The contribution of Aptitude Testing to the Vocational Rehabilitation of Adults with Traumatic Brain Injuries

by

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En vous remerciant de votre intérêt pour nos travaux, veuillez, madame Lacroix, recevoir tous nos voeux de succès dans votre démarche doctorale.

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ABSTRACT

Neuropsychologists are asked to provide information regarding a person's ability to work following a traumatic brain injury (TBI). The tests used by Neuropsychologists were not constructed to identify specific abilities required for successful job performance. The lack of criterion-related validity information makes it difficult to relate data obtained from neurospychological tests to specific occupations (Clemmons, 1985; Heaton & Chelune, 1978; Prigatano et al. 1986). This presents serious limitations for vocational assessment and rehabilitation of persons with traumatic brain injuries.

The General Aptitude Test Battery (GATB) is the vocational aptitude battery most widely used in vocational assessment. The GATB's relationship to work demands makes it the most practical assessment tool available for job screening and matching. Interpretive data for the GATB with persons with brain damage are scant (Clemmons, 1985; Cole, 1984).

The person's ability to work following a traumatic brain injury results from the interaction between their abilities/disabilities and demands of occupations. Research in neuropsychology related to the vocational abilities of brain-injured individuals has centred on measuring the person's incapacity.

This research investigates the GATB as an aptitude test battery for use with individuals with brain injuries and its usefulness for job matching with this population. The relationship between the person's measured aptitudes (GATB) and aptitude demands of occupations (PAQ) is examined. This is referred to as the person-job fit measure.

The GATB was administered to sixty (60) individuals with TBI. The Position Analysis Questionnaire (PAQ) was used to analyze participants' occupations. It provides an estimate of the GATB aptitude scores of incumbents successfully performing the position analyzed, that is, the aptitude demands of the job.

Two categories of occupations were analyzed:

"*Can do*": Occupations participants have the ability to perform, including positions currently held and jobs they have held since being injured and are no longer performing for reasons unrelated to the brain injury; and

"*Cannot do*": occupations participants are unable to return to, or were unable to maintain for reasons related to the brain injury.

Occupations were considered only if the person's ability or inability to do the job could be verified with the employer, co-worker(s), or the professionals who assessed her (his) vocational potential.

The structure of the GATB was investigated first with a large sample of regular job applicants and the confirmed structure was verified with the study sample. The GATB performance of this group of persons with TBI was examined. Lastly, the ability of the measure of person-job fit to correctly classify participants by job category was analyzed.

The results confirmed that the eight GATB aptitudes can be regrouped into three composites. Although this is useful for some applications, for clinical intervention in a vocational rehabilitation process, the use of all eight GATB aptitudes is recommended.

The GATB scores of participants in this study tended to be lower than the General Working Population on many of the GATB aptitudes. This reinforces the need for vocational rehabilitation intervention to help brain-injured persons enter or reenter the work force.

Results indicated that the measure of person-job fit using the GATB in conjunction with the PAQ provided a good indicator of that person's ability or inability to do a specific job. The person-job fit measures obtained from the GATB cognitive and perceptual aptitude composites are the best predictors of ability to work with this sample. The usefulness of the GATB motor aptitude and composite is questionable.

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DEDICATION

To Ted who's unbound enthusiasm for life
inspired me to take on this challenge.

Chapter One

INTRODUCTION

This chapter presents the purpose of the study and an overview of the research, describing the methodology and scope of the study. The organization and layout of the dissertation are outlined.

Epidemiologic investigations conducted in the United States during the past ten years have reported between 422,000 and 500,000 head injuries per year (Anderson & McLaurin, 1980; Rapp & Spivack, 1986; Rosenthal, Griffith, Bond, & Miller, 1990). Although the 1986 census in Canada inquired about disabilities, head or brain injury was not included as a separate category. Extrapolating from the American data, however, an incidence of more than 50,000 victims per year is estimated.

All surveys (National Head and Spinal Cord Injury, 1980; National Head injury Foundation, 1986; U.S. Department of Education, 1981 in above epidemiologic studies) identified people under 30 years of age as the most vulnerable, accounting for approximately 70% of closed head injury (CHI) victims. Because a large number of victims are of working age, researchers have given special attention to the vocational outcome of individuals with brain injuries.

Reintegration into the labor force is the ultimate goal of many individuals and rehabilitation programs. Return to work is often used as a measure of overall recovery from injury and of the success of rehabilitation programs.

A key factor in the vocational rehabilitation process leading to job placement and maintenance is the initial job matching. Job matching is the process of fitting a person's abilities and disabilities with the demands and characteristics of occupations.

The primary aim of this study was to investigate the utility of the General Aptitude Test Battery (GATB, United States Department of Labor, 1970) for job matching with individuals who have sustained traumatic brain injuries.

The GATB was used in combination with the Position Analysis Questionnaire (PAQ), a measure of the aptitude demands of occupations, to produce a measure of person-job fit. Person-job fit is a measure of the competence (or inadequacy), related to work aptitudes, that an individual has or may experience in a specific occupation. The study also provides further information on the GATB performance of individuals with brain injuries.

The dissertation is organized into five chapters and a series of appendices. Chapter Two presents the major findings of a review of literature pertinent to the study. The perceptual, cognitive, and behavioral dysfunctions consequent to brain injuries have serious educational, vocational, and social implications. The first part of Chapter Two details the problems that brain-injured individuals experience obtaining and maintaining employment, and the factors that determine an individual's employment potential following a traumatic brain injury. Work ability is typically assessed with psychological and neuropsychological tests. These tests are sensitive to brain dysfunctions, but, as the literature review reveals, limited in their ability to actually predict vocational outcome. The General Aptitude Test Battery (GATB), the most commonly used tool in vocational counselling and rehabilitation, measures the same work-related aptitudes by which the *Canadian Classification and Dictionary of Occupations* (CCDO) breaks down occupations into job demands. The second part of Chapter Two focuses on the GATB, describing its history, characteristics, validity as a predictor of work performance, relationship to neuropsychological tests, and strengths and it's weaknesses as a vocational assessment tool for specialists working with the disabled population.

In order to study the GATB's usefulness for job matching with brain-injured individuals, the relationship between their measured aptitudes and the aptitude demands of specific occupations had to be examined. Thus, the third part of the chapter focuses on the Position Analysis Questionnaire (PAQ), a tool that measures the aptitude demands of various jobs. The PAQ deals with job characteristics as they imply human characteristics or behaviors that can be quantified and analyzed. Literature on the PAQ's history, reliability, validity, and uses is presented. The factors that guided selecting it as a job analysis procedure are summarized. The chapter concludes with a presentation of the hypotheses and questions raised by the literature review.

Chapter Three presents the methods and procedures used to investigate the hypotheses and questions posed. Sixty people between the ages of 18 and 54 participated in the study, recruited from a rehabilitation centre, three private clinics, and a vocational college. The procedure for requesting participation and the criteria for selecting participants are described. A description of the study sample and descriptive statistics of the demographic variables (age, sex, education, employment) are offered. A presentation of the instruments used — the GATB and the PAQ — and the procedure used to gather data follows. The occupations that were analyzed were divided into two categories: jobs participants *could do,* and jobs they *could not do.* The chapter concludes with a summary of the dependent and independent variables.

Chapter Four presents the statistical analysis procedure used to test every hypothesis and examine each question. The results of the data analyses follow, starting with the structure of the GATB. The results of GATB factor analysis are presented, followed by the application of the confirmed model to the sample of traumatically brain-injured people. In the next section, the GATB scores of the participants are examined in relation to the hypotheses stated. The scores are compared with those of the General Working Population, and the relationship between mean GATB scores and participants' age, education, and employment status are analyzed.

Finally, the central question of the study is addressed. The measure of person-job fit is presented, and the extent of the fit is analyzed for all GATB aptitudes and composites and jobs participants could and could not do. The utility of the person-job fit measure for judging a traumatically brain-injured person's ability to work is examined. The last part of Chapter Four consists of a clinical case analysis that presents a detailed examination of the interaction between one of the participant's abilities and disabilities consequent to traumatic brain injury and the demands of his occupation.

In Chapter Five, the results presented in the previous chapter are discussed. The implications of the findings, for research and clinical intervention purposes, are presented, starting with those related to the structure of the GATB. Following is a discussion of the use of the GATB with individuals with traumatic brain injuries. Suggestions for alternative administrations of the GATB and possible modifications to the battery that may facilitate its use with traumatically brain-injured individuals are presented. The significance of the measure of person-job fit is discussed last. The conceptual framework of the measure, the

measure's usefulness for job matching, and its applications in the vocational rehabilitation process are addressed.

Finally, the conclusions and the limitations of the study are presented, ending with suggestions for future research.

Chapter two

LITERATURE REVIEW

This chapter consists of four parts. The first deals with the *vocational implication of brain injury*, focusing specifically on the problems that people with brain injuries experience obtaining and maintaining employment. A brain-injured person's ability to work is usually assessed by psychological and neuropsychological tests, which are sensitive to brain dysfunctions, but have limited validity as predictors of work ability. The General Aptitude Test Battery (GATB), used in vocational counselling and rehabilitation, measures aptitudes related to work demands and may be useful to determine vocational options for brain-injured individuals. Thus the second part of the section concentrates on the *GATB*, presenting a review of the GATB's characteristics and of related literature. Vocational rehabilitation involves assessing not only a person's spared and impaired abilities, but also the demands of occupations. The third part of this chapter presents a review of the *Position Analysis Questionnaire* (PAQ), the job analysis tool used to measure job demands, and related literature. The chapter concludes with a presentation of the *hypotheses and questions* raised by the literature surveyed.

I. VOCATIONAL IMPLICATION OF BRAIN INJURY

A. Return-to-Work Problems

Brain injuries affect a variety of cognitive, behavioral, and physical abilities. Deficits in these areas, individually or in combination, are barriers to obtaining and maintaining employment. In the past decade, a great deal of research has focused on the problems encountered in the vocational rehabilitation of traumatically brain-injured persons (Ben-Yishay, Silver, Piasetsky, & Rattok, 1987; Fraser, 1988; Fraser, Dikmen, et al. 1988; Heaton & Chelune, 1978; Prigatano et al. 1984, 1986; Wehman, Kreutzer, Wood, Morton, & Sherron, 1988; Wehman, Kreutzer, Stonnington & Wood, 1988). Although a detailed examination of the literature dealing with the vocational outcome of brain injury is beyond the scope of this study, a brief review of the major problems is presented.

1. High Unemployment Rate

Securing and maintaining employment is the first challenge that brain-injured individuals face. Work status following a brain injury—that is, whether a person is employed or unemployed—is a common measure of vocational-outcome studies. The literature reviewed indicates that 12 to 82% of persons with a traumatic brain injury are unemployed. Post-1970 studies have revealed higher unemployment levels, reflecting, perhaps, an increase in the number of survivors of severe injuries. The highest employment rate recorded was among brain-injured people who had participated in a comprehensive rehabilitation program: Ben-Yishay et al. (1987) and Prigatano et al. (1984, 1986) reported that 42 to 60% of participants returned to competitive employment 1 to 3 years after being discharged from hospital.

The wide range in the overall unemployment rate reflects the multiple factors that influence an individual's ability to obtain and maintain employment, and the fact that researchers have controlled for different determinants and defined factors such as severity of injury and employment status differently.

2. Work Definition

The term *employed* usually refers to paid, competitive employment. Many researchers use the expressions *competitive employment* and *competitively employable*, but *competitive* is rarely defined.

Competitive alludes to a work market in which employers are concerned primarily with identifying and hiring applicants who will perform optimally. It is important to know the basic components of a competitive labour market in order to identify the areas of skill that must be assessed. Neff (1968), Wehman (1981), and Rush (Ed.) (1986) suggested that working in a competitive labour market encompasses: (a) possessing or having the ability to acquire the skills and interest required of specific occupations or families of occupations; (b) having the capacity to obtain employment by competing on the open labour market; and (c) being capable of maintaining employment. All of these abilities can be impaired following a brain injury. In order to determine an individual's ability to compete, the brain injury's impact on these abilities must be assessed. It is also necessary to define the terminology used as a measure of vocational outcome and to specify the tools that

assess the elements of the concept. To conclude that brain-injured persons, individually or as a group, are competitively employable has serious implications in the areas of compensation and availability of vocational rehabilitation services. Psychologists must be cautious in their use of the terminology addressing work status.

The period of time an individual must work in order to be classified as either employed or unemployed has varied among studies. *Employed* was defined by Bayless, Varney and Roberts (1989) as having worked 75 percent of the time during the last 2 years, by Dennerll, Rodin, Gonzales, Schwartz and Lin (1966) as having worked 10 out of 12 months, and by Newman, Heaton and Lehman (1978) as having worked full-time for the last 6 months. These same researchers (listed in the same order) each defined *unemployed* as not having worked more than 25% of the time during the last 2 years, having worked 3.8 out of the last 12 months, and not having worked during the last 6 months.

The employed group may or may not have been differentiated on the basis of part-time and full-time work. Part-time employment, also referred to as underemployment (Clemmons, 1985), was usually defined by the number of hours worked in a week, or as a percentage of time worked, ranging from 75% to 25%. Wehman, Kreutzer, West, et al. (1989) proposed a monthly employment ratio to measure employment: the number of months a person worked during a determined phase over the total number of months he or she could have worked. The post-injury phase started on the date of hospital discharge. Wehman's measure of vocational outcome appears less arbitrary and thus more useful.

General categories of work, such as skilled versus unskilled and competitive versus sheltered/subsidized, were operationalized (Ben-Yishay et al. 1987; Bowman, 1991; Najenson, Groswasser, Mendelson & Hackett, 1980). Fraser, Dikmen, et al. (1988) used the *Dictionary of Occupational Titles* (DOT) to classify occupations and their levels of complexity. Descriptive measures of employment have included the Hollingshead occupational rating (Dikmen & Morgan, 1980) and the level attained in a sheltered workshop (Malgady, Barcher, Davis and Towner, 1980). Qualitative measures, such as work performance, were determined by supervisors' ratings (Clemmons, 1985).

The aptitude demands of various jobs were measured in two studies. Clemmons (1985) used the Occupational Aptitude Pattern (OAP), which determines the minimum aptitude requirements of an occupation as listed in the *Dictionary of Occupational Titles* (DOT).

Newman et al. (1978) used a research tool called the Minnesota Job Requirements Questionnaire (MJRQ), which estimates aptitude demands based on clients' ratings of the jobs. The MJRQ has not been subsequently developed as a commercially available measure.

3. Factors Affecting Employability

Subgroups within the population of brain-injured people have experienced varying degrees of difficulty finding and maintaining employment, depending on such factors as *severity of injury, pre-injury employment status, post-injury time lapse, and sex, age, and education.*

(a) Severity of injury.

The severity of a brain injury has been variously defined. Common measures used are the Glasgow Coma Scale score, the duration of post-traumatic amnesia, and the length of hospitalization. A brain injury has been classified as severe if the post-traumatic amnesia lasted more than 24 hours (Oddy & Humphrey, 1980) or at least 2 days (Brooks et al. 1987), and/or if the patient's Glasgow Coma score at the time of injury was 8 or less (Levin et al. 1979). Fraser, Dikmen, et al. (1988) classified injuries as mild (12+), moderate (9-11), or severe (3-8) according to Glasgow Coma scores. Rimel et al. (1981) defined a mild head injury as one presenting the combination of a minimum score of 13 on the Glasgow Coma Scale, loss of consciousness for up to 20 minutes, and up to 48 hours' hospitalization.

Employment rates ranging from 29 to 84% were recorded among those with *severe* head injuries (29%, Brooks, McKinlay, Symington, Beattie & Campsie, 1987; 44%, Levin, Grossman, Rose & Teasdale, 1979; 61% at 6 months, 82% at 1 year, and 84% at 2 years, Oddy & Humphrey, 1980). Among those with *mild* head injuries, the rates ranged from 76 to 91% (76%, Rimel, Giordani, Barth, Boll and Jane, 1981; 91% O'Shaughnessy & Fowler, 1984). Fraser, Dikmen, et al. (1988) reported an overall return-to work rate of 73% in a sample in which 60% of the participants had sustained mild head injuries.

Some authors have suggested a poorer vocational outcome, including inability to work at all, as the length of coma increases (Dresser et al. 1973) and as the length of post-

traumatic amnesia increases (Levin et al. 1979; Oddy & Humphrey, 1980). However, other researchers did not find a significant relationship between vocational outcome and the severity of injury as measured by the duration of post-traumatic amnesia (Brooks et al. 1987; Johnson, 1987). This may be due in part to the lack of common measures of post-traumatic amnesia.

Severity of injury has also been measured by the deficits present following the injury. Dresser et al. (1973) found significantly greater chances of unemployment among patients with aphasia, visual impairment, combined motor deficits, and seizures. Their study included penetrating head injuries, and a significant relationship between depth of injury and unemployment was observed. Levin et al. (1979) found that post-injury oculovestibular deficits were associated with greater levels of impairment, which in turn were related to poor vocational outcome.

On the whole, residual cognitive, emotional, and behavioral sequelae of brain injuries greatly exceed physical deficits as a cause of difficulty in long-term vocational rehabilitation (Brooks et al. 1987; Bruckner & Randle, 1972; Clemmons, 1985; Lezak, 1987; Prigatano et al. 1986). An individual's ability to return to work is affected by a variety of deficits: memory problems, personality change, loss of emotional control, concentration problems, slowed mental processing, social isolation, aspontaneity, and a tendency to fatigue (Fahy, Irving & Millac, 1967; Long, Gouvier & Cole, 1984; Thomsen, 1984; Van Zomeren & Van Den Berg, 1985; Najenson, Groswasser, Mendelson & Hackett, 1980; Groswasser, Mendelson, Stern, Schechter & Najenson, 1977). A number of studies indicate that brain injuries producing greater memory, learning, and personality deficits result in poorer work adjustments than do injuries similar in severity, but producing fewer deficits in these spheres (Bond, 1975; Bruckner & Randle, 1972; Weddell, Oddy, & Jenkins, 1980). Although physical limitations appear less restrictive, Wehman, Kreutzer, Stonnington, et al. (1988) found that they were barriers to placement in supported employment programs when they were combined with cognitive impairments.

(b) Pre-injury employment status.

Some studies compared pre- and post-injury employment rates. Levin et al. (1979) found that the employment rate dropped from 96% before injury to 44% after injury. Participants in their study had sustained severe head injuries, and their employment status was

measured 6 months to 9.5 years after their injuries. Rimel et al. (1981), considering only those people who were employed before they were injured, observed a post-injury employment rate of 66%. Brooks et al. (1987) measured participants' employment status over a 7-year period, and noted that the employment rate dropped from 86% before injury to 29% after injury.

Of those who were employed prior to being injured and who successfully returned to work, many took on less demanding positions (Brooks et al. 1987, Clemmons, 1985; Fraser, Dikmen, et al. 1988; McMordie, Barker, & Paolo 1990).

(c) Follow-up period.

Follow-up periods have varied enormously, from 3 months (Rimel et al. 1981) to between 7 and 9.5 years (Brooks et al. 1987; Levin et al. 1979). Brooks and colleagues found no evidence that employment likelihood increases more than 2 years post-injury, and a reexamination of Thomsen (1984) supports this conclusion. Ben-Yishay et al. (1987) noted a decline in employment rate in a post-discharge period of 1 to 3 years.

