 1980). In the Brooks et al. (1987) study, individuals with lowered levels of "fluid" intelligence were identified as being unlikely to return to work. Cattell (1963) and Horn and Cattell (1967) referred to fluid intelligence as consisting of nonverbal mental efficiency that is independent of education and
cultural influences. They further described fluid intelligence as being very sensitive to brain disease, damage, and age. As such it is sensitive to brain damage.

The VSS, previously described, is composed of six general areas of behavior. Of these behaviors Independence should be the most affected by a closed head injury and also the most sensitive to the severity of the injury. The behavior Independence requires that an individual adjust to changes in the work environment, organize work tasks, inspect work product to insure quality, and initiate and follow through with established work tasks without prompting. These are all cognitive areas that can be significantly impaired following a TBI and work behavior, i.e., Independence, is the most cognitively demanding behavior measured by the VSS; therefore, it may be the one most severely impaired area of work performance and most closely correlated to severity of injury.

Research Assumptions and Questions

The VSS was constructed such that it would measure work related behaviors of TBI individuals in an on-site work environment. It was developed to be sensitive to the special problems in work performance that TBI individuals experience in returning to work. The present study assessed the relationships among the different work behaviors measured as well as their relationships with two
subtests of the Halstead-Reitan Neuropsychological Test Battery (HRNTB) i.e., Categories and Trails B. The study was undertaken to identify whether specific subtests of the VSS are more sensitive to head injury than others and focused on the following major questions.

Question 1: What is the relationship between the behaviors described as Independence and Learning on the Vocational Scaling System?

The effects of a TBI on an individual's cognitive and physical attributes vary greatly from one person to another. These have been described in great detail in a number of studies and are reviewed in the literature review section of the present study. There are, however, a number of common deficits that result from head injuries that occur in a significant number of injured individuals. Benton (1979) described a "post-traumatic system complex" that is composed of seven distinct features. Of the seven features, three, (1) impairment in attention and concentration, (2) fatigability, and (3) disturbances in memory, appear to be the most commonly occurring deficits. Two of these three deficits closely approximate the types of abilities measured by Independence and Learning from the VSS. Independence measures behaviors that require attention and concentration, whereas Learning measures memory. This would indicate that the relationship between Independence and Learning should be greater than the
relationship between any of the other behaviors measured by the VSS.

Question 2: What is the relationship between the subscore for the behavior Independence and the total score from the VSS?

The VSS was developed to provide a measure of actual job performance and to assess improvement in performance as part of a treatment program. It assumes that successful performance of specific work tasks and the exhibiting of appropriate work behaviors are related to employment readiness. Secondarily, it assumes that performance deficits in any of the six behavior domains that it measures would preclude, or severely limit, an individual's ability to maintain employment. The total score from the VSS is the sum of the subscores and reflects the overall performance of an individual. Independence measures behaviors that require an individual to perform a variety of cognitive functions, i.e., organize tasks, initiate behavior, generalize specific work skills and behaviors, and adjust to changing work demands. This subtest is the most cognitively demanding subtest and as such should be most sensitive to effects on performance of a TBI; therefore, the relationship between the subscore of Independence and the total score for the VSS should be greater than the relationship between the total score of the VSS and any of the other five subscores.
Question 3: What is the relationship between the subscore for the behavior Independence and the scores obtained from Trails B and the Categories subtests of the HRNTB?

The behavior Independence is identified as measuring the most cognitively demanding skills and abilities assessed by the VSS. As such it should, therefore, also be the most sensitive to the effects of a TBI on performance and to the severity of the brain injury. Trails B and the Categories subtests have both been identified as being sensitive to brain injury (Reitan & Wolfson, 1986; Wheeler, Burke, & Reitan, 1963). Therefore, if Independence is the most sensitive behavior to TBI its subscore should show a greater positive relationship with the scores obtained from either the Trails B or Categories subtests of the HRNTB.

Definition of Terms

Following are the definitions of terms used in a specific way in this study.

Behavior: An individual's actions, reactions, and interactions in response to external or internal stimuli, including objectively observable activities.

Closed head injury: A subcategory for traumatic brain injury, a head injury that results from the impact of the head with an object which causes residual damage.
due to the sudden acceleration or deceleration of the brain mass within the brain case.

Employable: The ability to exhibit and maintain acceptable job specific behaviors on a full or part-time basis in a work setting. The ability to consistently meet job expectations in the areas of productivity, job quality, and appropriate interpersonal behaviors when provided established levels of supervisory support.

Traumatic brain injury: Trauma to the brain caused by some external mechanical force that results in a permanent change in brain functions.

The Vocation Scaling System's (VSS) six work behaviors are defined as follows.

Productivity (PRDCT): A measure of motor speed as it compares to the individual job production rate. It is stated in a percentage.

Learning (LNG): A measure of the amount of time it takes to learn and carry out a five-step task without assistance. It is measured in minutes.

Persistence/Attention/Stamina (STMNA): The ability to work a full day. It is measured in hours and half hours and divided into five discrete scores.

General areas (GEN): A measure of behaviors related to working attire, hygiene, and adherence to work and safety rules.

Independence (INDP): A measure of behavior related
to the ability to adjust to changes in work demands and
the environment, the degree of complexity of the tasks
that the individual can organize, and their ability to
monitor their own quality of work and initiate work acti­
vities without supervisory cuing.

**Social behavior (SOC):** A measure of behavior related
to the ability to interact appropriately with supervisors
and co-workers. It considers the individual's ability to
take direction, follow written and verbal instructions,
accept feedback from supervisors and co-workers, and
exhibit appropriate interpersonal behaviors.

**Limitations of the Study**

The sample for the study was comprised of individuals
who were referred to Hope Rehabilitation Network for
evaluation and/or treatment for a TBI. A significant
number of program participants were young males under 30
years of age who were involved in some type of automobile
related accident and had a source of funding to cover the
cost of services. This fact limited the number of indivi­
duals who participated in this study; and therefore, the
population may not represent a true cross-section of the
TBI population. A second limitation in this study is that
many individuals who sustain a mild head injury and subse­
quently return to work shortly after their TBI injury are
not included in this study. These individuals did not
need the types of services the treatment program provided and, therefore, were not referred for services. This significantly limited the number of mildly impaired individuals involved in the study, underrepresented that groups' effect on the findings, and limited its generalizability.

A third limitation of this study is some of the effects that several events of nature have on subjects which are not subject to scientific control. This study relied on a pathological group, i.e., a population of TBI individuals. There may be inherent weaknesses in this sampling since there was no control group with which to compare the results, and the findings may reflect a number of unseen variables. All efforts were made to closely evaluate the causative factor for the TBI and to insure that it met established criteria; but since this review was based upon available posttrauma information, there remains a possibility that some preexisting conditions contributed to the findings.

Finally, limitations result through the inherent weaknesses of utilizing statistical methods such as the Pearson product-moment technique for correlational studies. An unknown number of factors may contribute to the results in an undetermined way that is independent of the pathological group. Additionally, the results cannot be interpreted as having a cause and effect relationship.
Review of the Literature

The review of the literature was organized in the following manner: (a) a definition and explanation of the diagnosis labeled closed head injury (CHI), (b) the review of literature as it relates to the vocational consequences of a CHI, (c) a review of literature describing existing scales that measure the effects of a brain injury, and (d) the Halstead-Reitan Neuropsychological Battery and its subtests will be examined with emphasis on its sensitivity to brain dysfunction. Finally, a brief summary of the literature review will be undertaken to emphasize the major findings of this review.

Definition of Closed Head Injury

Traumatic brain injury results from the trauma to the brain caused by some external force that results in a permanent change in brain functions. This study was limited to a subgroup of the TBI population, the closed head injured (CHI) population. These are injuries that have resulted from the impact of an object with the head where the residual damage is caused by the sudden acceleration or deceleration of the brain mass within the brain case. It is differentiated from penetrating head wounds and brain damage caused by neoplastic, vascular, and other types of focal cerebral lesions due to the resulting damage. The CHI results in diffuse and bilateral cerebral
damage, whereas the other types of head injury result in a more focalized area of damage. Benton (1979), described this differentiation as:

Specific cognitive impairments indicative of focal brain injury, such as aphasic disorders, sensory defects and higher-level perceptual deficits (i.e., "agnosias"), in combination with neurological signs of focal damage, occur much more frequently after penetrating brain damage. The more common picture after closed head injury is a constellation of relatively vague complaints of impairment in concentration, disturbances in memory and emotional instability with a paucity of specific neurological signs of cerebral abnormality. (p. 220)

The brain is a tissue that is composed of approximately 100 billion nerve cells or neurons (Hubel, 1979). These neurons serve as the pathways for neural impulses to be transmitted or received throughout the brain. Ommaya and Gennarelli (1974) have described the physical process that results in a traumatic brain injury. They described the brain as a semi-gelatinous mass that is encased within a bone structure. When the head is struck or hits some object this mass will move within the brain case under the effects of this sudden rotation, deceleration or acceleration, distorting its original shape. These movements, following the blow to the head, have a shearing effect on the long axons process within the brain resulting in microscopic lesions. The locations of these lesions occur more prevalently in the frontal or temporal poles of the brain but also occur throughout the brain in a diffuse and nonspecific pattern. A secondary damaging effect of the
TBI results from the effect of the brain being compressed against the sides of the brain case causing bruising.

Additional features of a CHI have been described by Levin, Benton, and Grossman (1982). Their findings are similar to those of Ommaya and Gennarelli's (1974) and include contusions as well as the shearing and stretching of the neural pathways that allow different parts of the brain to communicate with one another. Levin et al. (1982) also described an additional consequence of the CHI: antracranial hemorrhaging, which is the increase in the intracranial pressure that results from the swelling of damaged brain tissue or the presence of subdural bleeds. Hemorrhaging can cause lesions and is an additional cause of CHI residual effects.

Traumatic brain injury, by definition, is trauma to the brain caused by some external mechanical force that results in a permanent change in brain functions. Closed head injury is a more specific category of injury within this group. Understanding this distinction between TBI and CHI is important for this study since the population studied is composed of CHI individuals. The CHI effects exhibited by the present study's population were primarily nonlocalized phenomena with some superimposed localized residual effects due to the consequences of hematomas and hemorrhaging.
The Vocational Consequence of a Closed Head Injury

Benton (1979) has described the residual cognitive deficits, emotional difficulties, and personality changes that result from a head injury. This "post-traumatic system complex," as he described it, is composed of seven distinct features. They are:

(1) impairment in attention and concentration;
(2) fatigability; (3) disturbances in memory;
(4) emotional instability and lowered tolerance of frustration and noise; (5) personality alteration in the direction of either depression and withdrawal or disinhibition and euphoria; (6) aphasic deficits; (7) basic and higher-level sensory deficits of various types. (p. 220)

The first three deficits described are the most commonly occurring residuals of a head injury. Approximately 40% of the head injured population suffering these residuals fail to make a satisfactory adjustment to the social and economic demands of life following their injuries.

The vocational consequences of a closed head injury are as diverse as the deficits exhibited by the injured individual. A review of the studies of vocational outcome in an annotated bibliography by Kay, Ezrachi, and Cavallo (1984), demonstrated that the percentage of head injured individuals returning to work varies from 24% to almost 100%. The accuracy of these findings is suspect, however, since the various researchers have used different criteria for assessing the severity of the head injury as well as
what actually defines a "return to work." Some studies have mixed those individuals who return to school with their return to work population.

The number of comprehensive studies of vocational status following head injury is limited, but these studies do identify a number of common characteristics (Wehman, Kreutzer, Wood, Morton, & Sherron, 1988). These are: (a) The type and severity of the head injury determine the potential for a return to work, with those that are more severely impaired least likely to return; (b) less than 50% of those individuals who suffer moderate to severe injuries, as determined by post-traumatic amnesia or duration of coma, return to gainful employment; (c) finally, head injury is a phenomenon that primarily affects young men. Thus a significant portion of the traumatic brain injured individuals are young men in their early work years who are primary wage earners. Additionally, they are in the process of identifying and establishing a vocational career track and, following the injury, still have a normal life expectancy. The consequences of the injury places a variety of social stresses not only on the injured individual but also on family and spouses. In some cases involved family members and spouses forfeit their own employment to assume responsibility for the care of the injured individual.

studied the effects of severe head injury on the vocational outcome of 60 subjects. These individuals averaged 3.5 years post-injury with over 80% of them being between 16 and 40 years of age. They found that only 13% of this population returned to their pre-injury level of employment, with approximately 35% returning to either a less demanding work setting or a sheltered employment setting while the remaining 52% were unemployed. The factors identified as effecting the 87% who did not return to their former level of employment were physical status, motor coordination, attention and concentration, and thinking efficiency.

Dresser et al. (1983) investigated the vocational outcome of over 850 veterans of the Korean War 15 years post-injury. Their study group was composed primarily (75%) of individuals who had sustained some type of penetrating head wound rather than a closed head injury. Their findings were similar to Peck's et al. (1984) with a significant relationship between potential for returning to work and duration of coma. Overall, 75% of the population studied were employed, while 85% of those individuals who had not been in a coma were employed. Only 55% of those who had been in a coma for over 24 hours were employed. Dresser's et al. (1983) study concluded the pre-injury intellectual status, length of coma, depth of missile penetration, and physical and mental disability
following the injury were indicators of post-injury employment potential.

