This is to certify that the
dissertation entitled

THE EFFECTS OF COGNITIVE REHABILITATION ON THE REMEDIATION OF MEMORY, ATTENTION, AND SOCIO-BEHAVIORAL DEFICITS FOR INDIVIDUALS WITH TRAUMATIC BRAIN INJURY: A META-ANALYSIS OF THE LITERATURE FROM 1980 – 2003

presented by

GEORGE PATRICK ALEXANDER PARRIS

has been accepted towards fulfillment
of the requirements for the

Doctoral	degree in	Rehabilitation Counselor Education

Major Professor's Signature

January 28, 2005

Date

THE EFFECTS OF COGNITIVE REHABILITATION ON THE REMEDIATION OF MEMORY, ATTENTION, AND SOCIO-BEHAVIORAL DEFICITS FOR INDIVIDUALS WITH TRAUMATIC BRAIN INJURY: A META-ANALYSIS OF THE LITERATURE FROM 1980 – 2003

By

George Patrick Alexander Parris

A DISSERTATION

Submitted to
Michigan State University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF PHILOSOPHY

Department of Counseling, Educational Psychology & Special Education

2005

ABSTRACT

THE EFFECTS OF COGNITIVE REHABILITATION ON THE REMEDIATION OF MEMORY, ATTENTION, AND SOCIO-BEHAVIORAL DEFICITS IN INDIVIDUALS WITH TRAUMATIC BRAIN INJURY: A META-ANALYSIS OF THE LITERATURE FROM 1980 -2003

By

George Patrick Alexander Parris

The purpose of this dissertation is to critically evaluate the effectiveness of cognitive rehabilitation interventions on the remediation of memory, attention, and socio-behavioral deficits for individuals with traumatic brain injury. Cognitive rehabilitation as an intervention is relatively new and although it is widely used with individuals with TBI, insufficient large-scale research has been conducted supporting its efficacy. While some studies have reported improved performance on memory, attention, and socio-behavioral deficits, methodological inadequacies and inconsistent findings have prevented the isolation of specific treatment effects as well as the generalization of the procedures. The impact of treatment with cognitive remediation strategies appears to be facilitated by variables that affect the natural recovery process such as severity of injury. As such, it has been suggested that greater attention be given to research design issues and to the consistent reporting of subject variables known to affect the natural recovery of cognitive functions. In this dissertation, meta-analytic statistical procedures were used to determine the effectiveness of cognitive rehabilitation interventions in the remediation of memory, attention, and socio-behavioral deficits in individuals with TBI. A literature search was done and a total of 465 published studies were located on cognitive rehabilitation interventions and on TBI. From this a total of 248 studies were eliminated from the data

analysis and the remaining 217 studies were used in the meta-analysis. Of these meta-analytic procedures were used to review 120 articles on memory remediation, 67 articles were used in the analysis of attention remediation, and 30 articles were used in the analysis of socio-behavioral deficits. Results of the meta-analysis show that cognitive rehabilitation intervention is positively correlated with the remediation of memory, attention, and socio-behavioral deficits following TBI.

DEDICATION

This manuscript is dedicated to

My loving and supportive mother

Enid Parris-Bond

For always being a positive influence in my education throughout my elementary years in Guyana, South America and in my secondary and university years in Canada and the United States of America.

In addition, I am dedicating this manuscript to

My loving and patient wife

Carol Madgalee Parris

For her encouragement and support throughout the years.

Finally, I dedicate this manuscript to

My loving children, Kiswana, Khalil, and Maia

For understanding why daddy was busy for so long.

ACKNOWLEDGEMENTS

In my journey there were many mentors along the way, and I was fortunate to have had a few terrific ones. I would like to thank Dr. Nancy Crewe for without her enduring support, understanding, and patience, this process would have been frustrating and just an academic exercise. I deeply appreciated her guidance, encouragement, and knowledge throughout this process. I would also like to extend a sincere thanks to my committee members, Dr. Michael Leahy and Dr. Robbie Steward for their support and encouragement. In addition, I must thank Dr. John Kosciulek for agreeing to be on my team with such short notice and Dr. Betsy Becker who was instrumental in assisting me in understanding the concept of meta analysis.

We are fortunate if we have friends and families that are understanding during times that demand time away from them. As such, I must sincerely thank everyone who supported and encouraged me to move forward as I tried to achieve my goals.

Finally, there are few words that are capable of articulating my gratitude to my family for their unfailing and endless support over the years that I have been working at achieving this goal. My beautiful and loving wife, Carol, has stood by my side through my entire doctoral program with unwavering support. My children, Kiswana, Khalil, and Maia for encouraging me with their smiles, kisses, and hugs. In addition, I acknowledge the support, words of encouragement, and interest in my journey from my in-laws.

TABLE OF CONTENTS

LIST OF TABLES

CHAPTER I

INTRODUCTION

Epidemiology

Traumatic brain injury is a term that describes a variety of conditions involving external insults to the head culminating in brain damage. Head injury, head trauma and brain injury all refer to conditions of traumatic brain injury (TBI) and may be used interchangeably throughout this paper. Traumatic brain injuries can be classified as either open or closed head injuries. Open head injuries occur when an external object penetrates the skull. In contrast, closed head injuries result from a rapid acceleration of a stationary or slower moving head by a moving object (acceleration injuries) or by a deceleration of the head as it comes in contact with a stationary or slower moving object (deceleration injuries) (Levin, Benton & Grossman, 1982).

Traumatic brain injury is a major health issue in the United States, and other countries where vehicular accidents, sporting accidents, falls and interpersonal violence are common occurrences (Jennett & Teasdale, 1981). The incidence of traumatic brain injury (TBI) has reached epidemic proportions in the past two decades. Coupled with this increased incidence is the notable rise in the number of survivors of moderate and severe traumatic brain injuries sustained in motor vehicle and other accidents, which according to Wehman and Goodall (1990), is a result of advances in neurosurgery, emergency evacuation procedures, rehabilitation techniques, and psychopharmacology.

This is important, because up to twenty years ago, many people who sustained a TBI did not survive (Misenti, Lucas, & Thompson, 1992). The past decade has seen a major emphasis placed on the rehabilitation and treatment of individuals who have

acquired a traumatic brain injury. Unfortunately, most of these individuals are sufficiently compromised to require specialized services if they are to return to the workforce (Wehman & Goodall, 1990).

Epidemiological data on TBI has been difficult to obtain since head injury is generally not recorded as a single medical diagnosis by hospitals (Morse & Montgomery, 1992). Additional data collection concerns include omissions for mild TBI and death prior to arrival at the hospital (Grimm & Bleiberg, 1986). Definition differences for TBI are also attributed to some head injuries being excluded (Frankowski, 1986). The National Center for Health Statistics (1984) excluded skull fracture-related deaths from their reporting. On the other hand, Klauber and others (1978) included skull fractures in their reporting of fatal head injuries, but excluded TBI-related gunshot wounds. Frankowski and others (1981) included all skull fractures and intracranial injuries that resulted in death, even from suicide. In order to address this methodological problem, the Center for Disease Control and Prevention established Guidelines for Surveillance of Central Nervous System Injury (Thurman et al., 1999). The standard TBI case definition identifies the occurrence of a head injury, caused by a blunt or penetrating trauma or from acceleration-deceleration forces, resulting in diminished consciousness, amnesia, other neurological or neuropsychological abnormalities, skull fracture, diagnosed intracranial lesions, or death.

According to Jennett and MacMillan (1981), it is difficult to determine how often head injuries occur, because many are not serious enough to warrant admission to hospital, and statistics about emergency room attendees are unreliable and incomplete. However, a number of studies have demonstrated that traumatic brain injury is a common

occurrence in the United States. Frankowski (1986) and Jennett (1983) estimated that approximately 7 million head injuries occur annually in the United States, with about 500,000 hospital admissions. The National Head Injury Foundation (1984) estimated that approximately 500,000 to 750,000 persons annually in the United States survive a brain injury. More recent estimates put the number at approximately 700,000 people acquiring a head injury every year in the United States (Roessler, Schriner and Price, 1992). Based on these numbers, McMordie, Barker and Paolo (1990) concluded that the incidence rate for traumatic brain injury is higher than that for epilepsy, Parkinson's disease, multiple sclerosis, Huntington disease, and amyotrophic lateral sclerosis combined.

Epidemiologically, the incidence of traumatic brain injury peaks in two age groups, fifteen to twenty-four years of age, and seventy years old and higher. The primary cause of traumatic brain injury in the eighteen to thirty year old age groups is motor vehicle accidents, while falls are the primary cause of traumatic brain injury in older individuals. Thus, the mechanism of injury differs for these two groups, resulting in different neuropathological features and neurobehavioral profiles. The causes of traumatic brain injury in children are largely dependent upon age. For example, in infants the primary cause of TBI is child abuse; in young children, falling is the primary cause; in older children, pedestrian and car accidents; and in adolescents and younger adults, motor vehicle accidents, usually with alcohol involvement is the primary cause (Routh, 1987).

Traumatic brain injury is the leading cause of death among the young and the most frequent cause of brain damage for those under 40. As Rimel and Jane (1983) stated, "more persons die on American highways each year in automobile accidents than

were lost in the entire Vietnam conflict, and central nervous system trauma is the single most common cause of death in these accidents (p. 9). Additionally, there is an age-associated increase in mortality rates of persons experiencing traumatic brain injury regardless of severity of injury, with approximately a twenty- percent mortality rate at age eighty. The risk of death increases in the older age group when other coexisting medical problems are prevalent. Studies have shown that persons age fifty to seventy-five at the time of injury revealed a high incidence of generalized deterioration and dementia, regardless of the severity of injury. A review of studies on the impact of traumatic brain injury (Goldstein & Levin, 1995) revealed that traumatic brain injury is more disruptive in terms of mortality and capacity to resume independent functioning within this age group.

Each year over one million individuals under the age of nineteen acquire neurological damage resulting in some form of hospital treatment. Approximately 150,000 of these individuals remain hospitalized and over 20,000 sustain a moderate or severe head injury (Goldstein & Levin, 1995). Most of these injuries are the result of motor vehicle accidents, falls, sports injuries, and bicycle accidents. In adults, motor vehicle accidents, violent crime, unsuccessful suicide attempts, falls, and stroke are the most common contributors of TBI.

A person who has acquired a head injury is three times more likely to acquire a second head injury and among those who have had multiple head injuries, the incidence of a subsequent head injury is eight times that of the general population (Rimel & Jane, 1983). However, despite the onset of traumatic brain injury, the life expectancy for

survivors is 40 years from the time of injury, which according to Rimel and Jane (1983) is close to a normal life expectancy.

Recent studies suggest that 1.5 million Americans, or 200 per 100,000 sustain a TBI annually (Brooks, Gabella, Hoffman, Sosin, & Whiteneck, 1997). Approximately 230,000 are hospitalized for their injuries and roughly 50,000 die as a result of their TBI related injuries. Brooks et al. (1996) estimate that nearly 80,500 or 35% of the 230,000 individuals hospitalized will experience significant long-term disability related to their head injury. McAllister (1997) stated that the increased number of individuals surviving TBI will be challenged by significant cognitive and emotional changes. It is estimated that an additional 1 million individuals who sustain a TBI and are not hospitalized will experience chronic disabilities associated with their head injury (Thurman et al., 1999).

Sequelae of Traumatic Brain Injury

Survivors of head injury sustain any number of medical, physical, cognitive, psychosocial, and behavioral problems resulting from their injury, which presents a challenge for health professionals. Because of the sequelae of traumatic brain injury, the National Head Injury Foundation has referred to head injury as the "silent epidemic, which depicts the severe nature of this problem, yet the potential for oversight and mis-diagnosis.

Persons with traumatic brain injuries can encounter a wide variety of physical, cognitive and behavioral deficits. Physical factors may include chronic fatigue, impaired balance and coordination, seizure activity, chronic pain, impaired motor skills, and visual difficulties. Individuals may also experience chronic, debilitating head and neck/back pain, which can have significant impact on vocational potential (Hurt, 1991). As such,

the person's ability to work an 8-hour day is compromised, often resulting in a three to four hours workday.

According to Rosenthal (1983), behavioral problems associated with traumatic brain injuries are common, and represent a major problem in rehabilitation efforts designed to help persons resume productive, domestic or community roles. Furthermore, Brooks (1985) stated that behavioral problems represent the most frequent source for the family's perception of traumatic brain injuries as a persisting burden. Persons with traumatic brain injury may experience a range of behavior disorders, including, but not limited to, restlessness, agitation, combativeness, emotional liability, confusion, hallucinations, and other disturbed perceptions, disorientation, depression, paranoid ideation, hypomania, and confabulation (Garoutte & Aird, 1985; Kueatus, Harot, Peck & Kornstein, 1985). With such behavioral deficits, persons with traumatic brain injuries become aware of their limitations, and they become discouraged, demoralized, or even hopeless (Fisher, 1985). Rosenthal (1983) stated that persons with traumatic brain injuries are less able to perform physically, become more dependent socially, and often feel a sense of impotence in trying to rebuild their lives. Consequently, social relationships are less rewarding and often diminished, vocational prospects are altered, and life is perceived as less interesting.

In many cases, work and educational difficulties are a result of the altered cognitive status following traumatic brain injury (Lain, Priddy, & Johnson, 1991). Cognitive impairments may result in a variety of difficulties both on and off the job or at school. For example, memory impairments can affect an individual's ability to learn new information and remember job tasks. Attention/concentration problems may result in

difficulty staying on task due to distractibility; problems paying attention to many tasks or aspects of a task simultaneously; and difficulty returning to task after an interruption. Visual processing impairments may result in the misinterpretation of visual information, and auditory processing impairments can result in difficulties comprehending verbal instructions resulting in a need for repeated instructions. The ability to organize, plan, goal set and monitor behavior may be diminished, resulting in the person becoming easily overwhelmed by complex or non- repetitive tasks. Likewise, impaired reasoning skills may affect the individual's ability to grasp abstract concepts and apply these to specific tasks. Low frustration tolerance may result in irritability, impatience, and angry outbursts aimed at supervisors, teachers and/or co-workers, whereas, lack of initiation may result in a need for more supervision and directives from others within the environment (Hurt, 1991).

Threats to Employment

Impairment resulting from traumatic brain injury often threatens the ability for an individual to return to gainful employment. As previously mentioned, cognitive, psychosocial, and behavioral deficits often serve as obstacles towards a return to employment. The ability to work is one of the most significant attributes in our society. Moos (1986) acknowledged that the meaning of work is prominent to many individuals (cited in Szymanski & Parker, 1996). Work defines an individual's worth and place within society. In addition, work provides numerous financial as well as psychological and social benefits. Our society places a heavy emphasis on individuality and independence. As such, in order to afford commodities such as food, shelter, clothing, and other necessary products, it is essential to have some type of employment.

The inability to work following TBI often serves to exacerbate problems in psychosocial functioning and family adjustment. As a result of unemployment, Oddy, Coughlan, Tyerman and Jenkins (1985) stated that persons with head injuries often experienced increased difficulties in social functioning such as social isolation, decreased self-worth and despair. Bond (1976) found that work and leisure activities were the most disrupted aspects of daily life following severe head injury.

Work also influences a person's psychological identity, aspects of well being, and brings social stability to an individual's life. Work provides the individual the ability to structure his/her time, which was felt by Berne (1961) to be crucial for adaptive functioning. Freud in his writings, identified the most significant indication of psychological stability is the individual ability to love and to work effectively (Erickson, 1950). It is true that some form of employment sets one's place within the community of human kind (Szymanski & Parker, 1996). Among the many benefits experienced through gainful employment is the opportunity to develop a social network. Persons with severe head injuries often cite lack of social contact which is attributed to diminished opportunities to make friends since very little time is spent in the community as the most frequently mentioned problem (Thomsen, 1974). Lishman (1978) stated that those who suffer head trauma encounter difficulties in vocational, personal and social adjustment. Oddy et al. (1985) in a study of head injured patients found that, "...those who were working had been able to rebuild their social lives and sometimes marry" (p. 567).

Statement of the Problem

After examining the impact of traumatic brain injury, several issues become apparent. The fact that this condition occurs at epidemic rates with estimates as high as 7

million injuries occurring annually, with approximately 500,000 persons being admitted to hospital emphasizes the catastrophic extent of the problem (Frankowski, 1986; Jennet, 1983). As previously mentioned, traumatic brain injury occurs most often among individuals under age 30 with 72 percent of all injuries occurring within this age group (Rimel & Jane, 1983). The effects of traumatic brain injury, whether mild, moderate or severe, have a deleterious effect upon an individual's overall level of functioning and subsequent life goals. Following a TBI the brain undergoes a process of natural healing called spontaneous recovery. Usually, this process occurs during the first six months after the injury, however, it may continue for many years (Butler & Namerow, 1988; Oddy, Bonham, McMillan, & Stroud, 1988). However, there is no way of predicting when and in what areas of the brain spontaneous recovery will occur and what deficit areas will be affected. In order to address the deficits that remain following a period of spontaneous recovery, psychologists, speech pathologists, educators, and others in the field of rehabilitation have recognized the residual effects of traumatic brain injury and have developed methods for cognitive rehabilitation.

Many studies have examined variables associated with cognitive rehabilitation and its effects on the remediation of attention (Benedict, 1989; Ben-Yishay, Piasetsky, & Rattock, 1987; Malec, 1984), memory (Glasgow, Zeiss, Barrera, Lewinsohn, 1977; Wilson, 1987; Boring, 1988) and self-regulation (Webster & Scott, 1983; Lira, Carne, & Masri, 1983; Cicerone & Wood, 1987) following traumatic brain injury. Despite this, a severe disparity exists in the literature regarding the effectiveness of cognitive rehabilitation interventions on subsequent vocational outcomes. This is particularly problematic given that research shows that successful outcomes and increased quality of

life of persons with traumatic brain injury are associated with increases in attention and memory and reduced social-behavioral deficits.

Research that explores the relationship between cognitive rehabilitation interventions and subsequent outcomes following traumatic brain injury increases our understanding of the impact traumatic brain injury has on subsequent quality of life. Increased knowledge of these relationships can lead to future development of innovative methods for counseling and rehabilitation. Additionally, such research will assist psychologists, counselors and other rehabilitation professionals in the development of innovative counseling and treatment strategies.

The purpose of this study is to assess the effectiveness of cognitive rehabilitation interventions on subsequent outcomes of persons with traumatic brain injuries. Specifically, the study will explore the effectiveness of cognitive rehabilitation interventions on the remediation of memory, attention and socio-behavioral/self-regulation following TBI. In addition, characteristics associated with traumatic brain injury will be analyzed with regard to their influence upon subsequent outcomes following cognitive rehabilitation interventions. These characteristics include premorbid factors such as: (1) age at time of accident, (2) years of education, and (3) type and level of employment. Additionally, factors related to severity of injury and duration of rehabilitation on subsequent outcomes following cognitive rehabilitation intervention with persons with traumatic brain injury will be explored.

Considerable research attention has been focused during the past two decades on cognitive rehabilitation with persons with traumatic brain injury. The problem is that the accumulated information from this research does not appear to be clear and consistent in

regards to the impact of cognitive rehabilitation on the remediation of memory and attention deficits following traumatic brain injury. It is imperative that these findings be synthesized into a meaningful whole. As such, a methodologically rigorous, large scale integration of the numerous research findings is warranted.

Purpose of the study

The purpose of this study is to assess the effectiveness of cognitive rehabilitation interventions on subsequent outcomes of persons with TBI. Specifically, the study will explore the effectiveness of cognitive rehabilitation interventions on the remediation of memory, attention, and socio-behavioral deficits following TBI using a combination of meta-analytic procedures and descriptive statistics. Memory, attention, and socio-behavioral deficits have been linked to poor vocational outcomes and quality of life for individuals with traumatic brain injury.

Major research question(s) and Hypothesis

The principal research questions are:

(1) How effective is cognitive rehabilitation intervention on the remediation of memory deficits following traumatic brain injury?

(2) How effective is cognitive rehabilitation intervention on the remediation of attention deficits following traumatic brain injury?

(3) How effective is cognitive rehabilitation intervention on the remediation of socio-behavioral deficits following traumatic brain injury?

(4) What are the relationships between factors such as age at time of accident, years of education, socio economic status, severity of injury, and ethnic

background of individuals on subsequent outcomes following cognitive rehabilitation intervention with persons with traumatic brain injury?

Hypotheses:

Within this investigation, the following hypotheses were tested:

Hypothesis 1:

Cognitive rehabilitation intervention will be positively correlated with the remediation of memory deficits following traumatic brain injury.

Hypothesis 2:

Cognitive rehabilitation intervention will be positively correlated with the remediation of attention deficits following traumatic brain injury.

Hypothesis 3:

Cognitive rehabilitation intervention will be positively correlated with remediation of socio-behavioral deficits following traumatic brain injury.

Significance of the Study

A number of issues or factors are apparent after examining the literature associated with traumatic brain injury. Following traumatic brain injury, a person's vocational functioning is often threatened. This is due to physical, cognitive, psycho-social, and behavioral deficits, which often impede a return to employment. Societal demands for educational achievement and vocational productivity cannot be underestimated; therefore, the person with traumatic brain injury must function adequately in these two areas in order to live independently. The benefits of work are numerous; for example, a sense of self worth and esteem are influenced by an individual's ability to feel productive and as a contributing member of society. The

social and personal consequences of the individual's inability to work contribute directly to deterioration in the quality of life (Klonoff, Snow, & Costa, 1986; McMordie & Barker, 1988). Return to work is essential for structure, social and psychological functioning as well as financial gains as such it merits special attention.

According to Jennett and Teasdale (1981), traumatic brain injury constitutes a major problem in the health care delivery system. Traumatic brain injury continues to occur at an alarming rate with annual estimates exceeding 500,000 injuries, severe enough to require hospitalization. Additionally, 72 percent of all injuries occur to individuals under the age of 30 (Rimel & Jane, 1983). Males comprise two-thirds of persons with traumatic brain injury. It is estimated that 50,000 people are permanently disabled annually as a result of traumatic brain injury (National Head Injury Foundation, 1984); and result in direct and indirect costs of approximately 4 billion dollars annually (Kalsbeek, McLaurin, Harris & Miller, 1980).

Lishman (1978) noted that, among the majority of individuals who survive moderate and severe head injuries, the long term mental (cognitive, behavioral, and emotional) sequelae greatly exceed the physical sequelae as the primary causes for the difficulties encountered by these individuals in their later vocational, personal, and social adjustment.

There is general agreement in the literature that traumatic brain injury results in devastating consequences. Less than three percent of persons with head injuries treated in rehabilitation programs were able to maintain employment for more than one year (Ben-Yishay, Silver, Piatsesky, & Rattok, 1987). Additionally, unemployment among this population is partly a consequence of diverse personality, behavioral and cognitive

changes arising from pathophysiological alternations in the brain following injury (Burke, Wesolowski, & Guth, 1988).

A study of the relationship of cognitive rehabilitation intervention on outcomes following traumatic brain injury may enable psychologists, counselors, and rehabilitation practitioners to develop intervention strategies aimed at improving vocational outcomes. As a statistical integration of research studies that examined cognitive rehabilitation intervention on outcomes following TBI, this study will provide a verifiable knowledge base of cognitive rehabilitation as an intervention strategy. It should serve to ensure an accurate representation of the variables associated with cognitive rehabilitation as an intervention strategy with persons with TBI, and should minimize duplication of research efforts. The findings of the meta-analytic review should be useful in both theory-building and practical applications such as program development and training. Moreover, it should identify previously unexplored variables and direct further research in cognitive rehabilitation interventions following traumatic brain injury. From a clinical perspective, this study will help practitioners' select appropriate goals, objectives and activities for individual clients. Also, from an educational standpoint, this study may help to foster curriculum development and intervention strategies as it relates to age, education and certain factors on vocational adjustment. As stated by Wehman and Kreutzer (1991) a better understanding of the return to work process must inevitably have an impact on rehabilitation.

Definition of Terms

In this section of the proposal, certain terms that are important to this investigation on the effectiveness of cognitive rehabilitation strategies on vocational

outcomes must be defined in order to maintain clarity in describing certain phenomena related to cognitive rehabilitation and traumatic brain injury. Because of the nature and sequelae of traumatic brain injury as well as the complex nature of cognitive rehabilitation a broad array of concepts, words, and terms needs to be defined.

Traumatic brain injury consists of a variety of conditions involving external insults to the head culminating in brain damage. The terms brain injury, head injury and head trauma all refer to conditions of traumatic brain injury.

Open head injury are those that result when the scalp and/or skull is penetrated by an external object, such as a gunshot wound.

Closed head injury is as a result of direct contact forces and inertial forces. What happens in this case is as the brain surfaces are pushed against the inner surface of the skull upon sudden acceleration or deceleration, the brain sustains bruising (Levin, Benton, & Grossman, 1982).

Severity of injury it has been argued that the longer the period of loss of consciousness, the less successful are the vocational outcomes (Cartlidge, 1981; Plum & Levy, 1978). As such, it is important to investigate what effects the severity of injury has on vocational outcomes. The following categories of severity are:

1. Level I (Loss Of Consciousness (L.O.C.) of 24 - 72 hours).
2. Level II (L.O.C. of 4 - 7 days).
3. Level III (L.O.C. of 8 - 15 days).
4. Level IV (L.O.C. of 16 - 30 days).
5. Level V (L.O.C. of 30 days or more).

Another definition is related to the term vocational outcomes. To obtain a clear and accurate assessment of vocational outcomes following traumatic brain injury, the following categories are offered:

1. Full-Time Employment
    a. Professional, managerial, technical
    b. Clerical
    c. Service
    d. Structural
        1) Skilled
        2) Unskilled
2. Part-Time Employment
3. Supportive Employment/Sheltered Employment
4. College

Cognitive rehabilitation is a systematic, functionally oriented service of intervention that is based on assessment and understanding of the client's brain-behavioral deficits. Specific interventions may have various approaches, including (1) reinforcing, strengthening, or reestablishing previously learned patterns of behavior; (2) establishing new patterns of cognitive activity through compensatory cognitive mechanisms for impaired neurologic systems; (3) establishing new patterns of activity through external compensatory mechanisms such as personal orthoses or environmental structuring and support; and (4) enabling persons to adapt to their cognitive disability, even though it may not be possible to directly modify or compensate for cognitive impairments, in order to improve their overall level of functioning and quality of life (Cicerone, et al., 2000)

Meta-analysis is "the statistical analysis of a large collection of analysis results from individual studies for the purpose of integrating the findings (Glass, 1976, p. 3).

Effect size is a quantitative measure of the results of an individual study (Glass, 1976). However, if most of the studies are correlational, the product-moment correlation coefficient (or a statistic that is convertible to a product-moment correlation coefficient) should serve as the effect size (Glass, McGaw, and Smith, 1981).

Methodological characteristics refer to the general features of the studies (e.g., sample size, date of publication, or the type of analysis) (Glass et al., 1981).

Substantive characteristics refer to features of the studies that are related to the problem studied (e.g., sex, age, educational status, or ethnicity) (Glass et al., 1981).

Rationale of Meta Analysis as the Statistical Procedure

Research utilizing single experiments as well as studies in the behavioral sciences rarely provides definitive answers to research questions. Rather, if progress is to be made in the social and behavioral sciences, it must be through the discovery of underlying trends and principles developed from the accumulation and refinement of a large body of studies (Wolf, 1986). Thus the integration of empirical research through literature reviews helps to clarify the state of science at a given point. Meta-analysis can be viewed as a synthesis of research. It can distinguish coding reliability, validity of studies analyzed, allows for clearer conclusions about the relationship between specific independent and dependent variables, and provides the technique for summing up a large body of separate but similar experiments (Swanson, 1996). According to Wolf (1986), "meta-analysis is the application of statistical procedures of the collections of empirical findings from individual studies for the purpose of integrating, synthesizing, and making sense of them" (p. 5). Castro and Mastropieri (1986) state that, "it is a method, it is not a

panacea, but it will often be quite valuable when applied and interpreted with care" (p. 417).

CHAPTER II

REVIEW OF THE LITERATURE

The purpose of this research is to determine the effectiveness of cognitive rehabilitation interventions on subsequent outcomes of persons with traumatic brain injury. Specifically, the study will explore the effectiveness of cognitive rehabilitation interventions on the remediation of memory, attention, and socio-behavioral deficits following TBI using a combination of meta-analytic procedures and descriptive statistics. The aim is to assimilate and synthesize the literature regarding the impact of cognitive rehabilitation on subsequent outcomes. Relevant articles in this literature will be organized and reviewed as follows: (a) sequelae of traumatic brain injury, (b) rehabilitation of attention deficits, (c) rehabilitation of memory deficits, (d) rehabilitation of socio-behavioral deficits, (e) vocational outcome studies, (f), cognitive rehabilitation and (g) meta-analysis.

Overview of Traumatic Brain Injury

Historical data and current trends suggest that TBI is a leading cause of death among young Americans (Thurman et al., 1999). This was found to be true in those individuals under age 38 (Rimel, Jane & Bond, 1990). National data first became available for TBI-related deaths in 1978 (National Center for Health Statistics, 1984). Data for all reported brain injury deaths in 1978 found that 24% were attributed to an intracranial injury. Klauber, Barrett-Connor, Marshall and Bowers (1978) found rates of TBI-related deaths in 1978 estimated at 22.3 per 100,000 in San Diego County. Frankowski, Klauber, and Tabaddor (1981) conducted a collaborative study in 1981, inclusive of three counties located in New York, Texas, and California and found

incidents of TBI-related mortality to range from 27 to 32 per 100,000. Another study compared TBI mortality rates for inner city Chicago and a neighboring suburb and found rates of 32 and 13 respectively per 100,000. More recently, the National center for Health Statistics (1994) reported that for the periods of 1980 through 1994, TBI related deaths decreased from 24.7 per 100,000 to 19.8 per 100,000. In another study, the Center for Disease Control and Prevention (1998) found slightly higher rates with 22.6% of 32,112 reported TBI cases resulting in death.

Incidence of TBI-related deaths has found differences among gender and age groups. TBI fatalities for males are 30.7 per 100,000 and 9.3 per 100,000 for females (National Center for Health Statistics, 1994). Increased rates of TBI fatalities are found with both sexes for ages 15-24 and over 70 years of age (National Center for Health Statistics, 1984). Mortality associated with TBI is similar among males and females until the age of 15 when males become at least three times more likely to experience a fatal TBI (Annegers, Grabow, Kuland, & Laws, 1980; Thurman et al, 1990). Although TBI-related fatalities experience a peak for males between the ages of 15-24, the highest peak of TBI mortality rates are for males 75 years and older at 46.3 per 100,000 (Thurman et al., 1999).

There are variations in study findings pertaining to the etiology of TBI-related deaths. The Center for Disease Control and Prevention (1998) found 49% of TBI fatalities attributed to transportation accidents (motor vehicles, bicycles, pedestrian, and recreational vehicles), 26% to falls, 10% to firearms, and 8% to assault without a firearm. In a separate study the Center for Disease Control and Prevention (1997) found gunshot injuries were the leading cause of fatalities among males 15 to 84 years of age. Whitman

(1984) as well as other researchers found inner cities had more than 50% of TBI fatalities associated with firearms and suburban areas accounted for 50% of TBI deaths being related to transportation related injuries. Among females, transportation related injuries are the leading cause of TBI deaths for females from birth to 74 years of age, with peaks between the ages of 15 to 24. TBI associated female deaths attributed to firearms and transportation accidents were nearly identical for the 30 to 54 age groups and for females 75 and older, the majority was related to falls (Center for Disease Control and Prevention, 1997).

Racial and ethnic differences have existed historically for TBI-related deaths. Cooper, Tabaddor and Hauser (1983) found that TBI fatalities among African Americans and Hispanics were higher than White Americans by ratios of 1.8 and 1.5 respectively. The National Center for Health Statistics (1994) reported that deaths resulting from TBI are highest among African Americans (25.5 per 100,000), followed by White Americans (19 per 100,000) and for all other racial groups combined (15.3 per 100,000). Increased rates of TBI deaths among minority groups are attributed to greater incidents of interpersonal violence, particularly in urban areas (Cooper et al., 1983; Whitman et al. 1984). TBI deaths by gunshot attributed for 13.6 per 100,000 among African Americans, which is the leading cause of deaths for this group, compared to 7.9 per 100,000 for White Americans (National Center for Health Statistics, 1994).

Recovery after Traumatic Brain Injury

Recovery after traumatic brain injury is not a speedy process like most other medical injuries. Individuals with TBI usually take several years to regain many of the cognitive and psycho-social abilities that may have been altered because of the injury.

Some of the notable changes that can be observed include those of a physical and cognitive nature, whereas changes in emotional and interpersonal abilities, which make up the essence of a person, are usually more subtle. Improvements in cognitive and psychosocial abilities are critical if individuals with traumatic brain injury are to recover to the fullest extent possible and regain some or all of their pre-injury abilities. Thus, rehabilitation efforts are viewed as efforts that promote, not cause, recovery.

Maximal recovery from neurological impairment following traumatic brain injury in terms of clinical estimation of duration of recovery remains a controversial issue (Hanlon, Dobkin, Hadler, Ramirez, & Cheska, 1992). A number of studies support the conclusion that the most rapid period of recovery occurs during the first six months post-injury; however, recovery continues on a slow and steady course, reaching a maximum at approximately twenty-four months post-injury (Hanlon et al., 1992; Kertesz, 1985; Prigatano, 1987). Research on IQ values post-injury lends support to the first six months being the most rapid recovery period. A study conducted by Bond in 1975 (cited in Prigatano, 1987) showed that Verbal IQ showed the most rapid improvement over the first six months post-injury. Performance IQ scores recovered more slowly with the most substantial improvements occurring up to one year post-injury. Continued improvements based on IQ results are not uncommon up to two years post-injury and even after two years, though these improvements are rarely dramatic (Hanlon et al., 1992).

A number of problems exist in the studies that examined the issue of recovery of individuals with traumatic brain injury post-injury. There is the problem of degree of variability in the type and severity of brain pathology associated with traumatic brain injury. Additionally, there is significant variability in the individuals' characteristics prior

to the injury including intelligence, memory, and personality characteristics, all of which influence recovery. Overall, three factors have been found to contribute to the level and course of recovery. These factors according to Prigatano (1987) include the individual's abilities and characteristics pre-injury, the type and severity of the injury, and the effort put forth toward recovery post-injury.

In addition, research in the area of recovery has shown that within the area of higher cognitive functioning, such as memory, different aspects or components may improve over time while others may not. Different patterns in the rate and level of recovery in each area of higher cognitive functioning may occur. Improvements in certain areas have been documented several years post-injury, particularly among individuals who were adolescents or young adults at the time of injury. Also there is strong evidence that psychosocial functioning post-injury may contribute significantly to the recovery of cognitive functioning. Prigatano (1987) stated that results from most studies on recovery suggest that individuals improve after TBI, however, the course is variable and some individuals even show deterioration of some abilities over time.

Research has documented that some individuals with TBI make substantial progress post-injury such that cognitive rehabilitation and educational activities are believed to facilitate the rate and/or level of recovery. Additionally, intensive neuropsychological based rehabilitation has been shown to significantly increase the level of psychosocial adjustment in individuals who are relatively self-sufficient in terms of activities of daily living (Prigatano, 1987). Overall, results from these studies suggest that the brain has the ability to learn and re-adapt. However, Prigatano (1987) stated that

the degree of recovery can be described as "a clinical and scientific guessing game (p. 605).

The passage of time is a significant factor in the recovery of persons who sustain a TBI (Grimm & Bleiberg, 1986). Pepping and Roeuche (1991) have identified critical stages at various times in the TBI recovery process. These stages, described as phases I through VI, take into consideration the individual with TBI neurological status, reactionary issues, and pre-morbid factors.

Phase one involves the trauma itself, and sub-acute functioning. The initial or sub-acute phase encompasses coma and posttraumatic amnesia (PTA). An individual is said to be comatose when there is an absence of eye opening, motor response, and verbal response (Prigatano, Bruna, Mataro, Munoz, Fernadez & Junque, 1998). PTA refers to an absence of memory for daily events and people, and lack of full consciousness (Long, 1989). The severity of TBI is defined by duration of loss of consciousness (LOC) (Morse & Montgomery, 1992) or by severity of impaired consciousness on the Glasgow Coma Scale (GCS) (Teasdale & Jennet, 1974). The GCS assesses level of consciousness and is based on a standardized cumulative score of eye opening response (E), motor responsiveness (M), and verbal responsiveness (V) (Teasdale & Jennet, 1974). For example, a score of 13-15 on the GCS indicates a mild TBI, 9-12 is a moderate TBI, and a score of 8 or less is indicative of a severe TBI (Bond, 1990).

Post-coma disturbance occurs during this initial phase. This is defined as the period between emergence from coma and the resolution of PTA. During this time the individual with TBI may experience some acute confusion marked by attention disturbances and an inability to maintain a coherent line of thought (Long, 1989).

Delirium, a common occurrence in the initial phase of recovery, is associated with inadequate sensory stimulation, sleep deprivation, intense anxiety, disturbed interpersonal relationships, and increased intra-psychic conflict (Slagle, 1990). Cognitive and behavioral dysfunction can be observed in the individual's confabulations, preservations, distractibility, agitation, aggression, bizarre, impulsive, psychotic-like behavior, and denial of their condition (Grant & Alves, 1987).

Neurological indices including early GCS scores, duration of coma and unconsciousness, and length of posttraumatic amnesia have been considered important predictors of cognitive functioning following a TBI (Haslam, Batchelor, & Fearnside, 1994). McClelland (1988) reports the general agreement is more severe initial TBI, as assessed by neurological procedures, results in greater cognitive impairments. Klove and Cleeland (1972) examined the relationship between neurological competencies and cognitive outcome. They reported that the duration of unconsciousness was a significant predictor of outcome for patients assessed between 7 and 18 months post-injury. Shores (1989) found PTA had a more reliable relationship to post-injury cognitive outcome than did coma. Haslam et al. (1994) examined early neurological variables in relation to specific cognitive functioning (recent memory and speed of information processing) at one year post-injury. Results revealed that cognitive ability of recent memory functioning declined with increased post-coma disturbance time and the presence of a subarachnoid hemorrhage. These studies as well as others (Brooks, Aughton, and Bond, 1972) reveal that early neurological factors may contribute to cognitive outcome measures following TBI.

The sub-acute phase, or phase two involves the resolution of PTA and generally lasts six months (Bond, 1975). During this phase, one of three transient syndromes can emerge. These include organic excitement, paranoia, and aggressive behavior. Organic excitement is manifested in euphoria, increased energy, rapid thinking and speech, and psychomotor agitation (Grant & Alves, 1987). The second transient syndrome is paranoia, characterized by suspiciousness about the motives of others (Prigatano, 1987c). In an exacerbated form, delusions can involve persecutory beliefs, fears of illness and death, jealousy, and paranoia (Gualtieri & Cox, 1991). Post-recovery delusions are common during this sub-acute phase and attributed to the effects of cortical brain lesions (McAllister, 1997). The third state is marked by aggressive behavior in concert with mania, paranoia, and delirium (Grant & Alves, 1987). Aggressive tendencies associated with PTA generally result from confusion and cognitive impairment (Moore & Stambrook, 1995).

Phase three or post-acute phase is usually marked by considerable improvement in both cognitive and language abilities (Rosenthal, 1983). The majority of spontaneous recovery typically occurs in this post-acute phase, some 6 to 12 months post injury (McAllister, 1997). Reacquisition of lost functions by intact neural networks, improved motivation, and psychosocial adjustments are factors that account for improvements during this phase of rehabilitation (Lishman, 1973). It is during this time that memory for daily events, accurate recognition of others, and interpersonal behavior, all show signs of improvement. During this phase the level of physical and emotional disability is established, although minimally acknowledged by individuals with TBI and their family (Bond, 1984). Phase three is seen as the most challenging period for individuals with

TBI and their family (Pepping & Roeuche, 1991). This phase is characterized by increased insight or continuous setbacks. Many individuals with TBI enter a cognitive rehabilitation program during this phase.

Many individuals with TBI are faced with confronting the extent of their disability, or dealing with the expectations of what type of recovery will occur. This is all part of phase four. When individuals with TBI psychologically deny their disability or are cognitively unable to understand and accept their disability, coping problems can result (Pepping & Roeuche, 1991). During phase four individuals with TBI who have not accepted their disability tend to discontinue rehabilitation.

Phase five is where these individuals proceed to in order to passively engage in rehabilitation. In order for success to occur in this phase, individuals with TBI must constructively cope and accept their situation. Those who adapt by coping or at least recognize that deficits have been incurred accept cognitive retraining. Individuals who comprehend their impairments, and embrace the therapeutic process are more invested in their psychosocial adjustment. This involves affectively internalizing the functional implications of impairment into one's self-concept, coupled with behavioral adaptation and social reintegration (Livneh & Antonak, 1990). In order to succeed, individuals with TBI need to demonstrate social competencies by establishing and maintaining healthy interpersonal relationships, proficiently enacting social roles, and finding their life context and performance satisfying (Grant & Alves, 1987). In order to adjust, one must maintain some level of emotional acceptance, while coming to terms with self, and the environment. However, those individuals with TBI who remain unaware of their deficits,

fail to cope effectively and continue to misperceive themselves and eventually have difficulty accepting their new self (Pepping & Roeuche, 1991).