(d) Demographic factors.

The relationship between demographic factors and return to work following a brain injury has not been consistently addressed, and studies have produced varied conclusions. Rao et al. (1990) noted that the brain-injured individuals who returned to work were younger, had shorter coma periods and stays in rehabilitation centres, and had higher institutional discharge scores. Brooks et al. (1987) and McMordie et al. (1990) suggested that chances of employment decrease for brain-injured individuals aged 40 and older. Although Rimel et al. (1981) found a higher percentage of employment with increasing age, their sample appears to have included children, and it did not sufficiently define increasing age.

The sex variable has been difficult to study because most samples are predominantly male. Brooks et al. (1987) suggested a nonsignificant trend of a higher return-to-work rate for females. McMordie et al. (1990) surveyed a group of brain-injured adults (n = 177) and reported that females were more likely than males to return to work. Rimel et al. (1981) found higher rates of post-injury employment among individuals with higher education levels and socioeconomic status. Wehman, Kreutzer, Stonnington, et al. (1988) noted increased likelihood of placement among those with higher educational levels. Brooks et

al. (1987) found that pre-injury occupational level did not significantly relate to return to work following a head injury.

4. Transfer of Skills

Difficulties transferring acquired skills have been observed among brain-injured individuals in vocational rehabilitation. Prigatano et al. (1986), following the evaluation of the Oklahoma rehabilitation program, suggested that work trials be included in vocational rehabilitation, since patients are not able to transfer skills acquired through clinical rehabilitation to the work environment. The levels of functioning patients demonstrate in structured rehabilitation settings is not always exhibited in the workplace (Weinberger, 1985). In response to this problem, the supported employment model (Fraser, 1988; Wehman, Kreutzer, Stonnington, et al. 1988; Wehman, Kreutzer, Wood, et al. 1988; Kreutzer, Wehman, Morton,& Stonnington, 1988; Wehman, Kreutzer, West, et al. 1989; Wehman, Kreutzer, Wood et al. 1989; Wehman, West, et al. 1989) extends vocational rehabilitation intervention to the work site.

5. Vocational Goal Selection

One of the difficulties encountered in the initial stage of community vocational rehabilitation is setting realistic vocational goals. The organically based deficits associated with brain injuries—lack of awareness and impaired judgement, for instance —and the denial of deficits that is often observed after a trauma have frequently resulted in unrealistic vocational goals, which have in turn led to failure (Ben-Yishay, 1987; Prigatano et al. 1986; Wehman, Kreutzer, Stonnington, et al. 1988). The impact of this problem is reflected in unemployment rates that were higher 3 years post-injury than they were at 1 year post-injury (Ben-Yishay et al. 1987).

Summary: Return-to-Work Problems

Research into return to work following a brain injury has exposed problems in obtaining and maintaining employment. Researchers have examined the roles of several moderating factors and used many definitions of work. A patient's socioeconomic status, the injury itself, and post-injury rehabilitation are factors that determine his or her employment

potential. High rates of unemployment remain even after rehabilitation intervention. Brain-injured individuals who return to work are likely to occupy lower-level positions, and many have trouble maintaining employment.

The most common evaluation of work success is whether people are employed or unemployed, and whether those who are employed work full-time or part-time. Other measures, in order of the frequency with which they are used, are categorization of position held, job performance as rated by employers, and job demands as rated by participants. Information about participants' work status has been obtained from patients in the majority of studies, and from employers occasionally.

A marked lack of consideration has been given to specific definitions of the variables used to measure vocational outcome. Definitive measures of the demands of occupations held or unsuccessfully maintained by brain-injured individuals are noticeably limited. The two studies that determined the aptitude demands of the subjects' occupations (Clemmons, 1985; Newman et al. 1978) used measures that were later abandoned.

The prevalence of problems that brain-injured individuals experience entering and re-entering the work force calls for vocational rehabilitation intervention. The leading rehabilitation programs include vocational rehabilitation components within the treatment centre (Ben-Yishay et al. 1987; Prigatano et al. 1986) or in the community (Fraser, 1988; Wehman, Kreutzer, Stonnington, et al. 1988).

Whether set in a holistic rehabilitation program or a community vocational service, the vocational rehabilitation process begins by assessing individuals' abilities. This leads to job matching and setting realistic vocational goals.

B. Neuropsychological Assessment of Work Ability

Given the nature of the deficits caused by a traumatic brain injury, an individual's ability to work is usually assessed by a Neuropsychologist. Many researchers have studied the relationship between neuropsychological tests and work ability, focusing on two areas: the tests' ability to predict vocational outcome, and their usefulness in making a clinical judgement of the person's capacity to work.

1. Neuropsychological Tests and Vocational Outcome

The majority of researchers investigating the predictive and discriminative abilities of neuropsychological tests have used expanded versions of the Halstead-Reitan Battery (Bowman, 1991; Clemmons, Fraser, Dodrill, Trejo & Freelove, 1987; Clemmons, 1985; Dennerll et al. 1966; Dikmen & Morgan, 1980; Heaton & Chelune, 1978; Newman et al. 1978; Schwartz, Dennerll, & Lin, 1968). The Minnesota Multiphasic Personality Inventory (MMPI) is most often included as a personality measure (Bowman, 1991; Heaton & Chelune, 1978; Kunce & Worley, 1970; Newman et al. 1978; Wehman, Kreutzer, Stonnington, et al. 1988). Occasionally, studies have focused on the usefulness of individual tests (Tinker Toy Test: Bayless et al. 1989; Wechsler Adult Intelligence Scale (WAIS): Shalock & Harper, 1980; Webster, 1974, 1979).

Research indicates that composite scores are more powerful predictors than individual tests. The composite scores used were derived from established indexes, such as the Halstead-Reitan Impairment Index (Bowman, 1991; Dennerll et al. 1966, Newman et al. 1978; Fraser, Dikmen, et al. 1988) the WAIS Performance (PIQ), Verbal (VIQ), and Full Scale (FIQ) IQs (Clemmons, 1985; Heaton & Chelune, 1978, Newman et al. 1978), and the Wechsler Memory Quotient (Heaton & Chelune, 1978; Prigatano et al. 1986). Some researchers (Acker in Uzzell & Gross (Eds.), 1986; Dikmen & Morgan, 1980; Kunce & Worley, 1970) regrouped tests in factors, on the basis of face validities or clinical judgments, and obtained average factor scores. In the Santa Clara Medical Centre (CMC Acker in Uzzell & Gross (Eds.), 1986) Head Injury Project, test scores were transformed to a common measure (t or Z) and converted to an impairment index based on a Lickert scale.

Some individual and subtest scores were also found to be significantly related to employment status, including Digit Symbol in the WAIS (Prigatano et al. 1984; Stuss et al. 1985) Visual Reproduction and Paired Associates in the Wechsler Memory Scale (WMS) (Prigatano et al. 1984), the Paced Auditory Serial Addition Task (PASAT) (Brooks et al. 1987; Gronwall, 1977), Finger Tapping (Dennerll, 1966), Stroop Color-Word Interference Test (Stroop) (Clemmons & Dodrill, 1983), Trail B (Dennerll et al. 1966; Heaton & Chelune, 1978), Category Test (Dennerll et al. 1966; Heaton & Chelune, 1978), and MMPI (Bowman, 1991; Heaton & Chelune, 1978).

It is not surprising that composite scores are more often found as predictors: Work is a complex task requiring a combination of abilities, and a composite synthesizes a group of skills, more accurately reflecting the global criterion measured as work/no work.

The following section presents a brief review of literature from different categories of study, in order to illustrate the use of neuropsychological tests in predicting ability to work.

(a) Individuals with epilepsy.

Several researchers have examined the differences between the neuropsychological functioning of employed and unemployed epileptic patients. Dennerll et al. (1966) found that unemployed epileptic patients scored significantly lower on the WAIS than employed patients did, and performed significantly poorer on 11 of the 15 Halstead-Reitan tests. The personality and psychological adjustment measures used were the California Psychological Inventory (CPI) and the Edwards Personal Preference Schedule (EPPS). These measures indicated that levels of social competence are related to increased chances of employment. It is worth noting that the unemployed patients had significantly fewer years of education, histories of earlier onset and longer duration of epilepsy, and poorer responses to medication than those in the employed group. Although they were considered only mildly impaired, the unemployed patients' overall neuropsychological impairment was significantly greater than that of the employed group.

Schwartz et al. (1968), using a battery of tests almost identical to that used by Dennerll, found that a particular combination of neuropsychological and personality measures successfully identified the employment status of 77% of the employed participants and 80% of the unemployed. The best individual predictors of current employment status were three WAIS subtests (Comprehension, Similarities, and Digit Symbol) and two CPI scales (Self-Acceptance and Social Presence, both of which load on the social competence factor). Possible neurological differences between the groups were not reported.

Dikmen and Morgan (1980) grouped a series of 36 neuropsychological tests into six composites (Verbal, Visual-Spatial, Flexibility in Thinking, Memory and Alertness, Motor, and Concept Formation) according to face validities. They investigated the ability of individual and composite tests to differentiate between employed and unemployed epileptic persons, and high and low occupational status (Hollingshead occupational status

ratings). Individual and composite measures of Flexibility in Thinking and Memory and Alertness consistently differentiated between employed and unemployed, and the composites differentiated between high and low occupational status. The unemployed low-status group performed the worst and the employed high-status group the best on neuropsychological tests. The unemployed group generally had fewer years of education, and low occupational status was associated with an earlier onset and longer duration of seizures.

Clemmons and Dodrill (1983) examined the employment status of 42 young adults with epilepsy, 38 of whom were high school students at the time of testing. The average follow-up period was 6.44 years. The neuropsychological measures that were significant predictors of employment status were WAIS IQ scores, the percentage of neuropsychological test scores outside the normal limits, and the MMPI. The average IQ of the 56% who were unemployed was at the low end of the normal range, and significantly lower on all three IQ scores than that of the employed. A higher percentage of neuropsychological test scores outside the normal limit was observed among the unemployed. The MMPI was not found to be related to employment status at follow-up.

In summary, research suggests that unemployed persons with epilepsy are more likely to have histories of earlier onset of seizures, to have less education and attain lower occupational status, and, often, to have lower WAIS IQs. At least one study has related this population's neuropsychological problems to difficulties with flexibility of thinking, attention, and memory. Information on personality characteristics is sparse, but studies indicate that social competence is more often found among the employed than the unemployed. Clemmons (1985) concluded that the leading cause of unemployment among people with epilepsy is not the presence of seizures, but organically based intellectual and psychosocial deficits.

(b) Mixed etiologies.

Studies by researchers at the Colorado University Health Science Centre (Heaton & Chelune, 1978; Heaton & Pendleton, 1981; Newman, Heaton & Pendleton, 1978) are good examples of research into the role of neuropsychological tests in measuring work ability. The patients studied had sustained brain injuries of various origins—trauma, Cerebral Vascular Accident (CVA), tumors, anoxia, epilepsy, psychiatry, and surgery. Using the Halstead-Reitan battery of neuropsychological tests, expanded with the WAIS, MMPI,

three subtests of the Peabody Individual Achievement Test (PIAT), and WMS, Heaton & Chelune, (1978) investigated the predictive validity of test performance for work status—full-time, part-time, or unemployed—in a sample of 381 patients. They concluded that neuropsychological tests and MMPI are useful in predicting work status. The full-time employed performed best, the unemployed poorest, and the part-time employed at an intermediate level. Participants in all three groups were within the normal range on the WAIS Full Scale IQ, a fact that supports Lezak's (1987) conclusion that Full Scale IQ is not a useful measure of cognitive abilities following a traumatic brain injury. There were greater differences between the VIQ and PIQ scores of unemployed participants; they scored lower than average on the PIQ. The employed participants scored within the normal range on the Halstead-Reitan Impairment Index, and the unemployed obtained scores within the mild to moderately impaired range on most of the Halstead-Reitan tests. More personality disturbances were observed in the unemployed group.

The researchers carried out multiple regression and discriminant function analysis with half of the sample, allowing for cross-validation. Of the 10 best predictors of unemployment, the Halstead-Reitan Impairment Index was the single best predictor. The stepwise discriminant function analysis used selected measures—Russell's Average Impairment Rating (AIR), WAIS-VIQ and PIQ, PIAT, and/or the MMPI scales—to discriminate between full-time employed and unemployed. Using neuropsychological tests alone, the employment status of 74.2% of the participants was correctly identified. Using only the MMPI, almost 79% were correctly identified. These classification rates compare well with the 84% categorization rate obtained from the combination of neuropsychological and personality testing. False negative and false positive were not calculated. Adding the education variable as a predictor lowered the classification rate. Based on these findings, the authors suggested that current adaptive ability as tapped by many of the neuropsychological tests may predict likelihood of employment, but is less helpful for identifying accessible jobs.

Newman et al. (1978) followed up 78 persons who had been referred for neuropsychological testing. The interval between testing and follow-up was at least 6 months for 81% of the group. The participants who had been employed in the previous 6 months completed the Minnesota Job Requirements Questionnaire (MJRQ), which rates job

requirements and estimates demands with respect to the nine ability factors of the General Aptitude Test Battery (GATB).

Newman and his colleagues used the neuropsychological tests as predictors of future employment status, income, and estimated cognitive and perceptual aptitude requirements. The tests correlated not only with employment status, but with income and aptitude requirements. Using stepwise multiple regression, the researchers found that the AIR index was the most sensitive predictor of chronic unemployment. Using an AIR index cutoff point of 1.61, 78% of the unemployed were correctly identified. It is worth noting, however, that 18% were falsely identified as unemployed, and 14% falsely classified as employed. The WAIS-FSIQ and the MMPI psychopathic deviate scale best predicted the cognitive demands of the jobs. Jobs requiring perceptual/motor abilities were associated with good spatial relation test scores and relatively low MMPI depression scores, but not with scores on any of the major cognitive tests. In general, the MMPI did not have much predictive utility.

Because the MMPI was less predictive of future employment (Newman et al. 1978) than of current employment (Heaton & Chelune, 1978), Heaton and his colleagues suggested that current unemployment is associated with negative emotional reaction. Elevations on many scales, particularly depression, they said, could be consequent to prolonged unemployment. Wehman, Kreutzer, Stonnington, et al. (1988) noted that brain-injured individuals placed through supported employment programs showed more emotional stability and less depression on the MMPI than did nonplaced referrals.

(c) Participants in rehabilitation programs.

In their follow-up study, Ben-Yishay and colleagues (1987) investigated the relationship between functional, behavioral, and interpersonal *process measures* and return to work. They did not specify which tests were used. They concluded that of the five predictors found useful, three were behavioral, psychological, and personality measures, and two were measures of cognitive processing.

Prigatano et al. (1986) noted that both the WAIS-Digit Symbol test and the Katz-R adjustment scale significantly differentiated between employed and unemployed participants who had completed the rehabilitation program.

Wehman, Kreutzer, Stonnington, et al. (1988) found no relationship between the neuropsychological impairment of placed and nonplaced groups of brain-injured individuals referred to supported employment programs.

2. *Clinical Judgment of Work Ability*

In clinical settings, Psychologists use neuropsychological tests to delineate the cognitive and behavioral consequences of brain injuries, and to predict the likely impact of deficits on everyday functioning. To determine an individual's ability to work, clinical Neuropsychologists rely on their knowledge of what the tests measure, clinical observations and experience, and reports from occupational trials. Because the tests were constructed without regard for the abilities successful work performance requires, the vocational impact of the deficits observed via testing cannot be determined from information provided by the tests' psychometric properties (construct or criterion validity). Neuropsychologists make judgments on an individual's ability to work on the basis of their experience using the tests and on seeing how the client performs in a rehabilitation setting.

Psychologists translate the spared abilities and deficits into general functioning abilities related to work. Experienced clinicians (Heaton & Pendleton, 1981; Kay & Silver, 1988; Lezak, 1987) have assessed work ability by clinically interpreting neuropsychological test data. These clinicians repeatedly stress the need to use qualitative behavioral observations beyond test scores to judge a person's work ability.

Based on present knowledge of the relationship between neuropsychological tests and work ability, even experienced clinicians are limited to general statements. In offering an opinion on a person's ability to fulfil a specific job or work duties within a specific occupational field, a Psychologist can only extrapolate from the deficits observed in the testing situation and the description of the work that's available. In many instances, Neuropsychologists have limited and general information about job demands.

Summary: Neuropsychological Assessment of Work Ability

At present, Neuropsychologists usually assess brain-injured individuals' ability to work on the basis of neuropsychological tests. Although these tests are essential tools, sensitive to neuropsychological dysfunction, they present serious limitations for vocational assessment. In

view of the lack of criterion-related validity information about the tests, many authors (Clemmons, 1985; Heaton & Chelune, 1978; Prigatano et al. 1986) have pointed out the difficulty of relating data obtained from neuropsychological tests to specific jobs. The correlational analysis examining the relationship between tests scores and vocational outcome are generally not based on knowledge of the specific relationship between neuropsychological measures and work demands.

Studies of the predictive ability of neuropsychological tests have concentrated on employment status (employed, unemployed, or underemployed) rather than on job demands. Composite scores are generally better predictors of work status, and greater impairment as measured by neuropsychological tests indicates more problems in the workplace. Without further research including work demands, however, it is difficult to identify the factors explaining the correlations found and if the findings are applicable across occupations.

Most clinicians have limited opportunities to observe individuals in their natural environments, or even in rehabilitation settings. There is a definite need for a brief, yet valid measure of work ability that is sensitive to the deficits that follow brain injury. Prigatano, Pepping & Klonoff, in Uzzell & Gross (Eds.), (1986) noted that "if we are going to make recommendations about the reintegration of an individual into the community following brain damage, based on test results, we need to have a better understanding of how our current test procedures relate to such aspects of functioning as job performance and independence in activities of daily living" (p. 164).

C. Vocational Assessment of Work Ability

By investigating the assessment methods and tools used in vocational counselling, we may be able to increase our ability to use test data in the rehabilitation of brain-injured persons.

1. Job Matching

Job matching, the process of analyzing the compatibility of an individual's abilities and the demands of a specific occupation or family of occupations, is an important initial step in the vocational counselling and rehabilitation process. To find an acceptable worker-job fit, we must assess the abilities deemed necessary to successfully perform work, and know the demands of specific types of work.

Commercial computer job-matching programs used in vocational exploration search a database of all available jobs for those that match specific vocational profiles. In vocational rehabilitation, individual job matching is more appropriate, so that job modification can be investigated and work adjustment strategies can be developed. In both cases, the demands of a considered occupation are assessed using a job analysis procedure.

2. The GATB

The most widely used measure of work-related aptitude is the General Aptitude Test Battery (GATB). The GATB is available in 13 languages and is used in 35 countries (Droege, 1984). Standardization and validation studies have been conducted in 16 countries. In Canada, it is usually the aptitude test of choice in government and private vocational rehabilitation agencies.

The GATB's relationship to work demands as classified by the *Canadian Classification and Dictionary of Occupations* (CCDO) makes it the most relevant aptitude test available for job selection (Botterbusch & Michael, 1985). A major reference text compiled by the Canada Employment and Immigration Commission, the CCDO lists more than 7,000 Canadian job titles and their requirements in the areas of physical demands, environmental conditions, general educational development, aptitudes, interests, and temperament. The *Dictionary of Occupational Titles* (DOT) is the American counterpart of the CCDO.