Brooks et al. (1987) investigated the employment status of head injured individuals within the first 7 years following the accident. Each of these individuals had experienced either a coma of at least 6 hours duration (as measured by the Glasgow Coma Scale), a period of posttraumatic amnesia of at least 48 hours, or had been operated on for intracranial haematoma. Their population of 98 subjects had a pre-injury unemployment rate of 14%. Following the head injury, the unemployment rate was significantly higher with 73% of the population unemployed 4 years post-injury and 70% unemployed after 5 years. Their study indicated that there was minimal change in the employment status of head injured individuals from 2 years to 5 years post-injury. Brooks' et al. (1987) study, like previous noted research, identified impairments in cognitive status, personality problems, and behavioral disorders as being significant barriers to employment, whereas the physical deficits were not related to return to work. The study also assessed the effects of pre-injury occupational levels as predictors of return to work potential. They found that 50% of those individuals working in jobs described as a managerial or similar level returned to work. Whereas only 33% of those in a skilled manual job and 21% of those employed in an unskilled position
returned to work. A possible explanation is that the managerial category was composed primarily of individuals of a higher social class and a better educational background. This provided them with a greater skill base that they were able to utilize to compensate for the residual deficits following the injury. Additionally, it may indicate a greater willingness of employers to accommodate for injured individuals in this job category.

These studies noted a variety of reasons for failing to obtain and maintain employment. The reasons most often cited were: (a) decreased memory, attentional skills, and lack of persistence; (b) emotional disinhibition; (c) lack of or inappropriate interpersonal skills; (d) failure to understand or accept the residual effects of the injury; and (e) failure to establish realistic expectations regarding an appropriate employment niche following the injury.

Bruckner and Randle (1972) studied the return to work results of 93 patients who had suffered a severe head injury. They defined severe as a head injury that resulted in a period of posttraumatic amnesia of over 24 hours and/or a compound fracture of the skull or the occurrence of intracranial hemorrhaging. Their study followed up with its participants for a minimum of 3 years and found that 64% of them returned to work in an average time of 15 months following the injury. Bruckner and
Randle described psychological factors as having the most adverse effect on return to work; however, they did not elaborate in detail as to what these factors were.

One of the most extensive and comprehensive studies of employability and vocational outcome was completed as part of the New York University Head Trauma Program. Ben-Yishay, Silver, Piasetsky, and Rattock (1987) studied the effects of an intensive holistic cognitive rehabilitation program on the employability of 94 traumatically head-injured individuals with diffuse brain injuries. These individuals were unemployed at the time of entry into the program and had either failed at previous attempts to return to work, had failed in academic endeavors, were unsuccessful in programs through vocational rehabilitation facilities, or had not participated in any structured programming. These individuals were then placed in an intensive out-patient program that consisted of three separate components. The first component consisted of systematic holistic remediation treatment interventions. The second component consisted of individualized occupational job trials with supportive job coaching that culminated in the actual placement of the individual in a job. The final step consisted of the follow-up of the individual in his or her new position.

The study at the New York University Medical Center (Ben-Yishay et al., 1982) identified the problems posed by
severely head injured individuals in the rehabilitation process. Their study reported that they were able to relate the variety of functional and behavior deficits of the severe TBI clients whom they studied to five basic core deficits. These were:

1. Attentional deficits; 2. Impairments of or disturbances in the various skill structures; 3. Memory disorders of various types; 4. Dysfunctions in the area of verbal-ideation (e.g., various thought production, reasoning, and thought communication problems) and/or deficits involving the various expressive language disorders (including aphasias and dysarthria); and 5. Basic disturbances in the psychophysiological functions which manifest as "flat affect," reduced capacity to become emotionally "involved" and lack of or greatly reduced capacity for self "activation," (loss of "initiative," or adynamia—in Luria's term).

(p. 14)

The New York University Medical Center study (Ben-Yishal et al., 1982) was important since it took a holistic approach to rehabilitation and viewed the recovery process as one of reintegrating the TBI individual back into as normal a life style as possible. This was one of the first studies that took a systematic approach to identify specific residual TBI effects that inhibit the return to a normal life style and, from that, developed specific treatment strategies to overcome these barriers. This work has special relevance to this study, since a significant portion of their study and findings are directed towards work abilities and the potential for earning a living that the TBI individual possesses.
Therefore, the findings reported offer a possible framework whereby an understanding of the vocational implications of a TBI can be viewed and understood. Programatically their findings identified three major barriers that the TBI imposes upon the injured individual that need to be overcome in the rehabilitation process. These barriers are: (1) individuals decreased attentional skills, (2) decreased learning and memory skills, and (3) inability to generalize learned behavioral responses from one situation to another.

Additional results of the New York study (Ben-Yishay et al., 1982) identified that 84% of the participants were determined to have developed the ability to participate in a work setting at the end of their occupational trial, 63% at a competitive level and 21% in a subsidized or sheltered level. A further breakdown of the 63% who were deemed competitively employable shows that 3% were able to return to positions that required academic training, 37% to positions described as skilled or higher level clerical, and the remaining 23% to unskilled or lower level clerical positions. This New York study also evaluated the question of stability in the job setting over a 3 year period of time. Three years after completing the program 50% of the program participants were competitively employed; 22% were working at noncompetitive levels and 28% were not working in any setting. Ben-Yishay et al. (1987), the
researchers involved in this study, noted that often the deficits in the areas of cognitive, emotional, and behavior skills pose the greatest problems to vocational placement of the TBI individual rather than the residual physical deficits following the injury.

The effects of a traumatic brain injury, as previously described, can appear in four distinct areas of functioning. These areas are: (1) physical, (2) cognitive, (3) psychological, and (4) behavioral. The multiplicity of these effects and the lack of uniformity in their occurrence pose barriers to the vocational rehabilitation practitioner. Musante (1983) described specific cognitive and behavioral deficits that resulted from a traumatic brain injury and were believed to be vocationally relevant. These were: (a) diminished visual attention and concentration, (b) decreased memory efficiency, (c) concrete thinking, (d) preservation, (e) inability to organize and sequence tasks, (f) inability to generalize learning from one situation to another, (g) inability to process incoming information, (h) emotional lability, and (i) disinhibition. These deficits need to be evaluated and their vocational implications understood before successful return to work can be accomplished.
A Review of Existing Scales That Measure Recovery From Traumatic Brain Injury

The need to assess the status and measure recovery of patients who have suffered a TBI is not new (Gouvier, Blanton, LaPorte, & Nepomuceno, 1987; Hall, Cope, & Rappaport, 1985). Numerous scales have been developed to measure the status of recovery of the head injured individual. Most of these scales are for the period of acute rehabilitation that follows shortly after the injury with a few directed at the more long term recovery period. Many of these scales were developed as a substitute for accepted traditional psychological assessment tools to compensate for the fact that some patients were not capable of participating in this testing process. The Glasgow Coma Scale (GCS) is the most widely accepted scale utilized during this acute recovery period that follows the initial injury (Gouvier et al., 1987). The GCS was developed to assess and record the depth and duration of impaired consciousness and coma by objectively measuring three different areas of behavior (Teasdale & Jennett, 1974). These areas are: (1) motor responsiveness, (2) verbal performance, and (3) eye opening. Each of these behaviors are scored independently according to established guidelines by the physicians or nurses in the hospital setting. The results of this scale provide a descriptive measure of the duration of the coma as well as

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the duration of the different levels of responsiveness, thus, allowing for the accurate and reliable assessment of recovery over a period of time. The GCS, however, has limited utility since it is applicable only with coma patients and those individuals who are unable to participate in a more formal assessment process.

The Glasgow Outcome Scale (GOS) (Jennett & Bond, 1975) was developed to overcome some of the limitations of the Glasgow Coma Scale and to provide an objective scale to measure the results of acute medical treatment. The GOS was designed to be used in conjunction with the Glasgow Coma Scale and a framework for evaluating recovery and predicting future treatment needs as well as assessing the efficiency of prior treatments. Secondarily, it offered a basis whereby the description of the level of disability following head injury could be stated in a more consistent and accurate manner. The GOS describes recovery in five distinct outcome categories. They are: (1) death, (2) persistent vegetative state, (3) severe disability (conscious but disabled), (4) moderately disabled (disabled but independent), and (5) good recovery. Each of these categories is defined in greater detail than previously developed scales and attempts to overcome some of the lack of clarity in the use of specific terms in defining recovery. The GOS, however, is primarily a qualitative assessment instrument with a limited number of categories and
offers only a gross categorization of the deficits following a TBI (Hall et al., 1985).

The Expanded Glasgow Scale (EGOS) is an expansion of the Glasgow Outcome Scale (GOS) from its five categories to 10 categories (Smith, Fields, Lenox, Morris, & Nolan, 1979). The EGOS was developed not only to meet the evaluative needs during the acute stage of medical treatment but also to fulfill those needs during the rehabilitation treatment phase of recovery thus allowing for the assessment of improvement in functioning for long term rehabilitation clients. The GOS was modified and changed, using elements of a scale developed by Stover and Zeigler (1976), by expanding the death category to two categories, expanding the severe disability category to three levels, and increasing both the moderate and good recovery categories to two levels each. The resulting scale allows for describing the progress of the TBI individuals from the point of injury through the rehabilitation process by specifically documenting improvement over time and helping in estimating the potential for recovery from the head injury.

The Disability Rating Scale (DRS) is another instrument developed to overcome some of the previously described limitations of the GOS and other existing scales (Rappaport, Hall, Hopkins, Belleza, & Cope, 1982). The DRS measures recovery from the point of coma to community
entry and is especially useful in measuring that period of recovery from early arousal from coma to early sentient functioning. The DRS measures and identifies changes in:

1. levels of arousal and awareness— as is done by the Glasgow Coma Scale; (2) in cognitive ability to deal with problems of feeding, toileting and grooming; (3) in degree of physical dependence on others; and (4) in psychosocial adaptability as reflected primarily in the ability to do useful work as independently as possible in a socially relevant context. (Rappaport et al., 1982, p. 118)

The Disability Rating Scale consists of eight separate items that are within four distinct categories. These items are: (1) eye opening, (2) verbalization, (3) motor response, (4) feeding, (5) toileting, (6) grooming, (7) level of function, and (8) employability (Rappaport et al., 1982, p. 119). These areas are evaluated producing a score that can range from 0 (full recovery) to 30 (death). It has been used in comparative studies with the GOS and has been shown to be more sensitive in measuring recovery from the point between the acute medical treatment period and that point where TBI persons are able to participate in more traditional psychological and vocational assessments.

The scales previously described were primarily developed to be used during the more acute phase of treatment and to measure the medical recovery process of head trauma patients. The emphasis is on improvement in coordination, speech, and memory, rather than those skills necessary to
readily assess employability, work related skills, and ability to function in an independent living environment. One scale, the Function Life Scale (FLS) (Sarno, Sarno, & Levita, 1973) was developed to determine how disabled individuals' residual impairments affect activities of daily living. The FLS measures performance in 44 different day-to-day activities in five different categories; the categories are: (1) cognition, (2) activities of daily living, (3) activities in the home, (4) outside activities, and (5) social interaction. The scale was designed to be used with individuals who are in a home and community setting rather than a hospital setting, and it measures actual performance of specific tasks rather than the unique elements that constitute performance. The rationale for measuring actual performance of a task rather than its individual characteristics was to overcome some of the interactive influences of physical, psychological, social, economic and cultural factors that may influence performance. The FLS allows for assessing whether an individual is or is not performing a task rather than whether he or she possesses the necessary physical capabilities to do such.

Description of the Vocational Scaling System

The Vocational Scaling System (VSS) (see Appendix A) was developed by Hope Rehabilitation Network (HRN) because
there was no appropriate measurement tool for assessing performance in a work setting. The VSS provides an objective measure of specific behaviors of the closed head injured (CHI) individual's performance in and on the job work setting and provides a method of evaluating program participants' improvements. The scale was constructed so as to overcome some of the weaknesses noted in existing measurement tools.

Traditionally, vocational assessment and rating scales have measured discrete skills and abilities and, then, generalized "vocational potential" from the sum of these discrete scores. These measures, while working well with the populations on which they were normed, do not adequately assess the vocational potential of CHI individuals (Silver et al., 1982). These measurement instruments assume certain parameters that are consistent within the normal population and are not within the CHI population. They did not compensate for the decreased ability of CHI individuals to integrate and generalize new tasks or learning from one situation to another. Additionally, they failed to compensate for the fact that CHI individuals usually possess discrete areas of cognitive strengths and weaknesses that are not adequately assessed by traditional assessment tools (Silver et al., 1982). Finally, these standardized vocational assessment instruments are meant to be administered and scored in a
sheltered, restricted environment rather than in an actual job setting in which HRN program participants are evaluated and trained.

The VSS was developed to be easily administered, scored, and interpreted, and to numerically describe changes in work related behaviors. The scale describes an individual's actual behavior, or ability to perform a specific task at a specific time, rather than what his or her capacity or potential is. Secondarily, it serves as a tool to measure the outcome and efficiency of vocational services and program intervention techniques. The VSS measures six discrete areas of work behavior. Their general titles and working definitions are:

Productivity (PRDCT): A measure of motor speed as it compares to the individual job production rate. It will usually be stated in a percentage number.

Learning (LNG): A measure of the amount of time it takes to learn and carry out a five-step task without assistance. It is measured in minutes and broken down into five discrete scores.

Persistence/Attention/Stamina (STMNA): The ability to work a full day. It is measured in hours and half hours and divided into five discrete scores.

General areas (GEN): A measure of behaviors related to working attire.

Independence (INDP): A measure of behavior related
to the ability to adjust to changes in work demands and the environment; the degree of complexity of the tasks that the individual can organize, and their ability to monitor their own quality of work and initiate work activities without supervisory cuing. The measure has three areas of behavior that are assessed with each having five discrete scores.