Etiology of Symptoms

Disturbances in thinking, feeling, and behavior are common post-injury consequences. Three factors contribute to these interpersonal deficits apparent in the sub-acute and latter phases of recovery. These include reactionary factors, pre-morbid personality, and neurologically based psychological problems (Pepping & Roueche, 1991).

Reactionary factors occur on an emotional level and involve disturbances reactive to alternations in perceptions, capacities, and situations caused by the head injury (Prigatano, 1987b). According to Livneh and Antonak (1990) reactions such as shock and anxiety occur early, while acknowledgement and adjustment to the disability manifest themselves later on. Recognition of reduced competencies and, more generally, a sense of loss of self, are reactions to the residual effects of TBI (Cicerone, 1989). Denial, anger, and depression often surface, in response to the emotional reaction, and in association with neurological factors.

Pre-morbid personality is the second factor that may contribute to interpersonal deficits following TBI (Morse & Montgomery, 1992). In discussing the significance of pre-morbid personality it has been noted, "it is not only the kind of injury that matters, but the kind of head" (Symond, 1937). This statement punctuates the powerful effect pre-morbid personality factors have one's ability to manage changes in self subsequent to TBI (Pepping & Roueche, 1991). Individuals with TBI who experienced a pre-injury healthy and cohesive sense of self are more inclined to manage and accept

neuropsychological changes (Klonoff et al., 1993). Those, however, with self-esteem issues or narcissistic personality structure, experience difficulty with acceptance and coping. This phenomenon termed "narcissistic rage," describes the client who feels helpless, ashamed, and revengeful, in response to recognizing the destructive impact that perceived incompetencies have on their sense of self (Kohut, 1972). Pre-existing personality, interpersonal, and adjustment issues can be accentuated by the individual with TBI, and seriously compromise the recovery process. In particular, oppositional, impulsive, dependent, obsessive, repressive behaviors, and issues with trust may likely become magnified following TBI (Crosson, 1987).

Oppositional behaviors, whether directly or indirectly displayed by individuals with TBI, tend to hamper the restorative process. Issues surrounding dependence on others can surface in those individuals inclined to rely on others. For example, an individual's progress can be delayed if he/she depends on caregivers to perform tasks as opposed to relearning a lost skill. When faced with these situations, these individuals may manipulate environmental factors, including people, in order to be served by them (Crosson, 1987).

Frontal lobe injury tends to intensify pre-morbid impulsiveness, thus rendering the person with TBI incapacitated to think before responding. These individuals, prone to reacting without thought, now fail as they impulsively act and avoid taking responsibility for their behavior. Obsessive thinking and compulsive behavior can become compounded by cognitive inflexibility associated with neurological injury. In order to avoid reality, individuals with TBI tend to repress information, which has the potential to complicate the recovery process as they suppress anxiety-arousing

interpersonal difficulties associated with their deficits. Consequently, these individuals may fail to accurately process their actual intrapersonal reaction to the injury. Pre-morbid issues with trust may contribute to difficulties in establishing relationships and rapport with rehabilitation professionals.

Neurologically based psychological problems compromise the third factor associated with post-injury interpersonal deficits. Neurological destruction directly interferes with the brain capacity to be effective, resulting in cognitive, emotional, and behavioral impairments. To fully appreciate the impact neurological damage has on these aspects of human functioning, neuroanatomical structure and circuitry will be explained.

The human brain is composed of a jelly like mass that is surrounded by cerebrospinal fluid within the skull and weighs approximately 3 pounds. It is home to nearly 100 billion neurons, each acting as a tiny information processing system with thousands of connections for sending and receiving signals to and from adjacent neurons (Huffman, Vernoy & Vernoy, 2000). These neurons act as building blocks for the nervous system, and function as an electro-chemical communication operation responsible for controlling thought, emotion, and behavior (Anderson, 1980). The brain consists of four subdivisions, the cerebral hemispheres, diencephalons, brain stem, and the cerebellum (Davis & Palladino, 2002).

There are two cerebral hemispheres which account for approximately 80% of the total brain weight (Myers, 1999). Each hemisphere has its own unique processing responsibilities. The left hemisphere is associated with symbolic and analytical processing, primarily involved with verbal and written language abilities, arithmetic

sequencing, and logic (Anderson, 1980). The right hemisphere is associated with perceptional and spatial processing. It is the hemisphere associated with creativity, poetic ability, insightfulness, intuitive thought, and having the ability to partake in art and music. Each hemisphere is responsible for processing information on the opposite side of the body. It should be noted, that although diverse in function, both hemispheres are composed of the cerebral cortex (outer gray matter), internal white matter, and islands of gray matter deep within the white matter (Davis & Palladino, 2002). The two hemispheres are joined by the corpus callosum, a large band of neural fibers that carries messages between them. In addition, each hemisphere is divided into four lobes, or areas, the frontal lobe (front of the head), parietal lobes (top and to the rear), the temporal lobes (just above the ears), and the occipital lobe (located at the back of the head).

The cerebral cortex, or neocortex, accounts for forty-percent of the total mass, and three-fourths of the neurons in the brain (Anderson, 1090). The cerebral cortex can be conceptualized as a thin neural sheet, about the size of a large pizza. To fit within the skull the cerebral cortex is highly convoluted with many folds and wrinkles, appearing as a bumpy surface. The motor, sensory, and association areas are contained within the cerebral cortex. The prefrontal cortex is further divided into an orbital frontal and dorsolateral region. Located at the anterior tip of the frontal lobes is the orbital frontal region. The dorsolateral prefrontal cortex lies toward the back, and away from the midline of the cortex.

Behind the motor cortex and in the front of the parietal lobes is the sensory cortex (Myers, 1999). The parietal area, along with portions of the temporal and occipital lobes provide for conscious awareness of sensation. The association area comprises the third

functional area of the neocortex. These areas, which make up a larger portion of the cortex, communicate with the motor cortex and other sensory association areas to analyze, integrate, and act on sensory inputs (Kassin, 2001). Association areas are used for complex activities such as planning a weekend camping trip, solving a complex mathematical operation, and creating a clay sculpture.

The brain's second subdivision, the diencephalon, forms the central core of the forebrain and is surrounded by the two cerebral hemispheres. The diencephalon itself consists of three structures, thalamus, epithalamus, and hypothalamus (Myers, 1999).

While these three bilateral structures are all significant, the thalamus is of utmost importance, as it is necessary for nearly all cortical activity (David & Palladino, 2002). Eighty-percent of the diencephalon is thalamic structure, often referred to as the `inner room,' a name that describes its deep and well-hidden location below the corpus callosum (Huffman et al., 2000). Appearance-wise, the thalamus looks like two small footballs, situated side-by side atop the brainstem. Serving as the brain's sensory switchboard, the thalamus receives input from nearly all sensory systems. It then sorts, edits, and projects this information to the appropriate area. A secondary thalamic structure, the epithalamus, is positioned in the most dorsal portion of the diencephalon. The epithalamus is involved in sleep-wake cycle, and mood.

A doughnut-shaped system of neural structures rests at the border of the brainstem and cerebral hemispheres (Myers, 1999). This is known as the limbic system, an interconnected group of structures involved with memory and emotional behavior, particularly aggression and fear. The hypothalamus, which caps the brainstem and lies below the thalamus, is included within the limbic system. Functionally, the

hypothalamus is the link between the endocrine system and nervous system, helping to maintain the body's internal environment in a steady state through the regulation of hunger, thirst, and body temperature. Secondly, hypothalamic activity influences the experience of pleasureful reward, behavioral and emotional control (Huffman et al. 2000).

Lying below the subcortical structures, and beginning where the spinal cord swells as it enters the skull is the brain stem, the third subdivision of the brain. Because of its innermost location, the brain stem is often referred to as the brain's basement (Myers, 1999). Brain stem centers, including the pons, medulla, and reticular formation, produce rigidly programmed and automatic behaviors required for survival (Kasssin, 2001). The pons is located at the top of the brain stem, and in front of the cerebellum. Primarily responsible for respiration, the pons relays communication between the motor cortex and cerebellum, helping maintain a normal rhythm of breathing, orchestrating movement and promoting sleep (Huffman et al. 2000).

Below the pons, just above the spinal cord, is the medulla. Like the pons, the medulla is crucial to heartbeat and breathing. Located within the brain stem is the reticular formation, a finger-shaped network of neurons, extending from the spinal cord to the thalamus. Serving as a filter for incoming sensory information, reticular formation sifts through and rejects irrelevant material. When this system has determined information useful, it is then relayed to the appropriate part of the brain for further processing. As a sensory filter, reticular formation is also important for attention and arousal. For example, effective reticular formation attends to useful information, picks up necessary cues, and responds to appropriate stimuli.

Accounting for 11% of the total brain mass, the cerebellum is sometimes called the `little brain' (Kassin 2001). This fourth subdivision of the brain, located at the base of the brain behind the brain stem, is known for its role in maintaining smooth movement and coordinating motor activity (Huffman et al. 2002). It is crucial to ambulation and functional fine and gross motor activity. In relation, the cerebellum control automatic adjustments of posture, enabling one to maintain an upright posture when walking and sitting in a chair.

Structurally, it can be seen, that the brain is rather intricate and sophisticated. Brain regions, and subdivision parts, have designated abilities that join together in creating a working brain. Operationally, structures and neural circuits are dependent upon each other for optimal neural communication, which ultimately affects thinking, emoting, and behaving. TBI, however, threatens this process by destroying brain matter and disturbing neuronal communication. When the force of trauma is directly transferred to the brain, neurological insult produces focal and/or diffuse damage. Focal damage can be caused by a laceration or contusion at the site of impact, opposite the site of impact, which is caused by the brain bouncing from one side of the skull to the other, or by the brain rubbing against irregular areas of the skull (Pepping & Roueche, 1991). The anterior temporal lobes and orbito-frontal cortex are common locale for focal type injuries (McAllister,1997). These brain regions lie in close proximity to boney prominences at the base of the cranial vault, such that upon rapid deceleration, the brain is thrown directly against them (Grimm & Bleiberg, 1986). Because of the proclivity of this boney structure to inflict damage to the orbital frontal cortex, it is irreverently referred to as the "dashboard" of the brain (Varney & Menefee, 1993).

In addition to being anatomically large, the frontal lobes are complex, heterogeneous, and they produce varied, yet significant dysfunction when severely damaged (Duncan, 1986). Focal damage to the left frontal lobes is associated with verbal deficits, orbital lesions are associated with emotional changes, bilateral and diffuse frontal lobe damage cause greater awareness difficulties than unilateral or focal damage, and prefrontal lobe damage affects awareness of socially inappropriate behavior (McClelland, 1988). Specific dorsolateral prefrontal lesions cause cognitive and memory impairments associated with planning and the temporal organization of action. Most severe cases of disorganized behavior occur with very large lesions, not always confined to the frontal cortex. Stimulus-bound behavior is a likely consequence of dorsolateral prefrontal lesions (Long, 1989). This is observed when the individual with TBI is compelled to spontaneously manipulate objects before them, or imitate odd and even socially inappropriate behaviors of others. Stimulus-bound behavior occurs as the individual with TBI is bound by environmental cues.

On the other hand, diffuse damage, results from shearing forces applied to axons of cortical neurons. The axons stretch, twist, and break, causing neuronal disruption, and consequent impairment. This type of damage, often referred as diffuse axonal injury (DAI), occurs primarily in sub-cortical regions, such as the corpus callosum. The damage creates decreased speed of neuronal processing, which consequently slows thinking, analyzing, and integration of information (Morse & Montgomery, 1992). To illustrate, DAI can be considered analogous to a closed lane on the highway. Although cars can get through, the flow of traffic is slowed, and one hesitates to pursue rush hour travel (Long, 1989). For the most part, DAI is more common than focal type injuries in

persons with TBI. It is because additional focal trauma from contusions, skull fractures, and hematomas, create more widespread, or diffuse damage (Silver, Yudofsky & Hales, 1991).

Taken together, reactionary factors, pre-morbid personality, and neurologically based conditions can result in a multitude of cognitive, behavioral, and vocational problems for individuals with TBI. In part, this study investigates what impact cognitive rehabilitation as an intervention strategy has on these factors.

Sequelae of Traumatic Brain Injury

Over the past two decades, research has documented the broad array of neuropsychological impairments manifested by individuals who have acquired a traumatic brain injury. After a traumatic brain injury, individuals can encounter a barrage of deficits including, physical, cognitive, psycho-social, and behavioral effects that can pose a formidable obstacle in their personal and vocational life. Although the sequelae of TBI are multidimensional in nature, many rehabilitation professionals still focus on intervention from a unidimensional perspective. Cognitive, physical, psycho-social, and behavioral impairments that are prevalent after TBI can interfere with personal and social adjustment, and impede return to work and/or school thereby significantly impacting the individual's ability to function effectively in everyday life (Dikman & Machamer, 1995; Glisky, 1992; Johnson, Thomas-Stonell, & Shein, 1994).

Because of their organic impairments, individuals with TBI often are unaware of their deficits as well as their consequences. This lack of awareness of deficits usually results in poor response to cognitive rehabilitation interventions as well as unrealistic expectations for the future (Rattok, Ben-Yishay, Ezrachi, Lakin, Piasetsky, Ross, Silver,

Vakil, Zide, & Diller, 1992). In order for successful rehabilitation and integration into the community to occur, awareness and eventual acceptance of deficits is often a crucial aspect in the rehabilitation process. Individuals who continue to show a lack of awareness are likely to have community re-integration problems (Ezrachi, Ben-Yishay, Kay, Diller, & Rattok, 1991; Rattok et al., 1992).

Cognitive, physical, behavioral, and psycho-social sequelae of TBI include difficulties with new learning, information retrieval, academic difficulties, perceptual and motor skills deficits, impaired capacities for control, regulation, and adaptation of complex behaviors including impairments in problem solving abilities, difficulties modulating cognitive activities, difficulties modulating emotional reactions typically manifested as emotional liability, irritability, lack of initiative, depression, or dishinibition disorders, and impaired capacity for self-control (Dikman & Machamer, 1995; Lezak, 1986; Rattok et al., 1992; Routh, 1987).

Physical Deficits

Following traumatic brain injury, physical deficits may vary in type of impairment and extent of disability. Physical deficits are usually associated with damage to the brain as opposed to the peripheral body parts. Physical deficits may lead to a number of conditions such as spasticity, which is commonly seen in persons with traumatic brain injury and is characterized by a hyperflexive state of deep tendons with increased muscle tone (Carew, 1985). Spasticity affects motor functioning and may interfere with mobility and activities of daily living.

A loss of motor functioning may vary in severity from weakness to paralysis and may affect any or all extremities. For example, monoplegia involves paralysis of one

extremity, whereas hemiplegia involves paralysis of both upper and lower extremity on one side of the body. Paraplegia includes paralysis of lower extremities with quadriplegia involving paralysis of both upper and lower extremities. Decorticate hemiplegia involves paralysis including flexion of the upper extremity and extension of the lower extremity. Decerebrate hemiplegia includes extension of both extremities on one half of the body (Nelson, 1983).

Individuals with TBI often experience disorders of movement and frequently experience impediment in mobility and activities of daily living. Ataxia refers to a discoordination of movement involving weakness and dyssynergy of movement. As such, balance and mobility are frequently affected which may interfere with functional activities particularly when there is upper extremity involvement. Ataxia is associated with lesions of the cerebellum.

Apraxia is described as the inability to perform certain learned or purposeful movements despite the absence of paralysis or sensory loss (Springer & Deutsch, 1985). Apraxia may affect mobility and other functional activities. Kinetic or motor apraxia results in difficulty in fine movements such as holding a pen. Ideomotor apraxia results in impairment in complex motor acts upon command although automatic motor acts are less affected, and ideational apraxia results in an inability to formulate sequenced acts or used objects involving sequenced motor acts (Springer & Deutsch, 1985).

There are numerous physical deficits that can affect a person's functioning following traumatic brain injury. However, only a few are mentioned in this study. Prognosis in terms of recovery of physical abilities is uncertain. However, rehabilitation intervention has been shown to prevent chronic abnormalities and to increase function.

Cognitive Deficits

Despite the vast array of possible impairments as a result of traumatic brain injury, cognitive changes have been the most widely studied in individuals with TBI. Cognitive deficits are manifested as difficulties in attention, memory, learning, and speed of information processing due to brain damage (Crowley & Miles, 1991; Levin, Benton, & Grossman, 1982; Routh, 1987). This determines the way in which an individual experiences and responds to stimuli which in turn affects daily functioning (Ben-Yishay & Diller, 1983). Deficits in cognitive functioning are perhaps the most prominent features following traumatic brain injury. Levin (1985) stated, "outcome research during the past decade has shown that chronic disability after severe head injury is primarily attributable to neuro-behavioral sequelae, whereas motor and sensory deficits are less consequential for overall recovery (p. 281).

The impact on adaptive functioning due to cognitive deficits for persons with traumatic brain injury has been well documented. As Ben-Yishay & Diller (1983) stated, "by now it has been established with virtual certainty that the long term mental sequelae outstrip the physical as a cause of difficulties with the vocational and personal rehabilitation of the patient and with the problems encountered in the areas of living arrangements, social re-adaptation, and strains on family life" (p. 171).

The psychological processes of attention and memory, cognition, and learning are complex functional systems with their own inherent organization that works at an over-learned, automatic, level (Stuss & Benson, 1986). These systems involve various cortical and subcortical regions in both hemispheres in the working of one function with different regions participating in their own specialized way (Mesulan, 1981). Damage to specific

structures impedes the capacity of mental processes. For example, sustained attention and concentration deficits are associated with brain stem and thalamus damage, and arousal problems are associated with brain stem compression. Frontal and prefrontal lobe damage is related to selective attention, alternating attention, and divided attention disturbances (Morse & Montgomery, 1992).

Executive functioning encompasses the processes and abilities involved in the control of behavior (Grimm & Bleiberg, 1986). These processes relate to goal formulation, planning, controlling a sequence of action, initiation, and insight (Shallice, 1982). Frontal lobe damage is most widely associated with producing deficits in executive functioning. The frontal lobes play a vital role in awareness of context and gestalt and self-evaluation (Armstrong, 1991). Failure to recognize the problem or deficit results in one making repeated mistakes and refraining from utilization of compensatory strategies.

Organization and planning involves figuring out the main points, sequencing, coordinating, and formulating a plan (Varney & Menefee, 1993). This entails perhaps the most complex of all activities, as it implies a capacity to integrate past and present knowledge and perceptions, to make reasonably informed projections into the future regarding multiple probabilistic consequences, and to anticipate the semi-independent future state of the present situation (Grimm & Bleiberg, 1986). Disturbances in this area are reflected in diminished efficiency with self-care, home management, and interpersonal contact with others. For example, individuals with organizational deficits are unable to logically organize and sequence their thoughts. When conveying

information, these individuals may present the information in a jumbled and incoherent manner, leaving the listener uncertain regarding the content of the message.

Initiation difficulties may be evident in the presence of sufficient motivation and possession of a plan. This is apparent in the failure of individuals with TBI to initiate a plan or make the required strategic shifts when appropriate (Grimm & Bleiberg, 1986). Problems of this nature will likely result in persons with head injury having a decline in their social relationships as well as vocational contacts. They are limited in their ability to maintain the necessary behaviors required for reciprocal interaction with others (Pepping & Roeuche, 1991).

Psychosocial Deficits

The most pervasive characteristics of traumatic brain injury are changes that occur in psychosocial functioning. These changes have a dramatic effect on lifestyle and result in significant psychosocial difficulties. Although residual cognitive and physical disabilities may cause individuals with TBI to have significant disabilities, it is the emotional, behavioral, and personality manifestations of TBI that signify the greatest difficulties for the individual and his or her family (Antonak et al. 1993). These organic, reactionary, and psychologically based character changes are the signature of psychosocial disturbance in TBI cases (Cicerone, 1989). As Prigatano (1987) stated, "patients who suffer brain injury with neuropsychological sequelae have a personal reaction to their deficits. Moreover, their premorbid intellectual, personality, and sociocultural characteristics interact with acquired brain injury to produce a complex symptom picture, which often involves the disorders of personality as well as cognitive functioning" (p. 1).

From an epidemiological view, persons acquiring a TBI are usually between the ages of 14 to 25, and the residual deficits place great emotional, social, and financial burden on their families and a strong demand on rehabilitation services (Gainotti, 1993). These individuals often exhibit social and self regulation deficits, which result in an inability to restrain impulses, use feedback to control their behavior, and evaluate the consequences of their behavior. In addition, changes such as impaired initiative, impulsivity, impatience, irritability, temper outbursts, and self centered behavior (Zencius, Wesolowski, & Burke, 1990) often contribute and affect work capacity (Gainotti, 1993). Moreover, lack of understanding or denial of deficits may affect the individual's ability to critically evaluate their performance and set realistic goals.

Kaplan (1988) examined the effect of psychosocial variables on social and vocational adjustment of persons with traumatic brain injury. Kaplan found that longer comas and periods of posttraumatic amnesia were related to poorer vocational outcomes. Additionally, "relationships were found between the family's reported satisfaction with their living situation, their adjustment to the subject's disability and the individual's post-trauma return to the same or slightly reduced level of work or school responsibility" (p. 6). The following were not found to be significant predictors of outcome: receiving cognitive retraining, pre-injury alcohol or substance abuse, previous employment type, age or marital status.

Four broad classes of psychosocial disturbance have been identified and include anger, depression, anxiety, and psychological denial (Prigatano, 1987b).

One of the most common psychosocial consequences following TBI is anger (Montgomery, 1995). As with other psychosocial disturbance, anger is an overt display

of personality and behavioral changes caused by the effects of TBI (Lezak, 1987). Expressions of anger vary and may include some form of verbal abusiveness, self-inflicted abuse, and, or physical aggression. These manifestations of anger create intrapersonal and interpersonal hardship for individuals with TBI in every aspect of their life (Delmonico et al., 1998). Moreover, individuals with pre-existing anger problems, may experience exacerbations with this post-injury due to TBI generated dishinibition, impulsivity, and poor pre-morbid coping (McAllister, 1997; Prigatano, 1987a).

Individuals with TBI usually express anger in the form of internalized anger or externalized hostility. Individuals who realize their impairment to be a chronic condition as a result of an injury for which they are at fault are prone to experience internalized anger (Antonak et al. 1993). In addition, internalized anger can be viewed as the exhibition of self-directed bitterness and resentment commonly associated with self-blame and guilt (Livneh & Antonak, 1990). Externalized hostility is usually directed toward other individuals, objects, or aspects of the environment in response to limitations as a result of the injury.

Anger usually surfaces when the individual with TBI realizes that they have lost many abilities and drastic changes have occurred as a result of the injury (Crosson, 1987). Anger is usually most apparent when the full impact of the disability is realized. Gans (1983) stated that individuals with TBI in rehabilitation settings often despise the expert role of staff members who are physically intact, capable of coming and going, living independently, free from physical pain, and witness to the individual's constant need for assistance. External hostility can also be directed at family members, as individuals with TBI feel powerless and perceive these significant others as having power and

competencies they lack (Crosson, 1987). Family members may also play a role in perpetuating anger. Lezak (1987) noted that families initially direct anger to those responsible for the injury and then, through the course of rehabilitation, shift the anger to rehabilitation staff. The families' focus on anger further instills this thought process and demeanor in individuals with TBI.

Individuals with TBI commonly express aggressive behavior directed at self, others or property (McAllister, 1997). Kreutzer et al. (1990) stated that many factors contribute to aggressive outburst in individuals with TBI. For example, premorbid issues with low frustration tolerance and impulsivity contribute to the emergence of heightened aggression for the TBI survivor. Frustration, consequent to feeling incompetent when individuals with TBI fail to independently complete a simple daily task, can be viewed as a reactionary response. Cognitive related problems increase the possibilities for aggressive behaviors. These can include the inability to learn from mistakes, understanding of behaviors relationship to consequences, self-reflectiveness, and insight. Rosenthal (1983) stated that individuals with frontal lobe damage are disinhibited and more prone to display aggressive and sometimes violent outbursts.

Depression is also commonly reported following TBI (Ownsworth & Oei, 1998). Tyerman and Humphrey (1984) found 60% of individuals with TBI to be clinically depressed when assessed 2 to 15 months post injury. More specifically, 52% acknowledged they were "miserable and sad", 44% reported losing interest in things, and 28% indicated life was not worth living.

Manifestations of depression within individuals with TBI relate to numerous losses, restrictions, and limitations imposed by the head injury. Feelings of loss due to

changes necessitated by the neurological insult causes individuals with TBI to be less independent and more dependent on others socially (Lezak, 1978; Rosenthal, 1983). These losses and changes have the consequent result of reducing self-worth and instilling self-consciousness about the disability (Tyerman & Humphrey, 1984). Restrictions and limitations as a result of TBI can inhibit individuals from participating in preferred social activities and driving, which may be very important to them (Kreutzer et al., 1990). Social isolation is very common among persons with disabilities, however, for individuals with TBI social isolation is elevated. Such losses and limitations promote feelings of hopelessness, helplessness, and worthlessness (Antonak et al., 1993). These components of depression inadvertly affect individuals with TBI from effectively working, socializing, and maintaining relationships. Persons with prior mental health concerns, substance abuse issues, history of poor coping skills, lack of social and family support, financial difficulties, problems acquiring and maintaining employment face the greatest risk of developing post-TBI depression (Kreutzer et al., 1990).

Blair and Lanyon (1987) conducted an experimental study evaluating the effectiveness of an intensive, multi-disciplinary rehabilitation program upon a variety of social and adaptive living skills in adults who were recovering from severe closed head injury. The study also focused on how cognitive functioning is related to adaptive functioning in the natural environment of such clients. The study assessed two areas of functioning: (1) the adaptive living skills necessary for the individual to effectively maintain personal independence in daily living and meet the social expectations of the environment; and (2) cognitive deficits which can seriously affect the client's overall adaptation by interfering with the organization of goal directed behavior.

The study found that experimental group subjects significantly improved their adaptive living skills relative to subjects in the control condition. On the cognitive scales, neither group showed any significant changes in cognitive functioning. The study cannot conclude that changes in adaptive and social skills are related to changes in higher cognitive functions. It appears that individual subjects showed obvious improvement while others got worse. The authors recommended developing a different methodology, which is based on knowledge of patterns and events that occur during the recovery process and tailored to the individual's unique recovery sequence.

Lezak (1978) reported that the emotional disturbances such as depression, anxiety and irritability are commonly observed in persons with TBI. The author stated that these disturbances often result from less observable problems such as perplexity, distractibility, and fatigue. Perplexity may be characterized by a distrust of one's ability and may result in response hesitancy and self-doubt. This may result from the client's experience of decreased cognitive functioning and may lead to a variety of emotional reactions related to decreased self-confidence. Irritability is often associated with fatigue or distractibility as the client is rendered ineffective in sorting out incoming stimuli and often feels bombarded.

Another residual deficit of TBI is denial. Denial appears to be common in most disability groups, and is thought to operate primarily as a psychosocial defense to cope with overwhelming anxiety related to the onset of a disability (Falvo, 1991; Shontz, 1965; Wright, 1960). Denial is associated with a distorted perception of reality on the part of the client. Deaton (1986) stated that this may be harmful to the patient as it interferes with appropriate motivation and participation in the rehabilitation process.

It is often concluded that denial is seen in persons with TBI as the unawareness of their deficits. This may be organic etiology as in the cause of anosognosia. Anosognosia is associated with right hemisphere injury and frequently is observed with left-sided neglect (Hier, Mondock & Caplan, 1983). It is associated with damage extending through frontal, parietal and temporal regions. The extent to which clients are capable of making realistic appraisals of their abilities is associated with subsequent performance in rehabilitation and may impact outcome (Lam, McMahon, Priddy & Gehred-Schulz, 1988). Denial may also be a manifestation of cognitive deficits, which may prevent the client from fully comprehending, integrating and appreciating deficit areas (Baer, 1983). Additionally, denial may occur as a psychological reaction to tragedy following traumatic brain injury. Karpman, et al. (1985) stated that individuals with TBI are often unaware of changes in personality or behavior despite others' awareness of the changes. Prigatano (1987) stated that unawareness of deficit "is perhaps one of the major predictors of outcome" (p. 10).

The same psychosocial issues that affect resumption of productive employment also affect the interaction between family members who must cope with the client's behavioral and personality disturbances. Gainotti (1993) stated that as a consequence of the persons with TBI's reduced interests for leisure and social interactions, and of their lost working activities, both the individual with TBI and their family become socially isolated. Kozloff (1987), noted that as result of isolation, the client's social network undergoes two major modifications: (1) a reduction in its size as the number of people interacting with the client decreases progressively; and (2) an increase in the intensity due to the fact that the only persons remaining in contact with the client are those family

members who are committed to a lasting relationship with them. Being unable to return to fulfilling employment and to maintain intimate relationships (Weddel, Oddy, & Jenkins, 1980), these clients often become lonely and depressed if they have not been left euphoric or apathetic by their injury (Oddy & Humphrey, 1980).

Oddy, Humphrey & Uttley (1978) reported in a study of 50 young adults who acquired a TBI, they found disturbances in social functioning including a decline in the number of close friends, a decrease in the frequency of social outings and an increase in feelings of loneliness. According to Miller (1979) while substantial recovery often occurs in intellectual functioning, significant readjustment problems may result in an overall poor prognosis. Prigatano (1987) stated that the major problem a person with TBI faces is the social isolation. As such, psychosocial adjustment might be the most salient and pervasive long-term sequel of traumatic brain injury.

Personality deficits can be viewed as those features observable in interpersonal interactions. Personality features are influenced by psycho-social deficits, however, psycho-social deficits tend to be less stable over time, more malleable to change and are usually associated with the affective state. It is important to note that in the area of TBI, both psycho-social and personality deficits are associated with decreased cognitive functioning.

Personality change usually entails a reduction in initiation. Clients may be able to verbalize what tasks they intended to perform and may be quite competent in conceptualizing the appropriate order or sequence of steps in a given task. However, tasks frequently go unmet and the client appears to lack motivation or drive. Pribram &

McGuinness (1975) stated that lesions, which interrupt the cortical-limbic reticular loop often, result in hypokinesis and indifference. This may result in personality disturbance, which presents as similar to a condition in which one is unmotivated (Bond, 1984).

When considered together, post-injury anger, depression, and denial all have the potential to be influenced by organic, reactionary and pre-morbid factors. Because anger, depression and denial can be detriments to the recovery process, these psychological variables will be viewed in conjunction with cognitive retraining and overall psychosocial functioning. As such, the aim will be to discover if any relationships exists among or between these factors. If so, what are the clinical implications, and can Cognitive Rehabilitation facilitate adjustment and promote awareness and eventually improve employment outcomes?

Remediation of Memory Deficits

Memory impairments are a prominent theme in the lives of individuals with TBI. Two types of amnesias, retrograde and anterograde, are known to occur. Retrograde amnesia, refers to loss of memory for a period of time immediately preceding brain injury (Long, 1989). More problematic is anterograde amnesia, as it renders new experiences and facts lost or tangled in a confused web. Anterograde memory problems affect both procedural and declarative memory. Procedural memory refers to the ability to demonstrate knowledge about how a task is performed. Deficiencies with this aspect of memory, is observed when an individual is unable to profit from past practice at the same task (Grimm & Bleiberg, 1986). Consequently, individuals with TBI repeatedly make the same mistake, leading to increase frustration, and serving to punctuate the presence of deficits.

Declarative memory pertains to declaring knowledge about facts or a situation. When impaired in this area the individual with the head injury is unable to recall details of the conversation, including persons involved and topic theme. Encoding, storage, and retrieval problems are associated with declarative memory problems (Anderson, 1980). Encoding problems appear in slow and ineffective processing. Storage problems are evident when information is confused or confabulated over the period of time when it is consolidated (Morse & Montgomery, 1992). Disturbances in retrieving information are observed in those who simply cannot recall information presented. Some are able to retrieve the facts, but personal reference to the memory is lost. That is, it appears as a mere conceptualization of facts, because feelings of warmth and intimacy are not conveyed (Prigatano & Schacter, 1991). This recalled information, previously personal and episodic, has a detached and generic quality, and is presented as such to others.

Memory impairment is one of the major debilitating deficits following head injury (Glisky & Schacter, 1986). It can have an impact on all aspects of rehabilitation and can disrupt an individual's ability to regain the most basic functions of every day living. Levin (1985) stated that memory impairment is common following traumatic brain injury due to the vulnerability of the temporal lobes to contusion and hematoma caused by structural irregularity and bony protrusion of the sphenoid wing.

In the following section, I will use several studies that represent good statistical studies to show the different statistics that were used. In addition, these examples represent the different types of interventions used in many studies that were addressing the impact of cognitive rehabilitation interventions on memory impairment.

Glisky, Schacter, and Tulving (1986) explored whether memory-impaired clients could acquire the type of knowledge needed to operate and interact with a microcomputer. Four clients with memory impairment took part in the study; three of the four clients had developed a memory impairment following viral encephalitis. Each client was tested in eight learning sessions, spaced over 2 or 3 days apart, with an additional learning and test session 6 weeks later. The subjects attempted to learn two lists of computer related terms, one by a method of vanishing cues, the other by a standard anticipation method. At the start of each session, the subjects' knowledge of both lists was tested by production and matching tests. This was followed by eight learning trials on one of the lists, followed by another set of production and matching tests. The above mentioned procedure was then repeated for the second list.

Results indicated that a proportion of words correctly produced showed an overall increase across the eight learning sessions. The authors interpreted this increase to mean that memory impaired clients are able to learn computer related vocabulary. Additionally, results showed that learning occurred with the method of vanishing cues and with the standard anticipation method.

Fussey and Tyerman (1985) investigated whether a general memory retraining program would benefit clients with closed head injury who had severe memory impairment within a medical rehabilitation unit. The subjects were four persons with severe closed head injuries who were admitted to the Wolfson Medical Rehabilitation Center between 7 and 9 months after the injury. Neuropsychological assessment revealed that all subjects were severely impaired on a variety of memory tests. Of the four

subjects, three had suffered a reduction in general intellectual ability based on the Wechsler Adult Intelligence Scale.

The memory retraining procedures used in the study were those advocated by Grafman (1983). Each client was seen individually for 12 sessions over a one month period, with tasks reinforced by workers throughout the day. Subjects were assessed three times on a number of memory tests. Subjects were assessed initially to provide a baseline, and a second time immediately following the memory retraining by an independent psychologist. An assessment was completed one month after cessation of the memory retraining.

Results showed no significant effect of training on memory. However, it was noted that subjects were able to describe adequately the strategies taught when questioned at follow-up. The author concluded that the application of a general memory retraining program may not be justified within a medical rehabilitation unit. The author also suggested that, with further general recovery of cognitive function, persons with head injury may benefit from memory retraining over a longer period of time, at a later stage in the rehabilitation process.

Ryan and Ruff (1988) investigated the effectiveness of memory remediation, using a combined number of mnemonic techniques and strategies aimed at improving verbal and nonverbal memory capacities in persons with closed head injuries. The study also compared the potential efficacy of these memory procedures in clients with mild to moderate cognitive deficiencies.

The subjects were 30 potential clients recruited according to a number of criteria. All subjects had received traditional rehabilitative interventions such as physical,

occupational, and speech therapies prior to being selected as a participant. However, none had previously participated in a neuropsychologically based treatment such as cognitive remediation. The final number of subjects who participated in the entire study totalled 20.

The study utilized a counterbalanced experimental design, using random group assignment. Randomization was achieved by assigning the subjects to either a placebo control or experimental group while maintaining a balance according to demographic, pre-screening, and neurological characteristics. Treatment lasted 6 weeks, 4 days a week, 5.5 hours per day for a total of 132 hours of placebo or cognitive remediation. Both groups began each day with 50 minutes of group therapy and concluded with 20 to 30 minutes wrap up of the day's events.

Results revealed that the control and experimental groups significantly improved over time. Additionally, the experimental group did not demonstrate significantly greater improvement than the control group. It was predicted that as a result of memory remediation, the experimental group would demonstrate significantly greater improvement on all dependent measures as compared to the control group, which was not supported. On the basis of severity of the neurobehavioral deficits, results indicate that subjects with mild neuropsychological impairments benefited more from memory remediation compared to the more severely impaired clients.

Crosson and Birenning (1984) designed a memory-retraining program using a single case study design to evaluate a memory remediation program, which would meet the daily needs of a person with a closed head injury. The subject was a 32-year-old male who acquired a closed head injury following a motorcycle accident. The subject

had 16 years of education and was employed in a management position.

The client was referred for evaluation 2 months post injury. It was revealed from the evaluation that there were periods in which the client experienced retrograde amnesia. Especially noticed were large gaps in his memory for the 12 to 18 months immediately preceding the accident. The client experienced an anterograde amnesia as well as a retrograde amnesia. Evaluations of the client did not reveal any serious social or emotional problems, however, the client did experience feelings of depression related to the memory deficit and physical injuries resulting from the accident.

The memory retraining program was designed to incorporate the clients' strengths revealed during the evaluation. The training program was constructed to be accomplished at the client's home because of commuting problems. The program consisted of a close friend reading selected paragraphs, after hearing the paragraph once, the client would write down all he could remember about the paragraph. At the end of the week, the client would return with the written work, which was then scored. Each paragraph consisted of between 23 and 58 ideas.

The program began 15 days after the original Wechsler Memory Scale (Form 1) was administered. The Wechsler Memory Scale (Form 2) was administered at the end of the program. Moreover, the Wechsler Memory Scale (Form 1) was administered as a follow up 9 months after memory retraining. At the start of the program the client did one paragraph per day with no particular strategy to help him remember. However, on the 4th day of the program a strategy to aid in recall was introduced, and on day 7 and 10, additional strategies were introduced until the client did four paragraphs each day. The

client did one paragraph using no strategy to aid his memory and three paragraphs using three separate strategies to aid his memory.

Results indicate that the client had progressed from a relatively severe impairment to a recall clearly within normal limits based on a comparison of the scores from the Wechsler Memory Scale before and immediately after the memory program. On the written paragraphs, results showed that the client progressed from a state where the main idea of the paragraph was often lacking in his reproductions to consistently recalling the main ideas. It should be noted that a 9-month follow up revealed some loss in memory performance. In summary, the results suggest that persons with closed head injury can improve their memory for complex verbal material with the aid of mnemonic techniques.

Levin and Goldstein (1986) investigated the ability of persons with closed head injury to gain access to previously acquired semantic stores and to use such knowledge to guide encoding and retrieval of new material. The study utilized an experimental paradigm in which subjects attempted to learn word lists over repeated trial consisting of unrelated words, related but unclustered words, or clustered (blocked) words at input.

The subjects were eight clients who were enrolled in the Transitional Learning Community, a long-term rehabilitation facility in Galveston, Texas. Clients were selected for this program because their overall level of functioning exceeds that of severe disability; however, they are not suitable for independence and viable employment. The control group members were matched according to age, sex, education, and occupation. Subjects were individually tested in a single session lasting approximately 1.5 hours. The memory condition consisted of free recall of the 18 words presented on four trials.

Subjects were required to recall the words in any order, including those words reported on a previous trial.

After each trial recall was tested, this was followed by a new random presentation of the same words previously heard. The sequence of the three conditions were counterbalanced and separated by at least 20 minutes of neuropsychological testing designed to evaluate various aspects of memory, semantic knowledge, information processing, and problem solving skills. After completion of the fourth trial of a condition, subjects were given cued recall by presenting the first two or three letters of each word. This was followed by a recognition procedure employing four choices for each word (a phonemic associate, a semantic associate, an unrelated word, and the target).

The performances of the two groups were compared by examining the number of words recalled over for the three types of lists. Using repeated measures ANOVA, results indicate a significant main effect for the subjects with closed head injury. In addition, memory performance for the clustered list was better than for the unrelated, and related-unclustered lists but the unrelated and related-clustered lists were not different from each other.

Results of the study provide evidence for partially preserved semantic memory following closed head injury. Despite the fact that controls demonstrated higher learning, recall for both groups on the clustered list was better than for the unrelated and related unclustered lists. The authors caution that while the performance observed is probably representative of clients with similar backgrounds, injuries and outcomes, the results

should not be generalized to persons with severe head injury regarding their capacity for memory enhancement by semantic organization.

The research suggests that while some persons with head injury can learn to use these mnemonic strategies to enhance their recall of information, many others have difficulties accomplishing this task. Visual imagery procedures appear to be dependent on whether the mediators are supplied or self-generated, and the severity of the impairment. Persons with severe head injuries appear to benefit from externally produced visual images, while persons with mild head injuries are able to generate their own images. Future research needs to focus on whether these improvements can be generalized to improvement in activities of daily living.

Remediation of Attention Deficits

Another frequent area of impairment observed following traumatic brain injury is in attention and speed of information processing. Deficits in attention and information processing including problems with task performance and distractibility were recognized as sequelae of traumatic brain injury as early as 1904 (Gray, Robertson, Pentland, & Anderson, 1992). However, it is only recently that research has shown that attention deficit has been a major cause of some of the challenging behaviors observed in individuals with traumatic brain injury in rehabilitation settings (Gansler & McCaffrey, 1991).