The GATB measures the same nine aptitudes by which the CCDO breaks down occupations. A person's tested abilities can therefore be matched with the criteria listed in the CCDO to select possible occupations with aptitude requirements equal to or less than his or her capabilities. Although many cognitive abilities not explicitly measured by the GATB—judgment, abstract reasoning, and speed of processing, for example—may be important to job performance, occupational norms are not yet available for them. The nine aptitudes the GATB *does* measure, however, have been found to account for much of the ability judged relevant to the world of work (Athelstan, in Kottke, Stillwell & Lehmann (Eds.), 1982).

Conclusion

The GATB is the aptitude test likely to be used with brain-injured persons, although interpretive data is lacking for this group. The present study contributes much-needed research into the GATB performance of brain-injured individuals and the relationship between the GATB and their demonstrated vocational capacities. The intent is not to replace neuropsychological testing with the GATB; the GATB was not designed to identify damage following a brain injury. It is a work-related measure, however, and it shows some correlation with neuropsychological tests. The objective of this study was to investigate the GATB's value as an assessment tool for Neuropsychologists working with brain--injured persons. Because the GATB is one of the central measures of this study, the following pages offer a description of the battery's characteristics and a review of pertinent literature.

II. THE GATB

A. History/Basic Description

The GATB has been in use for more than 40 years. It was developed by the United States Employment Service (USES) between 1942 and 1945, and the original form, B-1001, was operational by 1947. The second edition of the GATB, known today as B-1002, was completed in 1952 and produced in two forms, A and B. In 1983, two additional forms of the GATB-1002, Forms C and D, were introduced.

Forms A and B of the GATB have been used by the Canada Employment and Immigration Commission since 1966, and are available to Psychologists and Vocational Counsellors for vocational counselling and personnel selection with adult populations. The standardized administration of the GATB requires that participants have a Grade 8 reading level.

A complete description of the GATB is available in Appendix A. Briefly, the battery consists of 12 subtests measuring nine aptitudes. All subtests are executed with short time limits (5 to 7 minutes), and therefore measure both speed and quality of work. Some subtests, however, such as Motor Coordination and Form Matching, are intended more as measures of speed, while others, such as Arithmetic Reasoning and Verbal aptitude, are

intended as power tests. The speededness of the GATB has been criticized by most reviewers, and will be addressed later.

B. Norms

1. United States

Norms for the GATB were originally developed in 1952, from what USES referred to as the General Working Population Sample. This sample of 4,000 individuals between the ages of 18 and 54 was stratified to represent the distribution of the work force as described on the 1940 census for age (18 to 54), sex, occupation, and geographic area. The GATB scores from this reference population were used to derive GATB aptitudes, which are standardized with a mean of 100 and a standard deviation of 20.

A 1966 analysis of data from GATB research done between 1950 and 1966 (N = 23,428 workers) concluded that the norms had remained stable. The lack of recent normative information on the GATB has been criticized by reviewers (Hartigan & Wigdor, 1989; Keesling in Mitchell (Ed.), 1985; Weiss, in Buros, 1972). Significant changes in the composition of the labor market over the last 25 years suggest the need for revised GATB norms.

2. Canada

The first normative study in Canada, done in 1964, led to the conclusion that the difference in results did not merit separate norms, and consequently, the American norms were adapted. In 1985, subtest 6, Arithmetic Reasoning (on Forms A and B), was revised to eliminate imperial units of measure and sex bias, and to update price and wage information. The GATB norms were also revised for the paper-and-pencil tests. The normative sample representative of the Canadian General Working Population for the English version of the test consisted of 977 individuals between the ages of 18 and 54 (mean: 30.7) who "had at least one year work experience and were not unemployed for more than 6 out of the last 12 months. They all had a minimum of grade 8 education" (Behavioral Team, for EIC, Employment Counselling Development Division, 1985, p.8). A broad range of job categories was included in the sample, in each region and across the country.

C. Test Bias

The GATB is presented as an unbiased measure in relation to the variables sex, geographic location, age, ethnic minority, and education.

1. Sex

The GATB does not provide sex-based norms. The *Manual for the USES General Aptitude Test Battery, Vol. III: Development,* (1979) reports no significant difference in the GATB's predictive validity for job performance among men and women. Swarthout et al. (1984), completed a meta-analysis of 122 GATB validation studies (post-1972) using specific GATB aptitude patterns as predictors of employment for males and females. They analyzed the differences in validities between sexes using several approaches: chi square techniques, comparison of average validities, comparison of differences in validities weighted by sample size, and comparison of subjects' placement into job families (job families four and five, as per Hunter's (1983b) classification). The researchers concluded that the GATB's ability to predict job performance is similar for males and females.

2. Geographical Area

The same authors used a similar methodology to investigate the effect of geographical area, conducting four analyses. The chi square analysis revealed "slightly more significant" (Swarthout et al. 1984a, p.iii) differences between geographical areas. The authors indicated that this could have been related to statistical artifacts (type I error), and concluded that "there are no meaningful differences in GATB validities between geographic areas" (Swarthout et al. 1984a, p. iii).

3. Age

Performance on psychological tests has been thought to be influenced by age (Anastasi, 1978). Many psychological tests provide age-related norms—in other words, an individual is not compared to a single reference group, but to his or her age subgroup. The GATB, however, does not provide age-related norms. *Manual for the USES General Aptitude Test Battery, Section III: Development* reports no significant difference in predictive ability of the GATB Occupational Aptitude Pattern (OAP) due to age. Clemmons (1985) found no

significant differences on GATB scores (N = 354 people with epilepsy) across four age groups: 24 or younger, 25 to 29, 30 to 35, and 36 or older. Stoelting (1990) reported that age correlated significantly with GATB-G, V, N and Q with a mixed group (n=53 with physical disability and n=31 with psychiatric disability) of disabled individuals.

However, Weiss (in Buros, 1972) points out that all GATB aptitudes except V (Verbal) show a general decline with age, with scores on the most highly speeded tests declining more rapidly (Fozard, Nuttall, & Waugh, 1972). Hunter (1983a) analyzed the correlation between age, race, and the three factors he identified as underlying the GATB. He observed decrements due to age on all the GATB composites, with declines greater for psychomotor than for perceptual abilities. Taking into account the correlation between psychomotor and perceptual factors, age still had a small impact on perceptual ability.

The GATB has been criticized (Weiss, in Buros, 1972) for penalizing older workers when personnel selection is based on GATB performance. The argument used for comparing the unadjusted scores of older workers to those of the General Working Population, which has a mean age of 30, is that these workers compete with younger workers in the labor market. Other factors, however, such as accuracy and experience, may be as important as speed for certain occupations. It would be useful to compare an individual with both his or her age group and the group representing the majority of the working population as the labor force ages in the next decade.

4. Ethnic Minorities

The issue of differential validity of the GATB is not pertinent to this study, as the sample was homogeneously white and English-speaking. Racial bias in the employment selection process is a major concern in the United States, however, so the fairness of the GATB has been carefully examined. The question of whether there is a bias towards ethnic groups has focused on the predictive validity of the GATB for job performance. It has generally been concluded that the GATB is fair: it predicts or classifies people equally across ethnic groups, and the differences it shows in relation to job performance are believed to reflect real differences (NAS, Hartigan & Wigdor, 1989; Hunter, 1983c). In the end, the authors concluded that the issue was not a question of the GATB's fairness, but a social issue related to hiring policy and employment equity.

Kellett (1989) investigated the methodology used to study test bias. Six techniques to assess test bias were examined. Four GATB subtests were administered to ethnic minorities. Although the primary aim of Kellett's study was not to determine whether the GATB was a fair test, the analyses performed provided a detailed examination of the possible bias of the GATB across cultural groups. It must be emphasized however, that as pointed by the author, due to the focus of this study, the observations of bias on the GATB subtests cannot be generalized. As the author mentioned, the cultural groups and reference groups in the study sample were not selected to achieve representativeness, and only four subtests of the GATB were used.

Of interest is the fact that 41% of the comparisons of equivalence contrasting the cultural groups and the norm group led to decisions of non-equivalence. Using the comparative factor analysis technique, decisions of non-equivalence were never reached. This indicates that the GATB subtests measure the same constructs with all groups.

5. Education

The National Academy of Science (NAS) (Committee on the GATB, Hartigan & Wigdor, 1989) examined the relationship between mean education and validity of GATB composites across 755 validity studies. The validities of the cognitive composite were higher in the educated samples, while the validities of the motor composite were higher for the less educated sample. Stoelting (1990) noted a significant correlation between education and all GATB aptitudes with the exception of GATB-F and M with a mixte group of disabled individuals.

Summary: GATB Norms/Biases

The GATB was developed by the United States Employment Service (USES) and has been used for more than 40 years for vocational counselling and rehabilitation. USES's claim that the GATB is an unbiased and fair test is generally supported. However, significant changes in the composition of the labour market over the last 25 years suggest a need for revised GATB norms. The age factor needs to be accounted for, particularly for the speeded tests, and it is recommended that age-related norms and differentiation of speed versus accuracy measures be developed.

D. Factor Structure of the GATB

1. Initial Factor Analysis

The subtests comprising the GATB and the identification of aptitudes (factors) measured by these subtests emerged from nine factor analysis studies done between 1942 and 1944. Two main criticisms of the original factor analysis studies have been voiced. First, each of the original factor analysis studies contained between 15 to 29 tests, yet none of the studies included the actual 12 subtests that were eventually selected for the final version of the GATB. Accordingly, there was no opportunity to verify that the selected group of subtests had the assumed factor-analytic structure. Second, the samples of 5 of the 9 original studies contained fewer than 200 subjects each, and have therefore been judged insufficient to grant confidence in the replicability of the factors (Thorndike, 1978, in Hammond, 1983).

2. Subsequent Factor Analyses

Subsequent factor analyses have been reported in the last 20 years (Fozard et al. 1972; Hammond, 1983; Hunter, 1983a; Katz, Beers, Geckle & Goldstein, 1989; Mothersill & Sharp, 1991; Watts & Everitt, 1980). Various factor analytic methods have been used: factor analysis with varimax rotation (Fozard et al. 1972; Mothersill & Sharp, 1991), maximum likelihood followed by Maxwell's (1972) determinacy test (Hammond, 1983; Watts & Everitt, 1980), confirmatory factor analysis (Hunter, 1983a), and principal component analysis with varimax rotation (Katz et al. 1989).

These studies have all concluded that the GATB measures fewer than eight independent aptitudes—that, in fact, it measures three or four factors: a cognitive/symbolic factor, a perceptual factor, and a motor factor or factors. The factor analytic solutions have proposed different sets of subtests in each factor. The Clerical Perception and Form Perception subtests have been classified under different factors. Fozard et al. (1972), Mothersill and Sharp (1991), and Hammond (1983) reported that Clerical Perception loads on the cognitive/symbolic rather than the perceptual factor. Hammond explained that Clerical Perception is related to reading ability rather than to perceptual process. This conclusion is supported by the correlation between the eight GATB aptitudes reported by NAS, committee on the GATB (1989): "The highly correlated groups are VNQ, SP, and

KFM" (NAS, Hartigan & Wigdor 1989, p. 141). (The GATB aptitudes V, N, Q, S, P, K, F, and M are described in Appendix A.)

Fozard et al. (1972) and Mothersill and Sharp (1991) concluded that Spatial and Form Perception load on a "spatial-perceptual" factor. Hammond (1983) suggested that the two subtests thought to measure form perception load on different factors: Form Matching on cognitive/symbolic, Tool Matching on perceptual. He proposed that "the complexity of presentation of Form Matching items requires more relational fluency than the more one-to-one figure matching of the Tool Matching test" (pp. 45-46). Watts and Everitt (1980) proposed that the perceptual factor is composed of Clerical, Form, and Spatial Perception subtests.

Hunter (1983a) used a confirmatory factor analysis to investigate the heuristic models developed during an exploratory factor analysis. He concluded that the GATB measures three general abilities: cognitive, perceptual, and motor. The cognitive and motor composites are minimally correlated (.35), and the perceptual composite is correlated with both the cognitive (.76) and the motor (.51).

According to Hunter's analysis, specific aptitudes are largely irrelevant for prediction of job performance. General abilities are better predictors. Composite scores on the GATB, therefore, can be used as predictors of performance. In support of his theory of general abilities, Hunter demonstrated that composites accurately predict the validities of specific aptitudes, and that the cognitive and motor composites predict the perceptual composite. The predictive validities of aptitudes within the same composites, he suggested, are constant. Perceptual aptitudes, he argued, do not increase the predictive validity of the GATB for most jobs as long as the cognitive and motor aptitudes are perfectly measured.

Hunter's analysis of the dimensionality of the GATB has been criticized by the Committee on the General Aptitude Test Battery (NAS, Hartigan & Wigdor, 1989). In his examination of the correlations among validities of aptitudes within the same composites for the same jobs, Hunter corrected the correlations across studies for attenuation due to sampling error. The Committee on the GATB judged the reliability formula used to correct the correlations inaccurate in this case, "because the errors in measuring different validity coefficients are correlated" (p. 140). Estimating a matrix of correlations using a different correction for reliability, the committee disagreed with Hunter's conclusion. The composites, it said, do

not accurately predict the validity of single aptitudes, and the perceptual aptitude composite is not sufficiently accounted for by the two other composites.

Although the committee does not rule out the use of composites for predicting job performance, it neither endorses the organization of composites by content as proposed by Hunter nor rejects the perceptual composite as a predictor of job performance for most job families. The committee did not perform a confirmatory factor analysis on the GATB data to suggest a more appropriate factor structure.

Summary: GATB Factor Analysis

Factor analytic studies clearly indicate that the GATB's nine aptitude scores can be combined in composite scores without losing important information. There is, however, no consensus on the exact number of factors that adequately capture the information the GATB measures, or on how to regroup the subtests by composites. This indicates the need for further investigation. The only confirmatory factor analysis that was done (Hunter, 1983a) was conducted with the GATB aptitude scores rather than with the subtest scores. Considering Hammond's (1983) findings, and the criticism levelled against the original GATB factor analysis, it may be preferable to work with the subtest scores whenever possible.

Additional studies using confirmatory factor analytic methods are needed to clarify how information obtained from the GATB can be simplified. As Cronbach (1984) has cautioned, however, it is important not to oversimplify the GATB, and thereby reduce its usefulness. For prediction of job performance, Hartigan & Wigdor (1989) suggested that it might be more efficient to develop appropriate weights for individual aptitudes judged important for a particular class of jobs. This concept is similar to the Occupational Aptitude Pattern (OAP) system that was used in the past.

E. Psychometric Properties

1. Validity

(a) Content.

For a comprehensive and recent review of research on the GATB's psychometric properties, see Jaeger, Linn, and Tesh, (Appendix A) in Hartigan & Wigdor, (1989). In reviewing the convergent validity of the GATB, the authors selected "appropriate" studies among the numerous convergent validity studies of the GATB, according to the following rules:

> *First, only correlations between GATB aptitudes or subtests and corresponding components of other aptitude batteries were included.... Second, only correlations with aptitude battery components having titles similar to the GATB measure of interest were retained.... Third, in studies that reported correlations between all possible pairs of measures composed of a GATB aptitude and an aptitude from another battery, only the largest correlation between any GATB aptitude and an aptitude from the other battery was retained (p. 305).*

The convergent validity coefficients indicated that the GATB's cognitive aptitudes (GVN) are appropriately named and adequately measure the concept they represent. Perceptual aptitudes (SPQ) presented more variation, with spatial aptitude offering a respectably large coefficient, and Perceptual and Clerical Perception presenting less than adequate convergent validity coefficients. The authors suggested that the rigorous speed factor of the Form and Clerical Perception subtests may differentiate them from other tests used in the convergent validity studies. Data sufficient to support conclusions about the convergent validity of the psychomotor subtests were not available.

(b) Predictive validity/criterion-related validity.

The GATB's ability to predict training success and job performance has been continuously and extensively examined in 750 job performance criterion-related studies. Its ability to predict training criteria (.35, Hartigan & Wigdor, 1989) compares well with those of other test batteries, and has exceeded its ability to predict job performance (.30, Hartigan & Wigdor, 1989).

The GATB's ability to predict job performance has received special attention in the last decade with the development of the Validity Generalization-GATB (VG-GATB) referral

system. The VG-GATB is a test-based referral system for personnel selection, developed to improve person-job match and, consequently, to enhance productivity. The nine GATB scores are combined in three composite scores: GVN, SPQ, and KFM. The composites, in turn, are weighted in a classification system that identifies five job families. They are then combined to produce an overall aptitude score for each job family. This aptitude score is transformed into a percentile score, permitting a top-down selection ranking of applicants.

In the United States, widespread adoption of the VG-GATB referral system as the main employment selection procedure was proposed (Hunter, 1983d). In response to potential problems emerging from the universal application of the program, the U.S. Department of Labor (1989/90) commissioned the NAS to evaluate the Validity Generalization Program. The NAS Committee on the GATB did not support the use of the VG-GATB referral system as the prevailing selection procedure. Instead, it recommended optional administration of the GATB and the use of multiple criteria for referring applicants.

Development of the VG-GATB referral system and the thorough review by the NAS has led to a beneficial outcome: close re-examination of the properties of the GATB and the predictive role of aptitudes in job performance. Underlying the VG-GATB system are many important concepts, such as the generalizability of validity of aptitude tests, the classification of occupations, and the composition of the factors or general abilities measured by the GATB. The development of the VG-GATB system is based on the work of Hunter and Schmidt (Hunter, 1983b, 1983d; Schmidt & Hunter, 1977). A complete review of their work in relation to these concepts, and of the criticisms of it voiced by the NAS committee on the GATB and other authors, is beyond the scope of this chapter. However, a summary of the NAS committee on the GATB's conclusions is necessary for an understanding of the differences in the predictive validity of the GATB for job performance as reported by USES (Hunter, 1983d) and by NAS (Hartigan & Wigdor, 1989). For simplicity of expression, the work of the NAS, committee on the GATB, reported in Hartigan & Wigdor, (1989) will be referred to as findings of the NAS.

Although the Committee on the GATB agreed with the theory that validity observed in some occupations can be generalized to other occupations, situations, and people, it did not endorse the claim that the GATB is valid for all occupations in the labor market. USES (Hunter, 1983b, 1983d; Swarthout, 1988) and the Committee on the GATB used meta-

analysis to examine the GATB's predictive validity. Although both groups used the same studies (515 validity studies conducted between 1950 and 1972, and 264 validity studies dating from 1972), they differed on the corrections—sampling error, criterion unreliability, and range restriction—made to the observed validity coefficients in estimating the true validity. The Committee on the GATB said the adjustment made by Hunter overestimated the true validities of the GATB composites. The corrections Hunter applied increased the observed validity by 61%, while adjustments allowed by NAS resulted in a gain of 12%. Hunter reported the overall estimated true validity of the GATB at .50, and NAS reported it at .35, for studies done prior to 1972. Swarthout (1988) and NAS both observed an unaccountable decline of validity coefficients over time. For studies done after 1972, USES reported GATB composite validities of .30 for cognitive (GVN), .24 for Perceptual (SPQ), and .18 for Motor (KFM); NAS reported validities of .22, .19, and .15 respectively. The Committee on the GATB (NAS) concluded that the overall predictive validity coefficient of the GATB, based on studies from 1950 on, is .30, and that 90% of the validities fall between .20 and .40.