Social behavior (SOC): A measure of behavior related to the ability to interact appropriately with supervisors and co-workers. It considers the individual's ability to take direction, follow written and verbal instructions, accept feedback from supervisors and co-workers, and exhibit appropriate interpersonal behaviors. Area 6 is broken into two separate behavioral measures. One is called major social offenses and measures the frequency of threatening behaviors such as yelling, throwing things, and assaults. The second is called minor social offenses and measures the frequency of inappropriate non-threatening behavior such as facial grimacing, excessive body movements, talking, and laughing. Social behavior is comprised of two measures, each of which has five possible scores.

The behaviors measured by the VSS closely approximate those behaviors previously identified by Musante (1983) as presenting possible barriers to the vocational rehabilitation of TBI clients. Additionally, these behaviors are
quite similar to the cognitive, emotional, and personality changes that Benton (1979) described as some of the common consequences of a traumatic brain injury.

The New York City University Medical Center study (Ben-Yishay et al., 1982) identified specific program components it believed to be needed to meet the post-acute rehabilitation needs of the TBI population. Ben-Yishay et al. (1982) reported that this population needed a multi-layered, multiple intervention system of treatment, and that the treatment strategy needed to be comprised of three mutually reinforcing characteristics. These are: (1) a holistic plan whereby intervention strategies are organized and implemented using a variety of clinical strategies, (2) the program needs to be structured and operated as a mini-therapeutic community, and (3) individual program changes need to be introduced to each participant in a graduated fashion whereby program structure can be diminished as the individual becomes more independent.

Hope Rehabilitation Network has incorporated parts of these characteristics into the vocational component of the Traumatic Brain Injury Program. The Traumatic Brain Injury Program was especially sensitive to the implications towards implementing vocational reintegration on a gradual basis described by Ben-Yishay et al. (1982). A hierarchy of five levels of work environments was
developed (see Appendix B) for placing the traumatic brain injured individual for retraining and evaluation. These levels, starting with Level 1 and proceeding to Level 5, place increasing demands upon the participants' cognitive, emotional, and physical capabilities while decreasing the amount of program intervention. These work sites are located in the least restrictive environment possible with Levels 1 and 2 consisting of what is commonly called "sheltered employment"; but in this case, program participants may or may not be working in the same environment as other disability groups. It should be noted that in all of the levels of work site placement, participants are performing and completing actual jobs and are paid a commensurate wage for their production. Levels 3 through 5 are community-based work site placements where program participants are placed in a variety of employment settings with increasingly less direct program intervention and consultation. Level 5 is the most independent level of work site placement in which a participant can be placed, and is the final step before a return-to-work step is attempted. Here, as well as at Levels 3 and 4, program participants work along side noninjured workers under the direction and guidance of the supervisor at that work station. Performance, appropriateness of exhibited behaviors, and other relevant job tasks are judged and evaluated on the same standards as regular employees.
Additionally, while undergoing job trials, program participants can move from one work site/environment to another to establish their actual work ability and allow them an opportunity to experience a variety of job demands as well as assess job performance in a number of work settings.

The Vocational Scaling System is the instrument used to assess performance in each of these level of vocational placement. As Silver et al. (1982) noted:

Ongoing occupational trials are probably the most reliable, available measurement tools for the vocational assessment process with this particular population. Job trials allow for the step-by-step introduction of new, more varied tasks and permit the counselor to observe performance and implement supports that the trainee may need in order to perform at optional level. (pp. 93-94)

The work site placements or job trials allow program participants to experience actual successes and failures in as realistic a work setting as possible. Treatment support on the work site is provided by a vocational counselor and certified occupational therapy assistants. They work directly on the work site with head injured individuals and assist in the development and implementation of treatment strategies that have been developed by other team members, i.e., occupational therapist, vocational counselor, and social worker all under the supervision and direction of the clinical director, a licensed psychologist.
The Halstead-Reitan Neuropsychological Test Battery and Its Sensitivity to Brain Impairment

The Halstead-Reitan Neuropsychological Test Battery (HRNTB) is the most widely known and utilized test for the assessment of brain functioning in use at this time (Kolb & Whishaw, 1980). Two measures from this battery: Category test and Trails B, were chosen as measures of the severity of the brain injury because of their sensitivity to the effects of brain impairment (Reitan & Wolfson, 1986; Wheeler et al., 1963). This section is devoted to an analysis of the historical development and a review of the relevant research describing the sensitivity of these individual tests to brain damage as well as the sensitivity of the HRNTB to brain dysfunction.

The HRNTB was initially developed by Halstead in 1947 as a battery of seven tests that were grouped together because of their individual abilities to discriminate between individuals who had suffered frontal lobe damage and a normal group. Halstead (1947) put forth a new concept of intelligence whereby he proposed that there were three categories of intelligence: (1) psychometric intelligence, (2) clinical intelligence, and (3) neurological intelligence. Psychometric intelligence, he believed, developed out of the efforts of psychologists to measure adaptive abilities by way of specialized tests; these skills consisted of such things as judgement and
abstract reasoning skills. Clinical intelligence dealt with the concept of how effective an individual's behaviors were in his or her environment and was a product of clinical investigators' efforts to describe behaviors. Neurological intelligence was related to the effects of brain lesions on lower animals and humans. Halstead (1947) believed that these definitions were inadequate and did not adequately explain the overall concept of intelligence. Therefore, after utilizing several newly developed tests of brain function and factor analyzing the results he proposed the concept of "biological intelligence."

Halstead believed that biological intelligence was different from the intelligence measured by most psychological tests. He believed it was more closely attuned to the human nervous system and constituted its adaptive capability (Russell, Neuringer, & Goldstein, 1970). Halstead's study identified four factors which were to become the basis for his early work in the development of a battery of tests to measure adaptive brain functioning. These factors were: (1) central integrative field factor (Factor C), (2) abstraction factor (Factor A), (3) power factor (Factor P), and (4) the directional factor (Factor D). These factors were initially described in Halstead's (1947) book, *Brain and Intelligence.* Factor C, central integrative field factor, was thought to measure memory. Factor A, abstraction factor, was thought to measure
abstraction, while Factor P, power factor, was thought to measure alertness. Finally, Factor D, the directional factor, was thought to be a measure of an individual's ability to use a variety of factors in actual expression. Halstead (Shure & Halstead, 1958), following further study, abandoned the D factor and modified or retained the descriptions of the other factors; i.e. Factor A, an abstraction factor; Factor C, which was related to verbal intelligence; and Factor P, which was described as vigilance. Halstead's Battery was later adopted, modified, and expanded by Reitan (1955a), a student of Halstead's, as part of his early research into brain dysfunction. The research subsequently led to a significant portion of the earlier battery being incorporated into what is now called the Halstead-Reitan Neuropsychological Test Battery. Reitan's studies were not directed at exploring Halstead's concepts of biological intelligence but rather to assessing the nature of brain functioning (Reitan, 1966). His work involved the exploration of a variety of tests, with a goal of assembling a battery of tests that could evaluate brain damage. Reitan, with Robert F. Heimburgher, M.D., Director of Neurological Surgery, founded the neuropsychological laboratory at the Indiana University Medical Center in 1951. This setting offered the opportunity to collect a large amount of data on a variety of head injury groups utilizing a constant battery of tests. The data
was later used to develop what is now generally described as the Halstead-Reitan Neuropsychological Test Battery (HRNTB).

The HRNTB is composed of nine subtests, each of which provides an individual score and a composite score called the impairment rating. The battery is composed of tests that fall into six separate categories (Reitan & Wolfson, 1985). These are: (1) input measures; (2) measures of concentration, attention, and memory; (3) tests of verbal skills, (4) measures of spatial, sequential, and manipulatory skills, (5) tests of abstraction, reasoning, logical analysis, and concept formation; and (6) output measures.

The Halstead-Reitan Neuropsychological Test Battery is probably the most researched neuropsychological test in use today (Reitan & Wolfson, 1985). Reitan's (1955a) initial research was directed at determining Halstead's battery of tests sensitive to the presence or absence of cerebral damage by comparing control subjects with individuals who were known to have cerebral damage. He individually matched 50 brain-damaged individuals with 50 non-brain-damaged patients on the basis of race, sex, age, and years of formal education. These individuals were then administered Halstead's Test Battery and intergroup statistical comparisons were obtained on the Halstead Impairment Index and the 10 individual subtests. All but two of
these measures showed significant differences in discriminating between the brain-damaged and non-brain-damaged groups. The Impairment Index was found to be the most sensitive to detecting the presence of brain damage; however, the Category test was almost as sensitive to discriminating between the brain-damaged and non-brain-damaged groups.

Reitan (1958a) expanded on this earlier research when he compared the results of the Halstead's Impairment Index and subtests with the scores obtained from the Wechsler-Bellevue Scale. Reitan postulated that the Halstead Impairment Index would be more sensitive to brain damage than the Wechsler-Bellevue IQ measures. Previous research (Ptacek & Young, 1954) had shown that brain-damaged groups' IQ measures are significantly lower than non-brain-damaged group scores. Reitan's (1958a) results indicated that the Halstead Impairment Index was more sensitive to brain damage than any of the Wechsler-Bellevue variables selected for comparison.

The original Halstead Battery was modified and expanded by Reitan until it evolved into its current structure. The Halstead-Reitan Neuropsychological Test Battery was expanded by adding additional tests to supplement those initially identified by Halstead. Reitan (1955b; 1958c) added the Trail Making Test to the battery after studies indicated that Part B was sensitive to brain
damage and able to differentiate brain-damaged individuals from control subjects. An abbreviated and modified version of the Halstead-Wepman Aphasia Screening Test was added to the test battery after it was identified as being sensitive to brain damage (Wheeler & Reitan, 1962) and that it could provide lateralization information. Reitan (1958b) also modified two of the tests in Halstead's Battery; first the Finger Tapping Test was changed from a measure of only the dominant hand to include both hands. Second, the Tactical Performance Test scores for the dominant and nondominant hand were compared. These modifications allowed for a better assessment of lateralized brain damage. Finally, the Minnesota Multiphasic Personality Inventory (MMPI) was added to the battery as a measure of psychopathology.

Numerous other studies were undertaken to validate the ability of the Halstead-Reitan Neuropsychological Test Batteries to discriminate brain-damaged from non-brain-damaged individuals. Three studies (Wheeler, 1964; Wheeler et al., 1963; Wheeler & Reitan, 1963) reported that utilizing neurological criteria resulted in the correct classification of brain injured subjects in 81% to 98.8% of the cases. These results, however, were scarcely better than those obtained by using the simple cut-off scores for the Halstead-Reitan Battery (Reitan, 1967).

Vega and Parsons (1967) explored the validity of the
HRNTB taking into consideration the level of performance of the subjects when age and educational factors were considered. Their goal was to cross validate the test battery and to provide normative data on the tests from a different geographic setting than had been previously evaluated. Vega and Parsons were especially concerned with the level of performance in relation to test scores when such factors as age and level of education were considered. Their study used 50 subjects and 50 controls and they found that, when Halstead's impairment index was applied, 7 out of 10 subtests fell in the impaired range of functioning and 73% of the brain-damaged individuals were correctly classified as impaired. Vega and Parsons (1967) were able to improve this ability to correctly classify brain-damaged individuals to 79% through the modification of the impairment index through the changing of raw scores to t tests.

Filskov and Goldstein (1974) evaluated the validity of using the HRNTB as a means of identifying lateralization, localization, and process aspects of brain lesions. Their study compared the ability of commonly used physical diagnostic measures, such as angiograms, pneumoencephalogram, and brain scans to identify brain damage with that of the HRNTB. They reported a perfect success rate for the test battery on the population studied and indicated that a neuropsychological diagnostic approach in

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conjunction with a clinical or actuarial approach was more reliable than either the clinical or actuarial approaches used independently.

Halstead's (1947) impairment index was based upon the 10 tests of which his initial battery consisted. He developed his index to overcome what he believed were weaknesses previously applied in obtaining IQs on other psychometric tests, i.e., averaging the subtests. Halstead believed that averaging obscured and distorted important information that could be obtained from his battery since averaging did not identify specific strengths and weaknesses in performance. He established a cutting point or criterion score for each of the tests that indicated brain damage. When any one of the tests exceeded this score, it was counted in the index. Each of the 10 tests could contribute 1/10 to the index; for example: if four of an individual's scores exceeded the cut off score, their impairment rating would be .40. Usually, normal non-brain-damaged subjects obtain ratings of 0.0 to 0.3 with a 0.4 being considered a borderline rating; ratings from 0.5 to 1.0 indicate impaired brain functioning. The Impairment Rating has been found to be sensitive to impaired brain functioning when utilizing independent neurological findings as the criteria for establishing brain impairment (Reitan & Wolfson, 1985).
Categories Test

The Categories test is primarily a test of abstracting ability. It utilizes a projection apparatus, or more recently a booklet form, whereby a variety of stimulus figures that vary in size, shape, number, intensity, color, and location are projected onto a screen or shown on a page of a book for the patient's viewing. These figures are grouped according to some abstract principle which the patient is to determine based upon feedback from the examiner. The examinee is informed that they have to learn a principle that will allow them to correctly choose one of the four designs. The first group requires the matching of numerals, the second the correct matching of one of four numbers that corresponds to the number of items appearing on the screen. The sections become increasingly complex with the stimulus fields constantly changing and requiring the examinee to maintain a response pattern consistent with an underlying principle. These sequences continue through several groups and provide a nonverbal measure of complex concept formation.

Trail Making Test

The Trail Making test is comprised of two separate parts, A and B. Part A consists of a sheet of white paper with 25 circles on it, each containing a number from 1 to 25. This test requires the subject to connect the numbers
in order by drawing a line from one circle to the next, preceding from the circle with a number 1 in it to the circle with a number 2 in it and so on. The amount of time taken to complete these tasks is recorded. Part B is similar to Part A insomuch as it requires the subject to connect circles that are numbered from 1 to 13 and lettered from A to L. The task is to connect these circles in sequence, alternating from 1 to A to 2 to B and so forth until they are all connected. Again the time is recorded and a score is assigned based upon how fast the task was completed. This test assesses the individual's ability to recognize the symbolic significance of numbers and letters and maintain a sense of sequence. It also measures attention and memory to the most recent point of departure and rapid visual scanning. This test is one of the best measures of general brain functions (Reitan, 1955b, 1958c; Reitan & Wolfson, 1986).