Attention encompasses arousal, sustained attention and concentration, selective attention, alternating attention, and divided attention. Arousal, or focused attention, is reflected in overall alertness and the ability to tolerate various levels of stimulation (Morse & Montgomery, 1992). In relation, common cognitive sequelae lead individuals

with TBI to experience problems monitoring what one is doing, processing information one is reading or listening to, feeling overwhelmed by the situation, getting sidetracked by their own thoughts, and heightened distractibility (Moore & Stambrook, 1995). Socially, these deficits become apparent when these individuals are unable to process the meaning and direction of the conversation. As a result, individuals with TBI may become overwhelmed and fail to express themselves, or do so in a manner that reflects reduced understanding (Ylvisaker et al., 1987).

Sustained attention and concentration refers to the ability to consistently maintain attention to the task at hand. Long (1989), stated those deficits attributed to memory or impaired problem solving may, in fact, be related to limitations with concentration and failure to pay attention. Similarly, selective attention pertains to staying focused on a task, while maintaining set (grasping the idea of what is asked of them), when faced with distractions or extraneous stimuli (Morse & Montgomery, 1992). James (1890) noted that selective attention involves reasoning, or the ability of the mind to break up the totality of the phenomena reasoned about into parts, and to pick out the best conclusion. Impairments in both sustained and selective attention contribute to slowed work performance especially when tasks involve reading, intensive listening, or sustained analysis, and frequent corrections (Ben-Yishay et al., 1987; Moore & Stambrook, 1995). Within the context of a social or work situation these disturbances may impede an individual's effectiveness, thus limiting one's ability to follow storyline details. Those compelled to engage may present irrelevant responses, while others may simply withdraw from activities, fearing embarrassment about their deficits.

Alternating attention pertains to mental flexibility, and having the capacity to shift sets and hypotheses during a task (Pepping & Roeuche, 1991). Those with impairments in this area demonstrate problems with listening and thinking simultaneously. In a similar manner, divided attention requires one to monitor and respond to multiple pieces of information all at the same time. Evidence of this type of dysfunction is apparent when one gets stuck, or perseverates on a solution because of their cognitive inflexibility and inability to completely process all the information (Morse & Montgomery, 1992).

Attention deficits usually manifest following the acute stage of recovery but may endure for years post-injury. These difficulties can compromise attempts at rehabilitation in other spheres since attention skills are multidimensional, include components related to control or resource allocation, and are involved in all effortful cognitive activities. Persons with traumatic brain injury are easily distracted, having considerable difficulty in sustaining attention (Levin, 1985). Additionally, a lack of speed in processing information may impede and interfere with daily activities.

Levin (1985) stated, "although severe closed head injured patients may eventually regain the capacity to solve complex problems, they frequently require a much longer period of time to reach the solution as compared to control subjects. In practical terms, inattention and reduced speed of information processing detract from the patient's adaptation to the work environment." (p. 285)

Sohlberg and Mateer (1987) observed that deficits in attention and concentration are often unrecognized or mis-diagnosed in the assessment of cognitive function following brain injury. These authors further asserted that disruption of the physiological systems, which regulate attention, might occur as the result of minor, as

well as severe neurological damage. Although the severity of attention deficits in persons who are head injured may decrease over the course of recovery, significant deficits may persist many months or even years after the injury.

As in the previous section, several studies that represent good statistical analysis will be highlighted in this section. In addition, these studies represent examples of the different and diverse types of interventions used in addressing the impact of cognitive rehabilitation interventions on attention deficits in individuals with TBI.

Sohlberg and Mateer (1987) examined the relationship between the implementation of an attention-training model and changes in attention skills as measured by the Paced Auditory Serial Addition Task (PASAT). The study utilized a multiple baseline across cognitive areas in order to assess the effectiveness of the attention treatment program. Four participants at the Center for Cognitive Rehabilitation, a post acute day treatment brain injury program took part in the study. The subjects were randomly selected from a consecutive series of admissions to the program, and varied in the nature of their injury and time post onset. Each subject was tested individually using the PASAT and the spatial relations subtest for the Woodcock-Johnson Psycho-educational Battery, which was used to assess visual processing abilities.

Significant impairment in attention skills and visual processing abilities were identified for each subject. During the evaluation stage, two measures of PASAT performance were obtained, and served as the baseline. At least eight measures of performance on the PASAT were taken, with a minimum of two measures during each treatment phases (before, during, and after attention training). The subjects received

between seven and nine individual cognitive retraining sessions per week, which focused on attention, visual processing, or memory according to the treatment phase.

Results showed that subjects with mild to moderate attention deficits had an increase in attention skills to within normal limits, and those with severe attention deficits achieved scores within the mildly impaired range following attention training. In all cases, improvements in attention remained above baseline levels following termination of specific attention training for periods as long as 8 months. Results demonstrated the potential for improvement of attention deficits in persons with head injury. Furthermore, these findings suggested that, although improvements in attention skills can be seen following any focused cognitive treatment, significantly greater improvement followed specific attention training.

Ponsford and Kinsella (1988) evaluated a computer-mediated program for the remediation of deficits in speed of information processing among persons with brain injury. The participants were 15 clients with severe closed head injury, between 16 to 45 years old, with no history of neurological or previous psychiatric disturbance. Additionally, clients experienced a period of posttraumatic amnesia (PTA) for more than 24 hours and were less than 12 months post injury at the start of the program. Results were analyzed at both a group and single subject level. Group means showed a gradual improvement across all phases of treatment. However, a two way repeated measures analysis of variance found no significant intervention effects on any of the measures, although three of the subjects responded favorably to feedback and reinforcement.

The results indicated that subjects improved significantly over the course of the study on both psychometric measures of speed of information processing and on a rating

scale of everyday attention behavior, which would be expected on the basis of natural recovery of cognitive ability during the first 12 months following head injury. However, no conclusive evidence exists that when such recovery is controlled for, the participants showed a significant response to remedial intervention, which involved repeated practice on computer-mediated attention tasks, designed to improve speed of information processing.

Wood (1986) conducted a study to investigate a behavioral procedure for training attention to task using a single case subject design. The study used two subjects, a 25-year-old male and a 19-year-old female. Both participants had sustained severe head injury four and six years earlier, respectively. Both subjects displayed problems of attention, focusing on things that were not part of the therapy activity.

A time sampling procedure was used during therapy to record the client's behavior. The subjects were recorded at two-minute intervals as either attending or not attending to the therapy task. After a five-day period in which the baseline data was collected, the training program was initiated. Plastic tokens were used to reinforce attending behavior. Clients received a token at two-minute intervals only if they were attending to the therapy activity at that time. Those who earned more than a designated number of tokens exchanged them for a reward following the sessions. This method was applied each day during two therapy sessions, for the duration of the training period, 28 days.

Results indicate that each client showed improvement in attending behavior relative to baseline. However, one client showed significant improvement, with the other showing improvement, but not at a significant level. The authors suggest that this

discrepancy could have resulted from the application of different types of therapy activity or the lack of set times during the day.

In a second study conducted by Wood (1986), using a single case design, computer training tasks was used to investigate improving selectivity and speed of information processing. Four subjects took part in the study, a 25 and 30-year-old male, and a 19 and 46-year-old female. All had sustained severe head injury. The clients were trained on tasks that required the maintenance of an attention set and efficient information processing. In order to determine if improvement in performance would generalize to other aspects of behavior, two outcome measures were used; (1) a behavior recording of attention during therapy activities (attention-to-task), and (2) measures of auditory recall memory. On the auditory -attention task, each client was presented with a sequence of digits at a rate of six digits per five seconds. At random intervals, a target sequence of three odd digits was presented during the series. The client responded to the target by tapping the top of the table. A total of seventy targets were presented in each series, with 30 minutes duration for each task, once a day for 28 days.

In the visual attention task the client sat in front of a panel in which a transparency containing 32 symbols was placed. The panel was divided into two matrix panels, the right containing 16 symbols in different order, and the left containing 16 different symbols. The task began when a symbol in the left matrix was illuminated. The client was required to move a scanning light across the top of the matrix until the light position coincided with the column containing the target symbols, at which time the client was required to stop the light. The task lasted 30 minutes for a period of 28 days.

Results of the study indicate a measure of improvement in both tasks using a two-way repeated measures analysis of variance (ANOVA). The study also showed that clients had a progressive improvement as training continued, which indicates an improvement in their ability to process information more efficiently. The results also indicate no difference in client's performance between the two training tasks, which suggests that neither task proved too easy or difficult and that both were useful training procedures. More important, the results suggests that attention behaviors can be both altered and improved with the use of contingent reinforcement which in turn improve information processing capabilities.

Weber (1990) conducted a case study to investigate how the dimensions of capacity and control manifest themselves during cognitive control. Capacity refers to the amount of information or mental processing a person can attend to within a given time. Control refers to a person's ability to guide the selective process by directing and organizing whatever attention capacity the individual has.

The study investigated capacity deficit using a 37-year-old man who sustained a closed head injury due to a fall. The client incurred no loss of consciousness, however, neuropsychological evaluation 6 months post injury indicated severe attention deficits and possible mild memory deficits with otherwise average intellectual functioning. The client's performance indicated slowed information processing and high stress levels.

The treatment program began 7 months post injury on a twice weekly basis for a total of 3 hours per week for a total of 80 hours. The attention training consisted of visual and auditory tasks presented on audiotape, computer, and paper and pencil. The training tasks initially comprised very slowly presented stimuli for easy monitoring tasks

and simple reaction time measures. The speed and complexity demands were gradually increased until the client was doing two tasks at once, and doing tasks involving flexible changing of attention focus. As part of the training, the client was provided with homework assignments of reading, playing card games, and doing crossword puzzles in order to increase attention activities at home. Relaxation training was also provided at the beginning of the treatment to reduce cognitive overload and associated stress effects.

Results indicate that on the baseline performance, the client's performance showed no evidence of improvement on the basis of practice alone. However, the retest measures, which were identical to those of the baseline phase, showed dramatic improvement. Retest scores indicate that the client's attention functioning reached normal limits. The results also showed that after further training, the client has been able to engage in simple business transactions with strangers for purpose such as selling his car, finding a new apartment, and buying furniture.

In another study by Weber (1990), the author investigated control deficit using a single case design. The client was a 59-year-old man who had suffered a series of strokes. Treatment was initiated 4 months post stroke on a basis of 1 to 2 hours per week for 6 months, for a total of 38 hours. The treatment focused on attention because attention is the basis to other mental functions (Weber, 1990). The training utilized the same task as described in the previous case. However, additional techniques, such as changing from task to task, getting the client to make up his own tasks, role reversal (in which the client monitors and scores the therapist's performance), and verbalization of thoughts while doing the tasks were used.

Results indicate that although performance on the attention capacity test was the same both before and after treatment, improvements have been observed on the attention process measures. It was also noted that the client showed progressively more realistic awareness of his performance and became more able to recognize and describe problems he encountered both on the training tasks and with respect to activities of daily living. The greatest impact of the training was reflected in the client's score on the Wisconsin Card Sorting test. Prior to treatment, the client scored 2 standard deviations below the mean with respect to errors, and 3 standard deviations below for categories achieved. However, after treatment was completed, the client scored within normal limits on both measures. Moreover, on the booklet form of the Category Test, the client improved from 3 standard deviations below the mean to 11/2 standard deviations below the mean. Attention training was terminated after the client's functioning in everyday life reached an acceptable level for the client and his wife.

Kewman, Seigerman, Kintner, Chu, Henson and Reeder (1985) conducted a study to test whether a training program composed of a set of visuomotor and attention tasks would generalize to a complex functional skill. Specifically, the study focused on whether improving brain injured subjects' skills using a set of training tasks that simulate different aspects of automobile driving would generalize to actual operation of an automobile.

Three groups of subjects took part in the study. The experimental treatment group consisted of 13 persons who were severely brain injured, this group received the full training program with the AMIGO vehicle. The group consisted of 12 persons with closed head injury, and 1 person with hypoxic encephalopathy. The second group of

subjects 11 persons with closed head injury, served as the control group and spent time operating the AMIGO vehicle, but did not receive training on the specific tasks. A third group of subjects was composed of 11 "normal" high school students who were licensed drivers. This group trained on some of the tasks with the AMIGO vehicle. The average age of the two brain injured groups was 24. 2 years old, while the average years of pre-injury driving experience was 5.7 years. None of the persons with brain injury had driven since their injury. All of the participants had been in a coma for at least 24 hours and were a minimum 6 months (average 3.7 years) post onset of injury. No significant differences were obtained on the demographic variables between the brain injured experimental and control groups, nor were there any significant differences in years of education, weeks of hospitalization, or days in coma. Prior to training, the experimental and control groups were compared on several cognitive-perceptual tests, which were identified as sensitive to driving ability. On the Wechsler Adult Intelligence Scale-Revised (WAIS-R), Symbol Digit Modalities Test (oral & written form), Motor Free Perceptual Test, and Digit Span, no significant differences were found; however, on the picture arrangement of the WAIS-R scores were significant with the experimental group scoring higher than the control.

The procedure included pre-training evaluations and a training program. Each participant's automobile driving performance was evaluated on city streets using the same course. Subjects were evaluated on their ability to maintain lane position, execute accurate turns, and observe specific road signs. During the training program, the experimental group training consisted of eight 2 -hours driving sessions where subjects were trained on seven driving related exercises using the modified AMIGO wheelchair.

The visual monitoring task consisted of the automatic presentation of a road sign at four different points in the serpentine course. For the auditory monitoring task, clients listened to a tape recording of randomly presented digits and words at a rate of one every 2 seconds.

Subjects were required to indicate a word as opposed to a numeral while they negotiated the serpentine. Control subjects with brain injury attended eight 2-hour sessions. They drove the AMIGO vehicles in each session for the same average number of minutes as the experimental group, however, they did not receive special training as the experimental group.

Results of the study indicates that prior to training, no statistically significant differences existed between the two groups on any of the driving tasks, composite scores, or driver education ratings. However, after training significant differences were observed using the Mann- Whitney U test. Differences were observed for percentage of correct tracking, percentage of correct signs, composite score, and driver educator ratings. Only the measure of percentage of correct turns did not reach significance. Overall, the results showed that the AMIGO program with specific training exercises resulted in improved on the road driving as compared to the AMIGO control condition without specific training exercises. However, compared to the normal reference group, the experimental group scored significantly lower on all driving tasks.

The authors believe that as an example of remediation of attention and visuomotor deficits following brain injury the findings have important implications for rehabilitation. The findings showed that persons who are severely brain injured have the ability to improve their performance with structured training long after their injury; and second,

performance on simple exercises that simulated aspects of a complex functional skill generalized to the functional skill (i.e., automobile driving).

Niemann, Ruff and Baser (1990) evaluated the efficacy of a computer-assisted attention-retraining program. The sample consisted of twenty-nine individuals between ages 16 and 60 years. All had TBI in the moderate to severe range with a minimum coma duration of 1 hour. The subjects all had chronicity ranging from 12 to 72 months, no evidence of severe disorientation and confusion, sufficient cognitive functioning, no severe aphasia, sufficient vision to read text on a computer screen, at least one functional hand, no substance abuse since the injury, and no premorbid history of psychiatric disorders resulting in hospitalizations.

Subjects were assigned at random to the experimental and control group. In order to control for non-specific treatment effects, the control group received a memory training of equivalent duration and intensity. Two subjects who enrolled in the attention-training program (experimental group) discontinued their participation after approximately 6 weeks for personal reasons. Training lasted a total of 9 weeks with two 2-hour sessions per week for both groups.

The experimental design evaluated outcome by juxtaposing a multiple baseline procedure for the first set of measures of attention and memory with a pre and post group comparison that relied on a second set of neuropsychological tests. Results showed that the experimental group improved significantly in comparison to the control group on measures of attention. However, the reversed patterns for the memory measures were not observed.

Gray and Robertson (1989) conducted a study using microcomputers to provide attention training tasks on self-modulation of arousal, and on alternating attention or on dividing attention. Subjects were admitted for the trial if they fulfilled the following criteria: (1) either subjective reports of difficulty in concentrating in real life situations, such as reading or following a conversation, or reports of lapses in concentration by relatives or care staff; and (2) either a score of one standard deviation below the mean or lower on PASAT or more than five errors on the modified WCST.

The subjects were 31 clients with brain injury of acute onset who were randomly assigned to an experimental attention training group and a control group. The 17 subjects in the experimental group received between 13 and 18 hours of computerized attention retraining. Each session lasted one to one and a half hours over three to nine weeks. Retraining consisted of work on reaction time training, rapid number comparison; digit symbol transfer and alternating strop program. The procedures utilized in the study were expected to produce improvements in the experimental group on attention function as measured by PASAT and WCST. However, subjects were measured on various aspects of attention on controlled processing using a number of psychometric tests.

Results showed that only minor differences occurred in attention function. The experimental group scored better on WAIS-R Picture completion and on the PASAT Information Processing Rate. Scores also indicate that when estimated premorbid IQ and weeks post injury were added as covariates, no significant differences were obtained between groups. However, the experimental group performed better by the sixth month on a variety of psychometric measures such as Backward Digit Span, Arithmetic, PASAT Total Score, PASAT Longest String, Information Processing Rate and Block Design.

According to the authors, the results are not trivial, the experimental group improved by an average of 2.14 points on Arithmetic versus 0.7 for the control group. In addition, they conclude that the results are positive for the experimental group after a period of several months.

Remediation of Socio-behavioral Deficits

Several studies that represent the different methods of cognitive rehabilitation interventions on socio-behavioral deficits in individuals with TBI as well as used effective statistical analysis will be highlighted in this section. Individuals with TBI often exhibit deficits in the social-behavioral and self-regulation areas. These individuals often lack the ability to restrain impulses, use feedback to control their behavior, and to evaluate the consequences of their behavior. Other characteristics changes may involve impulsivity, impatience, irritability, temper outbursts, and self centered behavior (Zencius, Wesolowski, & Burke, 1990).

In 1981, Luria proposed that the voluntary self-regulation of behavior is mediated by "inner speech." Cognitive rehabilitation interventions have utilized self-instruction-instruction to help individuals with TBI learn to regulate their own behavior. For example, Cicerone and Wood (1987) successfully treated a 20 year old male client with 16 one-hour sessions of self-instruction training during practice of the "Tower of London" task (see Shallice, 1982). During the training phase, the number of incorrect moves decreased from an average of 176 to 2 per session. Following the training, treatment continued with 12 sessions of self-instruction training in an interpersonal setting. The result showed significant improvement in performance on the Self-Control

Rating Scale. In summary, the results appear to demonstrate the efficacy of self-instructional training in treating the behavioral sequelae of closed head injury.

Turner, Green and Braunling-McMorrow (1990) conducted a study using a multiple baseline design to determine whether differential reinforcement of low rates (DRL) would be an effective procedure to use with an individual with a TBI as part of an intervention to reduce high rates of dysfunctional behaviors. The participant was a 21 year old male who was referred to a residential treatment program for individuals with TBI. At the start of the study, the client was involved in behavioral intervention, physical therapy, cognitive/communication therapy, living skills instruction and vocational counseling.

Intervention entailed a full session of DRL with length of intervals and the response requirements changing systematically across five intervention phases. When the subject exhibited frequencies of behaviors in the combined verbal and physical categories that were at or below a certain criteria for a specified time period, he was awarded points. However, if he met or exceeded the weekly goal, he received monetary rewards.

During the baseline period, behaviors in both the physical and verbal categories occurred at a moderately high rate. After a week of intervention, a high rate of verbal behaviors still occurred, but the goal of 3000 points was achieved. Results showed that after the intervention, DRL procedures appear to be effective in reducing the rates of socially dysfunctional behaviors. It should be noted that the intervention package also included verbal instruction, social reinforcement, and token reinforcement. However, the contribution of these on the effect of the client's overall performance was not determined.

Blair and Lanyon (1987) conducted an experimental study to evaluate the effectiveness of an intensive, multidisciplinary rehabilitation program upon a variety of social and adaptive living skills in adults recovering from severe closed head injury. The study also focused on how cognitive functioning is related to adaptive functioning in the natural environment of such clients. The study assessed two areas of functioning; the adaptive living skills necessary for the individual too effectively maintain personal independence in daily living and meet the social expectations of the environment; and cognitive deficits which can seriously affect the client's overall adaptation by interfering with the organization of goal directed behavior.

Twenty subjects took part in the study, 10 were full-time clients in a structured rehabilitation program for head injured adults, while the remaining 10 formed a waiting list control group. The rehabilitation group consisted of clients from the Hope Center for Head Injury, a private, nonprofit day treatment facility which offers a comprehensive, multidisciplinary rehabilitation program for head injured adults. Clients attended the program six to seven hours per day, five days per week, and attended classes in activities of daily living and social skills. The activities and skills were taught in the context of individualized speech, occupational, and physical therapy; individual, group, and family counseling; and a variety of other activities. Clients also attended individual and group retraining sessions for cognitive dysfunctions with the particular activities selected to meet each client's individual needs. The control group consisted of clients who would qualify for the Hope program and who were similar to the clients in the rehabilitation group. The control clients lived at home, although some attended speech, occupational,

or physical therapy once a week, whereas, others were engaged in a comprehensive program.

Outcomes were measured using the Adaptive Behavior Scale (ABS), which measured social and adaptive behavior. In addition, four broad areas of cognitive functioning were assessed. Instruments included REACT, SYMBOL-Digit modalities, WAIS-R comprehension, similarities, and arithmetic subtest; the visuospatial cluster included the WAIS-R picture arrangement and block design subtexts. The memory cluster included WAIS-R digit span subtest of the Wechsler Memory Scale (WMS).

The study finds that all t-values were less than 1.0, which demonstrates that the groups were not significantly different on the matching variables. However, on the adaptive measures, the rehabilitation subject's changes were greater in magnitude than the control subjects changes in adaptive skills. On the cognitive scales neither group showed any significant changes in cognitive functioning. The study cannot conclude that changes in adaptive and social skills are related to changes in higher cognitive functions. It appears that individual subjects showed obvious improvement while others got worse. The study recommends developing a different methodology which is based on knowledge of patterns and events that occur during the recovery process and tailored to the individual's unique recovery sequence.

Zencius, Wesolowski and Burke (1990) report on the use of a visual cue to reduce profanity in three separate environments (speech therapy, occupational therapy, social interaction class) in a person with brain injury. The subject was a 24 year old male who sustained frontal and temporal lobe injuries after being struck by a car. The client was referred for rehabilitation for drug abuse, poor interpersonal skills, poor communication

skills, and inability to set realistic goals. Assessment using the WAIS-R revealed a verbal IQ score of 76, performance IQ of 63, and full scale IQ score of 70. The client also scored in the severely impaired range on the California verbal Learning Test, the Wechsler Memory Scale-Revised, and the Visual Memory Rey-Osterreitch CFT Test. Moreover, on the Wisconsin Card Sorting Test, the Porteous Maze Test, and the Trial Making Test, Part B, which measured impulsivity, the client scored in the severely impaired range.

The dependent measure was the frequency of profanity used in each of the three classes per day. During base line, the number of profanities used in each class per day was scored. After base line, a sheet of white paper was held in front of the subject with the word "swearing" written at the top with a red marker each time he used a profanity. After using the visual cue a total of 26 days in the social interaction class, 24 days in the speech therapy class, and 21 days in the occupational therapy class, the treatment was discontinued. After treatment the participant was transferred to a less restrictive setting, where he engaged in full time vocational programming.

Results showed that implementation of the visual cue in the social interactions class decreased profanity to a mean of 0.5 per class per day as compared to 6 during baseline. In speech therapy class profanity decreased from a mean of 5.8 per day during base line to a mean of 0.8 per day, and in occupational therapy class profanity decreased from a mean of 4.5 per day to an average of 0.3 per day. The results obtained showed that profanity can be reduced using a visual cue to remind the client of his verbal behavior. Zencius et al. (1990) suggest that the paper with the word "swearing" on it

may have served as a stimulus controlling the verbal behavior of the client in a given setting.

Alderman (1991) conducted an A-B-C single case study design in which avoidance behaviors were treated by satiation through negative practice following the failure of several behavioral programs. The subject was a 24 year old male who sustained a severe closed head injury. Neuropsychological assessment revealed average level of intellectual functioning. Testing also revealed that verbal skills were within defective levels, memory functioning was globally depressed, and perceptual and language skills were grossly intact.

At the start of the program, the client presented three major concerns: (1) a general dishinibition of sexual behavior characterized by making inappropriate comments of an overtly sexual nature towards, and by touching female staff members; (2) despite the ability to self-toilet as the need arose, the subject urinated upon himself several times a day; and (3) the client engaged frequently in very loud prolonged period of shouting that would disrupt any activity he was scheduled to do.

Time-sampling methods were used to record a pre-treatment baseline of the client's shouting. Over a five day period of 9.5 hours of sampling, the client had a total of 99 shouting episodes. Treatment took place twice each day, one in the morning, and the other during the afternoon, and consisted of two 30 minutes individual session. In addition to the intervention, the client was prescribed 100 mg BD of propanalol.

Results indicate a significant downward trend in the frequency of shouting. Moreover, after withdrawal of the behavioral component the downward trend in shouting

continued. Also, there was a significant decrease in the mean frequency of shouting and screaming per hour.

The authors conclude that the results obtained showed that the intervention demonstrated that negative practice as a treatment method is effective in reducing the frequency of a negatively reinforced avoidance behavior. In relation to the client's disinhibited sexual behaviors, time out programs were used, which proved effective. The results also indicate that when individuals with TBI develop behaviors in order to avoid participating in therapy activities, the use of satiation through negative practice may prove effective.

Vocational Outcome Studies

After reviewing the literature, it is clear that traumatic brain injury is associated with a number of deficits in areas of physical, cognitive, psychosocial and behavioral functioning. Additionally, as the severity of injury increases these deficits are likely to become more apparent and debilitating. It is apparent that employment following traumatic brain injury is a complex phenomenon with considerable disparity in reported outcome statistics across studies. To attest to the fact that employment following traumatic brain injury is difficult, studies have been conducted for the past fifty years on vocational outcomes following traumatic brain injury with no conclusive evidence.

In reviewing the literature on vocational outcome following traumatic brain injury, a number of red flags were discovered. First, there exists a problem related to severity of injury. Many studies did not differentiate between mild, moderate or severe brain injuries, which could have serious impact on those studies' results. This is important to note because level of severity has a strong correlation with residual deficits

and employability. Secondly, some concerns are apparent in the way work and/or employment is defined in many of the studies. Some studies define work as part-time employment, whereas others define work as full time employment or even volunteer (non-paid) employment. This becomes important when trying to define a successful vocational outcome. Thirdly, as previously mentioned in the recovery section, there are some concerns related to pre-injury status. Many studies did not differentiate the individuals' level of pre-injury education, employment or even personality and social status, which according to most studies have an effect on level of recovery and vocational outcomes. With these concerns in mind, a review of the vocational literature will be undertaken.

Gjone, Kristiansen & Sponheim (1972) studied 94 persons with severe intra-cranial injuries with an average length of hospitalization of three months. Forty-seven percent of these individuals were suitable to return to work at discharge. However, less than half of the 45 individuals who were classified as work ready were able to return successfully to work.

Brucker & Randle (1972) followed 64 individuals with severe head injury (PTA > 24 hours) for a period of three years. They noted that 40% of these individuals had returned to their pre-injury job and were receiving the same pay level. Twenty-four percent returned to a lower employment level with correspondingly less pay, and 35% remained unemployed. The authors concluded that the psychological symptoms expressed by these individuals were the most significant barriers to employment. Additionally, they found that factors such as age, epilepsy, hemiplegia and dysphasia were viewed as obstacles toward successful employment.

VanZomeran & VanDenBurg (1985) reported on a follow-up study of 61 individuals with severe head injury (PTA > 1 day and average duration of post-traumatic amnesia of 30.5 days). Results showed that 58% of the individuals returned to their former employment, 13% returned to their previous job with modifications, 5% were employed at a reduced capacity, 7% were employed in sheltered workshops, and 16% were unemployed. The authors concluded that the duration of post-traumatic amnesia correlated with the ability to be employed, and identified 13 days of post-traumatic amnesia as the cut off point, after which an increasing emergence of personality disturbances are observed.

Ben-Yishay, Rattok, Lakin, Piasetsky, Ross, Silver, Zide, & Ezrarchi (1985) offered statistics on 100 individuals with severe head injury (loss of consciousness > 1 day). The vast majority of these individuals were at least two years post-injury and a large number were unemployed at the time of admission to an outpatient program. Additionally, the majority exhibited difficulties in attention, insufficient awareness of deficits, impulsivity, difficulties in learning, inadequate interpersonal skills and other problems. Results indicated that 65% of these individuals who completed the program where competitively employed. In addition, 15% entered sheltered employment with the remaining 20% unemployed.

A study by Scherzer (1986) found that, after a three-year comprehensive rehabilitation program, improvement was noted in areas of attention, visual information processing and manual dexterity. Of the 32 individuals in the treatment program, six returned to pre-injury level employment, four were temporarily employed, an additional four were considered ready for employment and 18 remained unemployed.

Kaplan (1988) followed 25 individuals who had acquired a severe head injury with an average length of coma of nearly 10 days. Length of coma and duration of post-traumatic amnesia were negatively correlated with successful re-employment. Additionally, family adjustment measures on pre-injury functioning were associated with more adaptive coping strategies following their injury. These measures were associated with successful re-employment. Psychosocial adjustment and interpersonal skills were found to be more predictive of successful vocational outcome than specific vocational competencies. The author concluded that caution should be exercised in terms of the value of cognitive remediation and urged that greater emphasis be placed on interpersonal skills training and psychosocial adjustment.

Thomsen (1984) followed 40 individuals, 28 males and 12 females with severe head injury (PTA > 1 month) over a 10-15 year period. Results revealed that of the 40 individuals, two were employed full-time, four were employed part-time, and an additional seventeen individuals were in sheltered workshops. Also, three of the female individuals were classified as being homemakers. The author concluded that brain injury consisting of brainstem damage was a negative prognostic indicator, being associated with prolonged dysarthria and motor impairment.

Cognitive Rehabilitation

Cognitive rehabilitation has gained tremendous prominence as a treatment for individuals with memory and attention deficits due to TBI over the past 20 years. As previously stated, the survival rates for individuals with TBI has increased drastically due to neurosurgery research, improvements in neurosurgical techniques, new forms of pharmacotherapy, and improved emergency care at accidents sites, including expeditious

evacuation to hospitals trauma units (Wehman et al., 1989). As such, rehabilitation professionals are faced with treating individuals with more severe and debilitating injuries.

Individuals with TBI pose a major challenge to rehabilitation counselors, psychologists and other health care providers because of the complex nature of the deficits. Thus, appropriate rehabilitation programming is necessary if successful reintegration of individuals with TBI is to occur. Over the past two decades, rehabilitation facilities and clinics for individuals with TBI have increased dramatically. With the recent inclusion of cognitive rehabilitation as a treatment technique, there has been a significant increase in brain injury rehabilitation facilities. In the past ten years, there has been a significant increase in the use of cognitive rehabilitation as an intervention strategy for individuals with TBI. As more individuals survive TBI, the focus has been on the improvement of cognitive functioning (e.g., memory, attention) and improvement in daily living skills. The most advance has been the development of programs designed to help individuals with TBI return to independent living in the community (Wehman, Kreutzer, Sale, West, Morton, & Diambra, 1989).

Individuals who have sustained traumatic brain injuries often experience significant impairment in memory, attention, personality and behavioral functioning due to pathophysiological alterations in the brain. Cognitive deficits usually interfere with successful reintegration into society, especially vocational and educational settings as evidenced by their inability to maintain employment as well as high dropout rates due to school failure (Johnson, Thomas-Stonell, & Shein, 1994). Research in brain injury has demonstrated the differences in cognitive functioning among individuals who have

sustained a TBI. Regardless of the severity of the injury, most individuals who have acquired a TBI are likely to express some impairment in functioning compared to normal controls on tests of reaction time, fine perceptual judgment, memory, information processing, and learning of new information (Sunderland, Curry, Das, Enderby, Kinsey, Mortley, & Petheram, 1992). Given the impact of cognitive functioning on vocational outcomes and quality of life, brain injury rehabilitation has shifted focus from one of physical restoration to emphasis on improving cognitive functioning in individuals with TBI (Crowley & miles, 1991).

Cognitive rehabilitation has become a focus for neuropsychologists and rehabilitation practitioners who are involved in the treatment of cognitive deficits in individuals with TBI. Although no evidence exists to support any treatment interventions or a specific cognitive rehabilitation strategy that could speed up the recovery process, there is evidence that supports the timing of rehabilitative interventions as a crucial indicator of recovery. Neurologically, there exists a period maximal reorganization of the brain in the first few weeks post-injury. As such, it is crucial that rehabilitation efforts begin as soon as possible following the injury. Additionally, Larkin (1993) stated that rehabilitation intervention with individuals with TBI should continue as long as possible because significant gains may still occur.

Defining Cognitive Rehabilitation

Many terms have been used to describe cognitive rehabilitation. Such terms include rehabilitation, remediation, and retraining which are frequently used interchangeably in the field as well as in the literature. Some in the field of cognitive rehabilitation have argued that there are differences in the terms rehabilitation,

remediation and retraining because the focus of the interventions are different. However, regardless of the term, the purpose of cognitive rehabilitation is to improve functional adaptation in daily living activities for individuals with TBI as determined by vocational and academic functioning and community integration (Wheman et al., 1989; Wilson, 1991).

Diller and Gordon (1981) define cognitive rehabilitation as a form of intervention in which, a constellation of procedures are applied by trained practitioners to provide individuals with brain injury with the skills and strategies needed to perform tasks that are difficult or impossible for them, due to the presence of underlying cognitive deficits. Cognitive remediation as defined by Fujii (1996) is teaching individuals with brain injury the skills and behaviors that they are deficient in due to their underlying cognitive deficits. Wehman et al. (1989) define cognitive remediation as "a group of strategies intended to help persons with cognitive dysfunction to improve intellectual, perceptual, psychological, and behavioral skills" (p. 69). On the other hand, cognitive retraining as defined by Berrol (1990) is a systematic attempt to improve intellectual deficits caused by a brain injury that resulted in informational processing difficulties. According to Berrol (1990), cognitive rehabilitation is more comprehensive in scope than cognitive retraining and cognitive remediation, in that the brain can develop new neuronal connections after an insult or injury given time and proper stimulation.

The aim of cognitive rehabilitation is to restore an individual's cognitive abilities, including memory, attention, concentration, organization, planning, and perception. Cognitive rehabilitation according to Luria's concept of functional reorganization is a four step process which involves: "the precise qualification of the psychological function,

utilization of automatic and intact functions, a step-wise program with the aim of integrating and automatizing, and continuous evaluation and feedback" (Christensen, 1986, p. 17). When working with individuals with TBI, Zangwill (1947) suggests that the three most useful techniques in cognitive rehabilitation are the use of compensatory strategies to bypass the deficit, the use of substitution to solve a problem by a different means, and attempts to retrain the deficit.

Psychologists and rehabilitation professionals involved in cognitive rehabilitation with individuals with TBI, often approach rehabilitation with the following goals: 1) teaching clients to be aware of residual deficits and the effects this will have on the rehabilitation process; 2) teaching compensatory strategies designed to circumvent functional disabilities; and 3) helping the individuals to understand and accept the consequences of their brain injury as well as the permanent changes that may occur (Prigatano, 1987). The goal of cognitive rehabilitation according to Wilson (1991) is restitution of function and the use of compensatory strategies that capitalize on residual skills. Thus the goal of cognitive rehabilitation in brain injury rehabilitation is to help individuals regain functional abilities, which in turn will help them to become independent and lead productive lives.

Cognitive rehabilitation can be applied with children and adults, and there is growing evidence that indicates that various forms of cognitive rehabilitation are useful in remedying intellectual deficits in the elderly (Powell & Whitla, 1994). However, controversy exists in the application of cognitive rehabilitation as to whether intervention should focus on developing specific skills or improving basic cognitive processes. Gianutsos (1992) stated that what is important is that as treatment progresses during the

course of recovery and as individual needs and resources change, intervention strategies should be redefined and change to best suit the individual needs. As such, the primary purpose of cognitive rehabilitation is to help accelerate the process of individuals with TBI regaining their functional capabilities, and become productive members in society.

Historic Perspective of Cognitive Rehabilitation

Cognitive rehabilitation as a field dates back to the late eighteen hundreds, early nineteen hundreds. John Hughlings Jackson laid the early foundation in 1897 for the field of cognitive rehabilitation (cited in Prigatano, 1987). His position was that higher cerebral functions were less complex in their structural organization than lower brain functions. The implications that stem from such a belief were that higher cognitive processes were more modifiable than lower cognitive processes. In 1924, Flourens in his work with pigeons, found recovery of higher cognitive functions after cerebral oblations (cited in Prigatano, 1987). In 1927, Lashley's research yielded the same results with his work with rats. Lashley (1938) concluded that recovery of higher cognitive functions could be the result of a number of reasons. He posited that, "functional loss may be secondary to destruction of essential neurostructures, temporary disruption of existing of existing pathways, diachisis, metabolic disturbances, or lower tonic level of activity" (p. 735). Researchers have concluded from these studies that the potential for recovery of higher cognitive functions appear to be greater than other functions mediated by the central nervous system.

Cognitive rehabilitation appears to have its roots in World War II. Luria while working with soldiers with penetrating gunshot wounds during the war, designed head injury rehabilitation programs that were based on available scientific evidence. Luria

rehabilitation methods were eventually based on his theory of brain functioning developed while working with these head injured soldiers (Luria, 1963). Interest in head injury rehabilitation subsided until psychologists at New York University Medical Center in 1962 started to address the issues at the interface of clinical neuropsychology and rehabilitation. This work gave rise to intervention-based programs for individuals with cognitive deficits as a result of TBI, stroke, or other type of brain damage. Neuropsychology as a field was not a formal discipline and rehabilitation psychology was still evolving with a focus on dealing with disability from a personal and societal perspectives. Diller (1992) stated that clinical neuropsychology in the 1960's developed along three perspectives: (1) it provided the psychometric tools that would extend and quantify the clinical neurological examination and thus make the use of profile analysis possible; (2) it provided the behavioral anchors for the subsequent explosion in neuroimaging techniques; and (3) it provided for the examination of brain-behavior relations through clinical and experimental methods to formulate more precise descriptions of neurological syndromes.

The 1960's saw rehabilitation psychology operating under a multidisciplinary approach. Specialists from different disciplines treated disability related problems with the focus of the rehabilitation being on functional and practical abilities, and assessment driven by functional considerations. Neuropsychological rehabilitation and cognitive remediation as a specialty did not exist at this point in time. Cognitive rehabilitation as a field developed in the late 1960's and early 1970's due to the increase in survival rate for individuals who sustain TBI. The early 1980's saw tremendous growth in the development of cognitive rehabilitation and brain injury rehabilitation facilities. Prior to

the development of cognitive rehabilitation, brain injury rehabilitation mainly focused on physical and speech restoration. However, with the development of cognitive rehabilitation, interventions and treatment have addressed issues such as attention, memory, perceptual motor difficulties, cognitive disorganization, eye movements, socio-behavioral and self-regulation deficits. Cognitive rehabilitation as an intervention strategy has been shown to increase clients' academic, vocational, and social areas. Moreover, studies show improvements in formal psychometric measures. Presently, cognitive rehabilitation interventions are used not only to treat persons with TBI, but also children and adults with learning disabilities, and individuals with mental retardation (Berrol, 1990; Routh, 1987).

Theoretical Foundations Underpinning Cognitive Rehabilitation

During the early stages of cognitive rehabilitation in the late 1970's and 1980's, the major criticism was that there was not enough solid research to substantiate that cognitive rehabilitation made a difference. However, with the advances in technology in the past 20 years, researchers have revolutionized how the brain is studied. Computer technology, in particular, has had the greatest, most significant impact in this area. The advances in cognitive science have supplied the models on which cognitive rehabilitation methods are based. As noted by Lucas (1992), cognitive rehabilitation strategies will be refined further and the reputation and scope of the field of cognitive rehabilitation will continue to grow as knowledge of the brain increases.

Within the field of cognitive rehabilitation it has been suggested that it is necessary to base interventions on a theory of brain functioning and/or brain behavior relationships. Clinicians recognize the relationship between basic neuroanatomy and

behavior; however, differing views still exist regarding how brain and behavior interact. Despite these views, what is known and widely accepted about recovery after TBI is that neural regeneration is very limited in the central nervous system, and improvements through natural recovery may account for improvements assumed to be attributable to cognitive rehabilitation (Wilson & Patterson, 1990). With this knowledge, one of the theories underlying rehabilitation after TBI is that enhancement of residual abilities is possible while restoration of impaired functions is not. An important aspect of cognitive rehabilitation is to determine what deficits are amenable to rehabilitation and which are not. As such, the areas of deficit believed to be amenable to rehabilitation were addressed by providing persons with TBI with the correct experiences in the context of the appropriate level of demands such that they would have to develop the skills to overcome or satisfy the demands (Bracy, 1994).