A study of the GATB's predictive validity, using the VG-GATB approach, was completed in Canada in 1989/90 (Hackett, 1989, 1990). The sample comprised 63 applicants selected for entry-level positions at a General Motors plant in Ontario. They were chosen from a larger pool of applicants (N = 354) referred from a local Canada Employment Centre. All applicants were given the GATB prior to being hired, and completed the pre-employment GM Assessment Centre (AC) procedure, a multi-step, in-house assessment process yielding ratings used for employee selection. Phase I of the project was concerned with the predictive validity of the GATB for the AC rating.

Phase II of the project examined the GATB's value for predicting successful applicants' job performance. The predictors were the nine aptitude scores from the GATB, and the AC rating. The dependent variables included supervisors' performance ratings (BOS/USES) and other work criteria, such as tardiness and unauthorized absences. Phase II findings indicated that the overall percentage score obtained from the GATB using the VG-GATB approach does not correlate significantly with the supervisor's performance rating. Spatial aptitude (S) was the only GATB aptitude to correlate significantly with both the supervisor's rating and the AC rating; spatial aptitude and the AC rating were found to contribute significantly to predicting the supervisor's rating. According to Hackett, the

limited number of significant relationships between GATB aptitudes and job performance may be due to the lack of statistical power associated with the small sample, particularly if we assume the true overall validity of the GATB to be .22, as NAS found it for post-1972 studies.

Summary: Validity

The convergent validity studies of the GATB indicate that cognitive aptitudes are clearly measured with GVN. The Spatial Perception subtest is an adequate measure of perceptual ability. Both the convergent validity studies and factor analysis of the GATB, however, suggest that the perceptual aptitude (P and Q) subtests might measure a combination of traits that may be components of various abilities. Jaeger et al. in Hartigan & Wigdor, (1989) proposed that a comparative content analysis be used to clarify the construct measured by Form and Clerical Perception aptitudes.

Authors' conclusions about the GATB's predictive validity have varied with the corrections each allowed in estimating its true validity on the basis of observed validities. The Committee on the GATB opted for a conservative approach; its estimate of the GATB's predictive validity likely represents the lower end of the range, while USES's estimate tends to be inflated. Nevertheless, although the NAS Committee recognized that the overall validity coefficient was modest, it concluded that "GATB scores can provide useful screening information" (p 5).

2. Reliability

(a) Over time.

The stability of GATB scores over time intervals of one day to 3 years ranged from .57 to .80. An examination of temporal stability by age and by time interval yields a constant pattern of higher reliabilities for cognitive aptitudes (GVN), moderately smaller but adequate reliabilities for perceptual aptitudes (SPQK), and lower reliabilities for psychomotor aptitudes (F, M). The last are measured as subjects manipulate objects; perceptual and cognitive aptitudes are measured with a paper-and-pencil procedure. The Hand/Arm and Finger Manipulation subtests present lower reliabilities at first testing and faster declines over time than do the paper-and-pencil subtests. The Committee on the

GATB (Hartigan & Wigdor, 1989) concluded that the "reliabilities of the individual psychomotor subtests are low, although not so low for the psychomotor composite as to preclude its use" (p. 96).

(b) Between forms.

Most studies examining the reliability of the GATB between forms have used Forms A and B. The coefficients of equivalence between parallel forms have followed patterns similar to that of the coefficient of stability. Paper-and-pencil subtests have been more reliable than manipulation subtests, and cognitive aptitudes have had higher coefficients of equivalence (GVN .83 to .93) than psychomotor aptitudes (.73 to .84) with adults for time intervals of one year or less. These are considered acceptable reliabilities. Clemmons (1985) did not find any significant difference between A and B Form scores for individuals with epilepsy.

In summary, the GATB's temporal stability and equivalent form reliability are adequate.

Summary: Psychometric Properties

The Committee on the GATB (Hartigan & Wigdor, 1989) concluded that "the GATB is adequate in psychometric quality" (p.4). It also mentioned two problems: weak test security, and speededness, which makes the GATB easily coachable. This issue is important if the GATB is to be used as a primary selection tool, as suggested in the VG-GATB referral system. It does not, however, affect the use of the GATB for counselling purposes. The speededness does affect use of the GATB with some people with disabilities; this issue will be discussed later.

F. The GATB and the Disabled Population

1. Standardized Tests and Disabled Individuals

The effectiveness of using standardized ability tests with disabled individuals has been of ongoing concern. The problems are well summarized in a report from the U.S. National Research Council (Sherman & Robinson, 1982). Tests need to be adapted to particular disabling conditions, but this raises concerns about the comparability of abilities measured

and scores obtained with these modified tests. Research conducted by Willingham et al. (1988, in Hartigan & Wigdor, 1989) for the U.S. Educational Testing Service (ETS), using scholastic aptitude tests with students suffering hearing, visual, or motor impairment or experiencing learning difficulties, stressed the difficulty of developing a procedure for transforming and interpreting their modified-test scores. Defining the disability and measuring the degree of severity was a major problem for the researchers. Obtaining enough people for each group representing various degrees of disability was also problematic. For the GATB, these difficulties would present great challenges.

2. The GATB and Disabled Individuals

The GATB has been adapted to service people who are visually impaired, hearing impaired, or use wheelchairs (motor subtest, M). USES developed the NATB, a non-reading version of the GATB, in 1963 to assist people with low reading levels and people who cannot easily understand the instructions (such as the mentally retarded population). A 1974 study by the Vermont State Department of Education indicated that the NATB could more clearly depict the abilities of educationally deprived individuals than the GATB, as it produced more Occupational Aptitude Patterns (OAPs). The NATB was abandoned by USES, however, because of certain psychometric weaknesses: it has no norms of its own, and must use the GATB's; construct validity is based only on the GATB (correlation of NATB subtests and GATB subtests ranges from .50 to .73); a criterion-related validity study of the NATB has not been done; and no reliability data are available for the NATB.

3. Neurological Impairment

Neurologically impaired subpopulations that have been investigated with the GATB fall into three groups: persons with epilepsy, psychiatric patients, and people suffering mixed etiologies of brain impairment, including trauma, tumors, and cerebrovascular disease (CVA).

(a) Epilepsy.

GATB studies with epileptic persons have focused on the pattern of scores and the relationship of GATB scores to both work performance and neurological condition. Generally, their GATB scores are significantly lower than the published norms (Clemmons

1983, 1985). A marked difference between the cognitive composite (VN) and the motor composite (KFM) has been noticed (Clemmons, 1983, 1985; Tellegen, 1965); the lowest scores are on the motor subtests. Clemmons (1985) reported that the GATB subtest scores of 50 patients with epilepsy were ranked Q, V, S, P, N, K, M, F, highest to lowest (Clemmons, 1985, p. 24). Low motor scores were thought to be related to the use of anticonvulsant medications and the consequences of organic brain damage.

Clemmons (1983, 1985) and Tellegen (1965) investigated the GATB's predictive validity for job performance and employment status among persons with epilepsy. Clemmons examined the effectiveness of the GATB's Occupational Aptitude Pattern (OAP) for predicting job performance. The supervisors' ratings of job performance were divided into three categories—high, medium, and low—corresponding to the OAP criterion of desirability of referral. A 3 X 3 chi square analysis found no significant correlation between job performance and OAP. The small samples within the cells ($n = 47$) may have contributed to this lack of correlation, as may have the low aptitude scores that restricted the subjects' classification by the OAP system. Furthermore, the development and use of the OAP classification has been seriously criticized (Anastasi, 1988; Hunter, 1983b; Weiss in Buros, 1972), and the lack of predictive ability observed may be due in part to the weaknesses of the OAP system.

Tellegen noted that the GATB aptitude scores of epileptic persons who were employed were generally higher than those of people best suited for sheltered workshops. The difference was again more marked for the motor composite, being significant for all motor aptitudes. In contrast, only two of the six nonmotor aptitudes yielded scores that were significantly different between the employed and unemployed groups. Tellegen also examined the relationship of a variable that he called nonmotor-aptitude-minus-motor-aptitude to employment status. He reported a greater difference between scores on nonmotor aptitudes and motor aptitudes among the unemployed.

Clemmons (1985) observed a significant difference between the average of the scores from the three motor subtests and the average of the scores from the remaining six subtests for 351 epileptic patients. The GATB scores of the employed group, however, when submitted to the t test, were not significantly different from those of the unemployed. The difference in Clemmons' findings may be related to the range of occupations held by the employed group. Clemmons noted that 30% of the participants in the employed group worked in

entry-level, unskilled positions. The level and range of motor and cognitive demands in such occupations are somewhat restricted. A wider scope of occupations, with greater demands in motor and cognitive abilities, would more likely be differentiated by GATB scores.

Clemmons (1985) examined the best predictor of employment status using the GATB together with the Washington Psychological Seizure Inventory (WPSI). Both measures were available for 83 patients. A stepwise discriminant function analysis identified GATB aptitude F (Finger Dexterity) and WPSI Clinical Scale 6 (adjustment to seizures) as the best predictors of patients' employment status (full-time, part-time, or unemployed). The accuracy of prediction ranged from 62% for the unemployed to 67% for the employed. As Clemmons pointed out, many individuals who performed poorly on the motor subtests subsequently obtained employment in occupations classified as requiring manual abilities greater than their tested performance. The percentage of correct predictions of employment status from neuropsychological tests and the MMPI reported by Heaton & Chelune, (1978) was higher. Neuropsychological test scores alone correctly classified 74.2% of the subjects' employment status, the MMPI correctly classified 78.8%, and the combination of neuropsychological tests and the MMPI correctly classified 83.7%. In a subsequent study, however, Newman et al. (1978) reported that the MMPI scores were not sensitive predictors of chronic unemployment, although these personality measures had been strongly related to current employment status in the previous study. This led the authors to conclude that "it may be that at least for some patients in the earlier study, emotional disturbance was more the result than the cause of unemployment" (p. 641).

A comparison of results from these three studies is difficult because their samples were different. Clemmons (1985) reported that most employed participants worked in entry-level positions. This may explain the sensitivity of the finger dexterity aptitude as a predictor of employment. Heaton & Chelune, (1978) do not describe the occupations held by the employed portion of the sample. Newman et al. (1978) reported that employed participants held a wide range of occupations, from physician to janitor. In this case, the best predictor of employment was the H-R Impairment Index.

Heaton and his colleague emphasized that although a discriminant function can be derived to detect individuals at high risk of unemployment, it provides little information about the cause of unemployment. He concluded that "the sensitivity of tests to brain damage is no

assurance that they tap abilities that are important in patients' day to day activities. Furthermore, even if an important ability is tapped by a particular test, the cut-off score which suggests impaired brain function may be quite different from that predicting, for example, inability to perform adequately at work" (p. 416).

The GATB was used not only to assess the employability of individuals with epilepsy, but also to evaluate its sensitivity to brain impairment. Tellegen (1965) used the GATB with chronic seizure patients. He examined the possibility of differential performance patterns among six groups divided according to brain function impairment. No significant differences were found between the four groups suffering from epilepsy alone—patients with right, left, or bilateral cerebral pathology, or with centrencephalic epilepsy. Grouped together, however, their performance was better than that of epileptic patients who also suffered hemiparesis and mental retardation.

Clemmons, Dodrill, Fraser, et al. (1984) examined the potential utility of the GATB as a screening device for detecting lateralized impairment of brain function in epileptic patients. The population was divided into three groups on the basis of neuropsychological assessment: right-brain impairment, left-brain impairment, and generalized impairment. The researchers found that individually the GATB scores did not differentiate diagnostic groups. The derived GATB-Verbal-minus-GATB-Spatial variable differentiated the group with right impairment from the groups with left and generalized impairment, but did not differentiate the left from the generalized. The right and left impairment groups exhibited a different overall response pattern.

(b) Psychiatric impairment.

The GATB performance of patients who had been diagnosed with psychiatric impairment was examined in two studies: Ciardiello (1981) and Helmes and Fekken (1986). Both reported lower GATB scores among this group than in a group of normal subjects. In relation to job placement, Ciardiello (1981) identified aptitude F (Finger Dexterity) as the single best predictor of successful completion of a sheltered workshop program for a group of schizophrenic patients. His finding is similar to Clemmons' (1985); this may be partly due to the resemblance between the determinant job demands in sheltered workshop and entry-level occupations.

Helmes and Fekken investigated the differences in GATB scores between psychiatric patients taking prescription drugs and those not taking drugs. They observed lower scores on all aptitudes except verbal (V) for the drug-taking group. Examining the differences among three different types of drugs, the researchers noted the poorest performances in people taking phenothiazines and anti-parkinsonian drugs. Differences between the drug versus nondrug groups were observed within diagnostic categories; significant differences were found on aptitudes F (Finger Dexterity), V (Verbal), and Q (Clerical Perception) among schizophrenics, and on aptitude F in patients with personality disorders. Helmes and Fekken concluded that both the type of psychiatric diagnosis and the type of drug affect GATB scores.

(c) Mixed etiologies.

Cole (1984) investigated the GATB's relationship to a neuropsychological test battery. The nature of the patients' (N = 113) disabilities included a variety of neurological disorders, including developmental disorder, trauma, tumor, CVA, and emotional disturbance. She reported GATB scores within the average to high-average range on all aptitudes except the motor subtests (KFM); these last were within the low-average to below-average range.

Summary: The GATB with Neurologically Impaired Individuals

The use of standardized ability tests with the disabled is a central problem in vocational and psychological assessment of this population. The question remains whether the GATB should be used with brain-injured people. There is no appropriate modified version of the test for this population, and the lack of validation studies relating disabled individuals' GATB scores to job performance is a deplorable weakness (Hartigan & Wigdor, 1989; Clemmons, 1985).

Research with people suffering various neurological impairments indicates the presence of a pattern of performance on the GATB. Many researchers have reported generally lower scores among the neurological patients than among the general working population. The most remarkable configurations on the GATB for this population are the low motor aptitude scores and the difference between the nonmotor and motor subtests. This brings into question the use of high-speed tests with the neurologically impaired, and points out

the need for further research into alternative administration and/or development of dual speed/accuracy norms for GATB motor subtests with this group.

Having considered all this, however, the Committee on the GATB (Hartigan & Wigdor, 1989) reported feedback from many vocational rehabilitation specialists, who found the GATB useful in working with the disabled. These professionals selected the GATB from many other instruments available. The committee recommended that the GATB "be used when feasible to assess the abilities of handicapped applicants, but as a supplement to decision making, not to take the place of counseling services" (p. 233).

Clemmons (1985) concurred that the GATB is useful to vocational counsellors despite the lack of demonstrated predictive ability of either aptitudes or the OAP for predicting job performance. The GATB's suggested sensitivity to lateralized cerebral dysfunction makes it an interesting tool for use with the neurologically impaired.

This review identifies a definite need for research into GATB performance among brain-injured people, and into the relationship between the GATB and their demonstrated vocational capacities.

G. The GATB's Relationship to Neuropsychological Test Batteries

Clemmons (1985) examined the GATB's relationship to the psychological tests included in the Neuropsychological Battery of Epilepsy (NBE). The most consistent relationship was between a variable he used—the percentage of scores outside the normal limit on the NBE—and the eight GATB aptitudes; correlations with this variable and GATB aptitudes ranged from .45 to.60. Using multiple regression, Clemmons (1985) and Clemmons et al. (1987) investigated the ability of the eight GATB aptitudes to predict neuropsychological deficits as measured by the percentage of neuropsychological test scores outside the normal limit on the NBE. Numerical and spatial aptitudes and motor coordination were found to make significant contributions to predicting deficits. Clemmons (1985) developed a prediction formula based on a sample of 50 individuals and cross-validated it on a sample of 25 people. The results obtained were not significant, however, and impairment level could not be reliably predicted from GATB scores alone. The small ratio of variables to subject (8:50) and the fact that the GATB aptitudes are correlated may partly account for his results.

Although a combination of GATB subtests did not predict the overall percentage of scores outside the normal limit on the NBE, Clemmons reported that some GATB subtests and neuropsychological subtests measured similar abilities. Clemmons (1985, Table 6, p. 55) found the following strong correlations between the NBE and GATB subtests: .70 for Full Scale IQ and Verbal aptitude scores and for Full Scale IQ and Numerical aptitude, .66 for Performance IQ and Spatial aptitude, .67 for Performance IQ and Form Perception, and .61 for Performance IQ and Clerical Perception, all on the Wechsler Adult Intelligence Scale-Revised (WAIS-R); -.53 for Stroop part I and Verbal aptitude; -.62 for Tactual Performance Test (TPT) and Spatial aptitude; .53 for Finger Tapping (total) and Motor Coordination, and .54 for Manual Dexterity and Finger Tapping; and -.57 for Trail Making B and Numerical aptitude.

Similar relationships between the WAIS and the GATB aptitudes were noted by Cole (1984) when she examined the GATB's relationship to the neuropsychological test battery used at the Cortical Brain Assessment Laboratory in Memphis. She postulated nine hypotheses representing the relationships between preselected neuropsychological tests and each GATB aptitude, and used first-level correlation analysis (Pearson r) to analyze the data. She also did nine stepwise multiple regressions to investigate the ability of preselected neuropsychological subtests (9 to 12) to predict each GATB aptitude (n = 88). She reported the highest multiple correlation coefficient (.76) predicting the GATB aptitude G (General Learning Ability) from 12 neuropsychological tests. Only the Verbal and Numerical aptitudes had multiple correlation coefficients greater than .60. The standard error of measurement was close to or greater than the GATB's standard deviation (20) in predicting P (Form Perception), K (Motor Coordination), F (Finger Dexterity), and M (Manual Dexterity). Cole investigated the global relationship between the two batteries using canonical correlation analysis. The first of three canonical variates represented a general cognitive measure, and accounted for most of the common variance shared by the two batteries. The second canonical variate was identified as a measure of "perceptual-motor processing" (Cole, 1984, p. 116), and the third canonical variate was not clearly identifiable.

Although Mothersill and Sharp's 1991 study did not focus on neuropsychological tests, their comparison of the correlations between the GATB composites and WAIS-R is of interest. As noted in the foregoing section reporting the factor analytic studies of the

GATB, Mothersill and Sharp concluded that nine aptitudes can be regrouped into three factors. The psychomotor factor correlated most strongly with the WAIS-R Digit Symbol (.55). The symbolic factor, composed of Verbal, Numerical, and Clerical Perception aptitudes, correlated most strongly with Arithmetic (.62), Digit Symbol (.59), and Vocabulary (.57). The spatial-perceptual factor, including Spatial and Form Perception, correlated with Block Design (.68) and Object Assembly (.57). Digit symbol is the WAIS-R subtest that most consistently correlated with the three GATB composites. As previously noted, Prigatano et al. (1986) found that the WAIS Digit Symbol test discriminated between employed and nonemployed individuals with brain injuries.

Summary: The GATB and Neuropsychological Tests

Correlational analysis of the GATB and selected neuropsychological tests is an exploratory and descriptive procedure that provides additional information about the GATB's construct validity. The most distinct relationship is clearly between measures of general intelligence.