The Trail Making test has been shown to differentiate brain-damaged from non-brain-damaged groups (Reitan, 1955b, 1958c). Part B of the Trail Making test is more sensitive to brain damage than Part A (Reitan, 1958c) and requires that the subject adjust from numbers to letters in order of sequence by connecting them with a line. The individual must be able to scan a sheet of paper in order to find which item is to be connected next (visual spatial searching) while keeping both the alphabetical and
numerical sequence in mind. Shifting back and forth between numbers and letters, while keeping the ascending order in memory, is somewhat similar to the cognitive demands of the Categories test. This test requires that the individual sustain a level of alertness and concentrated attention to the task; many tests that measure these characteristics are sensitive to brain damage (Boyd, 1984; Reitan, 1958c).

Summary of Literature Review

The major findings of the literature reviewed here established tentative conclusions related to the hypothesis concerning the relationship between the severity of a closed head injury and scores on the Vocational Scaling System.

As previously discussed, a significant number of individuals sustain a severe enough CHI each year to permanently limit their ability to return to their pre-injury lifestyle. Additionally, since the expected life span of the CHI individual is not negatively impacted by the injury, the cost for medical treatment and subsequently sustaining that individual in an environment as independent as he or she can manage places financial burdens on the family and available society resources.

A significant number of the CHI population is composed of young adults who are either in the process of
establishing, or have only recently established, independence from their original family unit. The residuals of the CHI have resulted in many physical, cognitive, and emotional changes in their lives that require specialized treatment if they are to maximize their recovery. A review of studies conducted at New York University Medical Center (Ben-Yishay et al., 1982) and other locations established the wide variety of deficits resulting from the injury and also established CHI persons as a unique disability population. They are unique in the sense that treatment has to be approached in a comprehensive and systematic fashion that recognizes some of the prominent cognitive deficits that have resulted from the CHI. The review of studies established that existing vocational evaluation instruments for other disabled groups are inappropriate for assessment of the head injured population since they are based upon certain assumptions regarding their ability to integrate new information and knowledge and then generalize it to novel situations. Secondarily, they assumed a certain homogeneity between the deficit of the disabled population and did not individualize treatment strategies to address the specific deficit profiles of the CHI individual.

A definition of CHI and its difference when compared to other forms of traumatic brain injury and other disability groups were undertaken. The review set forth an
understanding of the residual cognitive deficits following a CHI and noted some of the more common deficit patterns on how they inhibit overall functional recovery with specific reference to returning to competitive employment. Overall, the studies reviewed noted that treatment of CHI individuals is a growing area and that more systematic strategies need to be developed for treatment. Also, assessment of the effectiveness of treatment as well as a measurement of the recovery exhibited by the injured individual was ascertained.

A review of the research was undertaken to assess the relative strengths and weaknesses of some of the current, more commonly used scales that measure recovery. The Glasgow Coma Scale (GCS), Glasgow Outcome Scale (GOS), Disability Rating Scale (DRS), and the Functional Life Scale (FLS) were reviewed. Each scale, however, was found limited in its ability to adequately assess the ability of the CHI individual's performance in a work environment and identify in specific enough detail any changes in performance to benefit the assessment of a CHI individual's job performance.

Hope Rehabilitation Network, a private non-profit rehabilitation facility located in Grand Rapids, Michigan, has provided specialized rehabilitation services to head injured individuals since 1982. Treatment strategies have been directed towards assisting brain-damaged individuals'
return to as independent lifestyle as possible considering the residual deficits following some form of traumatic brain injury. As noted earlier, a need to be able to objectively evaluate performance of program participants in a wide variety of work settings was identified and a review of existing measurement tools found them to be inadequate. Lack of an appropriate evaluation instrument led to the development of the Vocational Scaling System, which is currently in use in the vocational component of HRN's treatment program.

A review of the literature established that there is a relationship between the severity of the traumatic brain injury and the potential for return to work, i.e., the more severe the injury the less chance that the injured individual will return to competitive employment. These studies utilized the length of coma or posttraumatic amnesia (PTA) as measures of severity. It is questionable as to whether the researchers utilized the same criteria for establishing duration of coma or PTA. The Halstead-Reitan Neuropsychological Test Battery, two of its most sensitive subtests, Categories, and Trails B, were reviewed in detail. A review of research findings indicates that each of these tests is sensitive to brain impairment and discriminate brain-injured from non-brain-injured individuals. Additionally, it identified that each of these tests was sensitive to the cognitive deficits that
are most likely to interfere with a CHI individual's ability to return to and function in a competitive work environment.

Organization of the Dissertation

The study is organized into four chapters. The first chapter offered a review of pertinent literature and the second chapter reviews the design and statistical methods used to arrive at the study's findings. Chapter 3 is a review of the data analysis with an accompanying discussion of the data, and Chapter 4 outlines findings, conclusions, and specific recommendations.
CHAPTER II

METHOD

Subjects

The total number of subjects in this study consisted of 34 inpatients and outpatients selected from a traumatic brain injury transitional living center at Hope Rehabilitation Network. All subjects had been referred for rehabilitation services to determine vocational potential, to increase independent living skills, and to provide treatment to improve their ability to function in the least restrictive environment possible.

The Closed Head Injury Group

The closed head injury group consisted of 34 cases. These subjects were drawn from an original group of 62 cases which had participated in vocational services in the traumatic brain injury program at Hope Rehabilitation Network. Two were excluded due to the cause of their brain damage not fitting the definition previously described in Chapter I. An additional 26 subjects were dropped due to the lack of the full range of scores from the Vocational Scaling System (VSS) for a variety of reasons. For example, some program participants did not
work on specific job sites for a significant period of time (approximately 20 work days) to be rated. Additionally, other subjects were not administered the VSS at the discretion of the treatment team.

As evidenced in Table 1, there were 5 females and 29 males with a mean age of 28 years 1 month at the time of entry into the program. The participants' ages ranged from 18 years 2 months to 50 years 7 months. Thus, the group was composed primarily of young adults with 24 of the participants falling below 30 years of age, only 4 being 40 years or older and 6 of the participants being between 30 and 40 years of age.

<table>
<thead>
<tr>
<th>Table 1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Analysis of Closed Head Injury Group by Age at Injury, Age at Time of Entry into Program, and Years and Months Post-Injury at Time of Program Participation</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Variable</th>
<th>N</th>
<th>Mean Age (Yrs/Mon)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Age at Injury</td>
<td>34</td>
<td>25/1</td>
</tr>
<tr>
<td>Age at Referral</td>
<td>34</td>
<td>28/1</td>
</tr>
<tr>
<td>Months Post-Injury</td>
<td>34</td>
<td>3/0</td>
</tr>
</tbody>
</table>

In terms of recency of injury, the traumatic brain injured population showed a mean of 3 years post-injury. There were four cases where the recency of injury was over 9 years. When these cases were excluded, the mean period
of time post-injury decreased dramatically to 1 year 11 months. The recency of the injury ranged from a low of 1 month to a high of 13 years 1 month.

The age at injury ranged from 15 years 11 months to 50 years 3 months with a mean of 25 years 1 month. The majority of injuries occurred with individuals 30 years old or younger. There were 14 individuals under 20 years of age whereas 13 individuals were between 20 and 30 years of age at the time of their injury. If the four individuals who were 40 years or older at the time of injury were excluded, the mean age at injury decreases to 22 years 1 month.

As seen in Table 2, the head injured group's formal educational level ranged from a low of 8 years to a high of 20 years with one participant having completed a doctoral degree prior to injury. The mean educational level was 11.90 years with six participants having participated in some type of formal educational training following graduation from high school. When these six individuals were excluded, the mean educational level obtained decreased to 11.14 years. The educational level of those subjects who were injured prior to the age of 20 showed that many did not finish high school. This was probably related to the impact that the accident had on their progress through the educational system due to the effects of the injury related cognitive deficits on their academic
skills rather than some preexisting lack of ability.

### Table 2

**Analysis of Educational Levels of Subject Group by Sex and Age at Time of Injury**

<table>
<thead>
<tr>
<th>Yrs/Month</th>
<th>N</th>
<th>M</th>
<th>F</th>
<th>Educational level</th>
</tr>
</thead>
<tbody>
<tr>
<td>0-20 yrs/0 months</td>
<td>14</td>
<td>14</td>
<td>0</td>
<td>11.0</td>
</tr>
<tr>
<td>20/1-30/0</td>
<td>13</td>
<td>10</td>
<td>3</td>
<td>12.08</td>
</tr>
<tr>
<td>30/1-40/0</td>
<td>3</td>
<td>2</td>
<td>1</td>
<td>13.33</td>
</tr>
<tr>
<td>40/1-</td>
<td>4</td>
<td>3</td>
<td>1</td>
<td>13.50</td>
</tr>
</tbody>
</table>

### Subject Selection

The subjects selected for this study were comprised of individuals who had been referred for inpatient or outpatient vocational rehabilitation assessment and treatment. Each of these individuals had suffered some type of closed head injury that had resulted in decreased cognitive functioning, were experiencing difficulties in obtaining or maintaining employment, or there was concern regarding their ability to obtain some type of employment.

Criteria utilized to select subjects were based upon a review of accompanying medical information to insure that participants had incurred a closed head injury. Excluded were those individuals who had received their
brain injury through some other type incident that did not meet established criteria. A majority of these participants had been involved in some type of auto related accident and were receiving some type of financial support for their medical and rehabilitation costs. In a few cases they were receiving wage replacement for their time away from work. A small number of individuals were involved in some type of litigation process due to the injuries and damages they received or caused.

Criteria Instruments

The three measures utilized in this research study were the Categories test, Trails B, and the scores obtained from the Vocational Scaling System developed at Hope Rehabilitation Network. The origin, description, and validity data related to the Categories test and Trails B were extensively reviewed in Chapter I. The data establishing their validity and design are reviewed in limited detail here.

The Categories test measures the highest levels of central processing, that is, the ability for logical analysis, reasoning, and to abstract. These abilities are very similar to Halstead's Abstraction Factor previously described. Numerous studies have been undertaken that establish the Categories test as one of the most sensitive tests to cerebral damage regardless of the location of the
lesion (Reitan & Wolfson, 1986). Doehring and Reitan (1962) identified that the Categories test was equally sensitive to left cerebral lesions as it was to right cerebral lesions and that brain-damaged individuals consistently performed worse than non-brain-damaged individuals.

Trails B requires that the individuals maintain a level of concentration and alertness as they scan a page of numbers and letters while connecting them in ascending order. This requires that they keep both the alphabetical and numerical series in memory as they connect them with a line. Like the Categories test, the Trails B portion of the Trail Making test has been shown to be sensitive to discriminating between brain-damaged and non-brain-damaged individuals (Reitan, 1955b, 1958c). Considering the relationship between the Categories test and Trails B to the neuropsychological model developed by Halstead, it is logical that these two tests are sensitive to brain damage (Reitan & Wolfson, 1986).

Data Collection Procedure

The Human Subjects Institutional Review Board (HSIRB) of Western Michigan University reviewed and approved the research protocol on December 9, 1988. The protocol was approved at no more than minimal risk after full review by the HSIRB.
Data collection for this study began with a review of client records of participants who received services from May of 1985 through January of 1989. There were a significant number of individuals who participated in the program during this time but were not included in the study because of a lack of test scores for the Vocational Scaling System. Additionally, a large number of the study subjects did not undergo neuropsychological testing as part of their program at Hope. These tests, or similar tests, were administered to program participants prior to referral; and repeat testing was not undertaken as part of the evaluation process. Only 11 and 12 of the study participants, respectively, underwent the Categories and Trails B test as part of the program evaluation. All the subjects who underwent neuropsychological evaluations were tested by staff who had training in the administration of each of the tests and were also supervised by a licensed psychologist. Administration and scoring of the VSS was undertaken by staff members who were trained in the administration and scoring of the scale and who were involved in its development and implementation. Scale administration was completed after study participants had completed at least 20 work days at one location. Data collection consisted of ongoing review, assimilation, and recording of appropriate data as subjects became available, as well as a review of previously obtained and stored data from
subjects who had completed the program.

Design of the Study

The current study was a descriptive research study designed to obtain information regarding the current status of specific vocationally relevant variables of individuals who had experienced some type of traumatic brain injury. There is no control group involved in the study and it was necessary to test variations of the hypothesis since there was no control over the independent variables. The study compared the relationship between the individual subscores of the Vocational Scaling System to one another and to the total score, as well as between the two measures of severity of injury, i.e., Trails B and Categories test.

The statistical method utilized to test the hypotheses was a correctional technique, the Pearson product-moment correlation (Ary, Jacobs, & Razavieh, 1979). This correlational procedure allows for assessing the magnitude of the relationships between variables and was obtained by using the SPSS-X system through Western Michigan University's Computer Services. The Pearson product-moment correlational coefficient is the most commonly used correlational index and is used when the scale of measurement is of either the interval or ratio type. The confidence level for rejecting the null hypothesis was established at
Research Hypotheses (Operational Hypotheses)

The four central hypotheses of this study are presented here in terms of their specific parameters. The individual null hypotheses that were tested will be stated in Chapter 3.

**Hypothesis 1**: There will be a significant positive relationship between the two behaviors, Independence and Learning. This relationship will be greater than the relationship between any other pairs of the six behaviors measured by the VSS.