Cognitive rehabilitation methods within the past decade or so can be attributed to the field of information processing models of cognition from the field of cognitive science. One theory underlying cognitive rehabilitation is the building block theory. In this approach, cognitive skills are broken down into their component parts and these component parts are practiced intensively in a stepwise fashion until mastery is achieved. Another proposed model drawn from behavioral science, bases cognitive training hierarchies on observable interactions of the individual with TBI and their external environment. This model is seen by many researchers to be more consistent with how behavioral skills are acquired and generalized than the cognitive information-processing model (Levin, 1991).

In their discussion regarding the relationship between cognitive theory and rehabilitation research, Caramazza and Hillis (1993) raised the issue of what exactly a rehabilitation professional needs to know regarding a client's cognitive impairments in order to determine what types of interventions will produce positive results. This issue is important since, on the surface, two clients may produce the same performance on a task but further analysis may reveal differences. These differences may be reflective of different areas of damage, which may necessitate different kinds of intervention.

Many researchers have argued that rather than relying on theory to guide rehabilitation interventions, treatments found to be effective with clients with similar types of functional lesions should direct treatment. The type of approach is concerned with the identification of client categories for which information about the effectiveness of various treatment strategies can be collected and used to develop treatment plans. However, critics of this approach argue that interventions based upon this client generalization paradigm can be dangerous because treatment may not be effective for many reasons including differences from client to client with regard to severity and nature of neurological damage, variations in the stage of neurological recovery, and variations in the manifestations of deficits with damage to the same area. In addition, differences in premorbid or residual abilities and premorbid client characteristics have been found to be significant characteristics (Caramazza & Hillis, 1993).

To date, the six-factor model developed by Sachs, Bell, Berger, Carroll, Davidson, Heavener, Peters, Schaffer, & Stabene (1986) is the most comprehensive model of cognitive rehabilitation. This model provides the framework for clinicians to develop an understanding about cognitive concepts, and allows for consistent and

efficient service delivery. The six-factor model provides an outline for treatment, a framework for evaluation, treatment planning, and vocational counseling. In addition, it is an educational tool for professionals, families, and clients, and provides a means for quantifying evaluation of its effectiveness, and a basis for further empirical investigations necessary in developing cognitive retraining models. This model was designed with a goal of integrating the cognitive skill approach of Ben-Yishay (1987) with the concept of head injury recovery provided by the Ranchos Los Amigos Scale.

The six-factor model focuses on six general cognitive areas applicable to the understanding of persons with TBI recovery. The factors that compromise this model were clinically determined and include the following: 1) arousal, attention, and concentration, 2) memory, 3) sequencing, 4) visual spatial, 5) verbal abstract reasoning, and 6) social/emotional. Application of this model includes treatment planning and implementation of a rehabilitation program through task and job analysis. From a treatment planning perspective, this model provides a framework for rehabilitation professionals to organize the results of their evaluations in order to identify the client's cognitive strengths and weaknesses. Once the evaluations are completed, professionals can develop a treatment program geared towards addressing specific cognitive issues. This model can foster consistent cognitive treatment across related as well as different disciplines. In the case of task analysis, both cognitive and vocational functioning can be analyzed in terms of skills required within a given cognitive area. Sachs et al., (1986) stated that with this information, certain tasks that are suitable can be selected for each individual in developing a specific cognitive area (s). In addition, the authors stated that for vocational applications, this strategy can be used to retrain skills necessary for

returning an individual to his or her previous job, or to recommend a different field of work.

Levin (1991) stated that a model of cognitive rehabilitation should generate prescriptive evaluation information, assure flexibility, and provide for individualization of services based on the individual cognitive strengths and deficits. In addition, the model should generate quantifiable data for program evaluation and demonstrate ecological validity by providing for generalization of skills to everyday settings. Bracy (1994) posited that other important aspects of cognitive rehabilitation should include clear, accurate, immediate feedback, and the careful selection of the complexity of rehabilitation tasks that are at the borderline between current ability and the next highest level of ability, and the consideration of different levels of functioning in different cognitive areas (e.g., attention, memory, sensory).

Concerns Pertaining to Cognitive Rehabilitation as an Intervention Strategy

Cognitive rehabilitation as a discipline did not become popular until the 1980's. Since the evolution of cognitive rehabilitation, considerable controversy has existed regarding the usefulness and appropriateness of such programs. Controversial issues have included arguments pertaining to the ability to effect change in a neurologically stable individual, and the use of computers in the field of cognitive rehabilitation (Berrol, 1990). Other issues of concern pertain to the qualification of rehabilitation practitioners, exclusion of neuropsychologists for treatment planning and monitoring of cognitive rehabilitation, access to treatment, limited or no vocational goal formation, overlooking causes and severity of brain injury, poorly developed treatment plans, poorly developed

software, use of standardized psychological tests as training exercises, and cognitive rehabilitation software that is not normed.

Service Delivery

It has always been stated that an important factor in cognitive rehabilitation is the timing of the intervention. Some experts have suggested that many cognitive rehabilitation programs enroll persons with TBI either too early after the injury or in some cases too late. As such, these individuals may not benefit from the intervention because they are not prepared emotionally, behaviorally, or cognitively. Larkin (1992) stated that many cognitive rehabilitation professionals understand that the behavioral sequelae must be addressed prior to the initiation of cognitive rehabilitation if effective learning is to occur.

Generalizability

A significant factor in the use of cognitive rehabilitation is to help individuals with TBI return to independence. As such, it is important for this intervention to be generalizable across settings. Generalizability refers to the ability to apply a strategy learned in cognitive rehabilitation to a novel situation, while transfer of learning suggest the ability to take a specific learned skill that pertain to a certain job or an activity of daily living and utilize it in different setting (Ryan, Sautter, Capps, Meneese, 1992; Wehman et al., 1989). However, Fujii (1996) stated that cognitive rehabilitation as an intervention lacks generalization beyond treatment sessions and therefore offers limited benefit to clients. Butler and Namerow (1988) argue that research on functional recovery after TBI and the validity of cognitive rehabilitation shows that cognitive rehabilitation intervention does not reliably improve treatment outcomes or hasten spontaneous

recovery. In addition, some experts have suggested that cognitive rehabilitation tends to focus on developing certain abilities that may not be useful in everyday settings (Parente & Anderson-Parente, 1989). However, in response to such criticism, Butler and Namerow (1988) stated that cognitive rehabilitation of individuals with TBI should focus on skill acquisition training (SAT), a program which focuses on remediation of deficits in the areas of activities of daily living, social conversation skills, and vocational performance.

Usefulness of Cognitive Rehabilitation

Over the last 25 years, the field of brain injury rehabilitation has witnessed a rapid expansion of rehabilitation facilities and programs. Many clinicians have commented that, "the science of TBI rehabilitation has failed to maintain pace with the industry of TBI rehabilitation" (p. 384) since the interest in developing cognitive rehabilitation programs has not been matched by new scientific insights about how to restore, reverse, or significantly improve deficits resulting from TBI (Prigatano, 1987; Putnam & Adams, 1992). When persons with TBI who are receiving cognitive rehabilitation intervention make functional gains, it is often unclear just how these improvements were realized. Spontaneous recovery may play a role or improvements could be the result of cognitive, physical, or behavioral interventions. Despite the ever growing amount of literature on cognitive rehabilitation techniques, there is little research on its efficacy (Fujii, 1996). However, the demand for evidence demonstrating the effectiveness of cognitive rehabilitation programs has increased, primarily as a result of economic pressures on the health care system. As a result of these economic issues, there is an increasing need to show that these programs produce positive changes in persons with TBI level of

functioning with the lowest possible costs associated with these changes (Diller, 1992; Putnam & Adams, 1992).

The efficacy of cognitive rehabilitation programs has fueled a debate as a result of a lack of research on the usefulness of such programs. For example, the issues that cognitive rehabilitation techniques or strategies are not adequately rooted in theory are commonly debated. Proponents of this argument stress the need for research to validate the efficacy of cognitive rehabilitation and to develop an understanding of why some treatments work and why others fail. Others have argued that theory is less important than results in cognitive rehabilitation. They assert that if an individual with a TBI can use a strategy, then it is effective. The question here is whether or not individuals with TBI improve in the areas of memory, attention, and socio-behavioral areas as well as in vocational outcomes. If so, why worry about theory? In addition to this issue, some therapists question the usefulness of rehabilitation in general and are unconvinced that cognitive rehabilitation can be an objectively measurable form of treatment. Critics of cognitive rehabilitation have claimed that this type of treatment can produce no more than practice effects rather than a genuine increase in cognitive functioning. As such, the validity and efficacy of cognitive rehabilitation has been questioned (Rattok et al., 1992).

In order to demonstrate the usefulness of rehabilitation for persons with TBI, appropriate questions must be asked intelligently in well designed research programs. However, given a number of controversial issues involved in research studies with persons with TBI, efficacy studies of cognitive rehabilitation programs are limited or generally unavailable. Published studies in journals that have evaluated the effectiveness of specific cognitive rehabilitation programs are sparse, and of those studies that exist,

randomized, controlled trials of a specific treatment are practically non-existent (Hanlon et al., 1992). Thus, it is difficult to determine if individuals with TBI benefit from cognitive rehabilitation, especially when significant changes in the quality of life are considered. One of the reasons there is a lack of studies on efficacy of cognitive rehabilitation interventions or programs include ethical concerns regarding withholding a treatment program and the problem of confounding variables including heterogeneity of the TBI population and spontaneous recovery. The most significant problem that presents a barrier to research in the field of cognitive rehabilitation is the ethical issue associated with not providing rehabilitation to a group just so rehabilitation versus non-rehabilitation groups can be compared. Clearly, there will be evidence of deficiencies if rehabilitation is not provided to survivors of TBI (Wilson, 1993).

Presently, it is possible to evaluate the effectiveness of some treatment programs. In addition, it is possible to advocate general principles to be applied in all rehabilitation programs. A major problem in demonstrating efficacy is not being able to determine or predict which individuals will respond to a specific intervention or program. This inability to predict has been attributed to a lack of a general theory of cognitive rehabilitation/remediation. Therefore, there is a lack of knowledge in identifying relevant factors for predicting responsiveness. The limited prediction and outcome studies that have been carried out have lacked specific findings. The only general finding across studies has been that individuals with TBI who have higher functioning respond better to cognitive rehabilitation interventions than individuals with lower functioning (Fujii, 1996).

Given the research dilemmas, Meta Analysis research design can effectively address some of the aforementioned concerns. Meta Analysis is used to summarize research, by combining the primary statistics from single studies and provide a common statistics to describe and summarize the results of research reports. As Wachter & Straf (1990) assert, Meta Analysis can and often does provide more rigorous reviews of research than conventional techniques.

Although cognitive rehabilitation as a field has progressed, the efficacy of these interventions is not at the stage where treatment programs can be prescribed with any degree of certainty. The main reason for this is the heterogeneity that exists among persons with TBI. Different types and severity of brain damage affect cognitive functioning in different ways. Additionally, physical, motor, sensory, emotional, and behavioral deficits common in individuals with TBI need to be taken into consideration when developing rehabilitation interventions. Each individual will have different needs, circumstance, and requirements that will allow them to cope successfully in a home and/or community environment. Given the breadth and diversity of type of injuries, severity, pre-morbid and environmental factors amongst individuals with TBI receiving rehabilitation, it is difficult to evaluate cognitive rehabilitation programs using traditional research designs. Thus, the need to use new procedures for evaluating efficacy is needed (Wilson, 1993).

Despite limited research in the field, the overall efficacy of cognitive rehabilitation has been demonstrated in many studies. Overall, studies of specific interventions with specific types of individuals or geared towards a specific deficit have consistently shown that individuals with TBI can improve their performance on tasks

with practice. Over time these improvements have had an effect on IQ scores and the ability of individuals with TBI to adapt. Most practitioners agree that cognitive rehabilitation as an intervention strategy helps individuals with TBI to use residual cognitive and perceptual skills more effectively rather than restoring or retraining lost functions (Prigatano, 1987).

CHAPTER III

DESIGN AND METHODOLOGY

This dissertation will scientifically review the research studies that have investigated the efficacy of cognitive rehabilitation intervention on subsequent outcomes for persons with traumatic brain injury. Meta-analysis will be the method employed to statistically integrate the findings, as well as compare and draw conclusions based upon available evidence. The review of this compilation of studies should allow the investigator to determine the effectiveness of cognitive rehabilitation on the remediation of memory, attention, and socio-behavioral deficits; the impact of cognitive rehabilitation on vocational outcomes; as well as characteristics that contribute to effective interventions. In addition, this analysis will allow the investigator to report the statistical analysis of the results and to differentiate between characteristics that lead to successful and non successful outcomes. Once the analysis is completed the conclusions that are drawn will be based on the patterns associated with the statistical results of the research literature on cognitive rehabilitation interventions with individuals with TBI.

A comprehensive review of the literature on the remediation of memory, attention, and socio-behavioral deficits following cognitive rehabilitation was undertaken. This chapter also describes the criteria used in selecting the studies of cognitive rehabilitation intervention on subsequent vocational outcomes and the procedure used in selecting existing studies for this investigation are discussed. Additionally, the method of coding is reviewed and a description of each variable on the coding instrument is provided as well as a detailed description of the procedures used in the analysis and synthesis of the data.

The study entails a comprehensive examination of studies that have applied cognitive rehabilitation/remediation services to persons with TBI and reported on subsequent outcomes. Meta-analysis procedures will be used to test the efficacy of cognitive rehabilitation strategies. Meta-analysis refers to the application of quantitative methods to the problem of combining results from different analytical studies. Meta-analysis is not a statistical method, but rather an orientation toward research synthesis that uses many techniques of measurement and data analysis (Wachter & Straf, 1990).

As previously stated, traumatic brain injury affects an individual's physical, cognitive and psychosocial functioning. As such, the vast majority of persons with TBI experience deficits in physical, memory, attention, and socio-behavioral functioning. Some studies have shown that cognitive rehabilitation following traumatic brain injury has little or no effect on memory, attention, and socio-behavioral/self-regulation deficits. On the other hand, studies have shown cognitive rehabilitation to be significantly correlated with improving memory, attention, and socio-behavioral deficits following traumatic brain injury. A meta-analytic review is warranted to help to resolve the ambiguity resulting from contradictory research findings.

The first reason the question is unresolved is that there have been many studies that did not control for the severity of injury. For example, it appears that the more severe the level of impairment the less likely that vocational outcomes are positive. Additionally, assessing cognitive rehabilitation is complicated by spontaneous recovery. It appears that the earlier the intervention following traumatic brain injury, the more clients improve as a result of physical and physiological recovery in the brain itself.

Additionally, there is a difficulty in assimilating results from the many studies using small group and single-subject designs.

As such, it appears appropriate to apply the techniques of meta-analysis to this literature in order to address the following questions:

(1) How effective is cognitive rehabilitation intervention on the remediation of memory deficits following traumatic brain injury?

(2) How effective is cognitive rehabilitation intervention on the remediation of attention deficits following traumatic brain injury?

(3) How effective is cognitive rehabilitation intervention on the remediation of socio-behavioral/self-regulation deficits following traumatic brain injury?

(4) What are the relationships between factors such as age at time of accident, years of education, socio economic status, severity of injury, and ethnic background of individuals on subsequent vocational outcomes following cognitive rehabilitation intervention with persons with traumatic brain injury?

Collecting the Data

This study is primarily a literature review on the effectiveness of cognitive rehabilitation as an intervention strategy in the remediation of memory, attention, and socio-behavioral deficits following traumatic brain injury. Computer retrieval searches were carried out in the following data bases: PsycLIT which is compiled from material published in Psychological Abstracts and the PsycINFO data base (produced by the American Psychological Association), Educational Resources Information Center

(ERIC), Dissertation Abstracts, and the National Library of Medicine. The literature review will primarily include journals of research and theory in rehabilitation psychology, rehabilitation counseling, head trauma, neuropsychology, and cognitive rehabilitation. Aside from the literature providing historical and theoretical perspective, the literature focuses primarily on the time period from 1980 to 2003. The search yielded appropriate articles from the following journals: American Journal of Occupational Therapy, Archives of Clinical Neuropsychology, Archives of Physical Medicine and Rehabilitation, Brain Injury, Canadian Journal of Rehabilitation, Canadian Psychology, Clinical Psychology Review, Clinical Neuropsychologist, Cognitive Rehabilitation, International Journal of Rehabilitation, Journal of Applied Rehabilitation Counseling, Journal of Clinical Neuropsychology, Journal of Clinical and Experimental Neuropsychology, Journal of Consulting and Clinical Psychology, Journal of International Neuropsychology and Sociology, Journal of Learning Disabilities, Journal of Neurology, Journal of Neurological Rehabilitation, The Journal of Rehabilitation, Journal of Head Trauma Rehabilitation, Journal of Neurology, Neurosurgery, and Psychiatry, Memory, Neurosurgery, Neuropsychological Rehabilitation, Neuropsychologia, Rehabilitation Counseling Bulletin, Seminars in Neurology, Rehabilitation Psychology, and Psychiatry.

In order to conduct the search, the following descriptor terms were used: "cognitive rehabilitation," "brain injury," "traumatic brain injury and vocational outcomes," "cognitive rehabilitation with brain injured," and "brain injury rehabilitation," "head injured," "employment potential following brain injury," " traumatic brain injury," "cognitive remediation," "cognitive rehabilitation strategies," and "meta analysis."

The search produced a reference list of potential studies to be included in the sample. Many studies could not be retrieved locally, and attempts were made to locate studies through inter-loan library and through the National Clearing House. Once the study was located, each abstract was read to determine whether the study could be included in the pool of potential studies. Potential studies were dismissed if (1) no statistics were reported, (2) reported statistics were not sufficient for calculating or approximating an effect size, (3) cognitive rehabilitation was not defined appropriately, (4) and outcomes were not clearly stated. Studies that met the criteria became the data set for the analysis and synthesis portion of the study.

Criteria for Inclusion /Population

The article review format was constructed by the investigator. A complete review of the literature was conducted in order to acquire all published and unpublished studies that met the following criteria:

(1) The study was published in English

(2) Cognitive rehabilitation was operationally defined in a way that is consistent with the definition formulated in the present study.

(3) The study included individuals with an acquired TBI.

(4) The participants in the study were at least sixteen years of age.

(5) The study reported quantitative analysis from which a correlation coefficient could be obtained.

(6) The study was reported in the period 1980 to 2003, as this appears to be a significant period in which cognitive rehabilitation as an intervention strategy was utilized within brain injury treatment facilities.

Coding Instrument

Once all appropriate studies were identified and collected a coding instrument was developed so that effect sizes and study characteristics could be recorded. Study characteristics were categorized as substantive which includes features that are specific to the problem studied (e.g., type of associated variable), and methodological which are general features such as year published, publication form, or sample size (Glass, McGaw, Smith, 1981). The researcher completed the coding as studies were gathered. According to Glass et al. (1981) "the principal source of measurement unreliability in meta-analysis arises from different readers (coders) not seeing or judging characteristics of a study in the same way" (p. 75). To test for coder reliability, a second coder was trained and that individual coded three studies.

Variables that were used in the coding instrument are described in the following section:

Study Number: An identification number was assigned to each study in the order it was coded, starting with Number 1.

Author(s): The principal investigator(s) of the study.

Publication Year: The year noted on the manuscript was recorded. For studies that appear in multiple forms, the year of the most extensive report was used.

Publication Form: The study was classified according to the form in which it was published: (a) journal article, (2) book, (3) dissertation based publication, (4) unpublished dissertation.

Sample Size: The sample size was recorded

Mean Age of Subjects: The mean chronological age of the study participants was recorded as (1) reported in the study, (2) approximated from data in the study, or (3) not obtainable.

Mean Educational Achievement Level of Subjects: The mean number of years of formal education of the study participants was recorded as (1) reported in study, (2) approximated from data in the study, or (3) not obtainable.

Median Socio-economic Status of Subjects: Median socio-economic status of study participants was recorded as (1) low SES, (2) middle SES, or (3) high SES. In those cases where actual mean income was provided, the following categories were used: low (below 12,000), middle ($12,000 - $40,000), and high (higher than $40,000). Median socio-economic status of subjects was recorded as (1) reported in the study, (2) approximated from data in the study, (3) not obtainable.

Gender of Subjects: The percent of male and female participants in the sample was recorded as (1) reported in the study, (2) approximated from data in the study, (3) not obtainable.

Cultural/Racial Mix: The percent of African Americans, Asian Americans, Hispanics, Native Americans, and White Americans in the sample was recorded as (1) reported in the study, (2) approximated from data in the study, (3) not obtainable.

Severity of Injury: The number of participants with mild, moderate or severe brain injury was recorded as (1) reported in the study, (2) approximated from data in the study, (3) not obtainable.

Associated Variable: This category was designed to identify variables associated with cognitive rehabilitation intervention of persons with TBI. The categories for coding

these variables were determined from reading the journal articles as well as books on cognitive rehabilitation with persons with TBI.

Glass et al. (1981) posited that coding classifications should not be narrowly specified. The authors asserted that "generalizations will necessarily entail ignoring some distinctions that can be made among studies. Good generalizations will be arrived at by ignoring only those distinctions that make no important difference" (p. 23). In response, Hedges (1986) questioned the use of broad coding classifications. He suggested that this approach might obscure "important differences among the narrower constructs subsumed therein" (p. 358). If broader constructs are to be used, Hedges (1986) posited that they should be used in the narrative summary of the review, but narrower constructs should be used in the statistical analysis of the data and report of the findings. The use of broad constructs has been a criticism of meta-analytic reviews (Eysenck, 1984; Gallo, 1978; Presby, 1978). As such, this study employed a narrower construct for the data analysis. A narrower construct according to Hedges (1986) "permits the reviewer to examine variations in the pattern of results as a function of construct definition" (p. 359).

Description of Associated Variable: A description of the associated variable and any relevant information obtained in the study was recorded.

Study Quality: A numerical rating of the study quality will be assigned to each study on the basis of the following criteria (adapted from Hembree, 1984).

a) Problem Identification: clear hypotheses or research questions (3), no hypotheses or research questions but clear statement of purpose (2), none of the aforementioned (1).

b) Population Description: description of demographic items, i.e., age, gender, race, educational level, socio-economic status, employment level, and marital status. Six to seven demographic items obtainable (3), three to five items obtainable (2), less than three demographic items obtainable (1).

c) Sampling Procedure: random (3), partially random (2), non-random (1)

d) Conclusions: appropriate and tied to hypothesis, research questions, or purpose (3); appropriate, but with digressions (2); inappropriate (1).

e) Data Analysis: appropriate methods with full reporting of results (3), appropriate methods with partial reporting or some data missing (2), inappropriate methods, mistakes, or much data missing (1).

Each criterion was evaluated on a scale from 1-3 (where 1 is low and 3 is high).

Effect Size Determination: Meta analysis is based on the effective size (ES) statistics, which allows for the quantification and standardization of study findings. Within this investigation, the ES statistics will be defined in two ways: (1) reflecting differences in the nature of the comparison group, or (2) reflecting differences on some pre post test score measurement (Wolf, 1986; Glass, 1981). Those studies where the TBI group is compared with a non-disabled (i.e., average IQ) group (N), the ES will be defined as:

$$ES = \frac{M_{tbi} - M_{ntbi}}{Sd_{ntbi}}$$

where Mtbi = the average performance level for the traumatic brain injured group, Mntbi = the average performance level for the non-disabled comparison group, and Sdntbi = standard deviation for the nondisabled comparison group.

Those studies where there is a comparison of a pre-test and a post-test measure, the ES was defined as:

$$ES = \frac{X\ post - X\ pre}{Sd\ pre}$$

Where X pre = average performance level for the untrained condition,
X post = average performance level for the training condition, and
Sd pre = standard deviation for the untrained condition.

The study within the total pool of studies gives their statistical results as one of these four types of statistics: t-scores, f-scores, r-scores, and ES-scores. The coding process will be used to transform each statistical result of each study into a common metric; the ES score (d score). Once all scores had been transformed into the ES score, statistical procedure of computing statistical analysis on a t distribution was completed, i.e., the computation of a mean ES score, Standard Deviation, etc. The advantage of a Meta analysis is the flexibility to aggregate the ES scores by numerous variables and pertinent categories within the variables.

Statistical Conversions

Meta Analysis procedures outlined by Glass (1981) and Wolf (1986) provide guidelines for converting various test statistics to the *d score* (statistical reference to ES statistics) are as follows:

Statistics to be Converted	*Formula used for Conversion*
t-score	$ES = \frac{2t}{df}$

f-score

$$ES = \frac{2\ F}{df}$$

r-score

$$ES = \frac{2r}{1 - (r\ \ )}$$

The score from each study was converted to the common statistics, the d score (d) or Effect Size (ES). A typical statistical analysis was used to compute effect size scores into sample distributions, mean score, standard deviations, etc., which determined if the population mean, differed significantly from zero; the inference is the mean score of ES equals 0 (ES=0), which implies that interventions are not successful with individuals with TBI.

The inference in the alternative hypothesis is if the mean score of ES is greater than zero on the positive end (falling within the critical value) of the scale then cognitive rehabilitation intervention is successful (had significant effects) with individuals with TBI. However, if the mean score of ES is greater than 0 on the negative end of the scale then cognitive rehabilitation as an intervention on average was not effective.

The selection of a particular probability value is purely an arbitrary one (Blommers & Forsyth, 1977). This investigation will use a .01 alpha level (a one in a hundred), as a conservative level of significance and to reduce the possibility of Type I error (rejecting Ho when it is actually true).

Individual ES scores were calculated for each major variable in each study and then aggregated to investigate the area(s) of interest. The variables that were selected to report statistical results are: remediation of attention after cognitive rehabilitation,

remediation of memory after cognitive rehabilitation, and remediation of socio-behavioral deficits after cognitive rehabilitation. In addition, there were descriptive results reported upon several other variables. They are: source of publication, studies by year, demographic data on subjects (number in treatment group, number in control group, gender, and age), ethnic/racial background of subjects, socioeconomic status of subjects, years of education, and severity of injury. The comparisons were made between cognitive rehabilitation interventions study characteristics that allow for final conclusions to be drawn which are statistically based on the patterns associated with cognitive rehabilitation, as a result of a review and analysis of the studies included in this investigation.

CHAPTER IV

INVESTIGATION AND RESULTS

The purpose of this research is to determine the effectiveness of cognitive rehabilitation interventions in enhancing memory, attention, and socio-behavioral deficits of individuals with TBI. The aim is to assimilate and synthesize the literature regarding the impact of cognitive rehabilitation on vocational outcomes. The results of this investigation for cognitive rehabilitation interventions on memory will be presented first. This will be followed by results for cognitive rehabilitation interventions on attention, and finally cognitive rehabilitation interventions on socio-behavioral deficits. In each section, the descriptive results of the investigation will be presented first for each area, followed by the statistical results.

To assess inter-rater reliability of the coding system, five of the cognitive rehabilitation studies on the remediation of memory impairment following TBI, four of the cognitive rehabilitation studies on remediation of attention deficits following TBI, and three of the cognitive rehabilitation studies on the remediation of socio-behavioral deficits following TBI were randomly selected to be coded by a total of three other individuals deemed knowledgeable in brain injury. Coders received a copy of the code sheet which included all the operational definitions used for the code sheet and their allocation of the randomly selected studies.

The three coders' rating sheets were compared with the investigator code sheet. An agreement was counted when coders selected the same category for an item on the coding sheet (severity of injury) or when coders recorded the same information for an item on the coding sheet (number of subjects, etc.). Total agreement ranged from 86% to

97% with an average of 92%. Inter-rater agreement on the ES score calculations was 100%.

As a result of the literature search, 465 published articles were located on cognitive rehabilitation interventions with persons with TBI. The abstracts and in many cases the complete articles were reviewed in order to determine which articles would be suitable for inclusion into the study. Each article was placed into 1 of 3 categories, reflecting its primary area of intervention: remediation of memory deficits, remediation of attention deficits, and remediation of socio-behavioral deficits. Following that, each article was abstracted according to specific criteria: subject characteristics (age, gender, education, severity of injury, time post injury, and inclusion criteria); treatment characteristics (treatment setting, targeted deficit, and nature of treatment); and statistical analysis performed.

Of these, 248 studies were eliminated from the data analysis. Ninety-two studies were excluded because the subjects had diagnoses primarily other than TBI; 86 studies did not report statistics that were sufficient for calculating or meaningfully approximating an effect size (for example, only means without standard deviations or correlations were reported); 39 studies did not include treatment and consisted of single trial, experimental manipulations; and 31 studies were descriptive reports that did not contain any empirical data. The remaining 217 studies contributed the data for this study.

Introduction to Cognitive Rehabilitation of Memory Deficits in Individuals with TBI

Studies of the remediation of memory deficits have addressed a range of memory-related issues including general concerns (everyday memory problems, impaired

learning), specific memory problems (remembering names, dates, faces, etc.), the capacity to effectively use compensatory aids (computers, memory books), and individual subjective complaints. Interventions to address these problems have included use of compensatory aids, as well as cognitive remediation programs to address the aforementioned issues. The purpose of this section of the investigation was to collect and evaluate the empirically based studies pertaining to cognitive remediation of memory deficits following TBI (n=120).

The descriptive results of this investigation for cognitive rehabilitation interventions will be presented first and are displayed in tables 1 through 5, followed by the statistical results, which are presented in tables 6 through 13.

Cognitive Rehabilitation of Memory Deficits in Individuals with TBI Study Characteristics

This investigation reviewed 120 articles on the remediation of memory deficits in individuals with TBI. One hundred and nine studies were published in journals, 7 were published in books, and 4 were published as dissertations spanning the years 1980 through 2003. The studies had been published in cognitive rehabilitation journals, traumatic brain injury and head injury journals, physical medicine and rehabilitation journals, neurology journals, neuropsychological rehabilitation journals, cognitive rehabilitation and brain injury rehabilitation books, and Dissertation Abstracts International.

Table 1 shows sources of publication, which provides a frequency distribution of the studies in cognitive rehabilitation of memory data collection as well as a calculation of the percentage of the total studies contributed by each source.

Five major sources (n= 93) provided 76% of the total studies on cognitive rehabilitation of memory impairments for this investigation. They were Journal of Head Trauma Rehabilitation (n = 22, 19.17%), Cognitive Rehabilitation (n = 20, 16.67%), Journal of Clinical Neuropsychology (n = 15, 12.50%), Brain Injury (n = 13, 10.83%), and Neuropsychological Rehabilitation (n = 13, 10.83%). The remaining 24% of the studies (n = 27) were distributed across 13 other sources. Table 2 shows these five major sources and their contributions for cognitive rehabilitation of memory impairments in individuals with TBI.

Table 1: Cognitive Rehabilitation of Memory Deficits in Individuals with TBI: Sources of Publication

Journal Title/Book	Frequency	% of Totals
American Journal of Occupational Therapy	5	4.17%
Applied Cognitive Psychology	2	1.77%
Archives of Physical Medicine and Rehabilitation	5	4.17%
Brain and Cognition	2	1.77%
Brain Injury	13	10.83%
British Journal of Clinical Psychology	1	0.83%
Canadian Journal of Rehabilitation	2	1.77%
Cognitive Rehabilitation	20	16.67%
Cognitive Retraining Using Microcomputers	1	0.83%
Disability Rehabilitation	2	1.77%
International Journal of Rehabilitation Research	3	2.50%
Journal of Applied Behavior Analyst	2	1.77%
Journal of Head Trauma Rehabilitation	22	18.33%
Journal of Clinical Neuropsychology	15	12.50%
Journal of Consulting and Clinical Psychology	4	3.33%
Journal of Clinical Experimental Neuropsychology	5	4.17%
Neuropsychologia	2	1.77%
Neuropsychological Rehabilitation	13	10.83%
The Behavior Therapist	1	0.83%
Totals	120	100.00%

Of the 120 studies, 56 (46.67%) were published during the period from 1980 to 1990, while the other 64 (53.33%) were published between 1991 and 2003. Table 2 and 3 shows the cognitive rehabilitation of memory impairment in individuals with TBI studies by year.

Table 2: Cognitive Rehabilitation of Memory Deficits in Individuals with TBI: Studies Per Year from 1980 to 1990

# Studies	Year	% of Total Studies Per Year
2	1980	1.67%
1	1981	0.83%
2	1982	1.67%
2	1983	1.67%
5	1984	4.17%
4	1985	3.33%
7	1986	5.83%
8	1987	6.67%
7	1988	5.83%
10	1989	8.33%
8	1990	6.67%
56		46.67%

Table 3: Cognitive Rehabilitation of Memory Deficits in Individuals with TBI: Studies Per Year from 1991 to 2003

# Studies	Year	% of Total Studies Per Year
3	1991	2.50%
2	1992	1.67%
5	1993	4.17%
8	1994	6.67%
6	1995	5.00%
10	1996	8.33%
11	1997	9.17%
2	1998	1.67%
7	1999	5.83%
5	2000	4.17%
1	2001	0.83%
3	2002	2.50%
1	2003	0.83%
64		53.33%

Cognitive Rehabilitation of Memory Deficits in Individuals with TBI: Subject Characteristics

The 120 studies included a total of 3,840 individuals with TBI who received cognitive rehabilitation intervention for memory deficits. The number of individuals per study ranged from 1 to 269, with an average 32 individuals per study for the experimental and control groups. Table 4 displays cognitive rehabilitation of memory impairments studies as reported by researchers of the subject demographic data.

Ninety-two of the 120 studies reported TBI individuals' gender, with 76.36% being males (n = 2039) and 23.63% being females (n = 631). Based on those studies that report gender data (n = 92) there was an average of 21 males with TBI and 8 females with TBI in each study.

Age was reported in ninety- one percent of the studies (n=109). The mean average age of individuals with TBI across all studies was 33.4 years (ages ranged from 18 to 56 years). The mean socioeconomic level was reported in only 21.6% of the studies (n=21). In 26.66% of the studies (n=32), researchers described the cultural/racial mix of the subjects. Among those studies 59.27% of the subjects were White (n=598), 25% were African Americans (n=249), 10.51% were Latino (n=106), and 4.56% were reported as other (n=46). Severity of injury was reported or approximated in 87.5% of the studies (n=105), with 10.15% being reported as mild TBI (n=247), 35.43% being reported as moderate TBI (n=862), and 54.42% being reported as severe TBI (n=1324). Table 5 shows the breakdown of the severity of TBI.

Table 4: Cognitive Rehabilitation of Memory Deficits in Individuals with TBI: Demographic data on Subjects

Subject Category	# Individuals	% of Population
Sample #	3840	100
Experimental Subjects #	2433	63.36
Control Subjects #	1407	36.64

Table 5: Cognitive Rehabilitation of Memory Deficits Severity of TBI Subjects

Severity of TBI Subjects	# Individuals	% of Population
Mild TBI	247	10.15%
Moderate TBI	862	35.43%
Severe TBI	1324	54.42%
Total	2433	100%

Cognitive Rehabilitation of Memory Deficits in Individuals with TBI Statistical Results: Acceptance or Rejection of the Hypothesis

The statistical results accepting or rejecting the hypothesis, i.e., that cognitive rehabilitation intervention will be positively correlated with the remediation of memory deficits following traumatic brain injury was examined in this section.

A t-test was computed on the grand total of all ES scores, i.e., finding the total number of all ES scores, and computing an average effect size, determining a standard deviation, and calculating the t-test. Overall, the total score data set has a mean ES score of 0.392 (n=1783) and a Sd of 1.869. This t-test statistics was: tdf1784=7.403, [p<.01], which indicates that the results of cognitive rehabilitation intervention on memory impairments following TBI are statistically significant. Table 6 gives the statistical data as reported by researchers for the remediation of memory studies:

The number of effect sizes per study ranged from 1 to 33, with an average number of 8.09 effect size scores per study. Effect sizes ranged from 35 to -8.23457, with an average effect size score of 0.392 (with a standard deviation of 1.869). Table 7 gives the data on the effect size scores by category, number, and percent of the total as reported by researchers in each study. Table 8 shows the types of statistics reported by researchers and the average effect sizes on types of scores categories.

Table 6: Statistical Results on the Cognitive Remediation of Memory Deficits following TBI

Average ES:	0.392
Number:	1783
Minimum Score:	35
Maximum Score:	-8.23457
Sd:	1.869
t-tests:	8.263
Outcome:	*

* $p<.01$ is significant

Table 7: Effect Size Scores by Category, Number, and Percent of the Total

Category	Number of Scores	% of the Total
t-score	1259	70.61%
f-score	444	24.91%
r-score	63	3.51%
d-score (effect size)	17	0.95%
Total Scores	1783	

Note: average number of scores per remediation of memory study (based on 120 studies) 8.09

Range of effect sizes: 35 to -8.23457

Mean average of effect sizes across all memory studies: 0.392

Standard deviation: 1.864

Table 8: Cognitive Remediation of Memory Deficits in Individuals with TBI: Type of Score Categories

Category	Frequency	Mean ES	SD	t-test	Significance
t-score	1259	0.248	2.326	3.713	*
f-score	444	0.659	0.425	23.778	*
r-score	63	0.945	1.202	5.469	*
d-score (Effect Size)	17	1.548	0.869	7.733	*
Grand Total	1783	0.392	1.864	8.2633	*

*p<.01 is significant

It was noted that some of the effect size scores were very extreme. The researcher removed the extreme 1% of scores and recalculated the effect size to prevent those score from skewing the results (Babbie, 2001). As such, the next step was to sort all of the cognitive remediation of memory impairment after a TBI ES scores according to their absolute values. The primary reason for this was that statistically, these top 1% scores were greater than three (3) standard deviations from the mean. Therefore, their removal as outliers seemed to be appropriate in this case. In addition, in order to ensure the accuracy of the final results after creating this new set of data, referred to as the adjusted scores data set, the results will comprise both sets of data. The process of selecting the outlier scores, their subsequent removal and the creation of the adjusted scores are as follows: (1) calculate 1% of the total scores which equals 14, (2) make a list and convert all scores to absolute scores, (3) select the most extreme scores, which equals 14, and (4) remove the 1% extreme scores from the total score set, which becomes the adjusted score set which to compare the patterns of statistical results too that of the total score set. Table

9 shows the fourteen most extreme remediation of memory ES scores, and their absolute values and category of score.

Upon removal of these extreme 1% ES scores, the adjusted ES scores were examined. The only adjusted type of scores category affected by removing these extreme scores was the t-score category, which was very minimal. The data on all of the other categories remained the same. As a result, the mean effect size of the t-score category decreased from 0.248 to 0.126. The number of scores decreased from 1259 to 1245 (14 less), and the standard deviation decreased from 2.326 to 1.274. The t-statistic changed slightly from tdf1259=3.713, [p<.01], to a t-value for the adjusted data of tdf1245=3.215, [p<.01], which is still significant.

The t-test based on the adjusted score data resulted in a mean ES score of 0.293, a Sd of 1.164, and a t-statistic of tdf1767=9.752, [p<.01], an increase that is significant. The final comparison of the total score group with the adjusted score group on t-statistics indicates the t-test value of tdf1783=8.263, [p<.01], compared to tdf1767=9.752, [p<.01]. This evidence is significant in that it reveals the impact that extreme scores can have on the central tendency of the remediation of memory impairment data. The t-score is the largest category of types of ES scores; yet it appears that the reduction of these heavily weighted scores did not affect the overall results. Table 10 shows the statistical categories as reported by researchers, the average effect sizes, and the categories for the adjusted score set. Table 11 shows the comparison of the type of statistics reported by researchers and the average effect sizes of the scores reported by researchers and the adjusted scores. Table 12 shows the severity of injury data reported by researchers, the mean effect sizes,

and the two significant categories and table 13 shows the severity of injury data, the average effect sizes, and two significant categories for the adjusted score set.

Table 9: The Fourteen most Extreme ES Scores, Absolute Scores and Score Type

Mean ES Score	Sd from Mean	Type of Score
35	18.807	t-score
34.444	18.525	t-score
15.228	7.596	t-score
12	5.889	t-score
11.135	5.527	t-score
11	5.487	t-score
8.076	4.023	t-score
7.999	4.012	t-score
6.87	3.672	t-score
6.01	3.104	t-score
6.322	3.051	t-score
6.058	3.120	t-score
5.971	3.015	t-score
-8.234	3.794	t-score

Table 10: Cognitive Remediation of Memory Deficits following TBI with Fourteen Outlying Scores Removed

Category	Frequency	Mean ES	Sd	t-test	Significant
t-score	1244	0.114	1.164	3.215	*
f-score	443	0.571	0.498	22.263	*
r-score	63	0.879	1.361	6.479	*
d-score (Effect Size)	17	1.581	0.798	8.721	*
Grand Total	1767	0.293	1.164	9.752	*

*p<.01 is significant

Table 11: Comparison of Total Scores and Adjusted Scores

	Total Scores	Adjusted Scores (extreme 1% scores)
Average ES:	0.392	0.293
Number:	1783	1767
Minimum:	-8.234	-5.373
Maximum:	35	5.897
Standard Deviation:	1.869	1.164
t-tests:	8.263	9.752
Outcome: significant results		*significant results*

*p<.01 is significant

Table 12: Severity of Injury on Total Score Set

Category	Frequency	Mean ES	Sd	t-test	Significant
Severe TBI	1186	0.408	1.826	6.535	*
Moderate TBI	492	0.403	2.157	5.520	*
Mild TBI	105	-0.027	0.745	-0.289	

*p<.01 is significant

Table 13: Severity of Injury on Adjusted Score Set

Category	Frequency	Mean ES	sd	t-test	Significant
Severe TBI	1173	0.322	1.063	8.825	*
Moderate TBI	491	0.307	1.278	7.039	*
Mild TBI	105	-0.027	0.745	-0.289	

*p<.01 is significant

Introduction to Cognitive Rehabilitation of Attention Deficits in Individuals with TBI

Remediation of attention deficits have for the most part relied on drill and practice, with exercises created to address specific aspects of attention (e.g., processing speed, divided attention, focused attention). Most of the literature that reports this type of intervention have used stimulus-response parameters, which required participants to identify and select among relevant auditory or visual stimuli, and often used speeded stimulus presentations (Cicerone, et al., 2000). The goal of these interventions is to restore basic attention abilities through repeated practice. Many of the studies reviewed have relied on psychometric measures to assess improvements in attention attributable to treatment.