Both Clemmons and Cole have explored predictions in opposite directions, estimating the neuropsychological impairment as measured by neuropsychological tests from GATB aptitudes, and vice versa. Although correlation coefficients indicated significant contributions from some aptitudes and psychological tests, cross-validation was done in only one study, and the results were inconclusive.

H. Critiques of the GATB

In 45 years of continuous research, the GATB has been critically judged. Some of its flaws have been mentioned in the foregoing review, and can be summarized as follows.

The speededness of the GATB subtests has been reproached by many, for various reasons (Anastasi, 1988; Bolton, 1987; Clemmons, 1985; Hartigan & Wigdor, 1989; Keesling in Mitchell (Ed.), 1985). The NAS indicated that the GATB's speededness makes it vulnerable to coachability, and questioned the correctness of using stringent speed constraints for "power" tests. NAS, Bolton, and Clemmons all expressed concern about the disadvantage of using rigorous speed tests with the disabled population. These concerns were echoed by Hunter (1983b) and Weiss (in Buros, 1972) for the older population. An

alternative administration procedure should be considered in order to answer these concerns.

The factorial structure of the GATB needs to be addressed using current factor analysis and item-analysis methods (Anastasi, 1988; Keesling in Mitchell (Ed.), 1985). Opinion diverges on the composition of the GATB's factorial structure, particularly with respect to the perceptual subtests. The convergent validity of P and Q was found to be inadequate (Jaeger et al. in Hartigan & Wigdor, 1989). The demand for high speed was thought to play a role in obscuring the measures of perceptual ability.

Intercorrelations among the nine aptitudes limit the GATB's ability to predict job performance (Anastasi, 1988; Hartigan & Wigdor, 1989). Estimates of the predictive validity coefficients of the GATB range from adequate to very good depending on a conservative or more liberal statistical analyses used. Botterbusch & Michael, (1985) remarked on the concentration of semi-skilled jobs over skilled and technical occupations in the predictive validity studies.

Many authors have stated the need for new norms (Hartigan & Wigdor, 1989; Keesling in Mitchell (Ed.), 1985; Weiss in Buros, 1972). This is less of a concern in Canada, as norms for the GATB paper-and-pencil subtests were developed in 1985. There appear to be needs, however, for age-related norms and for separate norms for speed and accuracy.

The psychomotor tests appear to have many weaknesses, and need to be reconsidered. They have the lowest reliability and predictive validity, insufficient information to allow comment on their construct validity, and are, in their present form, the least useful tests for the disabled population.

Concerns about the GATB's security, the need for new forms, and a need for improved procedures for equating scores between forms were mentioned by the NAS in relation to the possibility of applying the VG-GATB referral system. These concerns, however, do not present serious problems when the GATB is used as a counselling tool.

The GATB has also been praised for its usefulness to vocational counsellors and for its technical development compared to those of other test batteries (Clemmons, 1985; Hartigan & Wigdor, 1989; Keesling in Mitchell (Ed.), 1985). It has been described as "unsurpassed as a vocational aptitude battery" (Bolton, 1987, p. 88). From a vocational

counselling and rehabilitation point of view, the GATB's relationship to jobs and training, and the relationship between its aptitude scores and job analysis results, are its major advantages (Botterbusch & Michael, 1985). Although further research is needed, the GATB has been updated, especially in Canada. Recent research related to the development of the VG-GATB referral program has reawakened and stimulated interest in the predictive ability of aptitude tests for work performance.

Conclusion

The GATB offers many advantages as an aptitude battery. It is supported by a large body of research documenting its strengths and weaknesses. Although improvements to the battery have been suggested, its relationship to work demands makes it the most practical assessment tool available for vocational rehabilitation. The GATB's relationship to certain neuropsychological tests and its suggested sensitivity to some neurological conditions make it a viable instrument with which to investigate neurologically impaired populations. Research into the GATB performance of brain-injured individuals, and the GATB's relationship to their demonstrated vocational capacities, is recommended in order to facilitate their vocational rehabilitation.

III. THE POSITION ANALYSIS QUESTIONNAIRE (PAQ)

A. Introduction: Job Matching

Job matching, as mentioned in the foregoing, is the process of matching workers' measured abilities to the aptitude demands of specific jobs. These aptitude demands are estimated with a job analysis procedure.

In order to study the GATB's usefulness for job matching with brain-injured individuals, it is necessary to examine the relationship between their measured aptitudes and the aptitude demands of their jobs.

Although the CCDO and the DOT list the aptitude demands of various jobs, it cannot be assumed that they accurately reflect the demands of jobs held by brain-injured individuals. Specific aptitude requirements vary among employers, and many brain-injured individuals return to modified jobs. In the present study, to ensure more accuracy, each occupation

currently performed or unsuccessfully maintained because of brain injury was analyzed to evaluate its aptitude demands, using the Position Analysis Questionnaire (PAQ).

B. Definition/Description

The PAQ is a standardized, structured job analysis questionnaire that deals with 194 job elements. One hundred and eighty-seven of these elements relate to work activities or work situation variables. These items are worker-oriented rather than task-oriented, focusing on the behaviors required to perform the job analyzed. The remaining seven items deal with compensation. Each job element is rated on a 2- or 6-point scale. The ratings are computer processed to derive *job dimension* scores. The quantification of information about the nature of jobs allows different statistical analyses, comparisons, and predictions using the PAQ. A more detailed description of the PAQ is reported in Appendix B.

C. History of the PAQ

Development of the PAQ began in 1959. Aiming to improve the job-matching procedures used in personnel selection and placement, Dr. E.J. McCormick, with the support of the Office of Naval Research, attempted to identify those human and job characteristics that are associated. The first instrument he developed was the Checklist of Work Activities, or CWA (McCormick & Palmer, 1958 in McCormick, Mecham & Jeanneret, 1977). It was followed by the Worker Activity Profile (Gordon & McCormick, 1963, in McCormick, Jeanneret & Mecham, 1972), a questionnaire designed to measure job characteristics that are related to human characteristics. Its successor, PAQ Form A, was produced in 1969, and PAQ Form B was produced between 1972 and 1974.

As various organizations continued to use the PAQ, the job data bank expanded, enabling the authors to draw from it a normative sample representative of the population as it was described by the 1970 United States census. This sample of 2,200 jobs was used to revise PAQ Form B, and to produce Form C (System II), released in 1977 (McCormick, Jeanneret & Mecham, 1977). The researchers calculated a new set of factors from the PAQ ratings, and conducted additional reliability and validity analyses. The recently updated *Position Analysis Questionnaire PAQ Technical Manual (sytem II)*, (1989) reports further research and development related to predicting the aptitude requirements of jobs. The

extensive development work done on the PAQ between 1972 and 1989 has produced a large body of reliability and validity information.

D. Reliability

Three inter-rater reliability studies are reported in the *Position Analysis Questionnaire PAQ Technical Manual (System II)*, (1977, 1989). The first (McCormick, Jeanneret, & Mecham, 1972) was part of the PAQ's development. Sixty-two jobs were analyzed by 62 pairs of analysts working in analyst/analyst, analyst/supervisor, analyst/incumbent, and supervisor/incumbent combinations. The average inter-rater reliability coefficient was .79. The second study (Taylor & Colbert, 1978) was based on a larger sample: 325 administrative jobs in various parts of the United States. Two independent PAQ analyses were obtained for each position. The average inter-rater reliability coefficient was .68. A subsample of rate-rerate yielded an average reliability coefficient of .78. The third study (Mecham, 1989a in McCormick et al. 1989) combined reliability studies from 35 organizations, producing a sample of 1,116 jobs and involving 3,156 pairs of analysts. The median reliability coefficient was approximately .88.

Other researchers have produced inter-rater reliability analyses. Frieling, Kannheiser & Lindberg, (1974) developed a German translation of the PAQ using a sample of 61 positions analyzed by randomly combined pairs of independent analysts. The average inter-rater reliability coefficient was .79. Harvey and Hayes (1986) reported the PAQ ratings from an analysis of 90 city government jobs by five analysts. "The median interrater correlation on the 88 jobs analyzed by 2 or more analysts was .95 (minimum=.86, maximum=.99)" (p. 355).

Summary: Inter-rater Reliability

The reported range of inter-rater reliability achieved is adequate for this type of questionnaire. The PAQ Services specifies in its documentation that appropriate training with the PAQ is required to utilize the instrument and achieve an adequate level of inter-rater reliability. Training material and procedures are offered, and when followed, it is suggested that an inter-rater reliability level of .80 can be expected.

E. Job Dimensions

Two types of job dimension scores have been derived from the PAQ ratings, one based on *attribute profiles* of the individual elements, the second on *job data*.

1. Job Dimensions Based on Attribute Profiles

The attribute concept is related to the notion of human traits. A complete listing of the attributes is included in Appendix B. Forty-nine attributes are considered aptitudinal, in that they reflect specific aptitudes such as arithmetic reasoning, spatial visualization, and manual dexterity. Twenty-seven are described as situational, reflecting the personality, temperament, and interests required to do the job.

In the course of their development of the PAQ, McCormick et al. (1972) had a minimum of 8 and a maximum of 18 industrial Psychologists rate all 76 attributes in terms of their relevance to each PAQ item. The ratings had substantial reliability: .85 to .95. The median rating for each attribute was derived, and these averages became the basis for a matrix of 76 attributes and 187 PAQ items. Using varimax rotation, a principal component analysis of the attributes matrix for each of the major PAQ divisions was done. The factors accounted for 79 to 89% of the total variance, and the attributes were thereby judged comprehensive and representative of the traits measured by this questionnaire.

Experts also scored the 76 attributes for their relevance to the job being analyzed. The attribute scores were transformed into percentile scores by comparing them to the distribution of the scores for the same attribute in the PAQ normative sample (2,200 jobs). The percentile compares the job analyzed with others in the labour market, thus indicating the relative uniqueness or importance of the attribute to the occupation analyzed.

Mecham (1989b in Mecham et al. 1989) investigated the predictive power of the attribute scores and percentiles. Occupations in the PAQ and GATB databases were matched on the basis of common nine-digit codes listed in the *Dictionary of Occupational Titles* (DOT). Correlations between the PAQ attributes and GATB aptitudes judged to measure the same or similar traits were computed by comparing the attribute scores and percentiles with GATB mean test scores, validity coefficients, and the inclusion (or not) of the test in a Specific Aptitude Test Battery (SATB).

Similar correlations were produced whether using PAQ attribute scores or percentiles. A moderate to high correlation was observed between the GATB cognitive aptitude scores (GVN) and the PAQ cognitive attributes. The correlation between the three attributes and the aptitudes measuring spatial abilities (S, P, and Q) was near 0 or negative. Interestingly, GATB aptitudes S, P, Q, and K showed moderate correlation (.44 to .63) with the PAQ cognitive attributes. Correlations between manual aptitudes (F and M) and attributes 61, 65, 66, and 69 were near 0 or negative. Similarly, Gutenberg, Arvey, Osburn, and Jeanneret, (1983) found limited correlations between the physically oriented overall dimensions (13 and 15) and the GATB validities of the psychomotor tests (K, F, M).

Correlations between the attribute percentiles and validity coefficients were generally low. Correlations between the inclusion of the GATB test in the SATB and the PAQ attribute percentile "were generally moderate and in the expected direction. Of special interest was the fact that the attribute data were indicative of whether the finger and manual dexterity tests were found to be useful in a selection battery (even though the mean scores correlated at a near zero level with attribute data)" (*The Position Analysis Questionnaire PAQ Technical Manual (System II)*, 1989, p. 33). This means that the GATB motor tests (F and M) and PAQ physically oriented attributes do not appear to measure similar abilities. However, a high percentile score on the PAQ physically oriented attributes indicates that the motor aptitudes measured by the GATB play a significant selective role for the occupation.

2. Job Dimensions Based on Job Data

Principal component analysis was used in three studies to determine the divisional and overall job dimensions underlying the PAQ. The job dimension scores in System II were derived from a 1977 analysis of the normative sample of occupations, and as System II is used in this study, the 1977 analysis is the only one reported here.

Eight principal component analyses were conducted with the data obtained from the normative sample of 2, 200 occupations. Five of the analyses used the data on the job elements in each of the first five PAQ divisions, and two separate analyses examined the dichotomous and remaining Division 6 items. These analyses produced 32 *divisional* job dimensions. A principal component analysis of most of the PAQ items pooled together yielded 13 *overall* job dimensions. When Jeanneret (1987, in Mecham et al. 1989)

conducted a confirmatory factor analysis of PAQ data organized by the 1980 census, similar factors emerged.

Job dimension scores, or factor scores, were derived from the principal component analysis of the PAQ. The job dimension scores were standardized with a mean of 0 and a standard deviation of 1. The *Position Analysis Questionnaire PAQ Users Manual (System II)*, 1990 (p. 154) indicates that some of the divisional dimensions in the normative sample are correlated. The 13 overall dimensions, however, are not.

The reliability of the job dimension scores was estimated by Mecham (1988a, in Mecham et al. 1989), using data pooled from studies conducted in 43 organizations. The inter-rater reliability coefficient was adjusted for restricted range, and the standard error of measurement was provided for each dimension score. The median reliability coefficient for the divisional dimensions ranged from .84 to .99, with a SE_M of .126 to .406. For the overall dimensions, the reliability coefficients ranged from .88 to .97, with a SE_M of .184 to .354 (*Position Analysis Questionnaire PAQ Technical Manual (System II)*, 1989, p. 15).

Summary: Job Dimensions

The PAQ measures job attributes that represent the aptitudes and interest traits of a job. The job analysis with the PAQ provides percentile scores for each of these traits that qualify and situate the occupation in relation to the world of work. For example, the job analysis of the occupation of Translator indicates a percentile score of 73% for the aptitude attribute 36, called "Long-term memory (30')" (see Appendix B for full description of the aptitude attributes). This means that only 27% of the jobs in the world of work place greater demands on long-term memory skills than this occupation.

The reliability of job attributes measured by the PAQ is adequate. The physically oriented PAQ aptitude attributes were found to be good indicators of the importance of the GATB motor aptitudes for job selection. The more global factors measured by the PAQ are grouped in 32 divisional dimensions and 13 overall dimensions. The reliability of job dimensions measured by the PAQ is adequate. The overall job dimensions scores are not correlated and used to predict GATB scores.

F. Job Component Validity of the PAQ

Job component validity refers to a method of estimating the aptitude requirements of jobs directly from job-related data. It is based on the hypothesis that "when different jobs have in common a given job component, the human requirements for fulfilling that component would be the same in all jobs in which that component exists" (*The Position Analysis Questionnaire PAQ Technical Manual (System II)*, 1989, p. 17). Job component validity offers a practical alternative to conventional test validation procedures, which involve examining the relationship between test scores and job performance for each occupation. An analysis of the occupation identifies the pertinent job dimensions, and once the relationship between the job dimensions and the aptitude test concerned is known, the validity of the test can be established. Job component validity has been tested by determining the relationship between the PAQ job dimension scores for particular jobs and test data obtained from people performing those jobs. The test data are the criterion, and the PAQ job dimension scores are the predictors.

Job Component Validity Analyses with *GATB* Tests.

Average GATB test scores have been estimated from the PAQ dimension scores since the PAQ was developed. Researchers believe that the mean test scores of job incumbents may indicate the relative levels of aptitude those jobs require. Their reasoning is based on two assumptions: that jobs demand different levels of aptitude for successful performance, and that people gravitate toward jobs commensurate with their abilities. The latter has been referred to as the gravitational hypothesis or selective migration theory (Mecham, 1989).

Three major job component validity studies have been conducted (McCormick et al. 1972; McCormick, Mecham & Jeanneret, 1977; Mecham, 1987 in Mecham et al. 1989), using data from the GATB and PAQ databases. In each case, occupations in the PAQ and GATB databases were matched on the basis of common nine-digit codes listed in the *Dictionary of Occupational Titles*. The findings of the most recent job component validity study (Mecham, 1987 in Mecham et al. 1989) are reported here, as it is based on the largest sample (460 validity studies). Predictions of GATB mean test scores from the PAQ analysis produced in the present study will be made from the regression equation derived from this data.

Mecham used the PAQ overall job dimension scores to predict incumbents' GATB scores. As shown in table 1, he found that the mean cognitive test scores were best predicted, followed by the perceptual scores. Mean dexterity test scores were the least successfully predicted, although the eye/hand coordination subtest scores were better predicted.

Table 1
Multiple correlations of PAQ Overall Job Dimension Scores with GATB Test Criteria

Adjusted multiple correlations	Squared
G.77	.59
V.78	.61
N.75	.56
S.72	.52
P.61	.37
Q.70	.49
K.67	.45
F.45	.20
M.24	.06

Note. Source: *Position Analysis Questionnaire PAQ Technical Manual (System II)*, 1989, p. 21).

The low correspondence between the PAQ job dimensions and the GATB Finger and Manual Dexterity aptitudes is a concern. As noted earlier, Mecham (1989b, in Mecham et al. 1989) reported that the correlation between the mean F and M scores and the attribute data was near zero. The attribute data, however, were related to the selection of the F and M aptitudes as relevant measures of an occupation.

Gutenberg et al. (1983) investigated the moderating effects of certain preselected PAQ job dimensions on the predictive validity of GATB aptitudes. The effects of three cognitive and two manually oriented job dimensions (13 and 15) were examined. Because the PAQ divisional job dimensions are correlated, partial correlations were used to ensure that the measured moderating effect was directly related to the dimension under study.

The validities for cognitive aptitudes (G, V, and N) were predicted from individual cognitive dimensions. The correlation was positive, indicating that when a job contains more cognitive features, proportionately higher validities are obtained on the GATB

cognitive tests. The cognitive PAQ dimensions also significantly moderated the validity of the GATB motor aptitudes (F and M). The correlation was negative, indicating that when the job contains fewer cognitive features, the validities on the F and M tests are higher. These results support Hunter's findings in his study (1983a) of the GATB's predictive validity.

Additionally, when Gutenberg and colleagues did a partial correlation, removing the effect of the cognitively oriented dimensions from the manual dimensions, they found no significant moderating effects, positive or negative, for the F and M test validities. The PAQ elements in the manual dimensions are more task-oriented than those in the cognitive dimensions. Schmidt, Hunter, and Pearlman (1981) stated that tasks, unlike behavior and cognitive process, do not moderate validities. The statement from Gutenberg et al. supports Hunter's 1983b conclusion, also expressed by others, that a cognitive measure is the best overall predictive measure of job performance.

Hunter (1983b) examined the ability of the PAQ overall dimensions to predict validity coefficients of the three GATB composites. He noted that the correlations between validity coefficients and PAQ overall dimensions were higher than the correlations for the job complexity dimension he had defined.

Summary: PAQ Job Component Validity with GATB

The PAQ's ability to predict GATB scores was satisfactory for all aptitudes with the exception of GATB-F and M. The low predictive ability of the PAQ's 13 overall dimensions and specific manually oriented dimensions used in isolation indicates a low correspondence between the manually oriented elements of the PAQ and the GATB motor aptitudes.