**Hypothesis 2**: There will be a significant positive relationship between the Independence subscore and the VSS total score. This relationship will be greater than the relationship between the five other subscores and the total score of the VSS.

**Hypothesis 3**: There will be a significant relationship between the behavior Independence and the impairment rating obtained from the Categories test. This relationship will be greater than the relationship between the other five subtests and the Categories test.

**Hypothesis 4**: There will be a significant relationship between the behavior Independence and the impairment rating obtained from the Trails B test. This relationship will be greater than the relationship between the other
five subtests and the Trails B test.

The statistical method used to test Hypothesis 1 was the Pearson product-moment correlation (Ary et al., 1979). It determined if the relationship between the two subscore totals, Independence and Learning, are significant. The expected results were that there would be a significantly greater positive relationship between these two behavioral subscores than the relationship between any combination of two behavioral subscores for the VSS.

Hypothesis 2 was also tested by using a Pearson product-moment correlation to determine whether the subscore of Independence has the most significant positive relationship with the total score of the VSS. Specifically, the subscore of the behavior Independence should have a significantly greater positive relationship with the total score from VSS than any of the relationships between the six subscores and the total score.

Hypotheses 3 and 4 were analyzed by Pearson product-moment correlation to determine the relationship between the scores obtained from the VSS and the impairment rating obtained from the Categories test and Trails B.

The expected results of Hypotheses 3 and 4 were that the subscore of the behavior Independence has the greatest negative correlation with the impairment rating obtained from the two neuropsychological measures utilized to measure severity of TBI, i.e., Categories and Trails B.
More specifically as the severity of the TBI increases, as measured by the impairment rating from these two tests, the corresponding subscores on the behavioral measure Independence will decrease. Thus, the behavior Independence is the most sensitive measure of severity of the subscores and the total score from the VSS.
CHAPTER III

DATA ANALYSIS

This study investigated the relationship between individual behaviors measured by the VSS and two tests that are sensitive to brain impairment, Trails B and Categories, two of the subtests of the Halstead-Reitan Neuropsychological Test Battery. Additionally it investigated the interrelationship of the subscores and total score of the VSS that was developed at Hope Rehabilitation Network. It was hypothesized that Independence, one of the subtests of the VSS, would have a greater positive relationship with the subscore for Learning than the relationship of any other pair of subscores from the VSS. Secondarily it was hypothesized that Independence would have the greatest positive relationship with the total score from the VSS when compared with the other subscores. Finally, it was hypothesized that the relationship between Independence and Trails B and Categories would be greater than the relationship between the total score and subscores of the VSS and these two tests. Statistical findings are reported and summarized in this chapter. The first part of the chapter will summarize data regarding the whole research population group. A review of
statistical data pertaining to individual hypotheses will follow. The chapter concludes with the presentation of additional statistical analysis that were undertaken in the study.

Analysis of Population Data

The descriptive data for the sample are presented in Tables 3 and 4. The standard deviations and the ranges for the subscores of the VSS, other than Independent subtotal, are small and quite similar ranging from 1.21 to 1.68 (.47 difference) and 5 to 6. The data is reflective of the limited number of measuring categories in the subtests Productivity, Learning, and Persistence/Attention/Stamina, which only have five possible scores. The limited number of possible choices restricts the variability and range within these three subscores. However, the behaviors measured by the General and Social subscores are not as restricted in the range of scores obtained, i.e., 23 and 9, respectively. The restricted range, i.e., 6, and means of 13.21 and 8.84 are both at the upper limits of the possible scores. In conjunction with the standard deviation of 1.68 for General subscore and 1.50 for Social subscore, the score indicates minimal variance in both the General and Social subscores. It may be indicative of a lack of variability in the behavior measured by these subscores in the research population or that the VSS is
not sensitive to the subtle differences in behavior measured by these subtests. The Independence subscore and the total score from the VSS exhibited the largest range and standard deviation of all the scores from the VSS. This is due, in part, by the size of the possible range for each, i.e., 19 and 59, respectively.

Table 3

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Productivity</td>
<td>34</td>
<td>3.07</td>
<td>1.21</td>
<td>5</td>
</tr>
<tr>
<td>Learning</td>
<td>34</td>
<td>3.31</td>
<td>1.23</td>
<td>5</td>
</tr>
<tr>
<td>Stamina</td>
<td>34</td>
<td>2.82</td>
<td>1.55</td>
<td>5</td>
</tr>
<tr>
<td>General subtotal</td>
<td>34</td>
<td>13.21</td>
<td>1.68</td>
<td>6</td>
</tr>
<tr>
<td>Independent subtotal</td>
<td>34</td>
<td>14.10</td>
<td>2.90</td>
<td>13</td>
</tr>
<tr>
<td>Social subtotal</td>
<td>34</td>
<td>8.84</td>
<td>1.50</td>
<td>6</td>
</tr>
<tr>
<td>Total score</td>
<td>34</td>
<td>45.27</td>
<td>6.07</td>
<td>29</td>
</tr>
</tbody>
</table>

Table 4 summarizes the range, standard deviation, and mean for the raw scores and impairment ratings for the Trails B and Categories test. The mean of 1.75 and standard deviation of 1.29 for the Categories test impairment rating indicates that a majority of the program participants were either mildly or unimpaired in their performance of this test. The mean of 2.73 and standard
deviation of 1.35 for the Trails B test impairment rating indicates that the majority of program participants scored in the mildly or moderately impaired range of cognitive functioning.

Table 4
Means, Ranges, and Standard Deviations for the Raw Score and Impairment Rating for the Trails B and Categories Test

<table>
<thead>
<tr>
<th></th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>Categories</td>
<td>12</td>
<td>1.75</td>
<td>1.29</td>
<td>4</td>
</tr>
<tr>
<td>Raw score</td>
<td>12</td>
<td>59.00</td>
<td>34.28</td>
<td>93</td>
</tr>
<tr>
<td>Trails B</td>
<td>11</td>
<td>2.73</td>
<td>1.35</td>
<td>5</td>
</tr>
<tr>
<td>Raw score</td>
<td>11</td>
<td>151.64</td>
<td>101.41</td>
<td>315</td>
</tr>
</tbody>
</table>

Table 5 provides the range, standard deviation and mean for the individual questions that comprise the sub-total scores for the behaviors, General, Social, and Independence. Three of the questions, Social 1, General 1, and Independence 2, have a restricted range and appear to show little variation in the behavior measured by each of them. They do not appear to be able to discriminate between differences in performance or the specific behavior does not exhibit much difference within the population to be evaluated. Additionally, the findings exhibit that a significant number of the questions resulted in scores that are skewed to the upper limits of the scale.

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This could be reflective of a lack of sensitivity within the individual questions to subtle differences in performance or that the population measured is homogeneous and lacks variability. Two of the questions, 1 and 1a, both in the category Independence appear to approach a more normal curve in the distribution of scores that they measure.

Table 5

Means, Ranges, and Standard Deviations for the Individual Questions That Comprise the VSS

<table>
<thead>
<tr>
<th>Individual questions</th>
<th>N</th>
<th>Mean</th>
<th>SD</th>
<th>Range</th>
</tr>
</thead>
<tbody>
<tr>
<td>General 1</td>
<td>34</td>
<td>4.80</td>
<td>.54</td>
<td>3</td>
</tr>
<tr>
<td>General 2</td>
<td>34</td>
<td>4.01</td>
<td>1.08</td>
<td>4</td>
</tr>
<tr>
<td>General 3</td>
<td>34</td>
<td>4.40</td>
<td>.92</td>
<td>5</td>
</tr>
<tr>
<td>Independence 1</td>
<td>34</td>
<td>2.56</td>
<td>1.13</td>
<td>5</td>
</tr>
<tr>
<td>Independence 1a</td>
<td>34</td>
<td>2.65</td>
<td>1.15</td>
<td>5</td>
</tr>
<tr>
<td>Independence 2</td>
<td>34</td>
<td>4.80</td>
<td>.48</td>
<td>3</td>
</tr>
<tr>
<td>Independence 3</td>
<td>34</td>
<td>4.10</td>
<td>1.36</td>
<td>5</td>
</tr>
<tr>
<td>Social 1</td>
<td>34</td>
<td>4.80</td>
<td>.48</td>
<td>2</td>
</tr>
<tr>
<td>Social 2</td>
<td>34</td>
<td>4.04</td>
<td>1.19</td>
<td>5</td>
</tr>
</tbody>
</table>

The Pearson product-moment correlation coefficients for relationships between the individual subscores and total score are summarized in Table 6. All of the individual subscores have significant relationships with the
<table>
<thead>
<tr>
<th></th>
<th>PROCT</th>
<th>LNG</th>
<th>STMNA</th>
<th>GENSBTOT</th>
<th>INDSTOT</th>
<th>SOCBTOT</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG</td>
<td>.2596</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = .069</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STMNA</td>
<td>.1370</td>
<td>-.0342</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = .220</td>
<td>p = .424</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>GENSBTOT</td>
<td>.0671</td>
<td>.2688</td>
<td>.1894</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = .353</td>
<td>p = .062</td>
<td>p = .142</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDSTOT</td>
<td>.4927</td>
<td>.4803</td>
<td>.4123</td>
<td>.3186</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = .002</td>
<td>p = .002</td>
<td>p = .008</td>
<td>p = .033</td>
<td></td>
<td></td>
</tr>
<tr>
<td>SOCSBTOT</td>
<td>.0404</td>
<td>-.0008</td>
<td>-.0651</td>
<td>.3906</td>
<td>.0162</td>
<td></td>
</tr>
<tr>
<td>TOTALSCR</td>
<td>.5183</td>
<td>.5411</td>
<td>.4649</td>
<td>.6253</td>
<td>.8464</td>
<td>.3585</td>
</tr>
<tr>
<td></td>
<td>p = .001</td>
<td>p = .000</td>
<td>p = .003</td>
<td>p = .000</td>
<td>p = .000</td>
<td>p = .019</td>
</tr>
</tbody>
</table>

Note: N = 34, Productivity (PROCT), Learning (LNG), Persistance/Attention/Stamina (STMNA), General Area (GENSBTOT), Independence Subtotal (INDSTOT), Social Subtotal (SOCSBTOT), Total Score (TOTALSCR).
total score, although the relationship between the Social subtotal and total score is smallest. Additionally, there is a significant relationship between the behavior Independence subscore and all of the other behaviors' subscores except Social. This result would support the notion that the behavior Independence is measuring some characteristics or variables that are related to the other behaviors.

**Hypothesis 1:** In order to test Hypothesis 1, a Pearson product-moment correlation coefficient was computed to test the null hypothesis that there would be no difference in the relationship between the subscores of Independence and Learning and the relationship between any other pair of subscores from the VSS. The Pearson product-moment correlation coefficient did indicate a significant relationship between the Learning subscore and the Independence subscore, $p = .002$ (see Table 6). However, there were other subscores that had significant relationships with Independence, for example, Productivity $p = .002$, Persistence/Attention/Stamina $p = .008$, and General subtotal $p = .033$ (see Table 6). The relationship between Productivity and the Independent subtotal was greater than that between Independence and Learning, i.e., $r = .4927$ and $r = .4803$, respectively. Therefore, the null hypothesis of no difference in the relationships between the subscores of Independence and Learning and the
relationship between any other subscores of the VSS could not be rejected at the established \( p < .05 \) level of confidence.

**Hypothesis 2:** The null hypothesis for Hypothesis 2 stated that there will be no difference in the relationship between the Independence subscore and the total score of the VSS and the relationship between any other subscore and the total score of the VSS. The results obtained indicated a significant relationship between all the subscores and the total score from the VSS (see Table 6). However, the magnitude of the correlation between the subscore for Independence and the total score is \( r = .8464 \), whereas the other correlations range from \( r = .3585 \) to \( r = .6253 \). Therefore, the null hypothesis of no difference in the relationships between the Individual subscore and the total score of the VSS and the relationship between any other subscore and the total score was rejected at the established \( p < .05 \) level of confidence.

**Hypothesis 3:** The null form of Hypothesis 3 stated a zero Pearson product-moment correlation coefficient between the Categories test impairment rating and the sub-total score from the behavior Independence. The obtained correlations (see Table 7) were \( r = -.6781, p = .008 \), with the Categories impairment rating and \( r = -.7037, p = .005 \), for the relationship of the Independent subscore with the Categories raw score. Therefore at the \( p < .05 \) level of
confidence the null hypothesis of no relationship can be rejected.