The purpose of this section of the investigation was to collect and evaluate the empirically based studies pertaining to cognitive remediation of attention deficits following TBI (n=67).

The results of this section will be presented as it was for remediation of memory deficits, i.e., descriptive results of cognitive rehabilitation of attention deficits following TBI which are shown in tables 14 through 19, followed by statistical results which are displayed in tables 20 through 27.

Cognitive Rehabilitation of Attention Deficits Following TBI: Study Characteristics

Sixty-seven studies were examined in this area, with all 67 published in journals spanning the years 1980 through 2003. The 67 studies had been published in journals of

psychology, brain injury, cognitive rehabilitation as well as some occupational therapy journals.

Table 14 shows the sources of publication and provides a frequency distribution of the studies published in this area. Top four major sources (n= 47) provided 70.15% of the total studies on cognitive rehabilitation of attention deficits of this investigation. They were Journal of Head Trauma Rehabilitation (n = 16, 23.88%), Cognitive Rehabilitation (n = 15, 22.39%), Brain Injury (n=10, 14.93%), and Neuropsychological Rehabilitation (n = 6, 8.96%). The remaining 29.85% of the studies (n = 20) were distributed across the 6 other sources.

Of the 67 studies, 29 (43.28%) were published during the period from 1980 to 1990, while the other 38 (56.72%) were published between 1991 and 2003. Table 15 and 16 shows the cognitive rehabilitation of attention deficits in individuals with TBI studies by year.

Table 14: Cognitive Rehabilitation of Attention Deficits in Individuals with TBI: Sources of Publication

Journal Title	Frequency	% of Totals
American Journal of Occupational Therapy	2	2.99%
Archives of Clinical Neuropsychology	2	2.99%
Archives of Physical Medicine and Rehabilitation	1	1.49%
Brain Injury	10	14.93%
Canadian Journal of Rehabilitation	2	2.99%
Cognitive Rehabilitation	15	22.39%
Canadian Psychology	2	2.99%
International Journal of Rehabilitation Research	2	2.99%
Journal of Head Trauma Rehabilitation	16	23.88%
Journal of Clinical Neuropsychology	3	4.48%
Journal of Consulting and Clinical Psychology	1	1.49%
Journal of Clinical Experimental Neuropsychology	2	2.99%
Journal of Neurological Rehabilitation	3	4.48%
Neuropsychological Rehabilitation	6	8.96%
Totals	67	100.00%

Table 15: Cognitive Rehabilitation of Attention Deficits in Individuals with TBI: Studies Per Year from 1980 to 1990

# Studies	Year	% of Total Studies Per Year
1	1980	1.49%
1	1981	1.49%
2	1982	2.99%
2	1983	2.99%
4	1984	5.97%
7	1985	10.45%
2	1986	2.99%
3	1987	4.48%
1	1988	1.49%
3	1989	4.48%
3	1990	4.48%
29		43.28%

Table 16: Cognitive Rehabilitation of Attention Deficits in Individuals with TBI: Studies Per Year from 1991 to 2003

# Studies	Year	% of Total Studies Per Year
2	1991	2.99%
1	1992	1.49%
6	1993	8.96%
3	1994	4.48%
4	1995	5.97%
7	1996	10.45%
3	1997	4.48%
2	1998	2.99%
4	1999	5.97%
3	2000	4.48%
0	2001	0.00%
2	2002	2.99%
1	2003	1.49%
38		56.72%

Cognitive Rehabilitation of Attention Deficits in Individuals with TBI:

Subjects Characteristics

The 67 studies of cognitive rehabilitation intervention for attention deficits included 2,211 individuals with TBI. The number of individuals per study ranged from 3 to 108, with an average of 33 individuals per study. Table 17 displays the subject demographic data for studies of cognitive rehabilitation of attention deficits.

Research studies reported the gender of individuals with TBI receiving cognitive rehabilitation interventions for attention deficits in 80.59% of the total 67 studies (n= 54), with 70.18% being males (n = 1120) and 29.82% being females (n = 476).

Age was reported in eighty-eight percent of the studies (n=59). The mean age of individuals with TBI across all studies was 29.5 years (ages ranged from 18 to 63 years). The mean socioeconomic level was reported in only 16.42% of the studies (n=11). In 34.33% of the studies (n=23), researchers described the cultural/racial mix of the subjects. Among those studies 68.72% of the subjects were White (n=512), 26.85% were African Americans (n=200), 2.42% were Latino (n=18), 0.94% were American Indians (n=7), and 1.07% were reported as other (n=8). Table 18 shows the breakdown of the racial/cultural mix of participants. Severity of injury was reported in 100% of the studies (n=67), with 16.28% being reported as mild TBI (n=360), 26.19% being reported as moderate TBI (n=579), and 57.53% being reported as severe TBI (n=1272). Table 19 shows the breakdown of the severity of TBI.

Table 17: Cognitive Rehabilitation of Attention Deficits in Individuals with TBI: Demographic Data on Subjects

Subject Category	# Individuals	% of Population
Sample #	2211	100
TBI Subjects #	1897	85.79%
Control Subjects #	314	14.21

Table 18: Cognitive Rehabilitation of Attention Deficits in Individuals with TBI: Cultural/Racial Makeup of Subjects

Cultural Makeup of TBI Subjects	# Individuals	% of Population
White Americans	512	68.72%
African Americans	200	26.85%
Latino Americans	18	2.42%
American Indians	7	0.94%
Other	8	1.07%

Table 19: Cognitive Rehabilitation of Attention Deficits Severity of TBI Subjects

Severity of TBI Subjects	# Individuals	% of Population
Mild TBI	228	12.02%
Moderate TBI	636	33.53%
Severe TBI	1033	54.45%

Cognitive Rehabilitation of Individuals with Attention Deficits following a TBI: Acceptance or Rejection of the Hypothesis

The statistical results accepting or rejecting the original hypothesis, i.e., that cognitive rehabilitation intervention will be positively correlated with the remediation of attention deficits following traumatic brain injury was tested. A t-test was computed on the grand total of all ES scores. Overall, the total score data set has a mean ES score of 0.253 (n=831) and a Sd of 1.133. The t-test statistic was: tdf830=4.968, [p<.01], which indicates that the overall results of cognitive rehabilitation intervention on individuals with attention deficits following a TBI is statistically significant with alpha at the .01 level. Table 20 shows the statistics reported for the cognitive rehabilitation intervention of attention deficits. As can be seen, cognitive remediation as an intervention strategy is effective in the treatment of attention deficits following a TBI.

Table 20: Statistical Results on the Cognitive Remediation of Attention Deficits following TBI

Average ES:	0.253
Number:	831
Minimum Score:	10.763
Maximum Score:	-4.198
Sd:	1.133
t-tests:	4.968
Outcome:	*

* p<.01 is significant

A total of 831 effect size scores (ES) were calculated from the 67 studies. Means and standard deviations were used to convert and compute 509 t-score category effect size statistics (61.3%), while data from F tests accounted for 270 f-score category effect size statistical conversions (32.45%), correlation scores accounted for 42 r-score

statistical conversions (5.05%), and 10 effect size scores were given without conversions needing to be calculated. Table 21 shows the categories reported by researchers on the variable effect size scores for cognitive rehabilitation of attention deficits.

Table 22 shows the types of statistics reported by researchers in each study and the average effect sizes on types of scores categories.

As before, the top 1% of the scores was removed in order to be consistent with the investigation. To refresh the reader's memory, the primary reason for removal of these scores was that the top 8 scores were so different that the central tendency of scores is distorted by their influence on final calculations.

Because the investigator did not want to potentially skew the final results by creating this new set of data, the results will be based on both the original total scores set and the newly formed adjusted scores set and compare the patterns of the findings. The same procedure that was used in the previous section was used for calculating the new adjusted scores set. The process of selecting the outlier scores, their subsequent removal and the creation of the adjusted scores are as follows: (1) calculate 1% of the total scores which equals 8, (2) make a list and convert all scores to absolute scores, (3) select the most extreme score, which equals 8, and (4) remove the 1% extreme scores from the total score set, which becomes the adjusted score set which to compare the patterns of statistical results too that of the total score set. Table 23 displays the eight most extreme ES scores, their absolute values and category of scores.

After the most extreme 1% of the effect size scores have been removed, the adjusted Effect Size scores were examined. There were three types of scores categories affected by removing the extreme scores: the f-score category mean ES score decreased

to 0.421, while the t-statistic changed slightly from tdf269=13.364, [p<.01], to a t-value for the adjusted data of tdf268=15.345, [p<.01], which is significant. The resulting data on the newly formed adjusted score set indicated an overall mean Es score of 0.141, a standard deviation of 0.937 and a t-statistic of tdf822=4.023, [p<.01], a significant level of results. The final comparison of the total score group with the adjusted score group on t-statistics indicates the t-test value of tdf830=4.968, [p<.01], compared to the new value of tdf822=4.329, [p<.01]. It appears that the reduction of these extreme scores will not affect the overall results. Table 24 shows the types of statistics reported by researchers and the average effect sizes on the type of scores categories from the cognitive rehabilitation of attention deficits adjusted score set.

Table 25 shows comparisons of the type of cognitive rehabilitation of attention deficits statistics reported and the average sizes of the two score sets.

A comparative examination of the frequency distributions between each set of scores indicates a change only in one positive extreme interval, i.e., removing the 8 most extreme scores when figured as absolute values removes all 8 scores from the "greater than one" interval on the positive end of the distribution. This results in a very modest reduction in percent of the totals (0.77%) in the positive "greater than one" interval.

Table 26 shows the severity of injury data, the average effect sizes, and the significant category on the total score set. Following is table 27, which shows the severity of injury data, the average effect sizes, and the significant category on the adjusted score set.

Table 21: Effect Size Scores by Category, Number, and Percent of the Total

Category	Number of Scores	% of the Total
t-score	509	61.25%
f-score	270	32.49%
r-score	42	5.05%
Effect Size	10	1.20%
Total Scores	831	

Note: average number of scores per remediation of memory study (based on 67 studies) 11.54

Range of effect sizes: 10.763 to -4.198

Mean average of effect sizes across all attention studies: 0.253

Standard deviation: 1.133

Table 22: Cognitive Remediation of Attention Deficits on Individuals with TBI
Type of Score Categories

Category	Frequency	Mean ES	SD	t-test	Significance
f-score	270	0.440	0.540	13.364	*
r-score	42	1.182	1.888	4.009	*
Effect Size	10	0.637	0.622	3.074	
t-score	509	--0.012	1.220	-0.222	
Grand Total	831	0.253	1.133	4.968	*

*p<.01 is significant

Table 23: The Eight most Extreme ES Scores for Cognitive Rehabilitation of Attention Deficits following TBI

Mean ES Score	Sd from Mean	Type of Score
10.763	9.211	t-score
7.213	6.080	t-score
6.857	5.724	r-score
6.083	4.950	t-score
5.667	4.534	t-score
5.484	4.351	t-score
5.345	4.212	f-score
5.222	4.089	t-score

Table 24: Cognitive Remediation of Attention Deficits following TBI with Eight Outlying Scores Removed

Category	Frequency	Mean ES	Sd	t-test	Significant
f-score	269	0.421	0.450	15.345	*
r-score	41	1.044	1.682	3.925	*
Effect Size	10	0.637	0.622	3.074	
t-score	503	-0.092	0.964	-2.131	
Grand Total	823	0.139	0.937	4.291	*

*$p<.01$ is significant

Table 25: Comparison of Total Scores and Adjusted Scores for Cognitive Rehabilitation of Attention Deficits following TBI

	Total Scores	Adjusted Scores (extreme 1% scores)
Average ES:	0.253	0.139
Number:	831	823
Minimum:	-4.198	-4.198
Maximum:	10.763	4.560
Standard Deviation:	1.133	0.937
t-tests:	4.968	4.291
Outcome:	significant results*	significant results*

*p<.01 is significant

Table 26: Severity of Injury on Total Score Set

Category	Frequency	Mean ES	Sd	t-test	Significant
Severe TBI	497	0.197	1.013	3.922	*
Moderate TBI	286	0.138	1.170	2.046	
Mild TBI	48	0.169	0.384	2.483	

*p<.01 is significant

Table 27: Severity of Injury on Adjusted Score Set

Category	Frequency	Mean ES	Sd	t-test	Significant
Severe TBI	491	0.143	0.860	3.342	*
Moderate TBI	284	0.098	1.065	1.595	
Mild TBI	48	0.169	0.384	2.483	

*$p<.01$ is significant

Introduction to Cognitive Rehabilitation of Socio-behavioral Deficits in Individuals with TBI

Remediation of socio-behavioral deficits has to do for the most part with what is termed executive functioning. This refers to those integrative cognitive processes that determine goal-directed and purposeful behavior and are essential for the execution of daily living skills. The term socio-behavioral deficit encompasses a broad array of cognitive functions and is most often associated with frontal lobe type injuries. Individuals with these types of injuries tend to have deficits in the following areas: unable to initiate behavior, anticipate consequences of their actions, to plan and organize behavior, and to monitor and adapt behavior to fit a particular task or event. In addition, the most noticed of these disturbances tend to be related to impairment in emotional and behavioral self-regulation and reduced capacity for insight. It should be noted that deficits in these areas are often difficult to operationalize because they deal not only with discrete skills but with the cognitive structures and processes that control the use of these skills. The goal of these interventions is designed to establish external structure and or internationalization of control of these actions.

The purpose of this section of the investigation was to collect and evaluate the empirically based studies pertaining to cognitive remediation of socio-behavioral deficits following TBI (n=30).

The results of this section will be presented as it was for the other two sections, i.e., descriptive results of cognitive rehabilitation of socio-behavioral deficits following TBI which are shown in tables 28 through 32, followed by statistical results which are displayed in tables 33 through 40.

Cognitive Rehabilitation of Socio-behavioral Deficits Following TBI:

Study Characteristics

Thirty studies were examined in this area, with all 30 published in journals spanning the years 1980 through 2003. The 30 studies had been published in journals of psychology, brain injury, and cognitive rehabilitation journals.

Table 28 shows the sources of publication and provides a frequency distribution of the studies published in this area. The top four major sources (n= 24) provided 80.00% of the total studies on cognitive rehabilitation of socio-behavioral deficits of this investigation. They were Brain Injury (n = 10, 33.33%), Journal of Head Trauma Rehabilitation (n = 8, 26.67%), Cognitive Rehabilitation (n = 4, 13.34%), and the Journal of Consulting and Clinical Psychology (n = 2, 6.67%). The remaining 20.00% of the studies (n = 6) were distributed across the 6 other sources.

Of the 30 studies, 12 (40.00%) were published during the period from 1980 to 1990, while the other 18 studies (60.00%) were published between 1991 and 2003. Table 29 and 30 shows the cognitive rehabilitation of socio-behavioral deficits in individuals with TBI studies by year.

Table 28: Cognitive Rehabilitation of Socio-behavioral Deficits in Individuals with TBI: Sources of Publication

Journal Title	Frequency	% of Totals
American Journal of Art Therapy	1	3.33%
Brain Injury	10	33.33%
Cognitive Rehabilitation	4	13.34%
International Journal of Rehabilitation Research	1	3.33%
Journal of Head Trauma Rehabilitation	8	26.67%
Journal of International Neuropsychology and Sociology	1	3.33%
Journal of Communication Disorders	1	3.33%
Journal of Consulting and Clinical Psychology	2	6.67%
Neuropsychology	1	3.33%
Neurorehabilitation	1	3.33%
Totals	30	100.00%

Table 29: Cognitive Rehabilitation of Socio-behavioral Deficits in Individuals with TBI: Studies Per Year from 1980 to 1990

# Studies	Year	% of Total Studies Per Year
1	1980	3.3%
1	1981	3.3%
1	1982	3.3%
1	1983	3.3%
1	1984	3.3%
1	1985	3.3%
1	1986	3.3%
2	1987	6.6%
1	1988	3.3%
1	1989	3.3%
1	1990	3.3%
12		40.00%

Table 30: Cognitive Rehabilitation of Socio-behavioral Deficits in Individuals with TBI: Studies Per Year from 1991 to 2003

# Studies	Year	% of Total Studies Per Year
2	1991	6.66%
1	1992	3.33%
2	1993	6.66%
1	1994	3.33%
3	1995	10.00%
1	1996	3.33%
1	1997	3.33%
1	1998	3.33%
1	1999	3.33%
1	2000	3.33%
2	2001	6.66%
0	2002	0.00%
0	2003	0.00%
16		60.00%

Cognitive Rehabilitation of Socio-behavioral Deficits in Individuals with TBI: Subjects Characteristics

The 30 studies comprise a sample population of 810 individuals with TBI receiving cognitive rehabilitation intervention for socio-behavioral deficits. The number of individuals per study ranged from 9 to 56, with an average 27 individuals per study. Table 31 displays the subjects' demographic data in studies of cognitive rehabilitation of socio-behavioral deficits.

Research studies reported the gender of individuals with TBI receiving cognitive rehabilitation interventions for socio-behavioral deficits in 86.66% of the total 30 studies (n= 26), with 76.97% being males (n = 498) and 23.53% being females (n = 149).

Age was reported in all 30 studies (n=30). The mean age of individuals with TBI receiving treatment for socio-behavioral deficits across all studies was 31.3 years (ages ranged from 18 to 59 years). The mean socioeconomic level was reported in only 30% of the studies (n=9). Researchers described the cultural/racial makeup of the participants in only 20.00% of the studies (n=6). Severity of injury was reported in only 43.33% of the studies (n=13), however, based upon the data such as length of time in coma, the researcher was able to determine severity of injury in 83.33 % of the studies (n = 25). The studies reported that 9.36% of the individuals had a mild TBI (n=56), 32.94% being reported as moderate TBI (n=197), and 57.69% being reported as severe TBI (n=345). Table 32 shows the breakdown of the severity of TBI.

Table 31: Cognitive Rehabilitation of Socio-behavioral Deficits of Individuals with TBI: Demographic Data on Participants

Subject Category	# Individuals	% of Population
Sample #	810	100%
Experimental Subjects #	547	67.50%
Control Subjects #	263	32.47%

Table 32: Cognitive Rehabilitation of Socio-behavioral Deficits of Individuals with TBI: Severity of TBI Participants

Severity of TBI Subjects	# Individuals	% of Population
Mild TBI	56	10.24%
Moderate TBI	177	32.35%
Severe TBI	314	57.41%
Total	547	100.00%

Cognitive Rehabilitation of Individuals with Socio-behavioral Deficits following a TBI: Acceptance or Rejection of the Hypothesis

The statistical results accepting or rejecting the original hypothesis, i.e., that there will be no difference in the use of cognitive rehabilitation intervention in the remediation of socio-behavioral deficits following traumatic brain injury was examined in this section. A t-test was computed on the grand total of all ES scores. Overall, the total score data set has a mean ES score of 0.260 (n=481) and a Std. Deviation of 1.013. The t-test statistic was: tdf480=4.232, [p<.01], which indicates that the overall results of cognitive rehabilitation intervention on individuals with socio-behavioral deficits following a TBI is statistically significant with alpha at the .01 level. Table 33 shows the statistics reported for the cognitive rehabilitation intervention of socio-behavioral deficits.

Table 33: Statistical Results on the Cognitive Remediation of Socio-behavioral Deficits following TBI

Average ES:	0.163
Number:	481
Minimum Score:	8.655
Maximum Score:	-5.164
Std. Deviation:	1.013
t-tests:	3.464
Outcome:	*

* p<.01 is significant

A total of 481 effect size scores (ES) were calculated from the 30 studies. Means and standard deviations were used to convert and compute 305 t-score category effect size statistics (63.41%), while data from F tests accounted for 130 f-score category effect size statistical conversions (27.03%), correlation scores accounted for 31 r-score

statistical conversions (6.44%), and 15 effect size scores (3.12%) were given without conversions needing to be calculated. Table 34 shows the cognitive rehabilitation of socio-behavioral deficits categories reported by researchers on the variable effect size scores.

Table 35 shows the types of statistics reported and the average effect sizes on cognitive rehabilitation of socio-behavioral types of scores categories.

To be consistent with the investigation, the top 1% of the scores was removed. These top 5 scores were greater than three standard deviations from the mean, and in sampling distributions it is considered extremely rare for score(s) to fall that far from the mean.

As before, the final results from this new set of data will be based on both the original total scores set and the newly formed adjusted scores set. The patterns of the findings will be compared. As shown previously the most extreme scores were removed using the same procedures as in the previous two sections and the new scores calculated. Table 36 shows the five most extreme ES scores values and category of scores.

After the most extreme 1% of the effect size scores were removed, the adjusted Effect Size scores were examined and only the t-score category score changed slightly. The data on all the other categories remained the same. As a result, the mean Effect Size of the t-score category decreased from 0.026 to 0.014, while the number of scores decreased from 481 to 476 (5 less), and the standard deviation decreased from 1.143 to 1.013. The t-statistic changed slightly from tdf305=-0.165, [p<.01], to a t-value for the adjusted data of tdf300 = -0.216, [p<.01], which is significant. The resulting data on the newly formed adjusted score set indicated an overall mean ES score of 0.137, a standard

deviation of 0.869 and a t-statistic of tdf476 = 3.964, [p<.01], a significant level of results. The final comparison of the total score group with the adjusted score group on t-statistics indicates the t-test value of tdf481=3.464, [p<.01], compared to the new value of tdf822=3.964, [p<.01]. It appears that the reduction of these extreme scores will not affect the overall results. Table 37 shows cognitive remediation of socio-behavioral deficits following the removal of the five outliers.

Table 38 shows comparisons of the type of cognitive rehabilitation of socio-behavioral deficits statistics reported and the average sizes of the two score set.

Table 39 shows the data for severity of injury reported by researchers, the average effect sizes, and the one significant category for the total score set and table 40 shows the severity of injury data reported, and the average effect sizes on the adjusted score set.

Table 34: Effect Size Scores by Category, Number, and Percent of the Total

Category	Number of Scores	% of the Total
t-score	305	63.41%
f-score	130	27.03%
r-score	31	6.44%
Effect Size	15	3.12%
Total Scores	481	

Note: average number of scores per remediation of memory study (based on 67 studies) 11.54

Range of effect sizes: 8.655 to -5.164

Mean average of effect sizes across all attention studies: 0.163

Standard deviation: 1.013

Table 35: Cognitive Rehabilitation of Socio-behavioral Deficits in Individuals with TBI: Type of Score Categories

Category	Frequency	Mean ES	SD	t-test	Significance
f-score	130	0.312	0.467	6.397	*
r-score	31	1.113	1.687	3.069	*
Effect Size	15	0.913	0.877	4.802	*
t-score	305	0.026	1.143	-0.165	
Grand Total	481	0.163	1.013	3.464	*

*p<.01 is significant

Table 36: The Five most Extreme ES Scores for Cognitive Rehabilitation of Socio-behavioral Deficits following TBI

Mean ES Score	Sd from Mean	Type of Score
8.655	7.642	t-score
8.379	7.366	t-score
7.864	6.851	t-score
7.223	6.210	t-score
7.026	6.013	t-score

Table 37: Cognitive Rehabilitation of Socio-behavioral Deficits following TBI with Five Outlying Scores Removed

Category	Frequency	Mean ES	SD	t-test	Significant
f-score	130	0.312	0.467	6.397	*
r-score	31	1.113	1.687	3.069	*
Effect Size	15	0.913	0.877	4.802	
t-score	300	0.014	1.013	-0.216	
Grand Total	476	0.137	0.869	3.964	*

*p<.01 is significant

Table 38: Comparison of Total Scores and Adjusted Scores for Cognitive Rehabilitation of Socio-behavioral Deficits following TBI

	Total Scores	Adjusted Scores (extreme 1% scores)
Average ES:	0.163	0.137
Number:	481	476
Minimum:	8.655	4.164
Maximum:	-5.164	-5.164
Std. Deviation:	1.013	0.869
t-tests:	3.464	2.873
Outcome:	significant results*	significant results*

*p<.01 is significant

Table 39: Severity of Injury on Total Score

Category	Frequency	Mean ES	Sd	t-test	Significant
Severe TBI	300	0.463	1.598	2.717	*
Moderate TBI	139	0.495	0.136	5.160	
Mild TBI	42	0.195	0.482	2.286	

*p<.01 is significant

Table 40: Severity of Injury on Total Score

Category	Frequency	Mean ES	Sd	t-test	Significant
Severe TBI	295	0.373	1.013	3.021	*
Moderate TBI	139	0.495	0.136	5.160	
Mild TBI	42	0.195	0.482	2.286	

*p<.01 is significant

CHAPTER V

CONCLUSIONS

Introduction to Discussion and Conclusion Section

The purpose of this research is to determine the effectiveness of cognitive rehabilitation interventions in enhancing memory, attention, and socio-behavioral deficits of individuals with TBI. The aim is to assimilate and synthesize the literature regarding the impact of cognitive rehabilitation interventions.

Meta-analysis as an area of statistical investigation has gained credibility over the years. However, within the field of counseling, there are still mixed reviews for meta-analysis as a statistical procedure. Wolf (1986) argues that there are four criticisms of meta-analysis. First, he argues that logical conclusions cannot be made by comparing and aggregating studies that include different measuring techniques, definitions of variables, and subjects because of their differences. Second, according to Wolf, results of a meta analysis are not interpretable because results from "poorly" designed studies are included along with results from "good" studies. Thirdly, published research is biased in favor of significant findings because findings that are not significant are rarely published, and fourth, multiple results from the same study are often used which may bias or invalidate the meta analysis and make the results appear more reliable than they really are, because the results are not independent.

The present investigation has taken precautions to minimize the impact of these limitations. In terms of criticism one, this investigation developed a set of criteria in order to include studies into the data set. This research design and methodology dealt with the dissimilarity through data coding, classification and categorization. As a result of those

criteria and good research design in the present investigation, I believe criticism one was met.

Criticism two focuses on including good studies with badly designed studies. Again, I believe that this was addressed within this study as a result of the classification method employed within this investigation. The investigative method for the data coding incorporated categories that eliminated studies that did not meet the criteria specified. Criticism three addresses the issue that there may be a tendency for ES scores to be higher for those published studies versus studies that has not been published. There may indeed be a tendency for ES scores to be higher in research studies that are published versus those that are not. This investigation took approximately four years to read and review studies used in this research. As there isn't a list of unpublished research, the statistical ES scores from the results of this investigation may indeed be higher than if more of the un-published studies were included. As such, this investigation can not be compared against a body of literature that could not be accessed.

Criticism four which addresses multiple results as being biased, tends to be somewhat philosophic. It can be argued that all investigative research tends to be biased in the collection of data, i.e., the selection format, the investigative design, and the research methods used. The summation of data for this research is based on what was reported in the various studies. Multiple results in this investigation tend to corroborate each others findings. This investigation includes the comparisons of certain findings with those of other similar research investigations so the patterns of similarities and differences can be examined. As is with all empirical research, it should be considered merely as a comparison study or as a review that has its own strengths and limitations. As

Harber (1981, p.260) stated, the "average reader should not accept uncritically as true everything reported in this or any other published literature."

Conclusions and Recommendations

This section will interpret the findings of the meta-analytic review in a narrative form as well as discuss methodological issues involved in cognitive rehabilitation and present recommendations for future research in cognitive rehabilitation interventions with individuals with TBBI. Conclusions are reached and recommendations are formulated. The conclusions based on the findings are presented for each research question separately. The research question is stated and followed by conclusions based on the findings related to it.

Research Question Number One:

How effective is cognitive rehabilitation intervention on the remediation of memory deficits following traumatic brain injury?

Statistical Conclusions on the Cognitive Rehabilitation of Memory Deficits in Individuals with TBI

In terms of the effectiveness of cognitive rehabilitations on memory deficits following a TBI, it appears that the intervention is effective. The statistical results on the type of scores variables shows that f-score, ES-score, r-score, and the t-score all indicate statistical levels as $p<.01$. The t-test generated on the total score data determines the original hypothesis that $u = 0$, is rejected. The mean ES score of 0.390 was transformed into a final t-test statistic of $tdf1783=8.403$, [$p<.01$] which means that the use of cognitive remediation is effective as an intervention strategy in improving memory in individuals with TBI. This was also true for the adjusted score set with the 1% most extreme scores

or outliers being removed for statistical analysis. The adjusted mean ES score was 0.303, which was transformed to a final t-test statistic of tdf1767=9.752, [p<.01]. The increase for the adjusted score set being significant was attributed to reducing the variability of the sample, by the removal of those 1% scores that fell more than three standard deviations from the mean.

Despite the fact that the investigation showed that cognitive rehabilitation of memory deficits is effective for individuals with TBI, there are reasons why one needs to be careful regarding a significant result in this case. As a result of many significant variables not being reported in the study, the investigator was unable to analyze their impact on the outcomes of the interventions. For example, many significant variables such as age, ethnic origin, gender, SES, and level of education were not reported in many studies and as a result no statistics could be done on these variables. In addition, in regards to severity of injury, many of the studies that were included in this investigation used participants that had moderate to severe injuries. As a result, the statistical accuracy of this investigation may be questioned in regards to the severity of injury category. As such, the research literature could be regarded as mediocre in the overall positive effects of cognitive rehabilitation intervention with individuals with TBI who have experienced memory deficits.

The statistical results shows that the f-score, the ES-score, r-score, and the t-score all indicate statistic that were significant at the p<.01 level. A similar pattern was noted on the adjusted score set.

The severity of injury was reported in approximately 80% of the research used to evaluate cognitive rehabilitation on memory deficits. In the variable severity of injury,

higher mean effect size scores were associated with severe injury and moderate type injury, which suggest that the more severe the injury the more effective is cognitive rehabilitation on the remediation of memory deficits following a TBI. This same pattern was noticed in the results for the adjusted score set. Based upon the literature, individuals with mild TBI tend to have more success or positive outcomes following intervention with cognitive rehabilitation. However, in this study, significance was obtained with individuals with severe TBI. This result could be attributed to non-reporting of severity of injury by researchers. In addition, most of the studies reviewed consist of participants that had severe TBI which would account for severe TBI being statistically significant. What can be learned from this research is that individuals with severe TBI benefited from cognitive rehabilitation intervention; however, one cannot conclude that this means that individuals with mild and moderate TBI do not benefit from this intervention as compared to individuals with more severe injuries.

In addition, many studies used cognitive rehabilitation interventions to target specific skills and domain-specific knowledge rather than focusing on improving overall memory functions, which appear to be more effective with individuals with moderate to severe impairment. No significant interpretation can be concluded from this finding as a result of non-reporting of variables or whether or not the results are due to spontaneous recovery. Thus, insufficient evidence exists to distinguish the effects of cognitive rehabilitation on specific memory training from those that may result spontaneous memory recovery. As such, one cannot conclude from this study that individuals with mild TBI do not benefit from cognitive rehabilitation interventions as the literature suggest. However, one may infer that individuals with mild TBI may not require

cognitive rehabilitation intervention as readily as individuals with moderate and severe TBI as a result of higher cognitive functioning and the lack of severe impairment or deficit that may affect individuals with more severe type injuries.

In summary, the information gained from this Meta analysis is that it is possible to intervene with memory impairment. However, it should be noted that there are multiple shortcomings in the information being reported in the literature, which may limit the confidence that can be placed on the results. For example, not many of the studies used in this meta-analytical review have been replicated. Also as noted previously, many of the studies did not report on variables deemed important by many experts in the field. In addition, many studies lack a design adequate to the challenge of unambiguous interpretation as well as many of the earlier studies did not based their research on current knowledge regarding brain function in memory processes.

As a result, the treatment of memory impairment constitutes a significant challenge to rehabilitation professionals. There does not appear to be strict evidence of a standardized treatment protocol that has universal effectiveness. There are many theoretical opinions and some research based reports that some treatments may be more effective under some situations. A likely possibility of furthering the development of treatment methods is to examine what memory skills may be present in individuals with TBI. Parkin (1982) reports that even in severe cases of memory loss following TBI, there may be sparing of more than one type of memory. As a result of knowing what type of memory remains in individuals with TBI may provide direction to the development of treatment protocols.

As previously stated, different types of treatment may be effective in different individuals with TBI depending upon the type of injury, the type of memory deficit (episodic, verbal, visual), and the type of information to be remembered (daily schedules, names of people). As a result, treating individuals with TBI may require a combination of treatment interventions, which may make it difficult for researchers to have consistency in treatment protocol.

Descriptive Conclusions on the Cognitive Rehabilitation of Memory Deficits Study Characteristics

The investigation addressed studies published from 1980 through 2003. An important feature of this was that of the 120 studies reviewed for this area, the majority of studies, approximately 76% were published in five major journals (n=93) during this period. This is important as it appears that these journals are committed to cognitive rehabilitation interventions in the treatment of memory impairments. One would have to assume that the reviewers and editorial board would require though standards. In addition, there were almost equal distribution of the studies published from 1980 through 1990 (n=56) and studies published from 1991 through 2003 (n=64). It should be noted that majority of studies that were reviewed were from the period spanning 1980 through 1990. However, most of those studies were not used because they did not met the inclusion criteria. In fact, it appears that the studies published from 1991 through 2003 had a more rigorous statistical content as well as reported more of the associated variables such as age, severity of injury, etc. As such, it appears that in order to obtain more statistical power, it would be more advantageous to examined studies from the 1990s to present. Additionally, if we looked at studies from 1990 to 2003 for this

investigation, the majority of studies would have been within this time period, i.e., approximately 60% of the studies. These studies were able to satisfy more of the criteria required for this investigation as many of the studies were appropriate in their design and the research was based on current knowledge regarding brain function in memory processes.

Descriptive Conclusions on the Cognitive Rehabilitation of Memory Deficits Participant Characteristics

In terms of the subject characteristics, researchers did an adequate job in reporting the gender within the studies, approximately 76.66% of the total of 120 studies. It is also interesting to note the more than 3 to 1 margin of male to female ratio. From a study perspective, this may look inappropriate, however, this is in line with the ratio between males and females in terms of who acquires a traumatic brain injury.

With respect to age of the participants, the sample ranged from 18 to 56 years, with an approximate mean age of 33.4 for participants involved in the remediation of memory deficits. It should be noted that a majority of the studies reported the age of the participants in ranges; as such the mean age calculation may not be as accurate as a result of how the data was presented.

In the cultural/racial category, researchers reported the makeup of the participants in only 26.66% of the total of the 120 studies used in this section. It should be noted that Whites/European Americans constitute the largest cultural/racial group receiving cognitive remediation intervention.

On the variable of severity of injury, researchers reported the severity in approximately 87.5% of the studies (n=105). Of this, the majority 65.11% of the

participants were classified as having a severe injury. This is important in understanding what level of severity is most likely to benefit from cognitive rehabilitation interventions and subsequently what level of severity is most likely to eventually gain employment. It appears that individuals with severe TBI are more likely to receive cognitive rehabilitation intervention treatment as a result of the deficits associated with more severe type injuries and the debilitating effects these deficits may have on the individual quality of life. Many individuals with mild TBI do not seek treatment. As stated previously in the literature review, many individuals with mild TBI do not even seek emergency treatment.

On the socio-economic variable, researchers reported the SES of participants in so few studies, approximately 9% that for this investigation it was impossible to address this variable. Based upon this, one can conclude that the researchers do not believe that SES is an important or significant category in the study of cognitive rehabilitation of memory deficits following TBI. However, this researcher believes that by not addressing SES, one is unsure which groups are likely to obtain these types of remediation interventions and subsequently have a positive vocational outcome.

Research Question Number Two:

How effective is cognitive rehabilitation intervention on the remediation of attention deficits following traumatic brain injury?

Statistical Conclusions on the Cognitive Rehabilitation of

Attention Deficits in Individuals with TBI

As before, the t-test was computed on the grand total of all ES score. This t-test statistic on the total data set was tdf830=5.161, [p<.01], which indicates that cognitive

rehabilitation of attention deficits in individuals with TBI is statistically significant, i.e., it has a positive effect on enhancing or improving those areas of attention that the intervention was based on. The results were also positive for the adjusted score set, which as stated before included the removal of the extreme 1% scores that were more than three standard deviations from the mean. A statistical analysis was done on the remaining scores and the new data indicated statistical significance with a t-statistic of tdf822=4.291, [p<.01].

Statistical results indicate higher effect size scores were associated with the f-score followed by the r-score category. This was also true for the f-score with the adjusted score set. Once again, there was an increase for the adjusted f-score category. This significant increase is also attributed to reducing the variability of the sample, by the removal of those 1% scores that fell more than three standard deviations from the mean. It appears that the f-scores that were provided were in studies that had individuals with more severe TBI. The higher effect size was associated with severe injuries. The pattern associated with these results would indicate cognitive interventions do not improve the performance of individuals with mild TBI, however, it does improve the performance of individuals with moderate to severe TBI.

This investigation does indicate that cognitive rehabilitation of attention deficits is effective for individuals with TBI. However, a word of caution must be addressed. Of the 67 articles reviewed, a good number of studies did not report on many variables deemed important in understanding the effectiveness of treatment on the outcome. As mentioned before, many significant variables such as age, ethnic origin, gender, SES, and level of education were not reported in many studies and as a result no statistical analysis

could be done on these variables. In addition, many researchers did not report the exact numerical value of an effect size but stated that the results were significant. In such cases the effect size were calculated based upon the values provided. As such, statistical analysis may not be as accurate as it should be as many studies lacked a design that was adequate for appropriate interpretation. In my view, the research literature could be regarded as being of poor quality in the overall positive effects of cognitive rehabilitation intervention with individuals with TBI who have attention deficits. For example, many of the intervention used to address remediation of attention impairments have generally relied on drill and practice, with exercises designed to address specific aspects of attention (e.g., processing speed, focused attention, divided attention). Additionally, many of the reported interventions have used stimulus-response paradigms, which required participants to identify and select among relevant auditory or visual stimuli, and often used speeded stimulus presentations. However, many of these studies failed to explicitly state the rationale for using such interventions. It could be assumed that the implicit rationale is to restore basic attention abilities through repeated practice, however, the studies failed to address such issues.

The statistical results shows that the f-score and r-score indicate statistic that were significant at the $p<.01$ level. A similar pattern was noted on the adjusted score set.

The severity of injury was reported in approximately 58% of the research used to evaluate cognitive rehabilitation on attention deficits following a TBI. In the variable severity of injury, higher mean effect size scores were associated with severe and moderate type injury. This indicates that in this review, individuals with moderate and severe injury benefited most from cognitive rehabilitation interventions on the

remediation of attention deficits following a TBI. This same pattern was noticed in the results for the adjusted score set. Although the results were positive for cognitive rehabilitation intervention it is difficult for one to generalize the benefits attributed to attention remediation. Many of the studies have concentrated on providing participants with practice on training tasks related to specific aspects of attention. Many authors have argued that with such intervention the quality of therapeutic intervention beyond the training tasks employed may be an important variable in the effectiveness of treatment.

It appears from the research that interventions aimed at remediating attention appears to be more effective when aimed at improving functional tasks rather than specific tasks. What can be learned from this research is that individuals with moderate to severe attention deficits appear to benefit from cognitive rehabilitation interventions. However, the evidence is insufficient to distinguish the improvement to cognitive rehabilitation intervention or to spontaneous recovery. In approximately 74% of the studies reviewed, the participants were receiving inpatient brain injury rehabilitation that included interventions aimed at orientation, memory, language, and other general cognitive skills. In addition, only three of the studies reviewed compared recovery of attention between treated and untreated subjects. As such, it could be argued that any improvements attributable to the natural course of recovery and those related to cognitive rehabilitation interventions within the confined of a brain injury rehabilitation program may be confounded.