However, Carter and Biersner (1987) examined the validity of the physically oriented PAQ attributes (71, 72, 74) and PAQ item 87 in order to assess the physical aptitudes required in 26 United States Navy jobs. When the strength requirements were assessed by the Robertson and Trent procedures (job analysis for physical demands), the PAQ strength attributes correlated with the physical demands of the jobs, yielding a point bi-serial correlation ranging from .69 to .77. Item 87, which measures the level of physical exertion

(*sedentary* to *very heavy*), had the strongest correlation (.87) with the measure of physical demand.

The PAQ attributes were also found to be good indicators of the importance of motor aptitude for job selection. Thus, the PAQ can assess an occupation's physical demands and strength requirements and determine their importance to the job analyzed as compared to the world of work. The PAQ's ability to predict the mean GATB scores for F and M, however, is limited. This may be due to F and M's weak abilities in predicting job performance, and to the fact that F and M are the least reliable of the GATB subtests.

Conclusion

The focus of the present study—the correspondence between measured aptitudes and job demands—required that a standardized job analysis procedure be used. The PAQ is supported by a large body of research and has been updated regularly. It has adequate reliability and validity properties.

The PAQ applies to a wide spectrum of work activities, and the fact that its common denominator of measure is human behaviour is an important characteristic. A worker-oriented analysis is more appropriate for dealing with brain-injured individuals than a task-oriented analysis is, because tasks can be modified to fit ability patterns. In vocational rehabilitation of brain-injured individuals, we are most concerned with the abilities and deficits that will affect these people's work performance. The PAQ deals with cognitive processing, behavioral, and physical abilities, all of which can be impaired following a brain injury and thus impact on vocational rehabilitation.

The aptitude attributes measured by the PAQ include many cognitive and motor abilities assessed by neuropsychological tests, such as memory, attention, ideational fluency, convergent/divergent thinking and abstract thinking, reaction time, stamina, eye-hand coordination, and continuous muscle control (a complete list is presented in Appendix B). Most important, the relationship between PAQ data and GATB scores facilitates direct comparison for job matching. Because its occupational database is large, the PAQ offers the potential for a variety of data analyses, including qualitative analyses of occupational data.

IV. HYPOTHESES AND QUESTIONS

The literature reviewed indicates that neuropsychological tests are the most common measures of a person's ability to work following a brain injury. Their effectiveness is limited, however, because the lack of criterion-related validity information about the tests makes it difficult to relate data obtained from the tests to specific work abilities. The GATB is related to work demands and to neuropsychological measures, and researchers have also suggested that it is sensitive to neurological conditions. These characteristics, and the availability of a valid standardized job analysis instrument—the PAQ—that assesses the aptitude demands of occupations, make the GATB a potentially useful job-matching tool to use in the vocational rehabilitation process with brain-injured individuals.

The studies reviewed raised several hypotheses and questions to be investigated. The term *hypothesis* refers to preplanned comparisons, *questions* to exploratory analyses. These hypotheses and questions focus on three issues: the structure of the GATB; the GATB performance of brain-injured individuals; and the fit between an individual's aptitudes as measured by the GATB and the aptitude demands of jobs as estimated by the PAQ.

A. Structure of the GATB

Many researchers, including Fozard et al. (1972), Hammond (1983), Hunter (1983a), Katz et al. (1989), Mothersill & Sharp, (1991), and Watts and Everitt (1980) effectively regrouped the GATB aptitudes into composites. The number and composition of factors varied among studies. Using a large sample of GATB aptitude scores from non-injured job applicants, the empirical models proposed can be verified.

Hypotheses.

1. Based on the literature review, the model most likely to be accepted is one that regroups GATB aptitudes into three composites: cognitive, perceptual, and motor. The configuration of aptitudes within each composite will most likely be as follows:

Cognitive:	Verbal (V), Numerical (N), and Clerical Perception (Q)
Perceptual:	Spatial (S) and Form Perception (P)
Motor:	Motor Coordination (K), Finger Dexterity (F), and Manual Dexterity (M).

2. The GATB composite model fitting data obtained from non-injured job applicants will fit the GATB data obtained from the brain-injured people in the sample.

B. GATB Performance of Traumatically Brain-Injured Individuals

Many researchers found that the GATB scores of neurologically impaired individuals were lower than those of the General Working Population. A noticeable pattern of scores emerged among neurologically impaired persons: They scored significantly lower on the motor subtests than they did on the non-motor subtests.

Hypotheses.

1. The scores obtained by the brain-injured individuals in the sample will be lower than those of the General Working Population (Ciardiello, 1981; Clemmons, 1983, 1985; EIC, 1985; Helmes & Fekken, 1986).

2. Participants' scores on the three subtests measuring dexterity will be lower than their scores on the non-motor GATB subtests (Clemmons, 1983, 1985; Cole, 1984; Tellegen, 1965).

C. Person-Job Fit

Different occupations require different levels of aptitude for successful job performance; people usually gravitate toward jobs in keeping with their abilities. Because the GATB's ability to predict job performance is satisfactory, matching an individual's GATB aptitude profile with the aptitude demands of various occupations will facilitate the selection of suitable occupations. The PAQ provides estimates of the aptitude demands of various occupations. The PAQ overall job dimensions adequately predict the mean GATB scores required to successfully perform a specific occupation with the exception of the motor aptitudes (F and M). The physically oriented PAQ attributes are adequate indicators of the physical demands of occupations.

The GATB aptitude profiles of brain-injured individuals may fit the PAQ aptitude demand profiles of jobs they can successfully do, and differ from those of jobs they cannot do. The difference between measured aptitude (GATB) and estimated aptitude demands of the job (PAQ) indicates the person-job fit.

Hypotheses.

1. The measured person-job fit will be significantly different between jobs brain-injured individuals *can do* and jobs they *cannot do*.

2. The measured person-job fit will be significantly different between occupations brain-injured individuals can perform and those they cannot for two of the aptitude composites: cognitive and perceptual.

Questions.

1. The limited ability of the PAQ job dimension scores to predict required motor aptitudes (F, M), and the weakness of the GATB motor aptitude measure, suggest a need to explore other relationships beyond the person-job fit for motor-related aptitudes. Some of the PAQ physically oriented aptitude attributes have been found to adequately assess the physical demands of occupations.

   Is there a relationship between the PAQ physically oriented attributes and participants' GATB motor scores? Is this relationship consistent for both jobs they *can* and *cannot do*?

2. Although there may be a markedly different person-job fit between jobs brain-injured people *can* and *cannot do*, it is important to determine if the measured person-job fit correctly classifies brain-injured individuals according to occupational type—that is, on the basis of the difference between the GATB-measured aptitude and the aptitude demand of the job (PAQ), is it possible to select occupations brain-injured individuals *can do* and reject those they *cannot do*?

The following chapter describes the method and procedure used to test these hypotheses and to investigate the questions posed.

Chapter Three

METHOD AND PROCEDURES

This chapter begins with a description of the selection criteria and recruiting procedure followed to solicit participation in the study. The demographic and vocational characteristics of the study sample are described. The instruments used, and the procedure followed, are presented next. The chapter concludes with a summary of the dependent and independent variables. Additional information is provided in Appendices A to G.

I. PARTICIPANTS

A. Selection Criteria

Sixty people participated in the study. Participants were selected on the basis of the following criteria.

1. Presence of a Traumatic Brain Injury

The injury must have resulted from environmental trauma, not a physiological condition (a tumor, stroke, or cerebrovascular injury), and have been confirmed by medical diagnosis.

2. Age Range of 18 to 54 at Time of GATB Testing

The normative sample for the GATB represents the general working population (aged 18 to 54). Although the legal working age is 16, USES does not recommend using the GATB with people aged 16 to 18. Separate GATB norms are available for Grade 9 and 10 students. These norms indicate unstable occupational aptitude patterns and limited predictive validities (*Manual for the USES General Aptitude Test Battery, Section III: Development*). People who had sustained brain injuries before reaching working age were accepted.

3. Absence of Other Disorders

Participants had no history of alcoholism, drug abuse, and/or psychiatric disorders since sustaining their injuries. This information was gleaned from the referral sources and through interviews with the candidates.

4. A Minimum of One Year Post-Injury

It is generally agreed that most of the recovery of abilities related to brain functions occurs within six months post-injury (Rosenthal, Griffiths, Bond & Miller (Eds.),1990). It is also recognized that individuals develop mental and social coping strategies over time, which affect their psychosocial and vocational rehabilitation. For this reason, vocational aptitudes and status are not assessed until at least 12 months post-injury.

5. Limited Disability

Participants had adequate reading and language abilities, had vision sufficient to read text, and had at least one functional hand.

6. Vocational History

The researcher interviewed each candidate, gathering information about his or her pre- and post-injury vocational history. Candidates for whom information was available on jobs they can and cannot perform for reasons related to their brain injury were selected for the study. Information regarding a participant's ability or inability to perform a given occupation was verified with the employer, a co-worker, and/or the vocational assessment on file at the referral agency.

B. Recruitment Procedure

Potential participants were attending agencies that provide psychological and/or vocational assessment, intervention, and training for people with brain injuries. A rehabilitation centre, three private clinics, and a vocational college agreed to cooperate with the study.

Each referral agency determined how it would contact potential participants. In some instances, candidates were advised by telephone that information on the study would be

mailed to them. Each candidate received information outlining the purpose of the research and what his or her participation would entail (Appendix C), a consent form (Appendix D), and a self-addressed, stamped envelope in which to return the consent form.

C. University of Victoria Human Subjects Procedure

In accordance with the University of Vicoria Human Subjects Committee procedure, each participant received a copy of the signed consent form and a description of the research project, detailing its potential benefits and risks. Precautions are taken to ensure that information obtained directly from participants or their files—their clinical and medical files and neuropsychological and aptitude tests—remains in strict confidence. Interpretation of results was discussed with some participants upon completion of the evaluation.

D. Recruitment and Selection of Study Sample

Two hundred and sixty-four information packages and requests to participate were mailed. Table 2 provides a detailed description of each referral agency's recruitment efforts. Of the people contacted, 102 (39%) replied; 61 fitted the selection criteria and agreed to participate when contacted by telephone. One person later wished to leave the study. The final sample included 60 individuals who had sustained a traumatic brain injury and fitted the other selection criteria. Descriptive statistics of the sample are supplied below.

Table 2
Recruitment and Selection per Referral Source

Source	Info mailed	Replied	Participants
Rehabilitation centre:	111	14	13
Private clinic 1:	87	67	33
Private clinic 2:	32	11	8
Private clinic 3:	30	8	5
Vocational college:	4	2	1
			1
		Total	$N = 60$

E. Descriptive Statistics of Study Sample

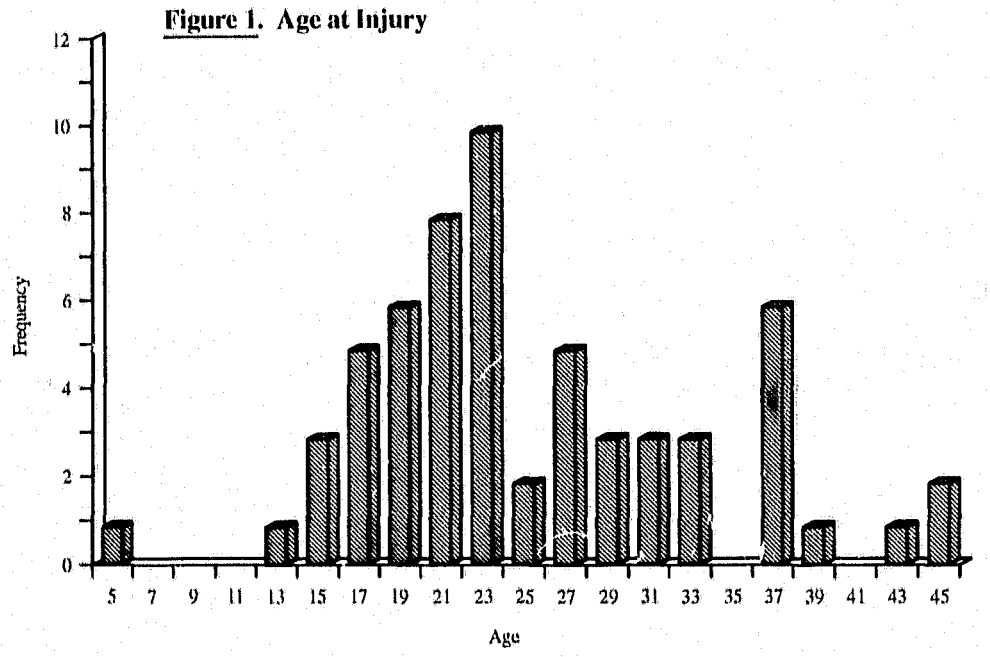
In the following section, the 60 individuals who participated in the study are described. Descriptive statistics related to the demographic variables (age, sex, education, and employment) are presented. The characteristics of this study sample are compared with descriptive statistics of traumatically brain-injured individuals that are provided in the literature review.

1. Age

Two sets of information regarding the age of the participants are presented. The first indicates their age at the time of injury, providing a basis for comparing this study sample with individuals reported in the literature review. The second indicates age distribution at the time of participation in the study.

The mean age of the participants at the time of injury was 24.8 and the standard deviation was 8.46. The age at the time of injury ranged from 5 to 45. This information is graphically presented in Figure 1.

Figure 1. Age at Injury



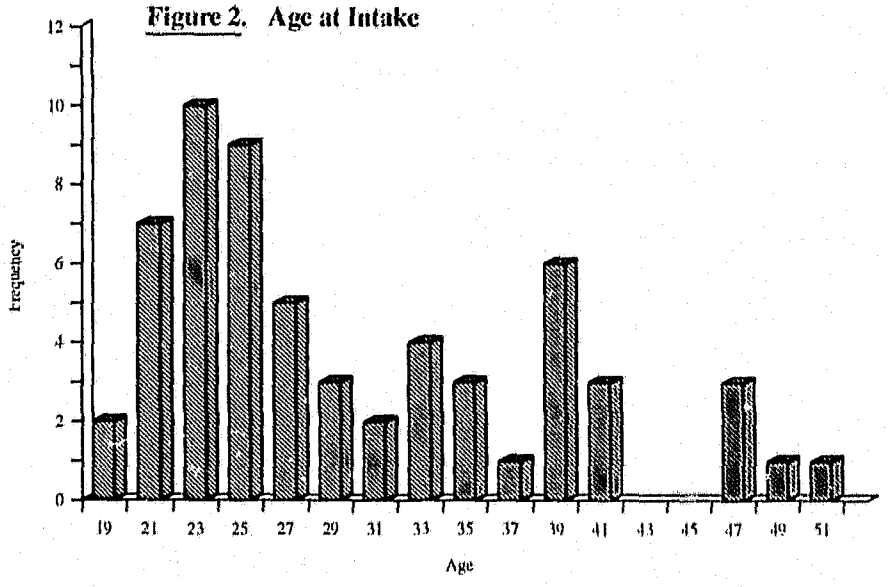
Note.

Mean	24.8
Median	22.5
Range	5 to 45
Standard deviation	8.46

Furthermore, in the study sample, the median age at injury was 22.5, and 70% of the participants were age 28 or younger. This is consistent with the literature reviewed (Anderson & McLaurin, 1980; Rapp & Spivack, 1986; Rimel & Jane, 1983 in Rosenthal, Griffiths, Bond & Miller (Eds.), 1990), in which people under 30 were identified as the most vulnerable, accounting for approximately 70% of closed head injury (CHI).

The participants' ages at intake are graphically presented in Figure 2. All participants are of working age and, as per the selection criteria described in the foregoing, between the ages of 18 and 54.

Figure 2. Age at Intake



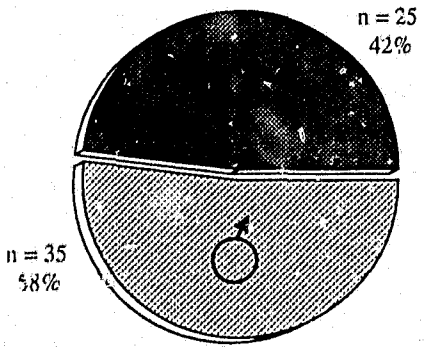
Note.

Mean	29.5
Median	27
Range	19 to 51
Standard deviation	8.4

2. Sex

The study sample comprised 25 (41.7%) women and 35 (58.3%) men (Figur 3). The literature reviewed indicated a ratio of 2-3 males to 1 female among individuals with traumatic brain injuries. The greater proportion of female participants in this study may reflect the fact that participation was voluntary, and it may be that women tend to volunteer more frequently than men do.

Figure 3. Sex Ratio



3. Education

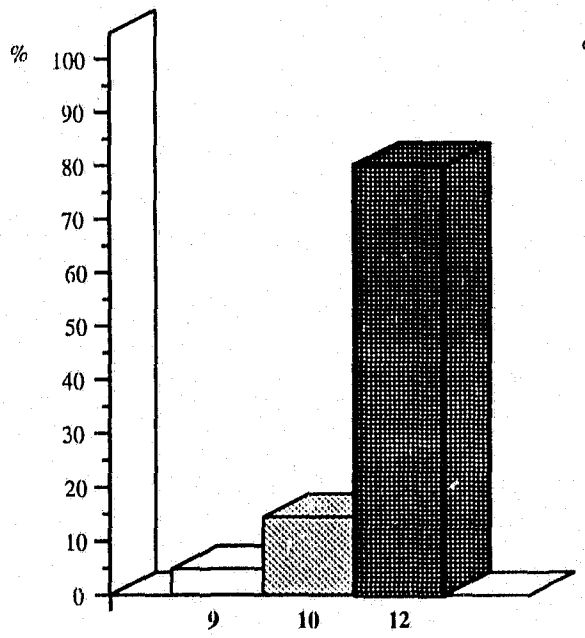
Data concerning participants' education levels at the time of injury and at the time of intake are presented. The information collected indicates the number of years of primary and secondary school and the level of post-secondary educational that each participant had completed. The post-secondary level was coded to represent completion of college, completion of trade school, university without completion of a degree, university with a B.A. and/or university with a master's degree or more. The number of years of education completed at the time of injury is directly related to age.

At the time of injury, only two participants had not completed primary school and 60% of the sample had completed Grade 12. More than half (56.7%) of the sample had no post-secondary education at the time of injury, although the mean age was 24.8 years. Of those who had completed some post-secondary education, 13.3% had completed college, 10% had completed trade school, 8.3% had attended university without completing a degree, and 11.7% had attained a B.A. Two participants had initiated master's degrees, but had not completed them.

At intake, all participants had completed primary school and 80% of the sample had completed Grade 12. Forty percent of the sample had not pursued post-secondary education. Of those who had completed some post-secondary education, 23% had completed college, 18% had completed trade school, 6.7% had attended university without completing a degree, and 11.7% had completed a B.A. Figure 4 illustrates the secondary school educational level attained at the time of participation int the study (intake), and Figure 5 the post-secondary educational level.

A comparison of the educational levels at injury and at intake indicate that participants who had pursued post-secondary education following trauma did so in shorter-term programs, such as those offered at colleges and trade schools, rather than at university.