Table 7

Pearson Product-Moment Correlation Coefficients Between the Vocational Scaling System Subscores and Total Score and the Impairment Rating and Raw Scores for Trails B and Categories Test

<table>
<thead>
<tr>
<th></th>
<th>TRAILS</th>
<th>TRAILS (RAW)</th>
<th>CATEGORIES</th>
<th>CATEGORIES (RAW)</th>
</tr>
</thead>
<tbody>
<tr>
<td>PRDCT</td>
<td>-.2137</td>
<td>-.2150</td>
<td>-.1951</td>
<td>-.1994</td>
</tr>
<tr>
<td></td>
<td>( p = .264 )</td>
<td>( p = .263 )</td>
<td>( p = .272 )</td>
<td>( p = 2.67 )</td>
</tr>
<tr>
<td>LNG</td>
<td>-.0737</td>
<td>-.0957</td>
<td>-.1549</td>
<td>-.1974</td>
</tr>
<tr>
<td></td>
<td>( p = .415 )</td>
<td>( p = .390 )</td>
<td>( p = .315 )</td>
<td>( p = .269 )</td>
</tr>
<tr>
<td>STMNA</td>
<td>-.0598</td>
<td>-.1183</td>
<td>-.0918</td>
<td>-.0431</td>
</tr>
<tr>
<td></td>
<td>( p = .431 )</td>
<td>( p = .364 )</td>
<td>( p = .388 )</td>
<td>( p = .447 )</td>
</tr>
<tr>
<td>GENSBTOT</td>
<td>-.1256</td>
<td>-.3432</td>
<td>-.2325</td>
<td>-.1616</td>
</tr>
<tr>
<td></td>
<td>( p = .356 )</td>
<td>( p = .151 )</td>
<td>( p = .234 )</td>
<td>( p = .308 )</td>
</tr>
<tr>
<td>INDSMTOT</td>
<td>-.6047</td>
<td>-.4754</td>
<td>-.6781</td>
<td>-.7037</td>
</tr>
<tr>
<td></td>
<td>( p = .024 )</td>
<td>( p = .070 )</td>
<td>( p = .008 )</td>
<td>( p = .005 )</td>
</tr>
<tr>
<td>SOCSBTOT</td>
<td>.1982</td>
<td>.2385</td>
<td>-.3290</td>
<td>-.4003</td>
</tr>
<tr>
<td></td>
<td>( p = .279 )</td>
<td>( p = .240 )</td>
<td>( p = .106 )</td>
<td>( p = .099 )</td>
</tr>
<tr>
<td>TOTALSCR</td>
<td>-.4011</td>
<td>-.4631</td>
<td>-.4197</td>
<td>-.4527</td>
</tr>
<tr>
<td></td>
<td>( p = .111 )</td>
<td>( p = .076 )</td>
<td>( p = .087 )</td>
<td>( p = .070 )</td>
</tr>
</tbody>
</table>

Hypothesis 4: The null form of Hypothesis 4 stated a zero Pearson product-moment correlation coefficient between the Trails B impairment rating and the subtotal score for the behavior Independence. The obtained correlation (see Table 7) was \( r = -.6047, p = .024 \). The null hypothesis was, therefore, rejected and the conceptual hypothesis of a linear negative relationship between the...
Independent subscore and the Trails B impairment rating was supported.

Additional Statistical Analysis

Additional statistical procedures were computed on the research data in an attempt to analyze the structure of the VSS and understand relationships between individual scores, subscores, and the total score. This was also done between the subscores and the total score from the VSS and the raw scores and impairment rating of both Trails B and the Categories test.

Pearson product-moment coefficients of correlations provided in Table 8 describe the relationships between the individual questions from the behavior Independence and the individual behavior subscores and total score from the VSS. The results would suggest a significant relationship between each of the individual questions and Productivity, where three of the four questions (Independence 2 did not meet established level of critical value for the Pearson product-moment correlation coefficient) established a relationship at the $p < .05$ level of confidence with correlation coefficients ranging from $r = .335$ to $r = .383$.

Table 8 summarizes the relationships between the individual questions from the behavior Independence and the total score from the VSS. Results indicate that three
Table 8

Pearson Product-Moment Correlation Coefficients for the Relationship Between the Vocational Scaling System Subscore, Total Score, and the Individual Questions for the Behavior Independence

<table>
<thead>
<tr>
<th>ITEM</th>
<th>PRDCT</th>
<th>LNG</th>
<th>STMNA</th>
<th>GENSBTOT</th>
<th>SOCSBTOT</th>
<th>TOTALSCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDP 1</td>
<td>.340</td>
<td>.269</td>
<td>.706</td>
<td>.093</td>
<td>-.075</td>
<td>.653</td>
</tr>
<tr>
<td></td>
<td>p = .025</td>
<td>p = .062</td>
<td>p = .000</td>
<td>p = .301</td>
<td>p = .337</td>
<td>p = .000</td>
</tr>
<tr>
<td>INDP 1a</td>
<td>.335</td>
<td>.378</td>
<td>.117</td>
<td>.195</td>
<td>.063</td>
<td>.575</td>
</tr>
<tr>
<td></td>
<td>p = .026</td>
<td>p = .014</td>
<td>p = .255</td>
<td>p = .134</td>
<td>p = .363</td>
<td>p = .000</td>
</tr>
<tr>
<td>INDP 2</td>
<td>.289</td>
<td>.085</td>
<td>-.296</td>
<td>-.115</td>
<td>-.238</td>
<td>.030</td>
</tr>
<tr>
<td>INDP 3</td>
<td>.383</td>
<td>.452</td>
<td>.297</td>
<td>.479</td>
<td>.128</td>
<td>.767</td>
</tr>
<tr>
<td></td>
<td>p = .013</td>
<td>p = .004</td>
<td>p = .044</td>
<td>p = .002</td>
<td>p = .236</td>
<td>p = .000</td>
</tr>
</tbody>
</table>

Note: N = 34 Independence (INDP)
of the four questions have strong relationships with the total score at the established level of confidence. For these three questions, (Independence 2 did not fulfill the .05 confidence level requirement), correlational coefficients range from $r = .575$ (INDP 1a) to a high of $r = .767$ for INDP 3. In fact the correlation for INDP 3 of $r = .767$ established the second highest relationship, second only to that between the Independent subscore and the total score ($r = .846$). This would suggest that the behavior/skill/ability measured by the questions comprising the behavior Independence, specifically INDP 3, are sensitive to the overall performance of an individual on the VSS as measured by the total score.

Table 9 summarizes the relationships between the individual questions and the subscore for the behavior Independence. It should be noted that all of the individual questions, except INDP 2, meet the established confidence level of $p < .05$ when correlation coefficients are established. This would indicate that three of the four questions are sensitive to similar skills/abilities and that INDP 2 does not appear to measure a similar variable.
Table 9

Pearson Product-Moment Correlation Coefficients
for the Relationship Between the Individual
Questions and Subscore of the
Behavior Independence

<table>
<thead>
<tr>
<th>ITEM</th>
<th>INDP 1</th>
<th>INDP 1a</th>
<th>INDP 2</th>
<th>INDP 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>INDP 1a</td>
<td>.481</td>
<td>.084</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = .002</td>
<td>p = .3318</td>
<td></td>
<td></td>
</tr>
<tr>
<td>INDP 2</td>
<td>.051</td>
<td>.084</td>
<td>.010</td>
<td></td>
</tr>
<tr>
<td></td>
<td>p = .387</td>
<td>p = .023</td>
<td>p = .477</td>
<td></td>
</tr>
<tr>
<td>INDP 3</td>
<td>.409</td>
<td>.344</td>
<td>.223</td>
<td>.765</td>
</tr>
<tr>
<td></td>
<td>p = .008</td>
<td>p = .023</td>
<td>p = .103</td>
<td>p = .000</td>
</tr>
</tbody>
</table>

Table 10 summarizes the results of the correlational study completed on the relationships between the individual questions that comprise the behavior General and subscores and total scores of the VSS. It should be noted that none of the individual questions nor the general subtotal score reached the established level of p < .05 in their relationships with the subscores of Productivity, Stamina, and Learning. This indicates that the behavior General is sensitive to the measurement of variables different from those measured by these three behaviors. The question GEN 1 in fact does not meet the accepted level of confidence with any of the behavioral subscores or total score. Question GEN 3 does establish a significant relationship with the Independence subtotal score.
<table>
<thead>
<tr>
<th>ITEM</th>
<th>PRDCT</th>
<th>LNG</th>
<th>STMNA</th>
<th>SOCSBTOT</th>
<th>INDPSTOT</th>
<th>TOTALSCR</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEN 1</td>
<td>.024</td>
<td>.145</td>
<td>-.081</td>
<td>.033</td>
<td>-.083</td>
<td>-.011</td>
</tr>
<tr>
<td></td>
<td>(p = .446)</td>
<td>(p = .207)</td>
<td>(p = .324)</td>
<td>(p = .427)</td>
<td>(p = .320)</td>
<td>(p = .476)</td>
</tr>
<tr>
<td>GEN 2</td>
<td>-.094</td>
<td>.019</td>
<td>.147</td>
<td>.340</td>
<td>.043</td>
<td>.369</td>
</tr>
<tr>
<td></td>
<td>(p = .298)</td>
<td>(p = .457)</td>
<td>(p = .203)</td>
<td>(p = .024)</td>
<td>(p = .404)</td>
<td>(p = .016)</td>
</tr>
<tr>
<td>GEN 3</td>
<td>.219</td>
<td>.384</td>
<td>.221</td>
<td>.296</td>
<td>.580</td>
<td>.716</td>
</tr>
<tr>
<td></td>
<td>(p = .107)</td>
<td>(p = .013)</td>
<td>(p = .104)</td>
<td>(p = .045)</td>
<td>(p = .000)</td>
<td>(p = .000)</td>
</tr>
<tr>
<td>GENSBTOT</td>
<td>.067</td>
<td>.269</td>
<td>.189</td>
<td>.391</td>
<td>.319</td>
<td>.625</td>
</tr>
<tr>
<td></td>
<td>(p = .353)</td>
<td>(p = .062)</td>
<td>(p = .142)</td>
<td>(p = .011)</td>
<td>(p = .033)</td>
<td>(p = .000)</td>
</tr>
</tbody>
</table>

Note: \(N = 34\)
(r = .580) and the total score (r = .716) at the established levels of confidence. The General subtotal score also exhibits a strong relationship (r = .625) with the total score and it appears that each of these scores are sensitive to similar variables.

The Pearson product-moment correlation coefficients were calculated to determine the relationships between the individual questions and the subscore for the behavior General (see Table 11). It should be noted that none of the relationships between the individual questions met the established level of confidence, whereas two of the three questions satisfied this requirement when establishing the relationship with the General subscore. A closer inspection of the correlational coefficients shows a range of r = .677 (Gen 3) to r = .824 (Gen 2).

Table 11

<table>
<thead>
<tr>
<th>ITEM</th>
<th>GEN 1</th>
<th>GEN 2</th>
<th>GEN 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>GEN 2</td>
<td>.110</td>
<td>.268</td>
<td></td>
</tr>
<tr>
<td>GEN 3</td>
<td>-.136</td>
<td>.270</td>
<td>.062</td>
</tr>
<tr>
<td>GENSBTOT</td>
<td>.317</td>
<td>.824</td>
<td>.677</td>
</tr>
</tbody>
</table>

Note: N = 34
Table 12 summarizes the relationships between the individual questions that comprise the behavior Social, its subtotal score, and the total score for the VSS. The relationships between the individual questions and the subtotal score are both significant; especially the relationship between SOC 2 and the subtotal score. However, the relationships between the individual questions and subtotal score and the total score are weaker. In the case of SOC 2 the Pearson product-moment correlation coefficient did not reach the required probability level.

<table>
<thead>
<tr>
<th></th>
<th>SOC 1</th>
<th>SOC 2</th>
<th>SOCT</th>
</tr>
</thead>
<tbody>
<tr>
<td>SOC 2</td>
<td></td>
<td>.522</td>
<td></td>
</tr>
<tr>
<td></td>
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<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>P</td>
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<td></td>
</tr>
<tr>
<td></td>
<td>=</td>
<td>.001</td>
<td></td>
</tr>
<tr>
<td>SOCSBTOT</td>
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<td>.735</td>
<td>.962</td>
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<td></td>
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<td>P</td>
</tr>
<tr>
<td></td>
<td>=</td>
<td>.000</td>
<td>.000</td>
</tr>
<tr>
<td>TOTALSCR</td>
<td>.400</td>
<td>.290</td>
<td>.358</td>
</tr>
<tr>
<td></td>
<td>P</td>
<td>.010</td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>=</td>
<td></td>
<td>.048</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>P</td>
</tr>
<tr>
<td></td>
<td>=</td>
<td>.019</td>
<td></td>
</tr>
</tbody>
</table>

Note: N = 34

Summary

Hypothesis 1 predicted that the relationship between the subscores for the behaviors Independence and Learning
would be greater than the relationship between any two other behaviors measured by the VSS. This hypothesis was not supported by the results and the null hypothesis could not be rejected at $p > .05$. Data analysis found that there was a relationship between Independence and Learning i.e., $r = .480$ ($p = .002$); however, there were other relationships between the subscores that precluded acceptance of the hypothesis.

A comparison of the relationships between the subscores of the VSS found that the Independent subscore had significant correlations with Productivity, $r = .4927$ ($p = .002$); Stamina, $r = .4133$ ($p = .008$); and the General subtotal scores, $r = .3186$ ($p = .033$). Additionally, it was found that there was a significant correlation between the Social and General subscores, i.e., $r = .3906$ ($p = .011$).

The results of these comparisons (see Table 6) would indicate that the behavior Independence subscore has the greatest number of significant relationships with the subscores of the other behaviors. However, the relationship between Learning and Independence is not significantly greater than the relationships between some of the other behaviors.

It is interesting to note that the Independence subscore correlates with a significant number of other behaviors. The significant correlations range from
would indicate that the behavior Independence is measuring some variable, or group of variables, that influences the individual's performance on each behavior. This would indicate that those behaviors measured by Independence, i.e., work flexibility, organizational and self-monitoring skills, and ability to initiate activities independently, have certain features that impact on performance in the areas of Productivity, General, and Learning.

Hypothesis 2 stated that there would be a significant relationship between the behavior subtotal score from Independence and that of the total score (see Table 6). The null hypothesis was rejected at the $p < .05$ level of confidence following the analysis of the data. Results indicate a positive relationship, $r = .8465 (p = .000)$, between the two scores. This indicates that increased performance on the variables measured by Independence subsequently relates to a better overall score as measured by the VSS total score. This is partially due to the fact that the Independence subscore contributes a greater possible weight to the total score i.e., approximately 33% of the total. However, a review of the individual questions' relationship to the total score (see Table 8) shows that three of the four reach statistically significant levels when Pearson product-moment correlational coefficients are obtained, with only Question 3 (INDP 3) not
meeting established $p < .05$ criterion. The results would provide added support to the idea that the behaviors measured by Independence are sensitive to the overall performance on the VSS as reflected by the total score.