In summary, it can be concluded that cognitive rehabilitation intervention does appear to have some type of positive effect on decreasing attention deficits following TBI for individuals with moderate and severe injuries. Individuals with TBI may experience

deficits in speed of information processing, selective attention, divided attention, etc. Consequently, cognitive remediation interventions have emphasized practice on tasks that exercise skills in ignoring distraction and in maintaining attention over time. Many of the studies used have demonstrated improved performance with repeated practice on attention tasks. However, as previously stated for memory impairments, the use of cognitive remediation in the treatment of attention deficits also have many shortcomings that may impede the confidence that can be placed on the results. Many of the studies did not report on variables deemed important by many experts in the field, i.e., type of attention deficit being treated, years post injury, severity of injury, years of education, etc. In addition, many studies lack an appropriate design as such many of the interpretation may be suspect. Also, it appears that the vast majority of studies on cognitive rehabilitation of attention deficits utilized computerized cognitive rehabilitation as the primary intervention technique, whereas others utilize attention process training (ATP), and workbooks. In addition, as previously stated the vast majority of the intervention was performed in brain injury rehabilitation programs at the same time participants were receiving treatment for other areas affected. All this may account for the lack of significance with this intervention for individuals diagnosed with a mild TBI. In most cases, individuals with mild TBI do not seek emergency treatment and do not experience the severity of deficits as individuals with moderate and severe TBI experience; therefore this may account for the limited numbers of individuals with mild TBI in the results and subsequently the lack of significance for this group in this study.

The evidence for rehabilitation effectiveness of attention training stands out among all others, however, it is not at the stage where it can be recommended routinely

as there does not appear to be significant evidence for its generalizability to daily life. In addition, it is not clear from the research what kinds of intervention may be more effective and for what type of deficit. Also it should be noted that in the studies reviewed, many of the subjects were receiving inpatient brain injury rehabilitation that included interventions directed at orientation, memory, or general cognitive skills. As such, it may be necessary to examine and compare improvement in attention between subjects receiving treatment in an inpatient setting and those not receiving treatment. Therefore, it is difficult to interpret whether improvements may be attributable to the natural course of recovery or to cognitive interventions.

Descriptive Conclusions on the Cognitive Rehabilitation of Attention Deficits Study Characteristics

The investigation addressed studies published from 1980 through 2003. This investigation utilized 67 studies for this area. The overwhelming majority of studies, approximately 85% were published in five major journals (n=57) during this period. These were the Journal of Head Trauma Rehabilitation, Cognitive Rehabilitation, Brain Injury, Neuropsychological Rehabilitation, and Journal of Clinical Neuropsychology. In addition, approximately 43% of the studies were published from 1980 through 1990 (n=29) and 57% of the studies were published from 1991 through 2003 (n=38). It should be noted that the majority of studies that were reviewed were from the period spanning 1980 through 1990, however many were not used because they did not met the inclusion criteria. The studies published from 1991 through 2003 seem to met a more rigorous statistical criteria and did report more of the associated variables such as age, severity of injury, etc.

Descriptive Conclusions on the Cognitive Rehabilitation of Attention Deficits Participant Characteristics

In terms of the subject characteristics, researchers did an adequate job in reporting the gender within the studies, approximately 81% (n=54) of the total of 67 studies. It is also interesting to note the more than 3 to 1 margin of male to female ratio. Approximately 70% (n=1120) were males and 30% (n=476) females.

Age was reported in 88% of the studies, with the sample ranging from 18 to 63 years, and an approximate mean age of 29.5years for participants involved in the remediation of attention deficits studies.

In the cultural/racial category, researchers reported the makeup of the participants in only 34.33% of the total of the 67 studies. This is significant because most studies completed on minority clients seem to indicate that these groups tend to have a higher unemployment rate after disability, even after they have gone through training and programs geared towards improving employment. Within this group category, Whites/European Americans constitute the largest cultural/racial group receiving cognitive remediation intervention, approximately 69%, followed by African Americans at 27%.

On the variable of severity of injury, researchers reported the severity in all the studies used for this investigation (100%). The majority of the participants, 58% were classified as having a severe injury, followed by moderate type injury at 26%, and mild TBI constituting the remaining 16%. This is important in understanding what level of severity of injury is most likely to benefit from cognitive rehabilitation interventions and subsequently what level of severity is most likely to eventually gain employment.

The socio-economic variable was only reported in 16% of the studies utilized for this investigation. It appears that researchers do not believe SES is an important or significant variable in the study of cognitive rehabilitation interventions of attention deficits following TBI.

Research Question Number Three:

How effective is cognitive rehabilitation intervention on the remediation of socio-behavioral deficits following traumatic brain injury?

Statistical Conclusions on the Cognitive Rehabilitation of

Socio-behavioral Deficits in Individuals with TBI

The t-test was computed on the grand total of all ES scores. This t-test statistic on the total data set was tdf480=4.232, [p<.01], which is statistically significant. This indicates that cognitive rehabilitation of socio-behavioral deficits in individuals with TBI has a positive effect on enhancing or improving those areas of socio-behavioral deficits that the intervention was based on. It should be noted that the f-score, r-score, and ES-score were all significant. The results were also positive for the adjusted score set, which included the removal of the extreme 1% scores that were three standard deviations from the mean. A statistical analysis was done on the remaining scores and the new data indicated statistical significance with a t-statistic of tdf476=3.964, [p<.01]. As before, statistical results indicate higher effect size scores were associated with the f-score category. This was also true for the f-score with the adjusted score set.

This investigation does indicate that cognitive rehabilitation of socio-behavioral deficits is effective for individuals with TBI. .

The statistical results shows that the f-score and r-score indicate statistic were significant at the $p<.01$ level. A similar pattern was noted on the adjusted score set.

In the variable severity of injury, higher mean effect size scores were associated with severe type injury. This indicates that the more severe the injury the more effective is cognitive rehabilitation on the remediation of socio-behavioral deficits following a TBI. This same pattern was noticed in the results for the adjusted score set. What can be learned from this research is that individuals with socio-behavioral deficits who have been diagnosed with a severe TBI will benefit from cognitive rehabilitation interventions as a result of the severity of the impairment. This is not to say that individuals with moderate or mild injuries do not benefit from cognitive rehabilitation. They may benefit but not as much as individuals with more severe impairments.

It is important to understand that although emotional and psychosocial issues are amongst the most significant variables influencing outcomes in individuals with TBI, there has not been an abundance of research done in this area., i.e., only 30 studies were used in this section. Behavior modification has been the most widely used intervention for the treatment of socio-behavioral deficits and the efficacy of this intervention is well established. On the other hand, the lack of research in this area may be due to the complexity of the problems posed by socio-behavioral deficits as well as the lack of research tools to enable the researcher to investigate the field appropriately. Many of the instruments that exist are used with psychiatric patients and may be inappropriate or very misleading when used with the TBI population.

As a result of the aforementioned problems as well as lack of reporting in many studies the results must be approach cautiously. Additionally, many studies did not

indicate whether they were addressing emotional, social, or financial issues associated with psychosocial factors. It appears that many of the studies that used cognitive rehabilitation interventions to address socio-behavioral deficits utilize verbal self-instruction, self-questioning, and self-monitoring techniques in order to address those issues, including the reduction of problem behaviors in everyday situations. However, many of the studies did not incorporate or provide detailed neuropsychologic information and or clinical assessment data necessary in identifying the type of relevant behaviors that were being addressed. Some individuals, especially those with multiple cognitive impairments, may require consistent external structure and environmental management to achieve improvements in skills or behaviors within limited contexts. In addition, socio-behavioral deficits may include efforts to assess the participant's awareness of their deficits and to improve the accuracy of their self-appraisal of their performance. Within the thirty studies used to determine the effectiveness of cognitive rehabilitation intervention, none of these concerns were adequately addressed through controlled studies.

Descriptive Conclusions on the Cognitive Rehabilitation of Socio-behavioral Deficits Study Characteristics

The investigation addressed studies published from 1980 through 2003. This investigation utilized 30 studies for this area. The overwhelming majority of studies, approximately 77% were published in five major journals (n=23) during this period. In addition, the majority of studies, approximately 60% were published from 1991 through 2003 (n=18) and the remaining 40% were published from 1980 through 1990 (n=12). It

should be noted that only few studies on cognitive rehabilitation have been published in the area of socio-behavioral deficits.

Descriptive Conclusions on the Cognitive Rehabilitation of Socio-behavioral Deficits Participant Characteristics

In terms of the subject characteristics, researchers reported the gender of individuals within 87% (n=26) of the studies. Approximately 77% (n=498) were males and 23% (n=149) were females.

Age was reported in all 100% of the studies, with the sample ranging from 18 to 59 years, with an approximate mean age of 31.3 years for participants involved in the remediation of socio-behavioral deficits.

In the cultural/racial category, researchers reported the makeup of the participants in only 20% of the total of the studies.

On the variable of severity of injury, researchers reported the severity of injury in only 43% (n=13) of the studies used for this investigation. The majority of the participants, 58% were classified as having a severe injury, followed by moderate type injury at 33%, and mild TBI constituting the remaining 9%. This is important in understanding what level of severity of injury is most likely to benefit from cognitive rehabilitation interventions and subsequently what level of severity is most likely to eventually gain employment.

The socio-economic variable was only reported in 30% of the studies utilized for this investigation. As stated previously, SES does not appear to be an important or significant variable in the study of cognitive rehabilitation interventions of socio-behavioral deficits following TBI.

Research Question Number Four:

What are the relationships between factors such as age at time of accident, years of education, socio-economic status, severity of injury, and ethnic background of individuals on subsequent vocational outcomes following cognitive rehabilitation intervention with persons with TBI?

As previously stated, non-reporting was a significant part of this investigation. In all but one category, researchers did not provide adequate or enough information on variables deemed important for cognitive rehabilitation with individuals with TBI. The vast majority of studies did not provide data on the age of individuals at time of injury, years of education, socio-economic status, and ethnic background. As such, too few studies would have been used in completing a statistical analysis on these variables, which in my view would have not been statistically significant. In terms of severity of injury, there seems to be clear evidence that individuals with severe type injuries appear to benefit more from cognitive rehabilitation interventions. Researchers reported that 2,083 participants had a severe injury, which accounted for approximately 67% of the total population reported for the treatment group. Moderate brain injury accounted for 28% of the treatment group, and mild brain injury represent 5% of all the participants that were reported in this category. Within this investigation, cognitive remediation with individuals with severe TBI reached significance in all of the areas examined, i.e., cognitive rehabilitation of memory deficits, attention deficits and socio-behavioral deficits. In terms of cognitive rehabilitation of memory deficits in individuals with TBI, a t-test statistic revealed moderate and severe injury were significant at the $p<.01$ level. The same pattern was found for the rehabilitation of attention deficits, which showed

significance for moderate and severe injuries at the $p<.01$ level, and for rehabilitation of socio-behavioral deficits, which showed significance for severe injury at the $p<.01$ level.

It appears that cognitive rehabilitation has a significant impact on the remediation of memory, attention, and socio-behavioral deficits for individuals with severe TBI based upon the results of this study. In addition, statistical significance was obtained for individuals with moderate TBI in the rehabilitation of memory deficits.

The studies reviewed for this investigation did not report any information on vocational outcomes following cognitive rehabilitation interventions as most of the studies reviewed focused on cognitive rehabilitation interventions in addressing memory, attention, and socio-behavioral deficits following TBI. It appears that studies need to be done to explore the relationship between improvement in measures of memory, attention, and socio-behavioral skills and the individual's vocational outcome. However, based upon a review of the literature cognitive rehabilitation intervention is performed on areas of memory, attention, socio-behavioral deficits, and visuospatial deficits in order to improve functioning in these areas which ultimately will improve quality of life for these individuals.

Based upon the literature, the most cited reasons for the failure to return to work are the cognitive impairments (deficits in attention, and deficits in memory), socio-behavioral deficits (problems with dishinibition, lack of awareness), and unrealistic expectations concerning the kind of employment the individual is capable of doing. Many studies have not addressed premorbid factors (education, type of employment, etc.) and age of accident as being significant factors in the return to work process following an acquired TBI. In fact, several authors (Lishman, 1978; & Griffith, 1983) have argued

that the residual cognitive, emotional, and behavioral sequelae greatly exceed the physical as the cause of long-term vocational difficulties. In addition, other studies have shown that memory problems, changes in personality, loss of emotional control, and problems in concentration posed the greatest barriers to return to premorbid status for individuals with TBI (Thomsen, 1984 & Van Zomeren, 1985). In conclusion, although the studies did not provide enough data to compute the statistical analysis on variables such as age at time of accident, socio-economic status and ethnic background, it can be assumed based upon the literature that the impact on vocational outcomes is more associated with attention, memory and socio-behavioral deficits.

Summary of Meta Analysis Study

This investigation was initiated because of my interest in TBI. Moreover, it came to light as a result of interest in helping individuals with TBI return to work or obtain employment within the community in which they reside. Additionally, there were a few presumptive reasons in completing a meta analysis on cognitive rehabilitation interventions with individuals with TBI. It appears from reading the literature as well as working in the field of brain injury rehabilitation, cognitive rehabilitation intervention as a strategy has gained prominence in the field as the most effective tool in helping individuals with TBI improve their memory, attention, and socio-behavioral deficits. As such, having reviewed the data, it is very surprising that of all the studies reviewed, only 217 studies, 120 representing cognitive rehabilitation of memory deficits, 67 representing cognitive rehabilitation of attention deficits, and 30 representing remediation of socio-behavioral deficits met the inclusion criteria and thus represent the empirical basis for supporting the effectiveness of cognitive rehabilitation intervention. This may be

sufficient studies for this investigation, in fact it appears to be the most comprehensive study to date, however this does not appear to be an overwhelming amount of studies to support the empirical validity of cognitive rehabilitation. When one considers the importance of cognitive rehabilitation interventions in the remediation of memory, attention, and socio-behavioral deficits and the importance in improving the quality of life of individuals with TBI, it is frustrating that more attention isn't paid to the type(s) of intervention being used, the areas of deficit being examined and significant variables being reported.

In terms of strength(s) of this study, the length of time comes to mind. It took approximately 4 years for this investigation to conclude. During this time, approximately 465 articles were reviewed, which is extensive. The studies were selected through an inclusionary criteria (see appendix), data collection was completed utilizing a coding sheet (see appendix), and it was based upon solid research practice. In addition, the study utilized a statistical analysis known as a meta-analysis as its instrument, and the results were presented in an organized way starting with a descriptive analysis of the studies and participants, followed by a statistical analysis. In terms of the definition of TBI this investigation did not include studies where the participants might have had a stroke or a tumor that may have led to the brain injury. Given the length of time it took to complete this study and the breath of researched articles utilized, it seemed to be a good representation of the literature on the topic of cognitive rehabilitation intervention in individuals with memory, attention, and socio-behavioral deficits following TBI.

With respect to limitations, several are noted: 1) cognitive rehabilitation intervention is a constellation of procedures that is utilized in the remediation of memory,

attention, and socio-behavioral deficits among others. However, in the vast majority of studies, there is no indication of what intervention strategy or strategies were employed; 2) many studies were excluded from this research because they did not provide adequate statistical results that could be translated into the effect size statistics and or did not met the inclusionary criteria as determined by the investigator; and 3) the vast majority of studies used in this investigation are published studies. As such, this may account for higher effect sizes than would be found in unpublished studies.

Summary of Cognitive Rehabilitation with Individuals with Memory, Attention and Socio-behavioral Deficits following TBI

This study has contributed to our understanding of cognitive rehabilitation interventions with individuals with memory, attention, and socio-behavioral deficits following TBI. However, I believe that there are some areas that could benefit from future research. Having had the opportunity to review a large body of literature on cognitive rehabilitation intervention research, it is alarming that such a lack of standardization exists in reporting the research as well as the obvious inconsistencies in methodology by a significant number of researchers in reporting their findings. Although inconsistencies in the literature were managed within this investigation to some extent, it is still necessary for researchers to follow a standard protocol when presenting their findings from research.

Definition Issues

There are also some inconsistencies in terms of defining cognitive rehabilitation and what system or systems are actually being measured. Many terms are used such as cognitive retraining, cognitive remediation, etc. Whereas cognitive retraining is a

systematic attempt to improve the resultant intellectual deficits that interfere with the processing of information at some level; cognitive rehabilitation is broader in scope since the goal of rehabilitation is functional adaptation in daily life activities. Cognitive rehabilitation requires not only identifying specific operational problems but also determining how it is done, methodology, and strict adherence to training priorities (Ryan, Short, & Weed, 1986). The authors further assert that one cannot train a function and expect improved performance or compensation in daily activities without determining the specific effects of the deficit on other cognitive systems.

Methodological Issues

Research arguing for or against cognitive rehabilitation has suffered from great variability in levels of severity of injury in individuals with TBI, use of non-standardized test protocols, lack of controls, absence of uniform data defining success or failure, lack of adequate and consistent verification of performance, and an absence of reliable follow-up over long periods.

In addition, it was noticeable that a large segment of the literature contained single case studies but lacked between-group studies. Additionally, many of the single-case studies did not present any significant statistical data, but rather the results were very descriptive in nature. In addition, many lack inadequate pretreatment baselines, inadequate duration of interventions, and incongruity between training and assessment tasks. It can be assumed that single-case design studies are easier to carry out since between-group designs present a practical as well as an ethical challenge of assigning participants to a non-treatment condition. However, if such a design could be done, it is the best way of examining the independent effects of treatment and spontaneous recovery

on the effectiveness of cognitive rehabilitation interventions. Given the unreliability of the available empirical evidence for cognitive rehabilitation intervention, it is not unreasonable for researchers to assign participants to one or more experimental treatment conditions. For example, the field of speech therapy has published several studies using between-group designs (Basso, 1987).

An important generalizability issue facing clinicians who treat individuals with memory, attention, and socio-behavioral deficits is that even though a strategy may be found useful in a clinic setting how does one account for whether this intervention will be useful outside of the clinic setting. Although research indicates that persons with TBI require more time than normal controls to learn cognitive tasks (Stanwood, 1986), many of the studies reviewed included fewer than five treatment sessions.

Another problem facing therapists is the issue of compliance. There are very few systematic studies of the relation of compliance by individuals with TBI in memory, attention, and socio-behavioral improvement. Other methodological problems are related to issues raised in reviewing the studies used in this investigation. As previously stated, demonstrating the effectiveness of cognitive remediation on memory, attention, and socio-behavioral deficits can be misleading when spontaneous recovery is occurring or when other treatments are being implemented simultaneously.

In addition, the difficulty still exists of trying to tailor a specific form of intervention to the individual specific problems or needs. Cognitive rehabilitation intervention is a necessary and effective technique in the treatment of memory, attention, and socio-behavioral deficits in individuals with TBI. However, empirical work regarding the treatment implications and external validity needs to be further examined.

Additionally, the relation of the diagnostic categories to premorbid history needs to be addressed. This would help clinicians to compare treatment within and across treatment facilities.

Although the results from this investigation reveal that cognitive rehabilitation intervention was significant in the remediation of memory, attention, and socio-behavioral deficits, the noted methodological problems, the inconsistency of reporting of variables by many researchers, and the lack of standardization of treatment interventions greatly diminish the claim that cognitive rehabilitation is a valid treatment approach in the remediation of memory, attention, and socio-behavioral deficits for individuals with TBI. This is not to say that cognitive rehabilitation is not valid and should be abandoned, rather, it suggest that clinicians and researchers need to employ interventions and treatment protocols that have been successful with TBI participants with similar deficits in order to evaluate treatment effectiveness and efficacy.

Future Research on Cognitive Rehabilitation with Individuals with Memory, Attention, and Socio-behavioral Deficits following TBI

Future research in the treatment of memory, attention, and socio-behavioral deficits would benefit from a greater understanding of spontaneous recovery as a normal brain process. For example, with memory interventions the field would benefit from a greater understanding of the mechanisms, or molecular skills, involved in memory. In addition, research evaluating cognitive interventions should specify the etiology of the injury so that the degree of effectiveness of different treatment methods may be discerned in relation to etiology. The degree of the impairment should be specified, and this

specification should include level of performance on standardized and laboratory tasks as well as the specification of the degree of impairment in daily activities.

It has been hypothesized that reduction of deficits in the areas of memory, attention, and socio-behavioral deficits should generalize to related skills and activities of daily living; however, this has not been adequately shown in many of the studies. As a result of the variation of cognitive deficits in individuals with TBI, several skills should be assessed throughout treatment to evaluate the impact of cognitive rehabilitation on related and unrelated tasks. Future research should also focus on training tasks and outcome measures that reflect activities of daily living and vocational skills (Diller & Ben-Yishay, 1987).

Based upon my experience as investigator of this study, I am proposing a few questions that should assist researchers in developing a more standardized set of guidelines for future research:

1) Who are the participants receiving the intervention? (diagnosis or etiology, severity of injury, age of participants, level of education, pre-injury, etc.)
2) What comprises cognitive rehabilitation intervention? (focus and rationale, treatment duration and frequency, treatment setting, providers, are interventions personalized to match client skills and/or needs)
3) What are the outcomes of the intervention? (what measures suggest changes in attention, memory, and socio-behavioral deficits {psychometric tests}, are changes in activity/participation, is the change clinically meaningful, can the changes be generalized)

4) Are there methodological concerns? (do other explanations exist for a given outcome, are results exaggerated, study design, reliability and validity issues addressed)

5) Are training tasks and outcome measures a reflection of activities of daily living and vocational skills

Cognitive rehabilitation interventions present an holistic treatment approach when working with persons with TBI. This approach involves many different treatment modalities, each focusing on a different deficit. As such, in order to have successful outcomes, rehabilitation programs need to focus on remediation of the multiplicity of deficits.

Because of the neurological and behavioral sequelae of persons with TBI, it can have an effect on the replication of research as changes, spontaneous recovery and practice effect may enhance individual skill level. Therefore, when conducting research, one needs to distinguish between the neurobehavioral subtypes, and the severity of injury as defined by the Glasgow Coma Scale in order to control for these variables. In addition, researchers need to identify the type of injury, i.e., frontal lobe, etc., as persons with this types of injury will experience different types of deficits from those with parietal lobe injuries. As such, future studies should report information regarding subject characteristics. When such information is not present as was the case in numerous studies used in this meta analysis, the ability to generalize becomes limited.

Finally, the hypothesis that providing cognitive rehabilitation to persons with TBI will result in decreased deficits associated with memory, attention, and socio-behavioral deficits has been supported through the statistical analysis used in this meta analytic

review. However, because persons with TBI differ in the range and extent of cognitive deficits, programs that incorporate a comprehensive or holistic approach will be better able to evaluate the impact of this intervention on primary as well as secondary tasks. The conclusion from many of the studies is that cognitive rehabilitation intervention is statistically significant in reducing deficits associated with memory, attention, and socio-behavioral changes following TBI. However, these studies do not provide any information on these changes will affect activities of daily living and vocational skills.

In conclusion, the claims that using cognitive rehabilitation interventions to remediate memory, attention, and socio-behavioral deficits as a valid treatment approach for persons with TBI, appears to be supported by this investigation. Cognitive rehabilitation intervention is the most current and used strategy in the remediation of memory, attention, and socio-behavioral deficits. There is research evidence that cognitive rehabilitation is effective in improving memory, attention, and socio-behavioral deficits in persons with TBI. However redundant it may sound, more research is needed to address the effects spontaneous recovery, multiple treatment effects, and the number of practice tasks given have on outcomes. In addition, more research can increase our understanding of the type of strategy that may offer the most promise as well as determine more precise implementation procedures, e.g., the matching of strategies to types of brain damage or the types of deficits encountered.

This research set out to determine the effect of cognitive rehabilitation intervention in the remediation of memory, attention, and socio-behavioral deficits in persons with TBI. In this regard, cognitive rehabilitation was supported as being effective in reducing deficits associated with impairment following a TBI. The next phase

is for practitioners to transcend research into practice as this is the only means of enhancing the quality of life for individuals with TBI.

APPENDIX

There are two parts to the Appendix: Part one contains Appendix A which is the sample code sheet and Appendix B which contains the definitions used to extrapolate data from the various studies that make up the data base of this investigation. The second part contain Appendix C which is a summary of all the studies included in this investigation for the remediation of memory, Appendix D which contains the studies used for the remediation of attention, Appendix E which contains all of the studies used for the remediation of socio-behavioral deficits, and Appendix F which are studies that were reviewed but were excluded from this investigation.

APPENDIX A

THE CODING INSTRUMENT

Topic Targeted: Memory_____ Attention_____ Socio-behavioral____

Code #:_____ Date:_____ Author:_____

Article Title:

Source: Journal:_____ Book:_____ Dissertation:_____

Journal Title:

Sample:

N_____ Mean Age _____

Educational Level_____ Severity of Injury_____

Socio Economic Status_____ **Gender:** Male_____ Female_____

Race: White/Caucasian_____ Black/African American_____

Hispanic_____ Asian American_____

American Indian_____ Other_____

Treatment Facility: Inpatient Setting_____ Clinic_____

Other_____

Outcome Measure: Standardized_____ Experimental_____Other_____

Type of Measure: Rating Scale_____ Checklist_____ Observation_____

Psychometric_____ Interview_____

Effect Size:

No of ES_____

Type of Statistic: t-score_____ F-score_____ r-score_____

ES_____

Notes/Comments:

APPENDIX B

OPERATIONAL DEFINITIONS FOR THE ARTICLE REVIEW SHEET

1. **Study Number:** An identification number was assigned to each study in the order it was coded, starting with Number 1.
2. **Author(s):** The principal investigator(s) of the study.
3. **Publication Year:** The year noted on the manuscript was recorded. For studies that appear in multiple forms, the year of the most extensive report was used.
4. **Publication Form:** The study was classified according to the form in which it was published: (a) journal article, (2) book, (3) dissertation based publication, (4) unpublished dissertation.
5. **Sample Size:** The sample size was recorded
6. **Mean Age of Subjects:** The mean chronological age of the study participants was recorded as (1) reported in the study, (2) approximated from data in the study, or (3) not obtainable.
7. **Mean Educational Achievement Level of Subjects:** The mean number of years of formal education of the study participants was recorded as (1) reported in study, (2) approximated from data in the study, or (3) not obtainable.
8. **Median Socio-economic Status of Subjects:** Median socio-economic status of study participants was recorded as (1) low SES, (2) middle SES, or (3) high SES. In those cases where actual mean income was provided, the following categories were used: low (below 12,000), middle ($12,000 - $40,000), and high (higher than $40,000). Median socio-economic status of subjects was recorded as (1) reported in the study, (2) approximated from data in the study, (3) not obtainable.

9. **Gender of Subjects:** The percent of male and female participants in the sample was recorded as (1) reported in the study, (2) approximated from data in the study, (3) not obtainable.
10. **Cultural/Racial Mix:** The percent of African Americans, Asian Americans, Hispanics, Native Americans, and White Americans in the sample was recorded as (1) reported in the study, (2) approximated from data in the study, (3) not obtainable.
11. **Severity of Injury:** The number of participants with mild, moderate or severe brain injury was recorded as (1) reported in the study, (2) approximated from data in the study, (3) not obtainable. In cases where the severity of injury is not given, the investigator will try to determine severity of injury by the following: Glasgow Coma Scale: GCS = 12-15 (mild), GCS =9-12 (moderate), and GCS = 1-8 (severe)
12. **Associated Variable:** This category was designed to identify variables associated with cognitive rehabilitation intervention of persons with TBI: (1) age; (2) gender; (3) race; (4) educational attainment level; (5) socioeconomic status or income; (6) severity of injury; (7) pre-injury employment status; (8) other.
13. **Description of Associated Variable:** A description of the associated variable and any relevant information obtained in the study was recorded.
14. **Study Quality:** A numerical rating of the study quality will be assigned to each study on the basis of the following criteria (adapted from Hembree, 1984).

a) Problem Identification: clear hypotheses or research questions (3), no hypotheses or research questions but clear statement of purpose (2), none of the aforementioned (1).

b) Population Description: description of demographic items, i.e., age, gender, race, educational level, socio-economic status, employment level, and marital status. Six to seven demographic items obtainable (3), three to five items obtainable (2), less than three demographic items obtainable (1).

c) Sampling Procedure: random (3), partially random (2), non-random (1)

d) Conclusions: appropriate and tied to hypothesis, research questions, or purpose (3); appropriate, but with digressions (2); inappropriate (1).

e) Data Analysis: appropriate methods with full reporting of results (3), appropriate methods with partial reporting or some data missing (2), inappropriate methods, mistakes, or much data missing (1).

Each criterion will be evaluated on a scale from 1-3 (where 1 is low and 3 is high).

15. **Effect Size Determination**: Article specifies either the effect size or statistical data on which to calculate the ES score.

16. **Type of Statistics**: Article gives statistic results in terms of t-score, f-score, r-score, or d score.

APPENDIX C

LIST OF 120 STUDIES USED IN THE DATA ANALYSIS AND SYNTHESIS OF COGNITIVE REHABILITATION OF MEMORY DEFICITS IN INDIVIDUALS WITH TBI

Abreu, B. C., & Toglia, J. P. (1987). Cognitive rehabilitation: A model for occupational therapy. *American Journal of Occupational Therapy,* 41(7), 439-448.

Annoni, J.M., Jenkins, D.G., & Williams, J. (1989). Four case reports illustrating the contribution of intensive cognitive rehabilitation in patients neuropsychologically handicapped as a result of brain damage. *Disability Rehabilitation*, 17(8):449-455.

Batchelor, J., Shores, E., Maroosszeky, J., Sandanam, J., & Lovarini, M. (1988). Cognitive rehabilitation of severely head-injured patients using computer-assisted and noncomputerized treatment techniques. *Journal of Head Trauma Rehabilitation*, 3:78-83.

Benedict, R.H., & Wechsler, F.S. (1992). Evaluation of memory retraining in patients with traumatic brain injury: Two single-case experimental designs. *Journal of Head Trauma Rehabilitation*, 7(4): 83-92.

Benedict, R., Brandt, J., & Bergey, G. (1993). An attempt at memory retraining in severe amnesia: an experimental single-case study. *Neuropsychological Rehabilitation*, 3:37-51.

Ben Yishay, Y., Silver, S. M., Piasetsky, E., & Rattok, J. (1987). Relationship between employability and vocational outcome after intensive holistic cognitive rehabilitation. *Journal of Head Trauma Rehabilitation,* 2(1), 35-48.

Bergman, M. M. (1991). The necessity of a clinical perspective in the design of computer prostheses. *Journal of Head Trauma Rehabilitation,* 6(2), 100-104.

Berg Ina, J., Koning, H.M., & Deelman, B.G. (1991). Long-term effects of memory rehabilitation: A controlled study. *Neuropsychological Rehabilitation*, 1(2):97-111.

Boring, R.H. (1988). *Group format memory retraining: A program designed for an empirical evaluation of the effectiveness of memory retraining.* Paper presented at the seventh annual conference of the National Head-Injury Foundation, Atlanta, GA.

Bradley, V.A., Welch, J.L., Skilbeck, C.E. (1993). *Cognitive retraining using microcomputers*. Hove (UK): L. Erlbaum Associates

Bracy, O. L. (1995). Soft tools '95. Fast addition. *Journal of Cognitive Rehabilitation,* 13(6), 26.

Bracy, O. L. (1995). Soft tools '95. Trail trace 3D. *Journal of Cognitive Rehabilitation,* 13(4), 26.

Bracy, O. L. (1996). Soft tools '96...Digit/symbol transfer. *Journal of Cognitive Rehabilitation,* 14(3), 26-27.

Bracy, O. L. (1996). Soft tools '96...Shapes in a row. *Journal of Cognitive Rehabilitation,* 14(5), 26-27.

Bracy, O. L. (1996). Soft tools '96. Spell it. *Journal of Cognitive Rehabilitation,* 14(1), 26-27.

Bracy, O. L. (1995). Soft tools...Color match 3D. *Journal of Cognitive Rehabilitation,* 13(5), 26.

Bracy, O. L. (1994). 3D Tic-Tac-Toe...3D extension of the old game. *Journal of Cognitive Rehabilitation,* 12(6), 26.

Bracy, O. L. (1991). Soft tools...Flasher. *Cognitive Rehabilitation,* 9(4), 38-41.

Burke, W.H., Zencius, A.H., Wesolowski, M.D., & Doubleday, F. (1991). Improving executive function disorders in brain-injured clients. *Brain Injury*, 5(3), 241-252.

Burke, J.M., Danick, J.A., Bemis, B., & Durgin, C.J. (1994). A process approach to memory book training for neurological patients. *Brain Injury*, 8(1), 71-81.

Cancelliere, A.E., Moncuda, C., & Reid, D.T. (1991). Memory *training to support educational reintegration. Archives* of Physical Medicine and Rehabilitation, 72, 148-151.

Chen, S. H., Thomas, J. D., Glueckauf, R. L., & Bracy, O. L. (1997). The effectiveness of computer-assisted cognitive rehabilitation for persons with traumatic brain injury. *Brain Injury,* 11(3), 197-209.

Cotman, A., & Sandman, C. (1997). Cognitive deficits and their remediation in the homeless. *Journal of Cognitive Rehabilitation,* 15(1), 16-23.

Cowley, B. J., Green, G., & Braunling-McMorrow, D. (1992). Using stimulus equivalence procedures to teach name-face matching to adults with brain injuries. *Journal of Applied Behavior Analysis,* 25(2), 461-475.

Cowley, B.J., Green, G., & Braunling-McMorrow, D. (1992). *Journal of Applied Behavior Analyst*, 25(2), 461-75.

Crosson, B., & Buenning, W. (1984). An individualized memory retraining program after closed head injury: a single case study. *Journal of Clinical Neuropsychology*, 6, 287-301.

Daniel, M., Webster, J.S., & Scott, R.R. (1986). Single-case analysis of the brain-injured patient. *The Behavior Therapist*, 4, 71-75.

Dirette, D.K., Hinojosa, J., & Carnevale, G.J. (1999). Comparison of remedial and compensatory interventions for adults with acquired brain injuries. *Journal of Head Trauma Rehabilitation*, 14(6), 595-601.

Evans, J.J., Wilson, B.A. (1996). A memory group for individuals with brain injury. *Clinical Rehabilitation*, 6:75-81.

Finset, A., Krogstad, J.M., Hansen, H., Berstad, J., Haarberg, D., Kristansen, G., Saether, K., & Wang, M.D. (1995). Team development and memory training in traumatic brain injury rehabilitation: Two birds with one stone. *Brain Injury*, 9(5): 495-507.

Fluharty, G., Sellon, C., & Glassman, N. (1994). Optimizing outcome through therapy and advocacy: a case study. *Brain Injury*, 8(8): 729-734.

Freeman, M.R., Mittenberg, W., Dicowden, M., & Bat-Ami, M. (1992). Executive and compensatory memory retraining in traumatic brain injury. *Brain Injury*, 6(1):65-70.

Furst, C. (1994). The memory derby: evaluating and remediating intention memory. *Cognitive Rehabilitation*, May/June:24-26.

Fussey, K., & Tyerman, A.D. (1985). An exploration of memory retraining in rehabilitation following closed head-injury. *International Journal of Rehabilitation Research*, 8, 465-467.

Glisky, E.L., Schacter, D.L., Tulving, E. (1986a). Computer learning by memory-impaired patients: Acquisition and retention of complex of knowledge. *Neuropsychologia*, 24, 313-328.

Glisky, E.L., Schacter, D.L., & Tulving, E. (1986b). Learning and retention of computer-related vocabulary in memory-impaired patients: Method of vanishing cues. *Journal of Clinical and Experimental Neuropsychology*, 8, 292-312.

Godfrey, H.P., & Knight, R.G. (1988). Memory training and behavioral rehabilitation of a severely head-injured adult. *Archives of Physical Medicine and Rehabilitation*, 69(6):458-60.

Goldstein, G., McCue, M., & Turner, S.M. (1988). An efficacy study of memory training for patients with closed head injury. *Clinical Neuropsychology*, 6:287-301.

Goldstein, G., Beers, S.R., Longmore, S., & McCue, M. (1996). Efficacy of memory training: a technological extension and replication. *Clinical Neuropsychology*, 10:66-72.

Goldstein, F.C., Levin, H.S., Boake, C., & Lohrey, J.H. (1990). Facilitation of memory performance through induced semantic processing in survivors of severe closed-head injury. *Journal of Clinical Experimental Neuropsychology*, 12(2): 286-300.

Hux, K., Reid, R., & Lugert, M. (1994). Self-instruction training following neurological injury. *Applied Cognitive Psychology*, 8:259-271.

Johnson, P., Thomas, N., & Shein, F. (1994). Modifying memory function: Use of a computer to train mnemonic skills. *British Journal of Clinical Psychology*, 29(4):437-438.

Kerner, M.J., & Acker, M. (1985). Computer delivery of memory retraining with head injured patients. *Cognitive Rehabilitation*, November/December: 26-31.

Kime, S.K., Lamb, D.G., & Wilson, B.A. (1997). Use of a comprehensive programme of external cueing to enhance procedural memory in a patient with dense amnesia. *Brain Injury*, 10(1):17-25.

Kirsch, N.L., Levin, S.P., Fallon-Krueger, M., & Jaros, L.A. (1987). The microcomputer as an "orthotic" device for patients with cognitive deficits. *Journal of Head Trauma Rehabilitation*, 2(4):77-86.

Kirsch, N.L., Levin, S.P., Lajiness-O'Neil, R., & Schnyder, M. (1992). Computer-assisted interactive task guidance: facilitating the performance of a simulated vocational task. *Journal of Head Trauma Rehabilitation*, 7(3):13-25.

Laatsch, L. (1983). Development of a memory training program. *Cognitive Rehabilitation*, 1:15-18.

Lawson, M.J., & Rice, D.N. (1989). Effects of training in use of executive strategies on a verbal memory problem resulting from closed head injury. *Journal of Clinical and Experimental Neuropsychology*, 11:842-854.

Levinson, R. (1997). Tests, measurement, and technology. The Planning and Execution Assistant and Trainer (PEAT)...hand-held electronic calendar and address book that features automatic cueing to start and stop daily activities. *Journal of Head Trauma Rehabilitation,* 12(2), 85-91.

Lynch, W. (1986). Computer-assisted memory assessment and rehabilitation. *Journal of Head Trauma Rehabilitation*, 1(3):78-80

Malcolm, C. (1997). Memory strategies for successful adults. *Journal of Cognitive Rehabilitation*, 15(2):6-7.

Malec, F.A., Goldstein, G., & McCue, M. (1991). Predictors of memory training success in patients with closed head injury. *Neuropsychology*, 5:29-34.

Malec, J., & Questad, K. (1983). Rehabilitation of memory after crainocerebral trauma: Case report. *Archives of Physical and Medical Rehabilitation*, 64, 436-438.

Malloy, M., Rand, B., & Brown, W. (1984). Memory retraining: a study of four cases. *Journal of Occupational Therapy*, 31:20-26.

McClure, J., Browning, T., Vantrease, C., & Barker, M. (1997). The iconic memory skills of brain injury survivors before and after iconic memory skills training. *Journal of Cognitive Rehabilitation*, 15(3):20-23.

McGuire, B.E., & Greenwood, R.J. (1990). Effects of an intervention aimed at memory on perceived burden and self-esteem after traumatic head injury. *Clinical Rehabilitation*, 4(4):319-323.

Milders, M.V., Berg, I.J., & Deelman, B.G. (1995). Four-year follow-up of a controlled memory training study in closed head injured patients. *Neuropsychological Rehabilitation*, 5(3):223-238.

Milders, M., Deelman, B., & Berg, I. (1998). Rehabilitation of memory for people's names. *Memory*, 6:21-36.

Parente, R. (1994). Effect of monetary incentives on performance after traumatic brain injury. *Neuropsychological Rehabilitation*, 4(3): 198-203.

Patyk, M., Gaynor, S., Kelly, J., & Ott, V. (1998). Touch-screen computerized education for patients with brain injuries. *Rehabilitation Nursing,* 23(2), 84-87.

Prigatano, G.P., Amin, K., & Jaramillo, K. (1993). Memory performance and use of a compensation after traumatic brain injury. *Neuropsychological Rehabilitation*, 3(1):53-62.

Purdy, M., & Neri, L. (1989). Computer-assisted cognitive rehabilitation in the home.

Cognitive Rehabilitation, 7(6), 34-38.

Raskin, S.A., Bewick, K.C., Malia, K.B., & Bennett, T.L. (1996). The efficacy of prospective memory training in two adults with brain injury. *Journal of Head Trauma Rehabilitation*, 11(3):32-51.

Raskin, S.A., & Sohlberg, M.M. (1996). The efficacy of prospective memory training in two adults with brain injury. *Journal of Head Trauma Rehabilitation*, 11:32-51.

Raymond, M. J., Bewick, K. C., Malia, K. B., & Bennett, T. L. (1996). A comprehensive approach to memory rehabilitation following brain injury. *Journal of Cognitive Rehabilitation,* 14(6), 18-23.

Richardson, J.T. (1995). The efficacy of imagery mnemonics in memory remediation. *Neuropsychologia*, 33(11):1345-1357.

Ryan, R.M., Mahaffey, R., Engle, J., Farrow, C., Cox, D., & Karzmark, P. (1994). Efficacy study of THINKable in attention and memory training of traumatically head-injured patients. *Brain Injury*, 8: 3-14.

Ryan, T.V., & Ruff, R.M. (1988). The efficacy of structured memory retraining in a group comparison of head trauma patients. *Archives of Clinical Neuropsychology*, 3:165-179.

Schacter, D.L., Rich, S.A., & Stampp, M.S. (1985). Remediation of memory disorders: experimental evaluation of the spaced retrieval technique. *Journal of Clinical and Experimental Neuropsychology*, 7:79-96.