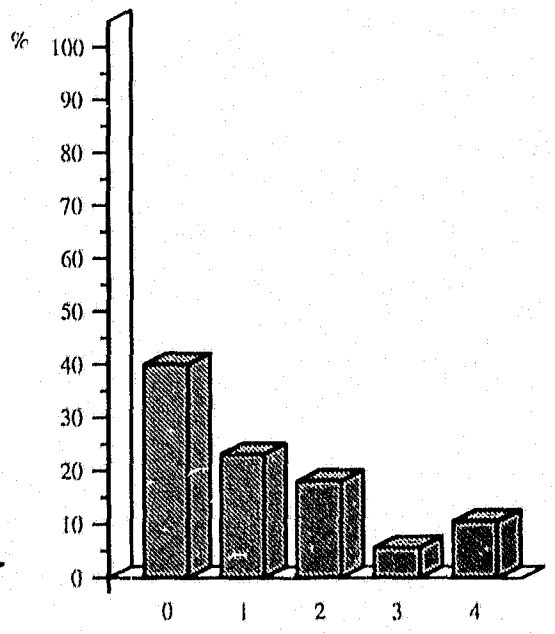
Figure 4. Education at Intake



Note.

Mean	11.55
Median	12
Range	9 to 12
Standard deviation	.928

Figure 5. Post-Secondary Education at Intake



Note.

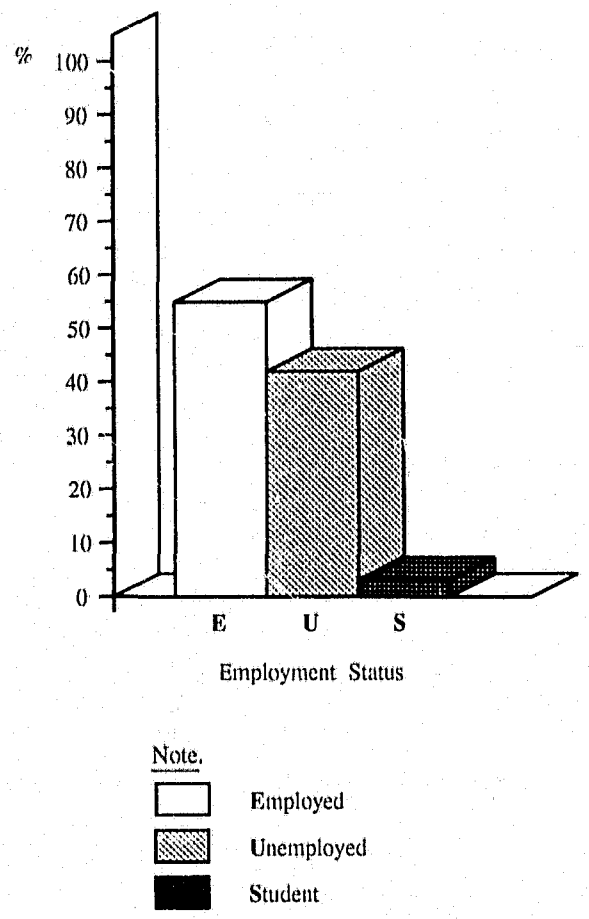
0 No post secondary education
1 College degree / certificate
2 Trade School
3 Attended University without completing a degree
4 Completed B.A.

4. Work Status

Work status at the time of injury and at intake was classified as employed (working full-time or part-time in a paid job), unemployed (not working for remuneration), or student. At the time of injury, 71.7% of the participants were employed, 6.7% were unemployed, and 21.7% were students. Age influenced employment status at the time of injury, just as it did education levels.

At intake, the percentage of participants employed dropped to 55%, the unemployed rose to 41.7%, and only 3.3% of the sample were students. Figure 6 illustrates participants' work status at intake.

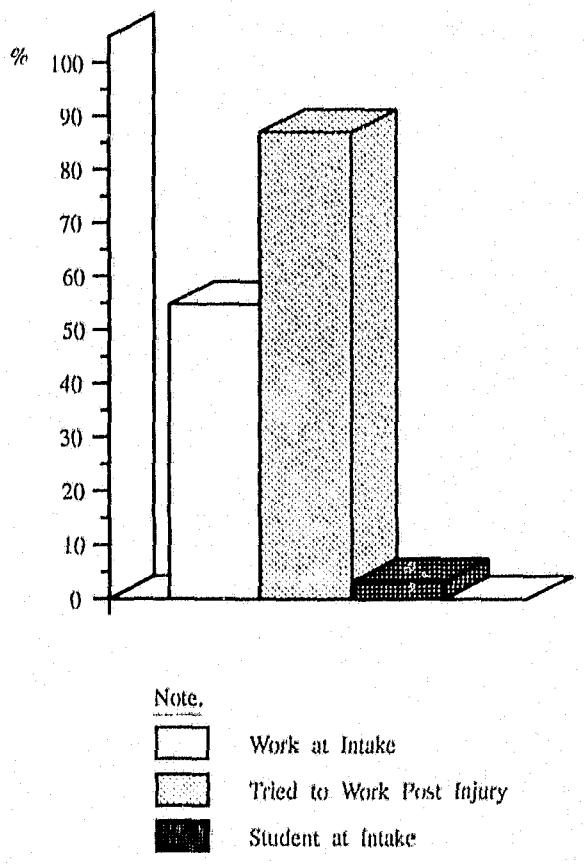
Figure 6. Employment Status at Intake



The rate of unemployment noted in the study sample (41.7%) is within the range reported in the literature among brain-injured individuals who participated in a comprehensive rehabilitation program (Ben-Yishay et al. 1987; Prigatano et al. 1984, 1986).

The participants' work histories post-injury indicated whether they had attempted to work after being injured. It is interesting to note (Figure 7) that 86.7% of the participants attempted to work post-injury and 55% were employed at intake. A cross tabulation of data on attempts to work post-injury and work status at intake revealed that of those who attempted to work post-injury, 63.5% were employed at intake, 32.7% were unemployed, and 3.8% were students.

Figure 7. Attempt to Work Post-Injury vs Work Status at Intake



This simple comparison does not directly imply that unemployment among those who showed a will and interest in working is directly and/or exclusively related to brain injury. However, the notable proportion of unemployed among those who attempted to work and the post-injury increase in unemployment raise concerns about the vocational difficulties experienced following such trauma.

A cross tabulation of participants' work status at injury and at intake reveals that of those employed at the time of injury, 53.8% were employed, 41.9% were unemployed, and 2.3% were students at intake. Of those who were unemployed at the time of injury, 25% were employed at intake and 75% remained unemployed.

A cross tabulation of employment status at intake and sex indicated a similar proportion of employed and unemployed within each group. Among women, 53% were employed and 44% unemployed, while 57% of the men were employed and 40% were unemployed.

5. Description of Occupation

As mentioned in the section of this chapter on procedure, the occupations analyzed were grouped into two categories: occupations participants *could do* and occupations they *could not do*. For descriptive purposes, the vocational information obtained was also classified, according to type of income, whether the job was a new occupation, and whether it was the occupation performed pre-injury or a modification of that job. It is necessary to bear in mind that this sample of occupations was restricted to positions for which the individual's ability or inability to do the job could be verified.

An examination of the occupations according to type of income revealed that 83.3% of the jobs were remunerated by the employer, 9.6% of the jobs offered subsidized pay, 2.4% represented unpaid work (student), and 4.8% were volunteer positions. Of the occupations participants *could do*, 26.2% of the jobs were those performed pre-injury and 9.5% were modified versions of those occupations. In 64.4% of the cases, occupations that participants *could do* were jobs they had not done pre-injury. Of the occupations participants *could not do*, 80.7% were their pre-injury occupations and 19.2 % were occupations they had not performed prior to trauma and had tried to do post-injury.

Summary: Descriptive Statistics of Study Sample

The study sample shows some similarity to the descriptions of traumatically brain-injured persons found in the literature review. The age at the time of injury and the level of post-injury unemployment are comparable. The proportion of females differs, which is likely due to the fact that participation in this study was voluntary.

At intake, the majority (80%) of participants had completed high school, and 60% of the study sample had completed some post-secondary education. At the time of participation, more than half were employed (55%), 41.7% were unemployed, and 3 were students. Of significance are the greater number of unemployed post-injury compared to pre-injury, and the fact that approximately 33% of those who had tried to work were unemployed.

The types of jobs analyzed indicated that in many instances people had to change occupations after being injured. This is illustrated by the fact that 80.7% of the occupations people *could not do* were their pre-injury jobs, and 64.4% of the occupations participants *could do* were new jobs that they had not performed pre-injury.

II. INSTRUMENTS USED

A. GATB

Participants who had not taken the General Aptitude Test Battery (GATB) 12 months post-injury completed the battery with the examiner. A description of the GATB is presented in Appendix A. A graduate student in psychology, trained by the principal researcher, administered the GATB in accordance with the administration procedure outlined in the GATB manual. The GATB can be administered in groups or individually. Among people with brain injuries, it is generally administered individually, and occasionally to two participants. GATB tests were scored manually, and an independent marker checked the scores.

B. PAQ

The Position Analysis Questionnaire (PAQ), Form C, System II, was used to analyze participants' occupations. Appendix B presents a description of the PAQ.

Although some jobs had the same title, each position in this study was analyzed as a separate job, as it is highly probable that occupations have been modified to suit individuals' residual abilities.

The PAQ is completed by job analysts (persons with advanced training, such as Vocational Counsellors) and Psychologists. In a 1986 study, Harvey and Hayes warned against having insufficiently trained or job-naive raters complete the PAQ, noting that the inter-rater reliability was "dangerously low" in such cases.

The job analyst obtains the information needed to complete the PAQ through a structured interview that requires familiarity with the questionnaire. The analyst initiates the interview by asking the informer to state 5 to 10 tasks that summarize the occupation. The informer is then asked to estimate the time spent on each task and its importance to the job. Further questions elaborate on where the incumbent obtains information, what she or he does with the information, what she or he produces, what environmental context she or he works within, and what type of interpersonal contact is involved. The analyst has the responsibility of evaluating the sources of information and making the ratings; the interviewee does not indicate what the ratings should be.

Research indicates that having more than three job analysts collect data produces only a limited improvement in reliability (*Position Analysis Questionnaire PAQ Technical Manual (system II)*, 1989, p. 32). Thus three vocational rehabilitation counsellors acted as job analysts in this study. One of these was the principal researcher, who trained the others as assistants. All have worked extensively with brain-injured individuals, and the principal researcher is a Certified Rehabilitation Counsellor (CRC, Commission on Rehabilitation Counsellor Certification, U.S.A) and Certified Work Evaluator and Work Adjustment Specialist (Commission on Certification of Work Adjustment and Vocational Evaluation, U.S.A).

The training procedure offered in the *Position Analysis Questionnaire PAQ Users Manual (System II)*, 1990 was followed. It was suggested in the August 1989 PAQ newsletter that an inter-rater reliability of .80 can be reached when this procedure is adhered to. Training material included the *Position Analysis Questionnaire Job Analysis Manual* (second edition, 1989), the *Position Analysis Questionnaire PAQ Technical Manual (System II)*, (1989), and the PAQ itself.

A number of procedures were used to help ensure rater reliability. Each analyst familiarized herself with the training manual and training notes provided by the principal researcher. Common analysis of different types of jobs followed, and feedback sessions were held once one to three analyses had been completed. A variety of occupations were analyzed during the initial training phase, including paid and unpaid work. Trades, technical, clerical, and management jobs were selected, in order to cover the range of work behaviours the PAQ measures. The analysts completed the PAQ with the incumbent and/or the employer or a co-worker.

Once each analyst had independently completed the PAQ ratings, scores were checked for consistency and reliability. Differences of more than one scale point on items incited discussions that resolved interpretation problems. Additionally, approximately 2,200 occupations are analyzed in the PAQ Services database. Whenever a position analyzed in this study corresponded to the DOT (*Dictionary of Occupational Titles*) description of one of the occupations already analyzed in the PAQ database, scores were compared to provide feedback and facilitate training.

The PAQ computer data processing option called record comparison (Enter-Act) listed the analysts' scores for comparison. The reliability option provided the inter-rater reliability. These analyses identified areas of disagreement in scoring the same job/position. The method used in the PAQ computer data processing to determine the reliability coefficient is to calculate the correlation coefficients (Pearson r) of each analyst's ratings with those of every other analyst. Using Fisher's r to z transformation, the average of all the correlation coefficients in the matrix is then calculated to produce the inter-rater reliability coefficient.

The PAQ computer processing services also provide the standard error of measurement (SE_M) as a measure of analyst agreement. The SE_M determines the degree of disagreement among analysts by comparing the job dimension scores obtained from their analyses of common occupations. On page 29 of the 1990 *Position Analysis Questionnaire PAQ Users Manual (System II)*, the SE_M is described as "the standard deviation of differences in scores between analyst pairs." It is obtained by "correlating the job dimension scores for the pairs of analysts for each dimension, calculating the standard deviation for each dimension across all analysts, calculating the standard error of measurement, and then estimating what the standard error of measurement would be for the combined or average ratings of

analysts with the degree of disagreement found" (page 27). The SE_M is considered a better indicator of analyst agreement than the correlation coefficient, because it considers both the reliability and the variability of the responses.

In this study, the initial training phase consisted of 10 separate analyses to reach the suggested inter-rater correlation level of .80 in three consecutive analyses. Five training sessions with the analysts took place during this phase, following the first, fourth, sixth, eighth, and tenth PAQ analysis.

Organizational considerations made it impossible to have two or three independent analyses for each position. Confidence in reliability is based on the inter-rater reliability achieved in training (table 3 and 4) and on the consistent reliability findings reported by McCormick et al. (1972) and Mecham et al. (1989). To ensure maintenance of the inter-rater reliability level throughout data collection, the principal researcher conducted a joint job analysis with each assistant every second or third PAQ analysis, followed by feedback sessions. This resulted in ten additional joint PAQ analyses and feedback sessions throughout the data collection period.

Table 3 presents a summary of the inter-rater reliability and SE_M provided by the PAQ (Enter-Act) computer data processing. For more detailed information on the inter-rater reliability, refer to Appendix E.

Table 3
Inter-Rater Reliability: PAQ Data Processing

Occupations Analyzed	Range of Average (r)	Range of Average (SE_M)
Training Phase		
10	.67 to .88	.62 to .43
Follow-up/data collection Phase		
10	.85 to .96	.50 to .27

The inter-rater reliability in PAQ scoring was also examined by using the intraclass correlation (Myers, 1972) which considers not only the similarity of the rank ordering and spacing, but also the absolute agreement between the scores. Table 4 presents a summary

of the inter-rater reliability calculated with intraclass correlation (RI). Additional information on the intraclass correlation is found in appendix E.

Table 4
Inter-rater reliability: Intraclass correlation

Occupations Analyzed	Range of (RI)
Training Phase	
10	.72 to .91
Follow-up/data collection Phase	
10	.84 to .96

Taking into account the absolute difference between raters the inter-rater correlation achieved during the training phase was satisfactory. The level of agreement was maintained throughout the data collection phase. In general, the inter-rater reliability obtained from both methods of calculation were similar.

III. PROCEDURE

Participants were telephoned once their signed consent forms had been received, and appointments were scheduled. A copy of the signed consent was given to participants at the time of the interview, and the researcher reminded them of the goals of the project and the requirements of their participation.

A. Interview

Either the researcher or the assistant collected relevant information from participants, using a data collection form (see Appendix F). The major areas of information covered were:

1. Demographic
2. Education: pre- and post-injury
3. Work history: pre- and post-injury
4. Medical/Psychological

B. Release of Information

The researcher identified sources of medical, psychological, and work-related information; subjects signed a release-of-information form for each source. The agency or professional involved received a copy of the release and a request for information. Appendix G present copies of the release-of-information forms and the template letter sent to request information.

C. Measures

After their interview, participants completed the GATB with an examiner unless this had been done 12 months post-injury. Based on the information obtained in the interview, the occupations to be analyzed and the most appropriate informants to interview were established. The informant could be the participant, a co-worker performing the same occupation, or the supervisor. Whenever participants consented, the supervisor or an experienced co-worker was contacted.

If a participant's judgment was questionable, and no one from his or her work site could be contacted, the PAQ interview was conducted with a similar employer. When an occupation was unfamiliar to the analyst, a job site observation was scheduled. The researcher who conducted the interview did not necessarily conduct the job analysis. In many instances, the analyst did not know if the participant could or could not do the job. Nor was the analyst aware of the participant's GATB performance. As mentioned earlier, the analysis was conducted by either one or two analysts.

The word *occupation* was defined as referring not only to paid, competitive work, but to all types of productive activities, including subsidized work, volunteer work outside the home, and students' studies.

Two categories of occupations were analyzed:

1. Jobs *Could do*
   Occupations participants have the ability to perform, including positions currently held and jobs they have held since being injured and are no longer performing for reasons unrelated to the brain injury; and

2. Jobs *Cannot do*

   Occupations participants have been unable to return to, or were unable to maintain for reasons related to the brain injury.

Occupations were not considered if information concerning an individual's ability or inability to do the job could not be verified with the employer, co-worker(s), or the professionals who assessed his or her vocational potential. In some cases, when no occupational information could be verified, individuals were not selected as participants. In others, information was available for more than one occupation that a participant was able or unable to perform. In the latter case, each occupation was analyzed. The PAQ questionnaires answered were combined at the item level, using the average score of each item, and this combined profile was used for the PAQ analysis.

The complete data profile for each participant includes: demographic, educational, and vocational information obtained during the interview; medical, psychological, and vocational information accessed with the release-of-information forms; his or her GATB scores; and the PAQ job analysis data.

IV. SUMMARY OF DEPENDENT AND INDEPENDENT VARIABLES

A. Independent Variables

1. Demographic

Information collected during the interview was used earlier in this chapter to describe the sample obtained. Univariate statistics examine the relationship of demographic and post-injury vocational status variables to the aptitude testing data obtained.

The literature reviewed indicates that specific variables may have a moderating effect on GATB scores. Authors have reported a decline in GATB performance (Chapter Two, page 24) and return to work (Chapter Two, page 10) with increasing age. The education variable mediates the correlation between GATB composites and validity coefficients (Chapter Two, page 25) and vocational outcome (Chapter Two, page 10). The relationship of age and education to GATB scores will be examined.

2. Vocational

A comparison of pre- and post-injury work status was reported above to describe the vocational outcome of the participants.

3. Medical

The medical diagnosis from each participant's file was verified to ensure presence of a traumatic brain injury.

A medical measure of severity was not considered appropriate for this study. The literature reviewed has suggested that medical measures of brain injury, such as the Glasgow Coma Scale and the duration of post-traumatic amnesia, are good indicators of the presence of neuropsychological and neurological deficits, but do not consistently predict vocational outcome (Rosenthal et al. 1990). Many authors have reported a relationship between deficits observed on neuropsychological tests and vocational outcome in general. Wehman, Kreutzer, Stonnington et al. (1988) noted that the severity of deficits as measured by neuropsychological tests did not affect placement in supported employment programs.

This study does not intend to explain vocational outcome in relation to participants' medical, psychometric, and demographic characteristics. Rather, it focuses on the correspondence between individuals' post-injury vocational reality and their measured work aptitudes.

4. Psychometric

GATB scores were obtained by testing participants during the present study, or from the Psychologist or Vocational Rehabilitation Counsellor who administered the battery to a participant at least 12 months post-injury. Hypotheses concerning the GATB and the performance of individual with traumatic brain injuries were stated at the end of Chapter Two.