Hypotheses 3 and 4 were related to the hypothesis that the subscore for the behavior Independence would be sensitive to the severity of the TBI. The Categories test and Trails B test, both subtests of the Halstead-Reitan Neuropsychological Test Battery, were chosen as measures of severity due to their sensitivity to the effects of brain damage. Table 7 summarizes the results of the data analysis supporting the conceptual hypothesis and rejecting the null hypothesis of no relationship. The behavior Independence was found to have a significant negative relationship with Trails B impairment rating, $r = -0.6047$ ($p = .024$), and the Categories test impairment rating, $r = 0.6781$ ($p = .008$). The negative correlation can be explained through an understanding that as performance decreases on Trails B and the Categories test, the impairment rating increases, whereas the opposite is true with the subscore for Independence.

None of the other behavior subscores or even the total score for the VSS were found to have a statistically significant relationship with either the Categories or Trails B impairment rating. This would indicate that the total score may not be sensitive to the severity of the
TBI and that the individual subtests may not be measuring behaviors/variables similar to those measured by Trails B and Categories.

The Categories test, as previously reviewed, requires an individual to analyze the nature of incoming stimulus, assess this input and establish a plan of action, i.e., organize activities, and then act upon this plan by performing certain activities. These requirements are very similar to the type of behavior that the Independence subtest purports to measure. The established relationship would support this contention and also reinforce a belief that the behavior Independence is the most cognitively demanding component of the VSS.

Trails B, as previously reviewed, requires an individual to utilize visual-spatial searching, analysis, and reasoning abilities in order to perform the test successfully. It also has been found to be sensitive to brain impairment. A review of Table 7 shows that there was a significant negative relationship between Trails B impairment rating and the Independence subscore. This relationship lends additional support to the contention that Independence measures the ability of an individual to analyze and organize incoming input and then initiate activity based upon these data.

Pearson product-moment correlation coefficients were obtained to determine the relationship between impairment
rating for the Categories test and Trails B. Results of that analysis did not reach accepted levels of significance i.e., \( p < .05 \). This would support the conclusion that within this sample each test is sensitive to different variables and that the behavior Independence is sensitive to each of these groups of variables.
CHAPTER IV

FINDINGS, CONCLUSIONS, AND RECOMMENDATIONS

Summary

This study was undertaken to analyze the structure of the Vocational Scaling System (VSS) and to determine the relationships between the behaviors that comprise its structure as well as its sensitivity to brain injury. The VSS was developed by Hope Rehabilitation Network (HRN) to assess the job performance of individuals who had experienced some form of traumatic brain injury. The staff at HRN were unable to identify an existing instrument that met their program needs and, therefore, developed the VSS to evaluate actual performance in an on-the-job setting in six specific behavioral domains. The scale provides a means to objectively measure, in a numerical fashion, job performance, thereby providing a mechanism to evaluate progress and identify specific areas of concern.

Ben-Yishay et al. (1982) noted, in their study at New York University Medical Center, that the types of instruments needed to adequately assess and describe the residual effects of a head injury were not available. They also reported that in order to adequately evaluate the vocational potential of a traumatically brain injured
(TBI) individual the evaluation should take place in as real a job setting as humanly possible. A review of the existing instruments for evaluating the effects of and improvement following a TBI found that many were directed at measuring that limited period of time following post-acute rehabilitation to completion of inpatient medical rehabilitation services. As such they either ignored assessing vocational performance or evaluated it in too simplistic a fashion to be practical for use at HRN.

The effects of a traumatic brain injury are diverse and lack uniformity in their occurrence following the trauma of the incidence. This study was limited to a subgroup of traumatic brain injured individuals, the closed head injured population. This population is composed of individuals who have experienced some type of injury as a result of an impact of an object with the head. The residual damage is subsequently caused by the sudden shifting of the brain within the skull and results in a more diffuse type of brain damage than is experienced by someone following a penetrating or other more focalized type of brain injury (Benton, 1979).

The residual deficits following a TBI are diverse and can fall within four distinct areas of functioning. These are: (1) physical, (2) cognitive, (3) psychological, and (4) behavioral (Ben-Yishay et al., 1987). The vocational implications that can result from these areas of deficit
can be equally diverse and present barriers to determining the vocational potential of the individual. Numerous studies have been undertaken to determine vocational outcomes following head injury. The results have been diverse and at times contradictory with successful return to work rates ranging from as low as 24% to a high of close to 100% (Kay et al., 1984). The reasons often identified for the failure to either obtain or maintain employment were: (a) memory difficulties, attentional deficits, and lack of persistence; (b) disinhibition; (c) inappropriate interpersonal skills; (d) failure to understand/accept residuals of injury; and (e) lack of realistic vocational goals.

Existing instruments, as previously stated, were not adequate for assessing vocational skills and job performance. They lacked the ability to measure the diverse variety of deficits that can result from a TBI and also were structurally flawed. They assumed that vocational potential could be generalized from the sum of the scores that were obtained by measuring discrete skills and abilities. This approach, however, was not appropriate with the traumatic brain injured population since the parameters assumed in its development were not generalizable to the traumatic brain injured population (Silver et al., 1982). Additionally, these instruments were developed to be utilized in a restricted environment rather than an
actual job setting in which HRN program participants are assessed.

Two subtests of the Halstead-Reitan Neurological Test Battery, Trails B and Categories, were chosen as measures of brain impairment due to their sensitivity to brain damage (Reitan & Wolfson, 1986). The individual subscores and the total score from the VSS were compared to these two test impairment ratings to determine the relationships between them. It was hypothesized that the subscore for the behavior Independence would have the most significant relationship to these measures since it required the most utilization of cognitive abilities that may be affected by a TBI and, therefore, should be the most sensitive score to brain impairment. It was further hypothesized that the relationship between the subscores for the behaviors Independence and Learning would also have a significant positive relationship because of the strong dependence upon a memory component in the structure for both behaviors and the negative impact a TBI has on memory capabilities.

The statistical analysis utilized to test each of the four hypotheses was the Pearson product-moment correlation coefficient. This method was utilized to establish the relationship between interval data.
Findings

Three of the four null hypotheses were rejected with only Hypothesis 1 failing to reach established levels of significance. The results suggest that the score for the behavior Independence is sensitive to the effects of brain impairment and is significantly related to the total score obtained from the VSS. Hypothesis 1, which predicted that the subscores for the behaviors Independence and Learning would have a significant and positive relationship was not rejected. This may be indicative of the behavior Learning being comprised of a more diverse range of skills and abilities than the memory component initially proposed and as such is sensitive to the effects of different cognitive deficits than those measured by the Independence subscore.

Hypothesis 2 stated that the relationship between the subscore for the behavior Independence and the total score for the VSS would have a significant positive relationship. This was strongly supported with the high order of the correlation that was obtained. Finally, Hypotheses 3 and 4 predicted that there would be a significantly negative relationship between the subscore for the behavior Independence and the impairment ratings from Trails B and the Categories test. The null hypothesis was rejected on both of these and the conceptual hypothesis that the subscore for Independence would be the most sensitive score on the VSS to severity of brain injury was

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supported. Overall the results indicate that the behavior Independence is the most sensitive score of the VSS to the severity of brain injury. Also the behavior Independence appears to be measuring some variable, or group of variables, that are common not only to the total score but also to the behaviors Productivity, Learning, and Stamina.

Conclusions

This study was undertaken to evaluate the structure and relationships between the different behaviors as measured by the VSS. Secondarily, it hypothesized that the behavior Independence was the most cognitively demanding behavior measured and as such should also be sensitive to the severity of the brain injury. Therefore the sub-score from this behavior should have a strong relationship with the total score from the VSS and with the impairment rating from the Trails B and the Categories test, two of the subtests from the HRNTB which are sensitive to brain impairment.

The Vocational Scaling System was developed by staff at Hope Rehabilitation Network to provide an instrument to evaluate vocational performance in an on-the-job setting. Its structure, and the behavioral categories that it measures, were chosen after reviewing program needs and the unique problems exhibited by the TBI population in an on-the-job setting (see Appendix A). This study is the
first effort to evaluate the relationships of the sub-scores and total score from the VSS and also to establish the relationships of these scores with some independent instrument i.e., Trails B and the Categories test of the HRNTB.

In the present study, the relationship between the behavior Independence and the total score and the sub-scores of the VSS was established. It was determined that the behavior Independence exhibited a significant positive relationship with the behaviors Productivity, Learning, and Stamina as well as a significant positive relationship with the total score. In fact, Independence was found to have significant relationships with more of the other behaviors than any other pair of subscores. This supported the idea that Independence measures a category of skills/abilities that are interrelated with the other behaviors. It would also support the idea that the VSS total score is closely related to the Independent subscore and may be overly influenced by its contribution. This influence may be reflective of the size of the numerical contribution to the total score, or it may be reflective of the significance performance in that category has on the overall score for the VSS of the individual being evaluated.

Additional statistical analysis was obtained on the relationship between the individual components of the
behavioral groups and their respective subscores, other behavior subscores, and the total score of the VSS. Results obtained showed that three of the four individual components of the behavior Independence related significantly with the Independence subscore and also the total score of the VSS. These results would reinforce the contention that Independence, as a category, was sensitive to similar skills/abilities as measured by the VSS total score. It should be noted that question INDP2 did not exhibit a significant relationship with the Independent subscore, total score, or any of the other subscores of the VSS. This particular question is related to job quality. A review of its mean of 4.8, standard deviation of .48, and range of 3 would indicate that it may not be sensitive enough to decrease ability in the performance of the quality control task. This area may not be negatively influenced by the head injury in this sample group, or the individual ranges for each score are too broad to discriminate between individual differences in performance. Overall, it would indicate that in terms of consistency and cohesiveness in measuring similar or related variables behavior Independence, as a score, exhibits a low positive relationship between its individual questions and the variables that they measure. Additionally each of this subgroup of variables (except for INDP2) has a relationship with, and contributes approximately evenly to the
The question INDP2 does not show a significant relationship with the subscore or the other components that comprise the behavior Independence and consideration should be given to modification of its structure or removing it from the scale.

Similar results were obtained for the relationships between the individual questions and the subtotal and total score for the behaviors General and Social. The General subscore and its individual questions showed significant positive relationships between the individual questions (except GEN 1), the General subtotal score, and the VSS total score. These relationships, although varying in strength, indicate that both question GEN 2 and GEN 3 appear to contribute to the General subscore and also exhibit a significant positive relationship with the VSS total score. The lack of a significant relationship between the individual questions would indicate that they measure different variables. Question GEN 1, contrary to the other two, does not show any significant relationship with the other questions, General subscore, or the VSS total score. This question is related to appropriateness of dress and hygiene issues and may not be a good measure of the area due to a lack of ability to discriminate between differences and appropriate work attire. The mean of 4.8, standard deviation of .54, and range of 3 may indicate a homogeneity in the population sample and could
also be an indicator that this particular behavior may not be an appropriate part of the scale. Consideration should be given to modification of the question or removing it from the scale. Overall the General subtotal score and individual questions (excluding GEN 1) exhibit a significant positive relationship with the total score from the VSS and appear to be measuring different skills/abilities than the other behavioral categories.

The Social behavioral group exhibited a significant positive relationship between the two questions that comprise the subtotal as well as with the subtotal score and the total score. The relationship between question SOC 2 and the total score was strong at $r = .962$, $p = .000$, and would indicate that this question measures a variable/behavior that is closely related to the total score. Questions SOC 2 is a measure of what is described as a minor social infraction, such as socially inappropriate behavior in a work behavior. This significantly positive relationship with the total score is very high and further reinforces the research findings that indicate that behavioral problems are one of the possible consequences of a TBI (Benton, 1979; Musante, 1983). The question SOC 1 is a measure of major social infractions, such as threatening behavior and assaults. This question had a low positive relationship with the subscore and total score from the VSS. A close examination of its mean
of 4.8, SD of .48, and range of 2 shows a significant homogeneity among the study population. This may be reflective of an active decision process by HRN staff to avoid admitting individuals with these behavioral problems into the program or excluding them from placement in the vocational component of the program. Consideration should be given to whether or not these questions continue to be appropriate for this scale or whether it should be modified or excluded.

The other behaviors measured by the VSS are composed of only one question; these areas are Productivity, Learning, and Stamina. Each of these three behaviors had a low but significant positive relationship with the total score of the VSS. Individually, they exhibit a significant relationship with only the behavior Independence; and therefore, each would appear to measure different variables or characteristics.

The behavior Independence, as hypothesized, appears to be the most sensitive behavior on the VSS to the severity of brain injury. Its strong negative relationship to the impairment rating obtained from Trails B and the Categories test from the HRNTB support this assumption. The results of the analysis of the relationships between the other behaviors and these two instruments were inconclusive and would indicate that the skills and abilities that they measure may not be as affected by the severity
of the head injury. This does not indicate that they are not diminished following a TBI but rather that they may not be reduced proportionally to the severity of the injury. It may also indicate that the affects of a TBI may have some type of plateau effect whereby skills are diminished but not necessarily proportional to the severity of injury.

Additionally, the behavior Independence appears to measure some groups of skills/abilities that is related to the other behaviors within the VSS. The positive relationships, although not always strong, would support the notion that that group of variables that comprise the behavior Independence is also closely related to the individual behaviors measured by the other behavioral groups within the VSS.

The results of this study would indicate that only the behavior subscore for Independence could be used to assess vocational potential if the potential for return to work is negatively effected by severity of brain injury. The results of previous studies regarding the return to work potential of head injured individuals has identified a relationship between severity of the injury and successful return to work (Wehman et al., 1988). These findings have shown that the more severe the injury the less likely it is for a return to work. The total score does not appear to be sensitive to the severity of injury and as
such would not adequately project employability if the severity of the injury has a negative impact on potential as has been previously noted. These results may reflect that there is a disproportional amount of contribution from some of the behaviors measured or possibly the lack of significant input obtained from some of the behavior scores in establishing the total score for the VSS.