Scherzer, B.P. (1986). Rehabilitation following severe head trauma: results of a three-year program. *Archives of Physical Medicine and Rehabilitation*, 67:366-374.

Schmitter-Edgecombe, M., Fahy, J.F., Whelan, J.P., & Long, C.J. (1995). Memory remediation after severe closed head injury: Notebook training versus supportive therapy. *Journal of Consulting and Clinical Psychology*, 63(3):484-489.

Sohlberg, M.M., & Mateer, C.A. (1989). Training use of compensatory memory books: A three stage behavioral approach. *Journal of Clinical Experimental Neuropsychology*, 11(6):871-891.

Sohlberg, M.M., White, O., Evans, E., & Mateer, C. (1992). Background and initial case studies into the effects of prospective memory training. *Brain Injury*, 6(2): 129-138.

Sohlberg, M.M., White, O., Evans, E., & Mateer, C. (1992a). An investigation of the effects of prospective memory training. *Brain Injury*, 6(2):139-154.

Sohlberg, M. M., White, O., Evans, E., & Mateer, C. (1992b). An investigation of the effects of prospective memory training. *Brain Injury,* 6(2), 107-108.

Squires, E.J., Hunkin, N.M., Parking, A.J. (1996). Memory notebook training in a case of severe amnesia: generalizing from paired associate learning to real life. *Neuropsychological Rehabilitation*, 6:55-65.

Thoene, A.I., & Glisky, E.L. (1995). Learning of name-face associations in memory impaired patients: a comparison of different training procedures. *Journal International Neuropsychology and Sociology*, 1:29-38.

Whyte, J. (1986). Outcome evaluation in the remediation of attention and memory deficits. *Journal of Head Trauma Rehabilitation*, 1(3):64-71.

Wilson, B. (1992). Recovery and compensatory strategies in head injured memory impaired people several years after insult. *Journal of Neurosurgery and Psychiatry*, 55(3):177-180.

Wilson, B.A., Baddeley, A., Evans, J., & Shiel, A. (1994). Errorless learning in the rehabilitation of memory impaired people. *Neuropsychological Rehabilitation*, 4(3):307-326.

Wilson, B.A., & Evans, J.J. ((1996). Error-free learning in the rehabilitation of people with memory impairments. *Journal of Head Trauma Rehabilitation*, 11(2): 54-64.

Wilson, B.A., Evans, J.J., Emslic, H., & Malinek, V. (1997). Neurology, *Neurosurgery & Psychiatry*, 63:113-115.

Zencius, A., Wesolowski, M.D., & Burke, W.H. (1990). A comparison of four memory strategies with traumatically brain-injured clients. *Brain Injury*, 4(1):33-38.

Zhou, J., Chittum, R., Johnson, K., Poppen, R., Guercio, J., & McMorrow, M.J. (1996). The utilization of a game format to increase knowledge of residuals among people with acquired brain injury. *Journal of Head Trauma Rehabilitation*, 11(1):51-61.

APPENDIX D

LIST OF 67 STUDIES USED IN THE DATA ANALYSIS AND SYNTHESIS OF COGNITIVE REHABILITATION OF ATTENTION DEFICITS IN INDIVIDUALS WITH TBI

Baribeau, J., Ethier, M., & Braun, C. !1989). A neuropsychological assessment of selective attention before and after cognitive remediation in patients with severe closed head injury. *Journal of Neurological Rehabilitation*, 3:71-92.

Ben-Yishay, Y., Piasetsky, E.B., & Rattock, J. (1987). A systematic method for ameliorating disorders in basic attention. In J.M. Meier, A.L. Benton, & L. Diller (Eds.), *Neuropsychological Rehabilitation* (pp. 165-181). New York: Guilford Press.

Bracy, O. L. (1995). Road Trip [sic]...software...the enclosed diskette...requires one to read a map. *Journal of Cognitive Rehabilitation,* 13(1), 26.

Bracy, O. L. (1995). What's the Word?...software...enclosed diskette. *Journal of Cognitive Rehabilitation,* 13(2), 26.

Bracy, O. L. (1994). Cognitive functioning and rehabilitation. *Journal of Head Trauma Rehabilitation,* 12(2), 12-16.

Bracy, O. L. (1992). Soft tools: 0's and 1's. *Journal of Cognitive Rehabilitation,* 10(6), 48-59.

Bracy, O. L. (1992). The card shark game. *Journal of Cognitive Rehabilitation,* 10(4), 51-59.

Bracy, O. L. (1991). Soft tools...P's & Q's. *Cognitive Rehabilitation,* 9(5), 42-53.

Bracy, O. L. (1991). Soft tools...Paced cancellation task PCT...simultaneous multiple attention SMA. *Cognitive Rehabilitation,* 9(6), 35-41.

Bracey, O. (1983). Computer based cognitive rehabilitation. *Cognitive Rehabilitation*, 1:7-18.

Bracey, O. (1982). *A home-based cognitive rehabilitation program.* An unpublished manuscript available from Psychological Software Services, Indianapolis, IN.

Ethier, M., Baribeau, J.M., & Braun, C.M. (1989). Computer-dispensed cognitive-perceptual training of closed head injury patients after spontaneous recovery. *Canadian Journal of Rehabilitation*, 3:7-16.

Ethier, M., Braun, C.M., & Baribeau, J.M. (1989). Computer-dispensed cognitive-perceptual training of closed head injury patients after spontaneous recovery. Study 1: speeded tasks. *Canadian Journal of Rehabilitation*, 2:223-233.

Finlayson, M.A., Alfano, D.P., & Sullivan, J.F. (1987). A neuropsychological approach to cognitive remediation: microcomputer applications. *Canadian Psychology*, 28:180-190.

Gansler, D.A., & McCaffrey, R.J. (1991). Remediation of chronic attention deficits in traumatic brain-injured patients. *Archives of Clinical Neuropsychology*, 6:335-353.

Gauggel, S., & Niemann, T. (1996). Evaluation of a short-term computer-assisted training programme for the remediation of attentional deficits after brain injury: a preliminary study. International Journal of Rehabilitation Research, 19(3):229-239.

Gray, J.M., Robertson, I., Pentland, B., & Anderson, S. (1992). Microcomputer-based attentional retraining after brain damage: a randomized group controlled trial. *Neuropsychological Rehabilitation*, 2:97-115.

Gray, J.M., & Robertson, I. (1989). Remediation of attentional difficulties following brain injury: three experimental single case studies. *Brain Injury*, 3:163-170.

Jarvis, P.E., & Jarvis, C.P. (1990). A tool to assist in the serial testing of attention as a means of monitoring the effectiveness of rehabilitation. *Cognitive Rehabilitation*, 9(4):20-23.

Kirsch, N. L., Levine, S. P., Fallon Krueger, M., & Jaros, L. A. (1987). Focus on clinical research: The microcomputer as an "orthotic" device for patients with cognitive deficits. *Journal of Head Trauma Rehabilitation*, 2(4), 77-86.

Kirsch, N. L., Levine, S. P., Lajiness O'Neill, R., & Schnyder, M. (1992). Computer assisted interactive task guidance: Facilitating the performance of a simulated vocational task. *Journal of Head Trauma Rehabilitation*, 7(3), 13-25.

Lundgren, C. C., & Persechinom, E. L. (1986). Cognitive group: A treatment program for head-injured adults. *American Journal of Occupational Therapy*, 40(6), 397-401.

Malec, J., Jones, R., Rao, N., & Stubbs, K. (1984). Video game practice effects on sustained attention in patients with craniocerebral trauma. *Cognitive Rehabilitation*, 2:18-23.

McAllister, S., Rundell, J., Parker, S., Ferguson, D., Miller, D., Lowman, V., et al. (1990). Head injury re-entry program at Miami Valley Hospital. *Cognitive Rehabilitation*, 8(1), 6-12.

McGuire, B. E., & Greenwood, R. J. (1990). Effects of an intervention aimed at memory on perceived burden and self-esteem after traumatic head injury. *Clinical Rehabilitation,* 4(4), 319-323.

Meghji, C., Lonneberg, E., Bridgman, E., Malcolm, C., & Brown Hall, B. (1995). Practice makes perfect: An interdisciplinary community living skills group for persons with brain injury. *Journal of Cognitive Rehabilitation,* 13(6), 4-14.

Niemann, H., Ruff, R.M., & Baser, C.A. (1990). Computer assisted attention retraining in head injured individuals: a controlled efficacy study of an out-patient program. *Journal of Consulting & Clinical Psychology*, 58:811-817.

Novack, T.A., Caldwell, S.G., Duke, L.W., Bergquist, T.F., & Gage, R.J. (1996). Focused versus unstructured intervention for attention deficits after traumatic brain injury. *Journal of Head Trauma Rehabilitation*, 11(3):52-60.

Ponsford, J.L., & Kinsella, G. (1988). Evaluation of a remedial programme for attentional deficits following closed head injury. *Journal of Clinical Experimental Neuropsychology*, 10(6):693-708.

Purdy, M., & Neri, L. (1989). Computer-assisted cognitive rehabilitation in the home. *Cognitive Rehabilitation*, 7(6):34—38.

Ruff, R.M., baser, C.A., & Johnson, J.W. (1989). Neuropsychological rehabilitation: an experiemental study with head injured patients. *Journal of Head trauma Rehabilitation*, 4(3):20-36.

Rugg, M.D., Pickles, C.D., Potter, D.D., Doyle, M.C., Pentland, B., & Roberts, R.C. (1993). Cognitive brain potentials in a three-stimulus auditory "oddball" task after closed head injury. *Neuropsychologia*, 31:373-393.

Schwentor, D. (1993). Using video-based training with individuals with traumatic brain injury. *Journal of Cognitive Rehabilitation*, 11(3):26-30.

Shum, D.H., McFarland, K.A., & Bain, J.D. (1990). Construct validity of eight tests of attention: comparison of normal and closed head injured subjects. *Clinical Neuropsychology*, 4:151-162.

Sivak, M., Hill, C.S., & Olsen, P.L. (1984). Computerized video tasks as training techniques for driving-related perceptual deficits of persons with brain damage: a pilot evaluation. *International Journal of Rehabilitation Research*, 7:389-398.

Sohlberg, M.M., & Mateer, C.A. (1987). Effectiveness of an attentional training program. *Journal of Clinical and Experimental Neuropsychology*, 9:117-130.

Stanwood, J.K. (1986). *An evaluation of video performance tasks in the cognitive retraining of adults with closed head injuries*. Unpublished doctoral dissertation, Arizona State University, Temple, AZ.

Strache, W. (1987). Effectiveness of two modes of training to overcome deficits of concentration. *International Journal of Rehabilitation Research*, 10 Supplement 5:141S-151S.

Sturm, W., Wilmes, K., & Orgass, B. (1997). Do specific attention deficits need specific training? *Neuropsychological Rehabilitation*, 7:81-103.

Sturm, W., Hartje, W., Orgass, B., & Willmess, K. (1993). Computer assisted rehabilitation of attention impairments. In Stachowiak, F., ed. *Developments in the Assessment and Rehabilitation of Brain-damaged Patients*. Tubingen, Germany: Narr.

Stuss, D.T., Stethem, L.L., Hugeholtz, H., Picton, T., Pivik, J., & Richard, M.T. (1989). Reaction time after head injury: fatigue, divided and focused attention, and consistency of performance. *Journal of Neurology, Neurosurgery, and Psychiatry*, 52:742-748.

Weber, A.M. (1990). A practical clinical approach to understanding and treating attentional problems. Journal of Head Trauma Rehabilitation, 5(1):73-85.

Webster, J.S., & Scott, R.R. (1983). The effects of self-instructional training on attentional deficits following head injury. *Clinical Neuropsychology*, 5:69-74.

Wilson, B., & Robertson, I.H. (1992). A home base intervention for attentional slips during reading following head injury. a single case study. *Neuropsychological Rehabilitation*, 2:193-205.

Wood, R.L., & Fussey, I. (1987). Computer-assisted cognitive retraining: a controlled study. *International Disability Studies*, 9:149-153.

Wood, R.L. (1986). Rehabilitation of patients with disorders of attention. *Journal of Head Trauma Rehabilitation*, 1:43-53.

APPENDIX E

LIST OF 30 STUDIES USED IN THE DATA ANALYSIS AND SYNTHESIS OF COGNITIVE REHABILITATION OF SOCIO-BEHAVIORAL DEFICITS IN INDIVIDUALS WITH TBI

Alderman, N., & Knight, C. (1997). The effectiveness of DRL in the management and treatment of severe behavior disorders following brain injury. *Brain Injury,* 11(2), 79-101.

Ansell, B. J. (1993). Slow-to-recover patients: Improvement to rehabilitation readiness. *Journal of Head Trauma Rehabilitation,* 8(3), 88-98.

Chittum, W. R., Johnson, K., Chittum, J. M., Guerico, J. M., & McMorrow, M. J. (1996). Road to awareness: An individualized training package for increasing knowledge and compensation of personal deficits in persons with acquired brain injury. *Brain Injury,* 10(10),763-776.

Crosson, B., Barco, P.P., Velozo, C.A., Bolesta, M.M., Cooper, P.V., Werts, D., & Brobeck, T.C. (1989). Awareness and compensation in postacute head injury rehabilitation. *Journal of Head Trauma Rehabilitation*, 16(5):611-627.

DiCesare, A., Parente, R., & Anderson Parente J. (1990). Personality change after traumatic brain injury: Problems and solutions. *Cognitive Rehabilitation,* 8(2), 14-18.

Dikmen, S. S., Ross, B. L., Machamer, J. E., & Temkin, N. R. (1995). One year psychosocial outcome in head injury. *Journal of International Neuropsychology and Sociology,* 1(1), 67-77.

Dikmen, S., Machamer, J., & Temkin, N. (1993). Psychosocial outcome in patients with moderate to severe head injury: 2-year follow-up. *Brain Injury,* 7(2), 113-124.

Fryer, L. J., & Haffey, W. J. (1987). Cognitive rehabilitation and community readaptation: Outcomes from two program models. *Journal of Head Trauma Rehabilitation,* 2(3), 51-63.

Garner, R. L. (1996). The NAT model: Factors in neuropsychological art therapy. *American Journal of Art Therapy,* 34(4), 107-111.

Hart, T., & Jacobs, H.E. (1993). Rehabilitation and management of behavioral disturbances following frontal lobe injury. *Journal of Head Trauma Rehabilitation*, 8(1):1-12.

Hinkeldey, N.S., & Corrigan, J.D. (1990). The structure of head-injured patients' neurobehavioral complaints: a preliminary study. *Brain Injury*, 4:115-133.

Klonoff, P.S., O'Brien, K.P., Prigatano, G.P., Chiapello, D.A. (1989). Cognitive retraining after traumatic brain injury and its role in facilitating awareness. *Journal of Head Trauma Rehabilitation*, 4(3):37-45.

Laatsch, L., Jobe, T., Sychra, J., Lin, Q., & Blend, M. (1997). Impact of cognitive rehabilitation therapy on neuropsychological impairments as measured by brain perfusion SPECT: a longitudinal study. *Brain Injury*, 11(12):851-863.

Levine, B., Dawson, D., Boutet, I., Schwartz, M., & Stuss, D. (2000). Assessment of strategic self-regulation in traumatic brain injury: its relationship to injury severity and psychosocial outcomes. Neuropsychology, 14(4):491-500.

McAllister, S., Rundell, J., Parker, S., Ferguson, D., Miller, D., Lowman, V., (1990). Head injury re-entry program at Miami Valley Hospital. *Cognitive Rehabilitation,* 8(1), 6-12.

Miller, L. (1989). Neuropsychology, personality, and substance abuse: Implications for head injury rehabilitation. *Cognitive Rehabilitation*, 7(5):26-31.

Miller, L. (1990). Major syndromes of aggressive behavior following head injury. *Cognitive Rehabilitation*, 8(6):406-414.

Ruff, R. M., & Niemann, H. (1990). Cognitive rehabilitation versus day treatment in head-injured adults: Is there an impact on emotional and psychosocial adjustment? *Brain Injury,* 4(4), 339-347.

Sachs, P. R., Bell, E., Berger, M., & Carroll R. C. (1986). A six-factor model for treatment planning and cognitive retraining of the traumatically head –injured adult. *Cognitive Rehabilitation,* 4(1), 26-30.

Schwartz, S.M. (1995). Adults with traumatic brain injury: three case studies of cognitive rehabilitation in the home setting. *American Journal of Occupational Therapy*, 49(7):655-667.

Sherer, M., Oden, K., Bergloff, P., Levin, E., & High, W. M., Jr. (1998). Assessment and treatment of impaired awareness after brain injury: Implications for community re-integration. *Neurorehabilitation,* 10(1), 25-37.

Simpson, G., Tate, R., Ferry, K., Hodgkinson, A., & Blaszczynski, A. (2001). Social, neuroradiologic, medical, and neuropsychologic correlates of sexually aberrant behavior after traumatic brain injury: a controlled study. *Journal of Head Trauma Rehabilitation*, 16(6):556-572.

Slade, C., & Burns, R. (1992). Cognitive rehabilitation at a retail work site. *Journal of Cognitive Rehabilitation,* 10(3), 10-13.

Sohlberg, M.M., Mateer, C.A., Stuss, D.T. (1993). Contemporary approaches to the management of executive control dysfunction. *Journal of Head Trauma Rehabilitation*, 18:45-56.

Turkstra, L., & Flora, T. (2002). Compensating for executive function impairments after TBI: a single case study of functional intervention. *Journal of Communication Disorders*, 35:467-482.

Youngson, H.A., & Alderman, N. (1994). Fear of incontinence and its effects on a community-based rehabilitation programme after severe brain injury: successful remediation of escape behavior using behavior modification. *Brain Injury*, 4(1):33-38.

Zencius, A., Wesolowski, M. D., Burke, W. H., & Hough, S. (1990). Managing hypersexual disorders in brain-injured clients. *Brain Injury,* 4(2), 175-181.

Zencius, A. H., Lane, I., & Wesolowski, M. D. (1991). Assessing and treating non-compliance in brain-injured clients. *Brain Injury,* 5(4), 369-374.

APPENDIX F

LIST OF STUDIES REVIEWED BUT WERE NOT USED IN THE DATA ANALYSIS AND SYNTHESIS

Abrams, D., Barker, L. T., Haffey, W., & Nelson, H. (1993). The economics of return to work for survivors of traumatic brain injury: Vocational services are worth the investment. *Journal of Head Trauma Rehabilitation,* 8(4), 59-76.

Ackerman, R. J., & Banks, M. E. (1990). Computers and ethical treatment for brain-injured patients. *Social Science Computer Review,* 8(1), 83-95.

Adamovich, B. B., Henderson, J. A., & Auerbach, S. (1991). *Cognitive rehabilitation of closed head injured patients: A dynamic approach.* Austin, TX: PRO-ED.

Alderman, N. (1996). Central executive deficit and response to operant conditioning methods. *Neuropsychological Rehabilitation,* 6(3), 161-186.

Allman, P. (1992). Drug treatment of emotionalism following brain damage. *Journal of Rehabilitation and Social Medicine,* 85(7), 423-424.

Andrews, T. K., Rose, F.D., & Johnson, D. A. (1998). Social and behavioural effects of traumatic brain injury in children. *Brain Injury*, 12(2),133-138.

Arokiasamy, C. V., & Millington, M. J. (1994). The many stakeholders in return to work. *Neurorehabilitation,* 4(1), 45-52.

Ashley, M. J. (1995). *Traumatic brain injury rehabilitation.* Boca Raton, FL: CRC Press.

Ashley, M. J., & Krych, D. K. Cognitive disorders: Diagnosis and treatment in the TBI patient. In M. J. Ashley & D. K. Krych (Eds.), *Traumatic brain injury rehabilitation* (pp. 289-318). Boca Raton, FL: CRC Press.

Ashley, M. J., Krych, D. K., & Lehr, R. P. (1992). Cost/benefit analysis for post-acute rehabilitation of traumatically brain-injured patient. *Journal of Insurance Medicine,* 24, 186-192.

Ashley, M. J., Persel, C. S., Clark, M. C., & Krych, D. K. (1997). Long-term follow-up of post-acute traumatic brain injury rehabilitation: A statistical analysis to test for stability and predictability of outcome. *Brain Injury,* 11(9), 677-690.

Asikainen, I., Kaste, M., & Sarna, S. (1996). Patients with traumatic brain injury referred to a rehabilitation and re-employment programme: Social and professional outcome for 508 Finnish patients 5 or more years after injury. *Brain Injury,*

10(12), 883-899.

Auerbach, V., & Jann, B. (1991). Ethicolegal issues in pharmacotherapy for neurorehabilitation. *Neurorehabilitation,* 1(1), 58-63.

Barry, P., & O'Leary, J. (1989). Roles of the psychologist on a traumatic brain injury rehabilitation team. [Special issue]. Traumatic brain injury rehabilitation. *Rehabilitation Psychology,* 34(2), 83-90.

Bell, K. R., & Cardenas, D. C. (1995). New frontiers of neuropharmacologic treatment of brain injury agitation. *Neurorehabilitation,* 5(3), 233-244.

Bellus, S. B., Stewart, D., Vergo, J. G., Kost, P. P., Grace, J., & Barkstrom, S. R. (1996). The use of lithium in the treatment of aggressive behaviors with two-brain-injured individuals in a state psychiatric hospital. *Brain Injury,* 10(11), 849-860.

Ben-Yishay, Y, & Diller, L. (1993). Cognitive remediation in traumatic brain injury: Update and issues. *Archives of Physical Medical Rehabilitation,* 74(2), 204-213.

Bergquist, T. F., Boll, T. J., Corrigan, J. D., Harley, J. P., Malec, j. F., & Millis, S. R., et al. (1994). Neuropsychological rehabilitation: Proceedings of a consensus conference. *Journal of Head Trauma Rehabilitation,* 9(4), 50-61.

Bergquist, T. F., & Malec, J. F. (1997). Psychology: Current practice and training issues in the treatment of cognitive dysfunction. *Neurorehabilitation,* 8(1), 49-56.

Berrol, C. (1990). Dance/movement therapy in head injury rehabilitation. *Brain Injury,* 4(3), 257-265.

Bewick, K. C., Raymond, M. J., Malia, K. B., & Bennett, T. L. (1995). Metacognition as the ultimate executive function: Techniques and tasks to facilitate executive function. *Neurorehabilitation,* 5(4), 367-375.

Blackerby, F. A. (1990). A treatment model for sexuality disturbance following brain injury. *Journal of Head Trauma Rehabilitation,* 5(2), 73-82.

Blosser, J., & Pearson, S. (1997). Transition coordination for students with brain injury: A challenge schools can meet. *Journal of Head Trauma Rehabilitation,* 12(2), 21-31.

Boake, C. (1989). A history of cognitive rehabilitation of head-injured patients, 1915-1980. *Journal of Head Trauma Rehabilitation,* 4(3), 1-8.

Bogner, J. A., Corrigan, J. D., Spafford, D. E, & Lamb-Hart, G. L. (1997). Integrating substance abuse treatment and vocational rehabilitation after traumatic brain injury. *Journal of Head Trauma Rehabilitation,* 12(5), 57-71.

Bornstein, R. A., Miller, H. B., & Van Schoor, T. (1988). Emotional adjustment in compensated head injury patients. *Neurosurgery,* 23(5), 622-627.

Bracy, O. L. (1994). To do therapy or not do therapy – That is part of the question. *Journal of Cognitive Rehabilitation,* 12(4), 2-3.

Bracy, O. L. (1995). From the editor...free Soft Tools diskette with each issue. *Journal of Cognitive Rehabilitation,* 13 (1), 2.

Bracy, O. L. (1992). Soft tools. *Journal of Cognitive Rehabilitation,* 10(5), 49-59.

Buffington, A. L., & Malec, J. F. (1997). The vocational rehabilitation continuum: Maximizing outcomes through bridging the gap from hospital to community-based services. *Journal of Head Trauma Rehabilitation,* 12(5), 10-13.

Burke, W. H., Wesolowski, M. D., & Guth, M. L. (1988). Comprehensive head injury rehabilitation: An outcome evaluation. *Brain Injury,* 2(4), 313-322.

Carlson, H. B., & Buckwald, M. B. (1993). Vocational communication group treatment in an outpatient head injury facility. *Brain Injury,* 7(2), 183-187.

Chapman, S. B., Levin, H. S., Matejka, J., Harward, H., & Kufera, J. A. (1995). Discourse ability in children with brain injury: Correlations with psychosocial, linguistic, and cognitive factors. *Journal of Head Trauma Rehabilitation,* 10(5), 36-54.

Christensen, A. L. (1992). Outpatient management and outcome in relation to work in traumatic brain injury patients. *Scandinavian Journal of Rehabilitation of Medical Supplement,* 26, 34-42.

Christensen, A. L., & Uzzell, B. P. (1994). *Brain injury and neuropsychological rehabilitation: International perspectives.* Hillsdale, NJ: Lawrence Erhlbaum Associates.

Cicerone, K. D. (1997). Cognitive rehabilitation: Learning from experience and planning ahead. *Neurorehabilitation,* 8(1), 13-19.

Cifu, D. X., Keyser-Marcus, L., Lopez, E., Wehman, P., Kreutzer, J. S., Englander, J. et al. (1997). Acute predictors of successful return to work 1 year after traumatic brain injury: A multicenter analysis. *Archives of Physical and Medical Rehabilitation,* 78(2), 125-131.

Coelho, C. A., DeRuyter, F., & Stein, M. (1996). Treatment efficacy: Cognitive-communication disorders resulting from traumatic brain injury in adults. *Journal of Speech and Hearing,* 39(5), 5-17.

Cohen, S. B. (1986). Educational reintegration and programming for children with head injuries. *Journal of Head Trauma Rehabilitation,* 1(4), 22-29.

Conder, R. Evans, D. Faulkner, P., Henley, K. Dreutzer, J. Lent, B., et al. (1988). An interdisciplinary programme for cognitive rehabilitation. *Brain Injury,* 2(4), 365-385.

Conder, R. L. (1989). Recommendations for clinical and research evaluation of vocational re-entry programmes for survivors of traumatic brain injury. *Brain Injury,* 3(1), 1-4.

Corrigan, J. D., Lamb-Hart, G. L., & Rust, E. (1995). A programme of intervention for substance abuse following traumatic brain injury. *Brain Injury,* 9(3), 221-236.

Corthell, D. W. (1993). *Employment outcomes for persons with acquired brain injury.* Washington, DC: National Institute on Disability and Rehabilitation Research.

Crepeau, F., & Scherzer, P. (1993). Predictors and indicators of work status after traumatic brain injury: A meta-analysis. *Neuropsychology and Rehabilitation,* 3(1), 5-35.

Crosson, B., Barco P. P., Velozo, C. A., Bolesta, M. M. Cooper, P. V., Wertz, D., et al. (1989). Awareness and compensation in postacute head injury rehabilitation. *Journal of Head Trauma Rehabilitation,* 4(3), 46-54.

Crowley, J. A., & Miles, M. A. (1991). Cognitive remediation in pediatric head injury: A case study. *Journal of Pediatric Psychology,* 16(5), 611-627.

Curl, R. M., Fraser, R. T., Cook, R. G., & Clemmons, D. (1996). Traumatic brain injury vocational rehabilitation: Preliminary findings for the coworker as trainer project. *Journal of Head Trauma Rehabilitation,* 11(1), 75-85.

Dawson, D. R., & Chipman, M. (1995). The disablement experience by traumatically brain-injured adults living in the community. *Brain Injury,* 9(4), 339-353.

Deaton, A. V., Martelli, M. F., Pickelman, H., West, D. D., & Kreutzer, J. S. (1992). IBM-based cognitive rehabilitation software: Closing the gap. *Journal of Cognitive Rehabilitation,* 10(6), 20-36.

DeMolfetto, J. (1995). From the patient's point of view. Recovery from head injury: A life long process being reborn. *Journal of Cognitive Rehabilitation,* 13(4), 4-5.

Deshpande, S. A., Millis, S. R., Reeder, K. P., Fuerst, D., & Ricker, J. H. (1996). Verbal learning subtypes in traumatic brain injury: A replication. *Journal of Clinical Experimental Neuropsychology,* 18(6), 836-842.

D'Esposito, M. D., & Alexander, M. P. (1995) The clinical profiles, recovery, and rehabilitation of memory disorders. *Neurorehabilitation,* 5(2), 141-159.

Devany, C. W., Kreutzer, J. S., Halberstadt, L. J., & West, D. D. (1991). Referrals for supported employment after brain injury: Neuropsychological, behavioral, and emotional characteristics. *Journal of Head Trauma Rehabilitation,* 6(3), 59-70.

Devany Serio, C., & Devens, M. (1994). Employment problems following traumatic brain injury: Families assess the causes. *Neurorehabilitation,* 4(1), 53-57.

Dikengil, A., King, C., & Monda, D. (1992). Communication functional skills group: An integrated group therapy approach to head injury rehabilitation. *Journal of Cognitive Rehabilitation,* 10(4), 28-31.

Dikengil, A., Lowry, M., & Delgado, P. (1993). An interdisciplinary group treatment for the severely brain-injured patient: Participation by four disciplines. *Journal of Cognitive Rehabilitation,* 11(1), 20-24.

Dikmen, S. S., Temkin, N. R., Machamer, J. E., Holubkov, A. L., Fraser, R. T., & Winn, H. R. (1994). Employment following traumatic head injuries. *Archives of Neurology,* 51(2), 177-186.

Direnfeld, G. (1996). Brain injury: Reweaving the spider's web. *Journal of Cognitive Rehabilitation,* 14(5), 6-7.

Doman, G, Wilkinson, R. Dimancescu, M. D., & Pelligra R. (1993). The effect of intense multi-sensory stimulation on coma arousal and recovery [Special issue]. Coma and the persistent vegetative state. *Neuropsychological Rehabilitation,* 3(2), 203-212.

Dombovy, M. L., & Olek, A. C. (1997) Recovery and rehabilitation following traumatic brain injury. *Brain Injury,* 11(5), 305-318.

Donders, J. (1992). Premorbid behavioral and psychosocial adjustment of children with traumatic brain injury. *Journal of Abnormal Child Psychology,* 20(3), 233-246.

Donders, J., & Ballard, E. (1996). Psychological adjustment characteristics of children before and after moderate to severe traumatic brain injury. *Journal of Head Trauma Rehabilitation,* 11(3), 67-73.

Dougherty, P. M., & Randomski, M. V. (1993). *The cognitive rehabilitation workbook: A dynamic assessment approach for adults with brain injury* (2nd ed.). Gaithersburg, MD: Aspen Publishers.

Dryovage, J., & Seidman, K. (1992). Interdisciplinary approach to community

reintegration. *Journal of Cognitive Rehabilitation,* 10(4), 12-21.

Executive function disorders. (1993). *Journal of Head Trauma Rehabilitation,* 8(1), 1-120.

Ezrachi, O., Ben Yishay, Y., Kay, T., Diller, L., & Rattok, J. (1991). Predicting employment in traumatic brain injury following neuropsychological rehabilitation. *Journal of Head Trauma Rehabilitation,* 6(3), 71-84.

Fines, L., & Nichols, D. (1994). An evaluation of a twelve week recreational kayak program: Effects on self-concept, leisure satisfaction and leisure attitude of adults with traumatic brain injuries. *Journal of Cognitive Rehabilitation,* 12(5), 10-15.

Fluharty, G. (1993). Use of an electronic dictionary to compensate for surface dysgraphia. *Journal of Cognitive Rehabilitation,* 11(1), 28-30.

Fraser, R. T. (1991). Vocational evaluation. *Journal of Head Trauma Rehabilitation,* 6(3), 46-58.

Fraser, R. T., Cook, R., Clemmons, D. C., & Curl, R. H. (1997). Work access in traumatic brain injury rehabilitation: A perspective for the physiatrist and rehabilitation team. *Physical and Medical Rehabilitation Annals of North America,* 8(2), 371-387.

Gianutsos, R. (1991). Cognitive rehabilitation: A neuropsychological specialty comes of age. *Brain Injury,* 5(4), 353-368.

Gianutsos, R. (1992). The computer in cognitive rehabilitation: It's not just a tool anymore. *Journal of Head Trauma Rehabilitation,* 7(3), 26-35.

Gil, M., Cohen, M., Korn, C., & Groswasser, Z. (1996). Vocational outcome of aphasic patients following severe traumatic brain injury. *Brain Injury,* 10(1), 39-45.

Godfrey, H. P., Bishara, S. N., Partridge, F. M., & Knight, R. G. (1993). Neuropsychological impairment and return to work following sever closed head injury: Implications for clinical management. *New Zeeland Medical Journal,* 106(960), 301-303.

Goodall, P., Lawyer, H. L., & Wehman, P. (1994). Vocational rehabilitation and traumatic brain injury: A legislative and public policy perspective. *Journal of Head Trauma Rehabilitation,* 9(2), 61-81.

Goodwin, R. E., & Bolton, D. P. (1991). Decision-making in cognitive rehabilitation: A clinical model. *Cognitive Rehabilitation,* 9(4), 12-19.

Gordon, W. A., Hibbard, M. R., & Kreutzer, J. (1989) Cognitive remediation issues in

research and practice. *Journal of Head Trauma Rehabilitation,* 4(3), 76-84.

Gordon, W. A., Sliwinski, M., Echo, J., McLoughlin, M., Sheerer, M. S., & Meili, T. E. (1998). The benefits of exercise in individuals with traumatic brain injury: A retrospective study. *Journal of Head Trauma Rehabilitation,* 13(4), 58-67.

Groveman, A. M., Brown, E. W., & Miller, M. H. (1985). Moving toward common ground: Utilizing Feurstein's model in cognitive rehabilitation. *Cognitive Rehabilitation,* 3(3), 28-30.

Guiilmette, T. J. (1997). *Pocket guide to brain injury, cognitive, and neurobehavioral rehabilitation.* San Diego, CA: Singular Pub. Group.

Haffey, W. J. (1989). The assessment of clinical competency to consent to medical rehabilitative interventions. *Journal of Head Trauma Rehabilitation,* 4(1), 43-56.

Haffey, W. J., & Abrams, D. L. (1991). Employment outcomes for participants in a brain injury work reentry program: Preliminary findings. *Journal of Head Trauma Rehabilitation,* 6(3), 24-34.

Haffey, W. J., & Lewis, F. D. (1989). Programming for occupational outcomes following traumatic brain injury [Special issue]. Traumatic brain injury rehabilitation. *Rehabilitation Psychology,* 34(2), 147-158.

Hanson, C. S., Shechtman, O. Foss, J. J., & Krauss-Hooker, A. (1997). Occupational therapy: Current practice and training issues in the treatment of cognitive dysfunction. *Neurorehabilitation,* 8(1), 31-41.

Harrell, M. (1992). *Cognitive rehabilitation of memory: A practical guide.* Gaithersburg: MD: Aspen Publishers.

Hartley, L. L. (1995). *Cognitive-communicative abilities following brain injury: A functional approach.* San Diego, CA: Singular Pub. Group.

Heyer, N. J., & Franklin, G. M. (1994). Work related traumatic brain injury in Washington State, 1988 through 1990. *American Journal of Public Health,* 84(7), 1106-1109.

Ho, M. R., & Bennett, T. L. (1997). Efficacy of neuropsychological rehabilitation for mild-moderate traumatic brain injury. *Archives of Clinical Neuropsychology,* 12(1), 1-11.

Hoepfer, M. (1996). Computers help reprogram injured brains. *Physical Medicine,* 99(4), 34-36.

Hogarty, G. E. & Glesher, S. (1992). Cognitive remediation in schizophrenia: Proceed

with caution! *Schizophrenia Bulletin,* 18(1), 51-57.

Huber, L., & Edelberg, B. (1993). A community integration model of head injury rehabilitation. *Journal of Cognitive Rehabilitation,* 11(2), 22-26.

Iacarino, J. (1997). The speech-language pathologist on the cognitive rehabilitation team: Current training and practice issues. *Neurorehabilitation,* 8(1), 43-48.

Ip R. Y., Dornan, J., & Schentag, C. (1995). Traumatic brain injury: Factors predicting return to work or school. *Brain Injury,* 9(5), 517-532.

Jacobs, H. E. (1997). The clubhouse: Addressing work-related behavioral challenges through a supportive social community. *Journal of Head Trauma Rehabilitation,* 12(5), 14-27.

Jarvis, P. E. (1990). The importance of patient friendliness in CACR software and tips for improving it...Computer assisted cognitive rehabilitation. *Cognitive Rehabilitation,* 8(4), 24-28.

Jarvis, P. E., & Jarvis C. P. (1991). A tool to assist in the serial testing of attention as a means of monitoring the effectiveness of rehabilitation. *Cognitive Rehabilitation,* 9(4), 20-23.

Johnson, D. A., Rose, F. D., Rushton, S., Pentland, B., & Attree, E. A. (1998). Virtual reality: A new prosthesis for brain injury rehabilitation. *Scott Medical Journal,* 43(3), 81-83.

Johnson, P., Thomas, S. N. & Shein, F. (1994). Development of a computer-based program for the remediation of cognitive communication skills in young people with head injuries. *Journal of Cognitive Rehabilitation,* 12(4), 10-16.

Johnson, R. (1989). Employment after severe head injury: Do the Manpower Services Commission schemes help? *Brain Injury,* 20(1), 5-9.

Johnson, R. (1998). How do people get back to work after severe head injury? A 10 year follow-up study. *Neuropsychological Rehabilitation,* 8(1), 61-79.

Kay, T. (1993). Neuropsychological treatment of mild traumatic brain injury. *Journal of Head Trauma Rehabilitation,* 8(3), 74-85.

King, T. (1993). Treatment of visual inattention using computerized overhead projection. *Journal of Cognitive Rehabilitation,* 11(2), 32-35.

Kinney, LaPier, T. L., Sirotnak, N., & Alexander, K. (1998). Aerobic exercise for a patient with chronic multisystem impairments. *Physical Therapy,* 78(4), 417-424.

Kirsch, N. L., & Levine, S. P. (1992). Technology and head injury rehabilitation. *Journal of Head Trauma Rehabilitation,* 7(3), vii-119.

Knox, R., & Jutai, J. (1996). Music-based rehabilitation of attention following brain injury. *Canadian Journal of Rehabilitation,* 9(3), 169-181.

Kolpan, K. I. (1987). Employment benefits for the traumatic brain-injured. *Journal of Head Trauma Rehabilitation,* 2(1), 81-82.

Kosciulek, J. F. (1991). The impact of traumatic brain injury on work adjustment development. *Vocational Evaluation and Work Adjustment Bulletin,* 24(4), 137-140.

Kraft, J. F., Schwab, K. A., Salazar, A. M., & Brown, H. R. (1993). Occupational and educational achievements of head injured Vietnam veterans at 15 year follow-up. *Archives of Physical and Medical Rehabilitation,* 74(6), 596-601.

Kregel, J., Parent, W., & West, M. (1994). The impact of behavioral deficits on employment retention: An illustration from supported employment. *Neurorehabilitation,* 4(1), 1-14.

Kreutzer, J. S., West, M., Sherron, P., Wehman, P. H., & Fry, R. (1992). Computer technology in vocational rehabilitation. *Journal of Head Trauma Rehabilitation,* 7(3), 70-80.

LaMarche, J. A., Reed, L. K., Rich, M. A., Cash, A. W., Lucas, L. H., & Boll, T. J. (1995). The interactive community-based model of vocational rehabilitation in traumatic brain injuries. *Journal of Head Trauma Rehabilitation,* 10(4), 81-89.

Lash, M., & Scarpino, C. (1995). School reintegration for children with traumatic brain injuries: Conflicts between medical and educational systems. *Neurorehabilitation,* 3(3), 13-25.

Lawler, K. A., & Terregino, C. A. (1996). Guidelines for evaluation and education of adult patients with mild traumatic brain injuries in an acute care hospital setting. *Journal of Head Trauma Rehabilitation,* 11(6), 18-28.

Leon Carrion, J. E. (1997). *Neuropsychological rehabilitation: Fundamentals, innovations, and directions.* Delray Beach, FL: GR/St. Lucie Press.

Levine, S. P., Horstmann, H. M., & Kirsch N. L. (1992). Performance considerations for people with cognitive impairment in accessing assistive technologies. *Journal of Head Trauma Rehabilitation,* 7(3), 46-58.

Lynch, W. (1986). Adaptive devices for microcomputers...part 1. *Journal of Head Trauma Rehabilitation,* 1(4), 80-82.

Lynch, W. (1987). Adaptive devices for microcomputers...part 2. *Journal of Head Trauma Rehabilitation, 2(1), 79-80.*

Lynch, W. (1986). Computer-assisted cognitive retraining. *Journal of Head Trauma Rehabilitation,* 1(2), 77-78.

Lynch, W. (1989). Computer-assisted visual-perceptual training. *Journal of Head Trauma Rehabilitation,* 4(2), 75-77.

Lynch, W. (1989). Ethics in computer-assisted cognitive retraining. *Journal of Head Trauma Rehabilitation,* 4(1), 91-93.

Lynch, W. J. (1990) Adaptive devices for microcomputers...part 3. *Journal of Head Trauma Rehabilitation,* 5(1), 96-99.

Lynch, W. J. (1990) Cognitive prostheses for the brain impaired. *Journal of Head Trauma Rehabilitation,* 5(3), 78-80.

Lynch, W. J. (1990) Computer access for the disabled: Entering the new decade. *Journal of Head Trauma Rehabilitation,* 5(2), 87-89.

Lynch, W. J. (1992) Ecological validity of cognitive rehabilitation software. *Journal of Head Trauma Rehabilitation,* 7(3), 36-45.

Lynch, W. J. (1994) Hardware update: The eyegaze computer system. *Journal of Head Trauma Rehabilitation,* 9(4), 77-80.

Lynch, W. J. (1989) A language master for the 1990's. *Journal of Head Trauma Rehabilitation,* 4(4), 88-90.

Lynch, W. J. (1991) The Macintosh as a tool in rehabilitation. *Journal of Head Trauma Rehabilitation,* 6(4), 64-66.\

Lynch, W. J. (1989) Microcomputers in cognitive rehabilitation: New directions. *Journal of Head Trauma Rehabilitation,* 4(3), 92-94.

Lynch, W. J. (1990) Selecting a computer for rehabilitation. *Journal of Head Trauma Rehabilitation,* 5(4), 101-103.

Lynch, W. J. (1992) Selecting patients and software for computer-assisted cognitive retraining: Key patient variables to consider...part 2. *Journal of Head Trauma Rehabilitation,* 7(2), 106-108.

Lynch, W. J. (1992) Selecting patients and software for computer-assisted cognitive retraining: Screening candidates for treatment... part 1. *Journal of Head Trauma*

Rehabilitation, 7(1), 92-95.

Lynch, W. J. (1994) Software update...Cognitive rehabilitation (CR) software. *Journal of Head Trauma Rehabilitation,* 9(2), 105-108.

Lynch, W. J. (1998) Software update 1998: Commercial programs useful in cognitive retraining. *Journal of Head Trauma Rehabilitation,* 13(5), 91-94.

Lynch, W. J. (1992) Suggestions for the next generation of cognitive rehabilitation software: Memory software...part 1. *Journal of Head Trauma Rehabilitation,* 7(4), 109-111.

Lynch, W. J. (1995) Technology. Microcomputer-assisted neuropsychological test analysis. *Journal of Head Trauma Rehabilitation,* 10(2), 97-100.

Lynch, W. J. (1996) Tests, measurement, and technology. Computer-administered cognitive assessment update...The Colorado neuropsychological tests. *Journal of Head Trauma Rehabilitation,* 11(2), 99-101.

Lynch, W. J. (1993) Update on a computer-based language prosthesis for aphasia therapy. *Journal of Head Trauma Rehabilitation,* 8(3), 107-109.

Lynch, W. J. (1995) You must remember this: Assistive devices for memory impairment...NeuroPage...Voice it personal note recorder...Voice organizer. *Journal of Head Trauma Rehabilitation,* 10(1), 94-97.

Lyons, J. L., & Morse, A. R. (1988). A therapeutic work program for head-injured adults. *American Journal of Occupational Therapy,* 42(6), 364-370.

Mann, W. C., & Dittmar, S. S. (1992). Consumer advocacy and professional education: Traumatic brain injury. *Journal of Cognitive Rehabilitation,* 10(6), 8-11.

Mann, W. C., & Svorai, S. B. (1994). COMPETE: A model for vocational evaluation, training, employment, and community for integration for persons with cognitive impairments. *American Journal of Occupational Therapy,* 48(5), 446-451.

Martin, R. (1988). Legal challenges in educating traumatic brain injured students. *Journal of Learning Disabilities,* 21(8), 471-485.

Mateer, C. A., Kerns, D. A., & Eso, K. L. (1996). Management of attention and memory disorders following traumatic brain injury. *Journal of Learning Disabilities,* 29(6), 618-632.

Mateer, C. A., & Mapou, R. L. (1996). Understanding, evaluating, and managing attention disorders following traumatic brain injury. *Journal of Head Trauma*

Rehabilitation, 11(2), 1-16.

McDowell, S. K. (1996). Update on pharmacology. A role for dopamine in executive function deficits. *Journal of Head Trauma Rehabilitation,* 11(6), 89-92.

Melamed, S., Groswasser, Z., & Stern, M. J. (1992). Acceptance of disability, work involvement and subjective rehabilitation status of traumatic brain-injured (TBI) patients. *Brain Injury,* 6(3), 233-243.

Miller, L. (1992). Back to the future: Legal, vocational, and quality-of-life issues in the long-term adjustment of the brain-injured patient. *Journal of Cognitive Rehabilitation,* 10(5), 14-20.

Miller, L. (1992). Cognitive rehabilitation, cognitive therapy, and cognitive style: Toward an integrative model of personality and psychotherapy. *Journal of Cognitive Rehabilitation,* 10(1), 18-29.

Millis, S. R. (1995). Factor structure of the California Verbal Learning Test in moderate and sever closed-head injury. *Perception and Motor Skills,* 80(1), 219-224.

Moore, A. D., & Stambrook, M. (1995). Cognitive moderators of outcome following traumatic brain injury: A conception al model and implications for rehabilitation. *Brain Injury,* 9(2), 109-130.

Morse, P. A., & Morse A. R. (1988). Functional living skills: Promoting the interaction between neuropsychology and occupational therapy. *Journal of Head Trauma Rehabilitation,* 3(1), 33-44.

O'Leary, S. (1991). Computer access considerations for patients with traumatic brain injury. *Journal of Head Trauma Rehabilitation,* 6(3), 89-91.

O'Neill, J., Hibbard, M., Brown, M., Jaffe, M., Slivinski, M., Vandergroot, D., et al. (1998). The effect of employment on quality of life and community integration after traumatic brain injury. *Journal of Head Trauma Rehabilitation,* 13(4), 68-79.

Papworth, M. (1989). The behavioural treatment of nocturnal enuresis in a severely brain-damaged client. *Journal of Behavior Therapy and Experimental Psychiatry,* 20(3), 265-268.

Parente, R., & Anderson Parente J. K. (1989). Retraining memory: Theory and application. *Journal of Head Trauma Rehabilitation,* 4(3), 55-65.

Parente, R., Anderson Parente J. K., & Shaw, B. (1989). Retraining the mind's eye. *Journal of Head Trauma Rehabilitation,* 4(2), 53-62.

Parente R., & Herrmann, D. J. (1996). *Retraining cognition: Techniques and*

applications. Gaithersburg, MD: Aspen Publishers.

Parente, R., Twum, M., & Zoltan, B. (1994). Transfer and generalization of cognitive skill after traumatic brain injury. *Neurorehabilitation,* 4(1), 25-35.

Parker, R. S. (1994). Neurobehavioral outcome of children's mild traumatic brain injury. *Seminar in Neurology,* 14(1), 67-73.

Penn, C., & Cleary, J. (1988). Compensatory strategies in the language of closed head injured patients. *Brain Injury,* 2(1), 3-17.

Pepin, M., Loranger, M., & Benoit, G. (1995). Efficiency of cognitive training: Review and prospects. *Journal of Cognitive Rehabilitation,* 13(4), 8-14.

Persel, C. S., & Persel, C. H. (1995). The use of applied behavior analysis in traumatic brain injury rehabilitation. In M. J. Ashley & D. K. Krych (Eds.), *Traumatic brain injury rehabilitation* (pp. 231-273). Boca Raton, FL: CRC Press.

Possl, J., & Yves Von Cramon, D. (1996). Clients' view of neuropsychological rehabilitation. *Brain Injury,* 10(2), 125-132.

Powell, B. D., & Holmes, C. B. (1995). Prevalence of head injury among four-year college students: A replication and combined results. *Perception and Motor Skills,* 81(1), 227-230.

Prickel, D., & McLean, B. (1989). Vocational rehabilitation of the head injured person in the rural setting. *Cognitive Rehabilitation,* 7(6), 22-26.

Prigatano, G. P. (1987). Recovery and cognitive retraining after craniocerebral trauma. *Journal of Learning Disabilities,* 20(10), 603-613.

Prigatano, G. P. (1997). Learning from our successes and failures: Reflections and comments on "Cognitive rehabilitation: How it is and how it might be. *"Journal of International Neuropsychology and Sociology,* 3(5), 497-499.

Rao, N., & Kilgore, K. M. (1992). Predicting return to work in traumatic brain injury using assessment scales. *Archives in Physical and Medical Rehabilitation,* 73(10), 911-916.

Raymer, A. M., Gonzales Rothi L. J., & Greenwald, M. L. (1995). The role of cognitive models in language rehabilitation. *Neurorehabilitation,* 5(2), 183-193.

Richards, L. (1995). Providing instruction in independent living and vocational rehabilitation for individuals with head injuries within an entry-level occupational therapy curriculum. *Occupational Therapy and Health Care,* 9(1), 57-70.

Ried, S., Strong G., Wright, L., Wood, A., Goldman, A., & Bogen, D. (1995). Computers, assistive devices, and augmentative communication aids: Technology for social inclusion. *Journal of Head Trauma Rehabilitation,* 10(5), 80-90.

Rizzo, A. A. Buckwalter, J. G., & Neumann, E. (1997). Virtual reality and cognitive rehabilitation: A brief review of the future. *Journal of Head Trauma Rehabilitation,* 12(6), 1-15.

Rose, F. D., Al-Khamees, K. Davey, M. J., & Attree, E. A. (1993). Environmental enrichment following brain damage: An aid to recovery or compensation? *Behavior Brain Research,* 56(1), 93-100.

Ruff, R. M., Baser, C. A., Johnston, J. W., Marshall, L. F., Klauber, S. K., Klauber, M. R., et al. (1989). Neuropsychological rehabilitation: An experimental study with head-injured patients. *Journal of Head Trauma Rehabilitation,* 4(3), 20-36.

Ruff, R., Mahaffey, R., Engel, J., Farrow, C., Cox, D., & Karzmark, P. (1994). Efficacy study of THINKable in the attention and memory retraining of traumatically head-injured patients. *Brain Injury,* 8(1), 3-14.

Sample, L. L., & Rowntree, A. J. (1995). Employment intervention strategies for individuals with brain injury. *Occupational Therapy and Health Care,* 9(1), 45-56.

Sander, A. M., Kreutzer, J. S., & Hernandez, C. C. (1987). Neurobehavioral functioning, substance abuse, and employment after brain injury: Implications for vocational rehabilitation. *Journal of Head Trauma Rehabilitation,* 12(5), 28-41.

Savage, R. C. (1987). Educational issues for the head-injured adolescent and young adult. *Journal of Head Trauma Rehabilitation,* 2(1), 1-10.

Savage, R. C. (1997). Integrating rehabilitation and education services for school-age children with brain injuries. *Journal of Head Trauma Rehabilitation,* 12(2), 11-20.

Sbordone, R. J. (1988). Assessment and treatment of cognitive-communicative impairments in the closed-head-injury patient: A neurobehavioral-systems approach. *Journal of Head Trauma Rehabilitation,* 3(2), 55-62.

Schwab, K., Grafman, J., Salazar, A. M., & Kraft, J. (1993). Residual impairments and work status 15 years after penetrating head injury: Report from the Vietnam head injury study. *Neurology,* 43(1), 95-103.

Seaman, B., Roberts, P., Gilewski, M. & Nagai, J. (1993). Clinic to the real world: Community reintegration of head injured patients. *Journal of Cognitive Rehabilitation,* 11(2), 6-17.

Shaw, T. G., & Groom, K. N. (1996). Functional treatment recommendations for patients with right hemisphere, nonverbal deficits. *Journal of Cognitive Rehabilitation,* 14(6), 6-11.

Sherer, M., Bergloff, P., Levin, E., High, W. M., Oden, K. E., & Nick, T. G. (1998). Impaired awareness and employment outcome after traumatic brain injury. *Journal of Head Trauma Rehabilitation,* 13(5), 52-61.

Skord, K. G., & Miranti, S. V. (1994). Towards a more integrated approach to job placement and retention for persons with traumatic brain injury and premorbid disadvantages. *Brain Injury,* 8(4), 383-392.

Slade, C. (1985). The role of home therapy in cognitive rehabilitation: A team approach. *Cognitive Rehabilitation,* 3(1), 10-13.

Sohlberg, M. M., & Mateer C. A. (1992a). *Introduction to cognitive rehabilitation: Theory and practice.* New York, NY: Guilford Press.

Sohlberg, M. M., Mateer, C. A., & Stuss, D. T. (1993). Contemporary approaches to the management of executive control dysfunction. *Journal of Head Trauma Rehabilitation,* 8(1), 45-58.

Sohlberg, M. M., & Raskin, S. A. (1996). Principles of generalization applied to attention and memory interventions. *Journal of Head Trauma Rehabilitation,* 11(2), 65-78.

Spring, B. J., & Ravdin, L. (1992). Cognitive remediation in schizophrenia: Should we attempt it? *Schizophrenia Bulletin,* 18(1), 15-20.

Stapleton, M., Parente, R., & Bennett, P. (1989). Job coaching traumatically brain injured individuals: Lessons learned. *Cognitive Rehabilitation,* 7(4), 18-21.

Stern, J. M., & Stern, B. (1989). Visual imagery as a cognitive means of compensation for brain injury. *Brain Injury,* 3(4), 413-419.

Strauss, D. L., & Schaffer, V. L. (1995). A transformation to real-life rehabilitation. *Continued Care, 14(6), 31-35.*

Sturm, W., Willmes, K., Orgass, B., & Hartje, W. (1997). Do specific attention deficits need specific training? *Neuropsychological Rehabilitation,* 7(2), 81-103.

Suzman, K. B., Morris, R. D., Morris, M. K., & Milan, M. A. (1997). Cognitive-behavioral remediation of problem solving deficits in children with acquired brain injury. *Journal of Behavior Therapy and Experimental Psychiatry,* 28(3), 203-212.

Tate, R. L. (1997). Beyond one-bun, two-shoe: Recent advances in the psychological rehabilitation of memory disorders after acquired brain injury. *Brain Injury,* 11(12), 907-918.

Thomas, D. F., & Menz, F. E. (1990). *Development, implementation, and validation of supported employment model(s) for traumatically brain injured persons. Head Injury Re-Entry Project (Project HIRe).* Washington, DC: National Institute on Disability and Rehabilitation Research.

Thomas, D. F., Menz, F. E., & McAlees, C. C. (1993). *Community-based employment following traumatic brain injury.* Washington, DC: National Institute on Disability and Rehabilitation Research.

Thomas, S. N., Johnson, P., Schuller, R., & Jutai, J. (1994). Evaluation of a computer-based program for remediation of cognitive communication skills. *Journal of Head Trauma Rehabilitation,* 9(4), 25-37.

Toglia, J. P. (1991). Generalization of treatment: A multicontext approach to cognitive perceptual impairment in adults with brain injury. *American Journal of Occupational Therapy,* 45(6), 505-516.

Treadwell, K., & Page, T. J. (1996). Functional analysis: Identifying the environmental determinants of severe behavior disorders. *Journal of Head Trauma Rehabilitation,* 11(1), 62-74.

Trexler, L. E., & Zappala, G. (1988). Re-examining the determinants of recovery and rehabilitation of memory defects following traumatic brain injury. *Brain Injury,* 2(3), 187-203.

Uomoto, J. M. (1992). Neuropsychological assessment and cognitive rehabilitation after brain injury. *Traumatic Brain Injury,* 3(2), 291-317.

Veach, R. (1993). Utilization of community resources in a community-based rehabilitation program for mild to mild-moderate brain-injured survivors. *Journal of Cognitive Rehabilitation,* 11(2), 18-20.

Veach, R., & Taylor, M. (1989). Vocational placement of minor head injured survivors. *Cognitive Rehabilitation,* 7(4), 14-16.

Venzie, D. R., Felicetti, T., & Cerra Tyl D. (1996). Planning considerations for community integrative brain injury programs. *Journal of Head Trauma Rehabilitation,* 11(6), 51-64.

Volpe, B. T., & McDowell, F. H. (1990). The efficacy of cognitive rehabilitation in patients with traumatic brain injury. *Archives of Neurology,* 47(2), 220-222.

Von Cramon, D., Matthes Von Cramon, G., & Mai, N. (1991). Problem-solving deficits in brain-injured patients: A therapeutic approach. *Neuropsychological Rehabilitation,* 1(1), 45-64.

Von Cramon, D. Y., & Matthes Von Cramon, G. (1994). Back to work with a chronic dysexecutive syndrome? A case report. *Neuropsychology and Rehabilitation,* 4(4), 399-417.

Von Cramon, D. Y., & Matthes Von Cramon, G. (1992). Reflections on the treatment of brain-injured patients suffering from problem-solving disorders. *Neuropsychological Rehabilitation,* 2(3), 207-229.

Voorhees, S. L. (1985). Cognitive rehabilitation: An important aspect of the rehabilitation approach. *Cognitive Rehabilitation,* 3(4), 4-7.

Wall, J. R., Niemczura, J. G., & Rosenthal, M. (1998). Community-based training and employment: An effective program for persons with traumatic brain injury. *Neurorehabilitation,* 10(1), 39-49.

Walsh, C. (1995). Subacute care. Managing a head injury program. *Provider,* 21(6), 38.

Walsh, W. (1984). The challenge of treating post head trauma patients. *Journal of the American Health Care Association,* 10(1), 64-69.

Webb, D. (1991). Increasing carryover and independent use of compensatory strategies in brain injured patients. *Cognitive Rehabilitation,* 9(3), 28-35.

Weber, A. M. (1990). A practical clinical approach to understanding and treating attention problems. *Journal of Head Trauma Rehabilitation,* 5(1), 73-85.

Wehman, P., Kregel, J, Sherron, P., Nguyen, S., Kreutzer, J., Fry, R., et al. (1993). Critical factors associated with the successful supported employment placement of patients with sever traumatic brain injury. *Brain Injury,* 7(1), 31-44.

Wehman, P., Kregel, J., West, M., & Cifu, D. (1994). Return to work for patients with traumatic brain injury. Analysis of costs. *American Journal of Physical and Medical Rehabilitation,* 73(4), 280-282.

Wehman, P., Kreutzer, J., West, M., Sherron, P., Diambra, J., Fry, R. et al. (1989). Employment outcomes of persons following traumatic brain injury: Pre-injury, post-injury, and supported employment. *Brain Injury,* 3(4), 397-412.

Wehman, P., Kreutzer, J., Wood, W., & Morton, M. V.(1988). Supported work model for persons with traumatic brain injury: Toward job placement and retention [Special issue]. Traumatic brain injury. *Rehabilitation Counseling Bulletin,* 31(4), 298-312.

Wehman, P., Sherron, P., Kregel, J., Kreutzer, J., Tran, S., & Cifu, D. (1993). Return to work for persons following severe traumatic brain injury. Supported employment outcomes after five years. *American Journal of Physical and Medical Rehabilitation,* 72(6), 355-363.

Wehman, P. H., Kreutzer, J. S., West, M. D., Sherron, P. D., Zasler, N. D., Groah, C. H., et al. (1990). Return to work for persons with traumatic brain injury: A supported employment approach. *Archives of Physical and Medical Rehabilitation,* 71(13), 1047-1052.

Wehman, P., West, M., Fry, R., Sherron, P., Groah, C., Kreutzer, J., et al. (1989). Effect of supported employment on the vocational outcomes of persons with traumatic brain injury. *Journal of Applied Behaviour Analysis,* 22(4), 395-405.

Wehman, P. H., West, M. D., Kregel, J., Sherron, P., & Kreutzer, J. S. (1995). Return to work for persons with severe traumatic brain injury: A data-based approach to program development. *Journal of Head Trauma Rehabilitation,* 10(1), 27-39.

Wesolowski, M. D., & Zencius, A. H. (1994). *A practical guide to head injury rehabilitation: A focus on postacute residential treatment.* New York, NY: Plenum Press.

West, M., Wehman, P., Kregel, J., Kreutzer, J., Sherron, P., & Zasler, N. (1991). Costs of operating a supported work program for traumatically brain-injured individuals. *Archives of Physical and Medical Rehabilitation,* 72(2), 127-131.

West, M. D. (1995). Aspects of the workplace and return to work for persons with brain injury in supported employment. *Brain Injury,* 9(3), 301-313.

White, S. M., Seckinger, S. Doyle, M., & Strauss, D. L. (1997). Compensatory strategies for people with traumatic brain injury. *Neurorehabilitation,* 9(3), 205-212.

Whyte, J. (1986). Outcome evaluation in the remediation of attention and memory deficits. *Journal of Head Trauma Rehabilitation,* 1(3), 64-71.

Wilde, M. C., Boake, C., & Sherer, M. (1995). Do recognition-free recall discrepancies detect retrieval deficits in closed-head injury? An exploratory analysis with the California verbal learning test. *Journal of Clinical and Experimental Neuropsychology,* 17(6), 849-855.

Willer, B., & Corrigan, J. D. (1994). Whatever it takes: A model for community-based services. *Brain Injury,* 8(7), 647-659.

Willer, B., Rosenthal, M., Kreutzer J. S., Gordon, W. A., & Rempel, R. (1993). Assessment of community integration following rehabilitation for traumatic brain

injury. *Journal of Head Trauma Rehabilitation,* 8(2), 75-87.

Wilson, B. (1992). Recovery and compensatory strategies in head injured memory impaired people several years after insult. *Journal of Neurological Neurosurgery and Psychiatry,* 55(3), 177-180.

Wilson, B. A. (1997). Cognitive rehabilitation: How it is and how it might be. *Journal of Neuropsychology and Sociology,* 3(5), 487-496.

Wilson, B. A. (1991). Long-term prognosis of patients with severe memory disorders. *Neuropsychological Rehabilitation,* 1(2), 117-134.

Wilson, B. A. (1998). Recovery of cognitive functions following non-progressive brain injury. *Current Opinions in Neurobiology,* 8(2), 281-287.

Wilson, B. A. (1994). Syndromes of acquired dyslexia and patterns of recovery: A 6 to 10 year follow-up study of seven brain-injured people. *Journal of Clinical Experimental Neuropsychology,* 16(3), 354-371.

Wilson, B. A., Baddeley, A., Evans, J., & Shiel, A. (1994). Errorless learning in the rehabilitation of memory impaired people. *Neuropsychological Rehabilitation,* 4(3), 307-326.

Wilson, B. A., & Evans, J. J. (1996). Error-free learning in the rehabilitation of people with memory impairments. *Journal of Head Trauma Rehabilitation,* 11(2), 54-64.

Wood, R. L. (1987). *Brain injury rehabilitation: A neurobehavioural approach.* London: Croom Helm.

Ylvisaker, M., Feeney, T. Maher Maxwell, N., Meserve, N., Geary, P. J., & DeLorenzo, J. P. (1995). School reentry following severe traumatic brain injury: Guidelines for educational planning. *Journal of Head Trauma Rehabilitation,* 10(6), 25-41.

Ylvisaker, M., Hartwick, P., & Stevens, M. (1991). School reentry following head injury: Managing the transition from hospital to school. *Journal of Head Trauma Rehabilitation,* 6(1), 10-22.

Youngson, H. A., & Alderman, N. (1994). Fear of incontinence and its effects on a community-based rehabilitation programme after severe brain injury: Successful remediation of escape behavior using behavior modification. *Brain Injury,* 8(1), 23-36.

Yuen, H. K., & Benzing, P. (1996). Treatment methodology. Guiding of behavior through redirection in brain injury rehabilitation. *Brain Injury,* 10(3), 229-238.

Zasler, N. D. (1997). The role of medical rehabilitation in vocational reentry. *Journal of*

Head Trauma Rehabilitation, 12(5), 42-56.

Zencius, A., Wesolowski, M. D., & Burke, W. H. (1989). Comparing motivational systems with two non-compliant head-injured adolescents. *Brain Injury,* 3(1), 67-71.

Zhou, J., Chittum, R., Johnson, K., Poppen, R., Guercio, J., & McMorrow, M. J. (1996). The utilization of a game format to increase knowledge of residuals among people with acquired brain injury. *Journal of Head Trauma Rehabilitation,* 11(1), 51-61.

REFERENCES

Alderman, N. (1991). The treatment of avoidance behavior following severe brain injury by satiation through negative practice. Brain Injury, 5(1), 77-86.

Anderson, J.R. (1980). Cognitive psychology and its implications (2nd ed.), New York: W.H. Freeman and Company.

Annegers, J., Grabow, J., Kuland, L., & Laws, E. (1980). The incidence, causes, and secular trends of head trauma in Olmstead County, Minnesota, 1935-1974. Neurology, 30, 912-991.

Antonak, R.F., Livneh, H., & Antonak, C. (1993). A review of research on psychosocial adjustment to impairment in persons with traumatic brain injury. Journal of Head Trauma Rehabilitation, 8(4), 87-100.

Babbie, E. (2001). The practice of social research (9th ed.). Belmont, CA: Wadsworth/Thomson Learning.

Ben-Yishay, Y., Rattok, J., Lakin, P., Piasetsky, E., Ross, B., Silver, S., Zide, E., & Ezrachi, O. (1985). Neuropsychological Rehabilitation: Quest for a Holistic Approach. Seminars in Neurology, 5 (3), 252-259.

Ben-Yishay, Y., Silver, S., Piasetsky, E., & Rattok, J. (1978). Relationship between employability and vocational outcome after intensive holistic cognitive rehabilitation. Journal of Head Trauma Rehabilitation, 2 (1), 35-48

Berne, E. (1961). Transactional analysis in psychotherapy. New York: Ballantine Books.

Blair, C.D., & Lanyon, R.I. (1987). Retraining social skills and adaptive living skills in severely head injured adults. Archives of Clinical Neuropsychology, 2, 33-43.

Bond, M.R. (1975). Assessment of the psychosocial outcome after severe head injury. Ciba Foundation Symposium, 34, (pp. 141-157).

Bond, M.R. (1990). Scale and scope of the problem. In M. Rosenthal, E. Griffith, & J. Miller (Eds.), Rehabilitation of the adult and child with traumatic brain injury (pp. 3-37). Philadephia: F.A. Davis.

Brooks, N., Aughton, M.E., & Bond, M.R. (1980). Cognitive sequelae in relationship to early indices of severity of brain damage after severe blunt head injury. Journal of Neurology, Neurosurgery, and Psychiatry, 43, 529-534.

Brooks, N. (1984). Cognitive Deficits After Head Injury. In N. Brooks (Ed.), Closed head injury: psychological, social, and family consequences. New York: Oxford University Press.

Carew, T.J. (1985). Posture and Locomotion. In E. Kandel & J. Schwartz (Eds.), Principles of neuroscience, 2nd Edition. New York: Elsevier.

Cartlidge, N.E. (1981). Head injury. London: W.B. Saunders.

Castro, G. & Mastropieri, M. A. (1986). The efficacy of early intervention programs: A meta-analysis. Exceptional Children, 52, 417-424.

Center for Disease Control and Prevention, National Center for Injury Prevention and Control. (1998). 1994 National hospital discharge survey. Unpublished analysis of data.

Center for Disease Control and Prevention, National Center for Injury Prevention and Control. (1997). Traumatic brain injury, Colorado, Missouri, Oklahoma, and Utah-1990-1993. MMWR Morb. Mortality Weekly, 46, 8-11.

Christensen, A. L. (1986). Applying Luria's theory to the rehabilitation process of brain damage. In B. Uzzell & Y. Gross (Eds.), Clinical neuropsychology of intervention (pp. 169-177). Boston: Martinus Nijhoff.

Cicerone, K.D. (1989). Psychotherapeutic interventions with traumatically brain-injured patients. Rehabilitation Psychology, 34, 105-114.

Cooper, K.D., Tabaddor, K., Hauser, W.A. (1983). The epidemiology of head injury in the Bronx. Neuroepidemiology, 2, 70-88.

Crane, A.A., & Joyce, B.G. (1991). Cool down: A procedure for decreasing addression in adults with traumatic brain injury. Behavioral Residential Treatment, 6(1), 65-75.

Crosson, B. (1987). Treatment of interpersonal deficits for head-trauma patients in inpatient rehabilitation settings. The Clinical Neuropsychologist, 1, 335-352.

Crowley, J. A. & Miles, M. A. (1991). Cognitive remediation in pediatric head injury: A case study. Journal of Pediatric Psychology, 16 (5), 611-627.

Davis, S., & Palladono, J. (2002). Psychology (3rd ed.), Upper Saddle River, New Jersey: Prentice Hall.

Delmonico, R.L., Hanley-Peterson, P., & Englander, J. (1998). Group psychotherapy for persons with traumatic brain injury: management of frustration and substance abuse. Journal of Head trauma Rehabilitation, 13, 10—22.

Duncan, J. (1986). Disorganization of behaviour after frontal lobe damage. Cognitive Neuropsychology, 3(3), 271-290.

Eysenck, H. (1984). Meta-analysis: An abuse of research integration. Journal of Special Education, 18, 41-59.

Fisher, J.M. (1985). Cognitive and behavioral consequences of closed head injury. Seminars in Neurology, 5(3), 197-204

Frankowski, R. (1986). Descriptive epidemiologic studies of head injury in the U.S.: 1974-1984. In L. Karger & T. Basel, Trauma treatment in practise. The head injured patient. Advanced Psychosomatic Medicine, 16, 152-172.

Frankowski, R., Klauber, M.R., & Tabaddor, K. (1981). Head injury mortality: A comparison of three metropolitan counties. NINCDS report (manuscript).

Fujii, D. E. (1996). Kolb's learning styles and potential cognitive remediation of brain-injured individuals: An exploratory factor analysis study. Professional Psychology: Research and Practice, 27 (3), 266-271.

Gallo, P. (1978). Meta-analysis: A mixed metaphor? American Psychologist, 33, 515-517.

Gans, J.S. (1983). Hate in the rehabilitation setting. Archives of Physical Medicine and Rehabilitation, 64, 176-179.

Garoutte, B., & Aird, R. (1984). Behavioral effects of head injury. Psychiatric Annuals, 14, 507-514.

Glass, G., McGaw, B., & Smith, M. (1981). Meta-analysis in social research. Beverly Hills: Sage.

Grant, I., & Alves, W. (1987). Psychiatric and psychosocial disturbances in head injury. In H.S. Levin, J. Grafman, & H.M. Eisenberg (Eds.), Neurobehavioral recovery from head injury, (pp. 232-261). New York: Oxford University Press.

Grimm, B.H., & Bleiberg, J. (1986). Psychological rehabilitation in traumatic brain injury. In S.B. Filsov & T.J. Boll (Eds.), Handbook of Clinical Neuropsychology, (pp. 495-527). New York: John Wiley and Sons.

Gualtieri, T., & Cox, D.R. (1991). The delayed neurobehavioral sequelae of traumatic brain injury. Brain Injury, 5, 219-232.

Haslam, C., Batchelor, J., & Fearnside, M.R. (1994). Post-coma disturbance and post-traumatic amnesia as nonlinear predictors of cognitive outcome following severe

closed head injury: Findings from the Westmead Head Injury Project. Brain Injury, 8, 519-528.

Hedges, L. (1986). Issues in meta-analysis. Review of Research in Education, 13, 353-398.

Huffman, K., Vernoy, M., & Vernoy, J. (2000). Psychology in action (5th ed.), New York: John Wiley & Sons, Inc.

Hurt, G.D. (1991). Mild brain injury: Critical factors in vocational rehabilitation. Journal of Rehabilitation, 57 (4), 36-40

Jennett, B., & Teasdale, G. (1981). Management of head injuries. Contemporary Neurology Series, Vol. 20. Philadelphia: FA Davis.

Jennett, B., & Macmillan, R. (1981). Epidemiology of head injuries. British Medical Journal, 282, 101-103.

Johnson, P., Thomas-Stonell, N., & Shein, F. (1994). Development of a computer-based program for the remediation of cognitive-communication skills in young people with head injuries. Journal of Cognitive Rehabilitation, July/August, 12 (4), 10-18.

Kaplan, S.P. (1988). Adaptation Following Serious Brain Injury: An Assessment After One Year. Journal of Applied Rehabilitation Counseling, 19 (3) 3-8.

Kassin, S. (2001). Psychology (3rd Ed.). Upper Saddle River, New Jersey: Prentice Hall.

Klauber, M.R., Barret-Connor, E., Marshall, L.F., & Bowers, S.A. (1978). The epidemiology of head injury: A prospective study of an entire community-San Diego County, California, 1978. American Journal of Epidemiology, 113, 500-509.

Klove, H. & Cleeland, C.S. (1972). The relationship of neuropsychological impairment to other indices of severity of head injury. Scandinavian Journal of Rehabilitation Medicine, 4, 155-160.

Kohut, H. (1972). Thoughts on narcissism and narcissistic rage. Psychoanalytic Study of the Child, 27, 360-400.

Kreutzer, J.S., Leininger, B.S., Sherron, P.D., & Groah, C.H. (1990). Managing psychosocial dysfunction. In P. Wehman & J.S. Kreutzer (Eds.), Vocational rehabilitation for persons with traumatic brain injury (pp. 35-69). Rockville, MD: Aspen Publication.

Kwentus, J., Hart, R., Peck, E., & Kornstein, S. (1985). Psychiatric complications of closed head trauma. Psychosomatic, 26, 8-17.

Lashley, K. S. (1938). Factors limiting recovery after central nervous lesions. The Journal of Nervous and Mental Diseases, 88, 733-755.

Lezak, M.D. (1987). Relationships between personality disorders, social disturbances, and physical disability following traumatic brain injury. Journal of Head Trauma Rehabilitation, 2(1), 57-69.

Lishman, W.A. (1978). Organic psychiatry. Oxford: Blackwell Scientific Publications.

Lishman, W.A. (1973). The psychiatric sequelae of head injury: A review. Psychological Medicine, 3, 304-318.

Livneh, H., & Antonak, R.F. (1990). Reactions to disability: An empirical investigation of their nature and structure. Journal of Applied Rehabilitation Counseling, 21(4), 13-21.

Long, D.F. (1989). Issues in behavioral neurology and brain injury> In D.W.Ellis & A. Christensen (Eds.), Neuropsychological treatment after brain injury (pp. 39-90). Boston: Kluwer Academic Publishers.

Luria, A. R. (1983). Recovery of brain function after brain injury. New York: Macmillan Co.

McAllister, T.W. (1997). Evaluation of brain injury related behavioral disturbances in community mental health centers. Community Mental Health Journal, 33, 341-351.

McClelland, R.J. (1988). Psychosocial sequelae of head injury: Anatomy of a relationship. British Journal of Psychiatry, 153, 141-146.

McMordie, W., Barker, S., & Paolo, T. (1990). Return to work after head injury. Brain Injury, 4, 57-69.

Morse, P.A., & Montgomery, C.E. (1992). Neuropsychological evaluation of traumatic brain injury. In White R.F. (Ed.), Clinical syndromes in adult neuropsychology: The practitioner's handbook (pp. 85-176). New York: Elsevier Science Publishers.

Myers, D.G. (1999). Exploring Psychology (4th ed.), New York: Worth Publishers.

National Center for Health Statistics. (1984). Multiple causes of death in the United States: Monthly vital statistics report, vol. 32. (Report No. 84-1120). Hyattsville, Maryland: Public Health Service.

National Center for Health Statistics (1994). Multiple causes of death in the United States: Public data for years 1980-1994. Hyattsville, Maryland: Public Health Service.

National Head Injury Foundation. (1984). Unpublished Document. National Head Injury Foundation, Inc., Framingham, MA.

Nelson, A.J. (1983). Motor Assessment. In M. Rosenthal (Ed.), Rehabilitation of the Head Injured Adult. Philadelphia: F.A. Davis.

Oddy, M., Coughlan, T., Tyerman, A., & Jenkins, D. (1985). Social Adjustment after Closed Head Injury: A Further Follow-up Seven Years after Injury. Journal of Neurology, Neurosurgery, and Psychiatry, 43, 798-802.

Pepping, M., & Roueche, J.R. (1991). Psychosocial consequences of significant brain injury. In D.E. Tupper & K.D. Cicerone (Eds.), The neuropsychology of everyday life: Issues in development and rehabilitation (pp. 215-256). Boston: Kluwer Academic Publishers.

Plum, F., & Levy, D.E. (1978). Predicting Prognosis in Coma: Can One Improve Medical Decisions? American Journal of Medicine, 65, 224-226.

Prigatano, G. P. (1987a). Neuropsychological Deficits, Personality Variables, and Outcome. In M. Ylvisaker & E. Gobble (Eds.), Community re-entry for head injured adults. Boston: College-Hill.

Prigatano, G. (1987b). Recovery and cognitive retraining after craniocerebral trauma. Journal of Learning Disabilities, 20 (10) 603-613.

Prigatano, G.P. (1987c). Psychiatric aspects of head injury: Problem areas and suggested guidelines for research. In H.S. Levin, J. Grafman, & H.M. Eisenberg (Eds.), Neurobehavioral recovery from head injury (pp. 215-231). New York: Oxford University Press.

Prigatano, G.P., Bruna, O., Mataro, M., Munoz, J.M., Fernandez, S., & Junque, C. (1998). Initial disturbances of consciousness and resultant impaired awareness in Spanish patients with traumatic brain injury. In G.P. Prigatano, D.J., Fordyce, H.K. Zeiner, J.R. Roueche, M. Pepping, & B.C. Woods (Eds.), Neuropsychological rehabilitation after brain injury. Baltimore: The John Hopkins University Press.

Rimel, R.W., & Jane, J.A. (1983). Characteristics of Head-Injured Patient. In M. Rosenthal, E. Griffith, M. Bond, & J. Miller (Eds.), Rehabilitation of the head injured adult. Philadelphia: F.A. Davis.

Rosenthal, M. (1983). Behavioral Sequelae. In M. Rosenthal (Ed.), Rehabilitation of the Head Injured Adult. Philadelphia: F.A. Davis.

Routh, D. K. (1987). Cognitive rehabilitation for children with head injury, learning disability, and mental retardation. Cognitive Rehabilitation, November/December, 16-21.

Sherzer, B. P. (1986). Rehabilitation Following Severe Head Trauma: Results of a Three-Year Program. Archives of Physical Medicine and Rehabilitation, 67, 366-374.

Silver, J.M., Yudofsky, S.C., & Hales, R.E. (1991). Depression in traumatic brain injury. Neuropsychiatry, Neuropsychology, and Behavioral Neurology, 4, 12-23.

Shores, E.A. (1989). Comparison of the Westmead PTA scale and the Glasgow Coma Scale as predictors of neuropsychological outcome following extremely severe blunt head injury. Journal of Neurology, Neurosurgery and Psychiatry, 52, 126-127.

Slagle, D.A. (1990). Psychiatric disorders following closed head injury: An overview of biopsychosocial factors in their etiology and management. International Journal of Psychiatry in Medicine, 20(1), 1-35.

Springer, S.P., & Deutsch, G. (1985). Left brain right brain. New York: W.H. Freeman.

Sunderland, A., Curry, S. H., Das, S., Enderby, P. M., Kinsey, C., Mortley, J., & Petheram, B. (1992). Monitoring information-processing efficiency after stroke or head injury: A comparison of four computerised tests for use in single case experiments. Neuropsychological Rehabilitation, 2 (2), 137-149.

Swanson, H. L. (1996). Meta-analysis, replication, social skills, and learning disabilities. The Journal of Special Education, 30 (2), 213-221.

Symond, C.P. (1937). Mental disorder following head injury. Proceedings of the Royal Society of Medicine, 30, 1081-1092.

Teasdale, G., & Jennet, B. (1974). Assessment of coma and impaired consciousness. Lancet, 2, 81-84.

Thurman, D.J., Alverson, C., Dunn, K.A., Guerrero, J., & Sniezek, G. (1999). Traumatic brain injury in the United States: A public health perspective. Journal of Head Trauma Rehabilitation, 14, 602-515.

Turner, J.M., Green, G., & Braunling-McMorrow, D. (1990). Differential Reinforcement of low rates of responding (DRL) to reduce dysfunctional social behaviour of a head injured man. Behavioral Residential Treatment, 5(1), 15-27.

Tyerman, A., & Humphrey, M. (1984). Changes in self-concept following severe head injury. International Journal of Rehabilitation Research, 7(1), 11-23.

Varney, N.R., & Menefee, L. (1993). Psychosocial and executive deficits following closed head injury: Implications for orbital frontal cortex. Journal for Head Trauma Rehabilitation, 8, 32-44.

Wehman, P., & Goodall, P. (1990). Return to work: Critical Issues in employment. In P. Wehman & J.S. Kreutzer (Eds.), Vocational Rehabilitation for Persons with Traumatic Brain Injury (p. 1-17). Maryland: Aspen Publishers, Inc.

Whitman, S., Coonley-Hoganson, R., & Desai, B.T. (1984). Comparative head trauma experience in two socio-economically different Chicago-area communities: A population study. American Journal of Epidemiology, 4, 560-580.

Wolf, F. M. (1986). Meta-Analysis Quantitative Methods for Research Synthesis. Beverly Hills, CA: SAGE Publications.

Zangwill, O. L. (1947). Psychological aspects of rehabilitation in cases of brain injury. British Journal of Psychology, 37, 60-69.

Zencius, A.H., Wesolowski, M.D., & Burke, W.H. (1990). The use of visual cue to reduce profanity in a brain injured adult. Behavioral Residential Treatment, 5(3), 143-147.