The results of this research indicate that the behaviors that the VSS attempts to measure have been identified by other research to be negatively effected by a head injury and as such need to be evaluated to determine vocational potential. The question still remains, however, whether each of these areas is being adequately assessed and what predictive weight each should have in determining employability. The behavior Independence was found to have a significant relationship with severity of injury and as such would appear to be the behavior most negatively impacted by a closed head injury. However, the rest of the scale needs to undergo further study to ascertain its exact relationship to those behaviors it purports to measure. The lack of validity studies to determine if each of the behaviors measures what HRN staff reports it measures is a weakness. The individual behaviors have face validity; however, the individual questions and choice of possible responses may need to be modified in order to more adequately assess individual differences.
This is especially important in those three behavioral categories that are comprised of only one question and as such may not adequately measure the content area. Additionally, studies need to be undertaken to determine the criterion-related validity of the VSS to determine whether there is a relationship between the total score and the ability to maintain competitive employment. This study will need to be longitudinal and structured such as to avoid or acknowledge contamination of the concept employability. Numerous studies have defined employability as the ability to maintain a job within a setting that is not always realistic, some of these settings provide special support services in order to stabilize and maintain that individual in the job. Additionally, sheltered workshops and supported work programs are included in these groups. These situations are not comparable to competitive employment, since special services and work provisions are provided to individuals that are unavailable to non-handicapped individuals.

The results of this study would not support the premise that the behavior Social, which measures the ability to interact appropriately with supervisors and co-workers and assesses the ability to follow written and verbal instructions, is being adequately assessed. The homogeneity of scores (especially SOC 2) would question whether it is sensitive enough to the range and frequency
of the inappropriate behaviors that can be exhibited by the TBI individual. A decreased ability to modulate behavior is one area that has been identified as a consequence of a TBI; however, findings of this study do not support that contention based upon a review of this sample. This appears to be reflective of the structure of the individual question and possible choices rather than a population variable. This behavioral measure needs to be expanded to add a measure(s) that assess ability to follow directions as well as accept and utilize feedback from supervisors. These areas are lacking at this time.

The VSS total score, as noted previously, is not affected equally by the performance of an individual on each of the six behaviors measured. Some of the behaviors i.e., Stamina, Learning, and Productivity, can contribute to a maximum of approximately 8% of the total score due to the limited number of contributing questions. Social, General, and Independence contribute up to approximately 17%, 25% and 34%, respectively, of the possible total score. The effects of this disproportionate contribution needs to be reviewed and a rationale based upon some established criteria needs to be formalized to continue this practice or to adjust the individual behaviors accordingly. (It should be noted that HRN is now currently assigning specific weights to each behavior to adjust the total score.)

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Recommendations

The following recommendations include suggestions for additional research and possible changes that can be made in the Vocational Scaling System. Initially, discussion will outline further research that can be pursued with this instrument after which possible areas where changes/modifications can be considered will be discussed.

The Vocational Scaling System needs to be evaluated to determine whether or not it is a valid measure of employability. This research needs to be pursued in two different areas to assess: (1) ability to measure behaviors it purports to measure, and (2) whether or not the total score is predictive of the ability to obtain and maintain competitive employment.

Criterion-related validity needs to be established on each of the individual behaviors to determine the extent to which they measure those skills/abilities that they were developed to assess. Additionally, content validity needs to be evaluated to determine whether the VSS is measuring all the areas of behavior that need to be assessed to measure the concept of job performance and employability. Numerous studies have been undertaken to determine what types of skills/abilities are affected by a TBI and their effect on employability. Further research needs to be undertaken to evaluate what other behaviors may have an influence on employability and how each of
these behaviors can be assessed. This will probably
require that individual behaviors be broken down into
their cognitive components and then these individual areas
will need to be evaluated in an on-the-job setting if
possible. This may require a much larger measuring in­
strument than initially anticipated and will also require
a more systematic approach to evaluated work performance.
Consideration will need to be given to the practicality of
this approach and weigh the specific needs of the treat­
ment program to determine the benefit of such changes.

Additionally, research needs to be undertaken to
assess the predictive contribution that each behavior has
in determining employability and measuring work site
performance. The current structure of the VSS allows for
some of the behaviors measured to provide a dispropor­
tionate weight to the total score. A need exists for data
on which to assign appropriate weights to the individual
behaviors so as to adequately measure their contribution
to the overall employability of an individual.

The ability of the VSS to predict a TBI individual's
ability to obtain and maintain competitive employment
needs to be undertaken through a longitudinal study. A
follow-up study of employment status needs to be under­
taken to establish the relationship between outcome and
the total score of the VSS. This will allow for further
modifications and changes not only in the VSS but possibly
in the structure of the services offered to TBI individuals.

Finally, a more systematic approach needs to be established by which the VSS is utilized in assessing performance. A review of client records at HRN exhibited a lack of consistency in the use of the VSS, with some program participants not being evaluated on a regular basis.

The current questions of the VSS need to be reviewed and consideration given to dropping some of them. As was previously noted, Questions GEN 1, SOC 1, and INDP 2 do not appear to be contributing significantly enough to warrant their continued use. Consideration should be given to changing or modifying their structure such that they are more sensitive to measuring the behaviors they were developed to assess.

The findings of this study should not be taken as suggesting the total restructuring of the VSS. The VSS was initially developed to meet a specific need to objectively measure and numerically rate on-site work performance of the TBI population. It currently does perform that function and is still in the developmental process. These findings offer an insight into the relationships between the VSS, its individual behavioral measures, and the Trails B and Categories test. The data obtained offer the first effort towards statistically evaluating the VSS.
and offering possible recommendations for improving its effectiveness and usefulness.
Appendix A

Vocational Scaling System
Vocational Scaling System

I. PRODUCTIVITY

1. Motor Speed (% of norm)

   1 - 0-20%
   2 - 21-40%
   3 - 41-60%
   4 - 61-80%
   5 - 81-100%

2. Nonmotor dependent task (to be defined by job site).

II. LEARNING

   Time required to learn 5 step task and carry out without further assistance.

   1 - more than 60 minutes
   2 - 30-60 minutes
   3 - 16-30 minutes
   4 - 6-15 minutes.
   5 - 5 minutes or less.

III. PERSISTANCE/ATTENTION/STAMINA

   Ability to work a full day.

   1 - up to 1-1/2 hours
   2 - 1-1/2 to 3 hours
   3 - 3 to 4-1/2 hours
   4 - 4-1/2 to 6 hours
   5 - 6 to 77-1/2 hours

IV. GENERAL AREA

1. Dresses appropriately for job assignment, appropriate, hygiene, etc.

   1 - does not consider appropriate dress, hygiene in work environment. Needs consistent reminders.

   2 - needed 5 to 10 reminders concerning dress hygiene in the past 30 days.

   3 - needed 3 to 5 reminders concerning dressing appropriately, hygiene in the past.

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4 - occasionally needs cuing, 2 reminders in the past month regarding hygiene, dress on job site.

5 - consistently appropriate for job site, no hygiene problems in the past 30 days.

2. Punctuality: Consistently and independently reports to work on time, returns from breaks promptly.

1 - 1 out of 5 days
2 - 2 out of 5 days
3 - 3 out of 5 days
4 - 4 out of 5 days
5 - 5 out of 5 days


1 - little awareness of safety issues. Needs daily cuing in this area.

2 - occasionally remembers safety rules. Needs cuing 3 to 4 times weekly.

3 - does not consistently follow safety rules. Need reminders in this area 1 to 2 times weekly.

4 - usually follows safety rules, occasionally reminders needed 2 to 3 times monthly.

5 - know and follows safety rules, need no cuing or reminders in this area once rules were established.

V. Independence

1a. Ability to adapt to changing work environments.

1 - cannot change job assignments at all within a day.

2 - can change jobs 1 to 2 times within a day with staff assistance.

3 - can make 1 to 2 job assignment changes in a day independently.

4 - can make 3 to 5 job assignment changes independently.
5 - can cope with a wide variety of assignment changes 6 to 8 times daily.

1b. Degree of complexity of task, i.e. efficient organization of task.

1 - 1 to 4 steps
2 - 4 to 7 steps
3 - 8 to 10 steps
4 - 11 to 14 steps
5 - 15 or more steps

2. Responsible for own quality control.

1 - consistent problems with job quality. 30% or less of work completed daily is accurate.
2 - 30 to 50% of work completed daily is accurate.
3 - 50 to 70% of work completed daily is accurate.
4 - 70 to 90% of work completed daily is accurate.
5 - 90 to 100% of work completed daily is accurate.

3. Responsible for own preparation for work each day, i.e. time cards, checking job assignments, etc.

1 - client needs daily cuing regarding work routines, prep 5/5 per week.
2 - clients needs reminders for at least one part of job prep 4/5 days per week.
3 - client is independent on work prep 3/5 days per week.
4 - client is independent on work prep 4/5 days per week.
5 - client independently remembers work routine 5/5 days per week.
VI. Social Behavior

1. Interacts appropriately with supervisor, co-worker, i.e. takes direction, follows instructions, accepts feedback, is pleasant & cooperative.

   a. Major social offenses: offensive, threatening behavior such as: yelling, throwing work materials, assaults, etc.

      1 - at least one incident of threatening behavior per day.
      2 - major social infractions 3 out of 5 days per week.
      3 - major social infractions 1 out of 5 days per week.
      4 - no major social infractions in the past two weeks.
      5 - no major social infractions in the past 30 days.

   b. Minor social infractions such as: grimacing, excessive body movements, excessive talking, laughing, etc.

      1 - minor social infractions 2 or more per day.
      2 - minor social infractions 3 out of 5 days per week.
      3 - minor social infractions 1 out of 5 days.
      4 - no minor social infractions in the past two weeks.
      5 - no minor social infractions in the past 30 days.
Appendix B

The Vocational Level and Scoring System
The Vocational Level and Scoring System

As the Vocational Scaling System was developed and utilized, we determined it was not what we felt accurately described the client's level of employability. As clients progressed through the vocational process we often saw drops in scores when changing job sites or low functioning clients were scoring very high.

Thus the Job Levels 1-5 have been developed to work in conjunction with the vocational scaling system.

With each site and/or job comes a variety of levels of supervision, routines, tasks, levels of complexity and social needs. They have been divided and categorized in varying job levels. Each job site used was then looked at and assigned a job level.

Now as clients progress through the vocational system, we may expect drops or increases in their scores but we also know their level of employability for that specific job level.

Definition of terms:
1. Social Stimulus - The amount of stimulation with the client's work environment.
2. Social Skills - The amount of interpersonal interaction with others.

JOB LEVEL

LEVEL I

1. Supervision is constant.
2. Client is not responsible for job routines/daily routines.
3. Client is expected to perform 1-2 concrete tasks (jobs).
4. Supervisor is responsible for quality control, not the client.
5. Social stimulus is strictly controlled.
6. Social demands are negligible.

LEVEL II

1. Supervision is immediately available as needed, not constant.
2. Client repeats invariable routines independently. (Supervisor is still responsible for novel routines.)
3. Client is expected to perform 3-5 concrete tasks.
4. Client is responsible for quality control with frequent spot checks by supervisor.
5. Social stimulus is managed as needed.
6. Social demands are minimal.

LEVEL III
1. Supervision is available as needed but client is not responsible for discerning when it is necessary.
2. Client is responsible for set up of routines with monitoring or fine tuning from supervisor.
3. Client is required to independently manage a variety of changes inherent in the otherwise familiar and over-learned work routine. Client may ask for assist in novel situations.
4. Client can be expected to perform up to 7 concrete tasks and is responsible for associated tasks related to completion (counting, securing supplies, packing, skidding, etc.) with monitoring.
5. Client is responsible for quality control with minimal checking by supervisor.
6. Client is expected to manage social stimulus without intervention from supervisor.
7. Social demands are minimal.

LEVEL IV
1. Supervision is available for consultation. Client and/or supervisor responsible for discerning need.
2. Client creates and maintains routine independently.
3. Client is required to have the ability to manage a wide variety of tasks and changes throughout the day following the prescribed routines but be able to be flexible with interruptions. The job may require the responsibility of making decisions according to employer policy and procedures.
4. Client has total responsibility for his/her own quality control. They may have responsibility for the work quality of others with consultation from the supervisor.
5. Independent management of a high degree of social stimulus is required. Consultation is available. Client is usually not responsible for others.
6. High degree of social skill is required.
7. This job requires procedural training in regard to set routines. Some abstraction skills are required.
LEVEL V

1. Supervision is available for consultation only. Client is responsible for seeking consultation.
2. Routines are independently created and maintained.
3. Client is required to have the ability to manage a wide variety of tasks and changes throughout the day. Client is responsible for high level decision making and needs the ability to be flexible with interruptions.
4. Client is totally responsible for work quality and possibly that of others.
5. Social stimulus is uncontrolled, client manages independently without intervention from supervisor.
6. High degree of social skill and intelligence is an ongoing requirement. This skill could be primary to the job. May require controlling sociability of others.
7. Specialized technical training or education is required. There are areas where application of a principle is necessary. Abstraction skills are required.
Appendix C

Raw Score for VSS, Trails B, Categories Test and Demographic Information for the Research Population
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BIBLIOGRAPHY


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Rappaport, M., Hall, K. M., Hopkins, K., Belleza, T., & Cope, D. N. (March, 1982). Disability Rating Scale for severe head trauma: Coma to community. *Archives of Physical Medical Rehabilitation, 63*, 118-123.