5. Aptitude Demands of Occupations

The aptitude demands of occupations participants *can* and *cannot* perform were estimated following PAQ analysis of the positions. Computer data processing by the PAQ Services estimated the GATB aptitude scores of people performing the analyzed jobs (Chapter Two,

pages 49-50). The estimated aptitude demand of the occupation compared to the person's GATB performance provides a measure of person-job fit. Specific hypotheses of the expected person-job fit by category of occupations were stated at the end of Chapter Two. The PAQ job attributes scores allow for exploratory comparisons between manually oriented aptitude attributes and GATB scores.

B. Criteria or Dependent Variables

The person-job match, or fit, between a participant's ability and the demands of the job. The difference between the person's measured aptitude (GATB) and estimated aptitude demands of the occupation (PAQ) reflects the "fit". This fit constitutes the principal measure with which to investigate the main question of the study regarding job matching.

V. CLINICAL ANALYSIS

A clinical analysis of a case misclassified by the measure of person-job fit, further examine the clinical usefulness of this measure. The availability of a complete medical and neuro-psychological data guided the post hoc selection of the particular case. The format used for the clinical case analysis is the International Classification of Impairments Disabilities and Handicaps (ICIDH) described in appendix H.

Chapter Four

DATA ANALYSIS

This chapter consists of two parts. The first deals with the statistical data analysis used to answer the hypotheses and questions posed. The second presents a descriptive clinical analysis of a selected case. The statistical analysis section presents, for each of the hypotheses and questions stated at the end of chapter two, the statistical analysis used to test these hypotheses and their subsequent findings. The order of presentation follows the order of introduction of the hypotheses and questions — that is, the structure of the GATB, the GATB performance of the study sample, and the person-job fit.

The first section concludes with additional analyses concerning the GATB performance of the study sample. Values were missing for the GATB motor aptitudes of one participant who was unable to perform the tasks that required two hands. The analyses including motor aptitudes (GATB-F and M) were done with 59 participants.

I. GATB STRUCTURE

There is a divergence of opinion about the structure of the GATB (Fozard et al. 1972; Hammond, 1983; Hunter, 1983; Katz et al. 1989; Mothersill & Sharp, 1991; Watts & Everitt, 1980). As mentioned earlier, it is useful from a research and clinical point of view to know the factor structure of the GATB. Based on the literature review, a first hypothesis concerning the factor structure of the GATB was postulated. Considering that the GATB is a well-standardized test, a second hypothesis postulated that the factor model confirmed with GATB data from a group of regular applicants will fit the study sample.

A. Hypothesis Tested

1. Hypothesis A1.

The most likely model to be accepted is one regrouping GATB aptitudes into 3 composites: cognitive, perceptual, and motor. The configuration of aptitudes within each

composite will most likely be as follows:

Cognitive:	Verbal (V), Numerical (N), and Clerical Perception (Q)
Perceptual:	Spatial (S) and Form Perception (P)
Motor:	Motor Coordination (K), Finger Dexterity (F), and Manual Dexterity (M).

2. The Statistical Analysis Procedure Used.

Based on the theoretical and empirical work done with the GATB, five structures were tested. A series of confirmatory factor analyses (CFA) examined whether the GATB aptitudes coalesce as a smaller set of latent variables. The confirmatory factor analysis differs from the exploratory factor analysis (FA) in that one specifies a priori the structural model of the data and which factors are correlated, if any. Given the model stipulated, factor loadings, uniqueness, and factor correlations are estimated. The fit between the model and the data is estimated by various "goodness-of-fit" indices. The confirmatory factor analysis was done using the computer program LISREL 6 (Joreskog & Sorbom, 1984).

The five structures or models were tested on a large sample from Employment and Immigration Canada, Employment Counselling Division (Hackett, 1989). Although, as mentioned in Chapter Two (p. 28) it would be preferable to do the confirmatory factor analysis with the GATB subtest scores, only the nine GATB aptitude scores were available. The sample consisted of 354 applicants referred from a local Canada Employment Centre for "unskilled (blue-collar, hourly paid, factory) positions. The mean educational attainment was grade 12" (Hackett, 1989, p. 4). The sample consisted of 193 women and 161 men.

Decisions regarding acceptable structures were made based on various "goodness-of-fit" measures (Joreskog & Sorbom, 1984).

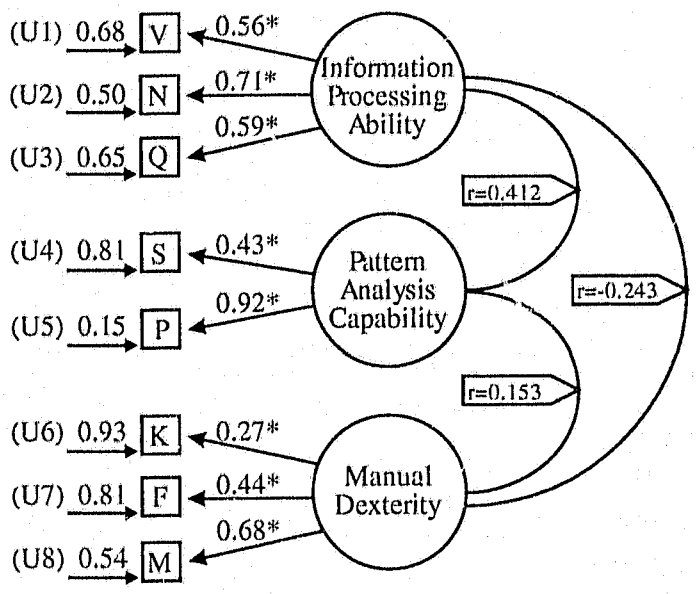
3. Results.

As shown in figure 8, the model that best fitted was the structure proposed by Fozard et al. (1972). Their model was the result of an exploratory factor analysis of the GATB subtests data from a sample of 1,146 participants from the Veterans Administration Outpatient Clinic. Mothersill & Sharp (1991) obtained a similar factor composition using the same

the same exploratory factor analysis procedure as Fozard et al. (1972) with a group of 573 injured workers (excluding head injuries).

In the present confirmatory factor analysis, the factors were allowed to correlate. This was done in order to deal with the criticism addressed to Fozard et al.'s (1972) analysis, and to reflect the reality reported in the literature showing that the GATB factors are correlated.

Figure 8. Confirmatory Factor Analysis with GATB Data of Regular Job Applicants



GFI = 0.928 AGFI = 0.847

χ^2 (17) df = 135.06 P < 0.000

RMSR = 0.084

* Significant values of factor loadings LISREL estimates (maximum likelihood) at α 0.01

Note. GMGATB data, N = 354, Hackett, (1989). Used with permission.

The maximum likelihood estimates of factor loadings (path coefficients via Lisrel) were found to be significant. The goodness of fit test was also adequate. The hypothesis that the model most likely to be accepted regrouped the GATB aptitudes into three composites, and their suggested composition, was confirmed. It is important to acknowledge that this sample of job applicants is restricted to blue-collar workers and is not representative of the general working population. However, the facts that a similar 3 factors structure was also found by other authors, and that the aptitudes grouping corresponds to the correlational pattern reported by the NAS (Hartigan & Wigdor, 1989) analysis of a large number of studies, offer additional support for the relevance of the model. The correlations between factors, indicated in the model in Figure 8 by the arrow/box on the lines joining the factors, ranged from low to moderate. The negative correlation observed between the IPA (Cognitive) and MD (Motor) factors is congruent with findings from Hunter (1983a). A negative correlation was reported (Hunter, 1983a) between the validity coefficient of the cognitive and motor factors.

B. Hypothesis Tested

1. Hypothesis A2.

The GATB composites model fitting data obtained from regular job applicants will fit the GATB data from the sample of brain-injured individuals.

2. The Statistical Analysis Procedure Used.

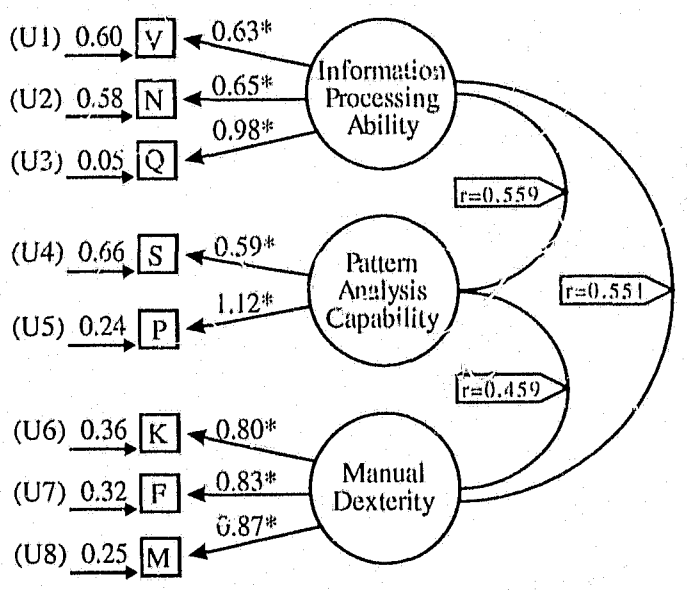
The confirmatory factor analysis procedure described in the foregoing was repeated with the GATB data from the study sample. The model confirmed with the sample of regular applicants was tested.

3. Results.

As shown in Figure 9, the maximum likelihood estimates of factor loadings (path coefficients via Lisrel) were found to be significant. The goodness of fit test was also adequate. The satisfactory fit of the model with GATB data of individuals who had sustained brain injuries indicates that the test measures the same factors with this group of disabled

individuals. The hypothesis that the model confirmed with a group of regular applicants will fit data from the study sample was confirmed.

Figure 9. Confirmatory Factor Analysis with Study Sample



GFI = 0.928 AGFI = 0.848

χ^2 (17) df = 17.15 P > .445

RMSR = 0.077

* Significant values of factor loadings LISREL estimates (maximum likelihood) at α 0.01

The correlations between factors are all positive, within the moderate range, and similar between all factors. The difference in the direction of the correlations between IPA (Cognitive) and MD (Motor) factors between the confirmatory factor analysis with the sample of regular applicants and the study sample is interesting to note.

Summary.

Five proposed factor models of the GATB were tested using a confirmatory factor analysis approach. The best-fitting model accepted confirmed hypothesis A1. This model was similar to the factor structure proposed by Fozard et al. (1972), with the difference that the factors were allowed to correlate. A confirmatory factor analysis with the GATB data from the study sample confirmed hypothesis A2. A similar factor structure of the GATB is found with this group, although the pattern of correlations between factors is somewhat different.

II. GATB PERFORMANCE OF BRAIN-INJURED INDIVIDUALS.

Some studies reviewed reported that neurologically impaired individuals had lower scores on the GATB than the General Working Population. A pattern of scores characterized by lower scores on the motor aptitudes emerged. Reports of the GATB performance of a group of individuals with traumatic brain injuries were absent in the literature. The sample of individuals reported by Cole (1984) included some individuals with traumatic brain injuries along with others who had neurological impairment from various etiologies. Based on the literature reviewed, two hypotheses were postulated regarding the GATB performance of a group of individuals with traumatic brain injuries. In a section titled "Additional Statistical Analyses", the GATB scores of the study sample will be examined in relation to other variables.

A. Hypothesis Tested.

1. Hypothesis B1.

The scores obtained by the sample of brain-injured individuals will be lower than those established for the General Working Population (Ciardiello, 1981; Clemmons, 1983, 1985; Helmes & Fekken, 1986).

2. The Statistical Analysis Procedure Used.

The frequency distributions including mean, standard deviation, and range for each GATB aptitude were computed. A comparison of the GATB data from the study sample with the General Working Population was done using confidence intervals.

3. Results.

Table 5 summarizes the data numerically. Figure 10 presents graphically the GATB performance of the study sample. The published GATB norms for the General Working Population are: mean of 100 and standard deviation of 20. The vertical lines (Figure 10) represent the confidence interval for each of the GATB aptitudes for the TBI sample. This indicates that 95% of the time, the mean aptitude score for the study sample is found within the interval illustrated by the vertical lines.

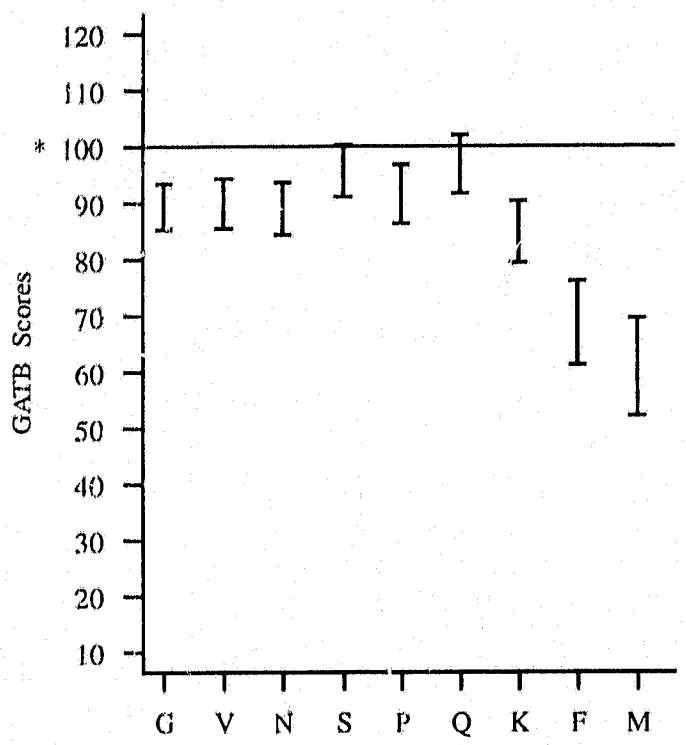
The confidence intervals of the mean GATB scores provide a graphic analysis of significance of difference between the GATB data of the study sample and the published norms. A confidence interval that does not include the General Working Population mean value reflects a significant difference between the mean GATB scores of the study sample and the published norms.

Table 5
Mean GATB Scores of Study Sample

Aptitudes:	Mean	SD	range	% of score below 80*
G	89.31	16	58-128	24
V	90.03	18.4	56-134	30
N	88.77	17.8	40-125	27
S	96.03	17.6	58-137	13
P	91.98	21.5	41-142	25
Q	97.21	20.5	51-147	17
K	83.38	29.3	16-142	45
F	69.27	38.9	1-120	64
M	61.24	34.4	-14-119	69

Note. * A score of 80 is one standard deviation below the mean of the General Working Population.

Figure 10. Confidence Intervals: Mean GATB Scores, Study Sample



Confidence Intervals at 95% confidence level

G = 85.26 - 93.33	V = 85.37 - 94.69	N = 84.26 - 93.28
S = 91.59 - 100.47	P = 86.53 - 97.43	Q = 92.03 - 102.39
K = 79.96 - 90.80	F = 61.94 - 76.60	M = 52.53 = 69.95

Note. * Mean Score of the General Working Population = 100

Figure 10 reveals that the mean GATB scores for the study sample were significantly different from the General Working Population's for aptitudes GATB-G, V, N, P, K, F, and M. GATB scores for the aptitudes S and Q were not found to be significantly different from the published norms. Clemmons (1985) reported similar findings with a group of individuals with epilepsy. The author found a significant difference between GATB scores G, V, N, K, F, and M of a sample of 351 individuals with epilepsy and the published norms (U.S.).

From a clinical interpretation point of view, scores below one standard deviation from the mean indicate a performance within the below-average range. The measure of one standard

deviation below the mean is also used as a conventional cut-off score in vocational selection. The mean GATB scores of the study sample (Table 5) were below 100 for all aptitudes. The mean aptitude scores for this sample are within the average to low-average range for all aptitudes except of Finger and Manual Dexterity (F and M). The mean value for the aptitude Motor Coordination (K) was close to one standard deviation below the mean, while the mean value for the subtests GATB-F and M were lower than one standard deviation from the published norms. As illustrated (Table 5) by the percentage (%) of scores below 80 (one standard deviation below the mean of the General Working population), a large proportion of participants' scores were within the below-average range for the motor aptitudes.

The variances (Table 5) appear to be heterogeneous. However, the differences do not affect the interpretation of the confidence intervals because a pooled variance is being used which is the best estimate of the population variance even when heterogeneity exists.

B. Hypothesis Tested.

1. Hypothesis B2.

The scores obtained by participants on the 3 subtests measuring dexterity will be lower than their scores on the other (non-motor) GATB subtests (Clemmons, 1983, 1985; Cole, 1984; Tellegen, 1965).

2. The Statistical Analysis Procedure Used.

A paired t test was used to compare the average score on the three motor aptitudes to the average score of the remaining five aptitudes.

3. Results.

As shown in Table 6, significant differences were found with these two groups, confirming the hypothesis that the scores on the motor subtests grouped into a composite were significantly lower than the scores on the other (non-motor) subtests (t (59) = -7.53, p 2-tail =.000).

Table 6
Mean GATB Motor and Non-motor Composite Scores of Study Sample

GATB Composites:	Mean	SD	*t* value	2-tail probability
Motor	71.28	27.80	-7.53	.000
Non-Motor	93	14.85		

The pattern of particularly low scores on the GATB motor aptitudes with neurologically impaired individuals reported in the literature was observed in the study sample.

Summary.

The GATB performance of a sample comprised only of individuals who had sustained a traumatic brain injury had not been reported to date. It was postulated that the performance of the study sample would be similar to the GATB performance of other samples of neurologically impaired individuals reported in the literature. A first hypothesis stating that the GATB scores of the study sample will be significantly lower than the published norms was confirmed for the aptitudes GATB-G, V, N, P, K, F, and M. These results are similar to the findings of a comparison between GATB scores of a group of individuals with epilepsy (Clemmons, 1985) and the published norms. GATB scores of this study sample were generally within the average to below-average range, with the exception of GATB-F and M. A greater variance among the GATB motor scores was noted. This was expected among a group with a neuropathology.

A second hypothesis stating that the scores on the motor aptitudes will be significantly lower than the scores on the other aptitudes was confirmed.

III. PERSON-JOB FIT

Job matching is the process of pairing the worker's profile of abilities and disabilities, environmental restrictions, and interests to the characteristics of occupations. The GATB's usefulness for job matching with individuals who have sustained brain injuries is important to the vocational rehabilitation process. The GATB is the most widely used work

aptitude test battery used in vocational counselling. Furthermore, its relationship to the *Canadian Classification and Dictionary of Occupations* and a job analysis instrument (PAQ) facilitates the job modification process. The relationship between the participants' measured aptitudes on the GATB and the aptitude demands of their jobs was examined. Two hypotheses and questions concerning the person-job fit were stated.

The literature reviewed indicated the GATB is useful for predicting work ability with regular applicants. The selective migration theory (Mecham, 1989) suggests that people tend to gravitate towards jobs compatible with their abilities. It was therefore postulated that the difference, or fit, between the participants' aptitudes as measured by the GATB and the aptitude demands of occupations they *can* perform will be significantly different from the same measure obtained with participants and jobs they *cannot do*.

The literature also indicated that the GATB motor aptitudes have poor reliability and lower predictive validity for job performance, and that the prediction of GATB motor aptitudes with the PAQ is weak. This led to another hypothesis that a significant difference on the person-job fit would be found only on the cognitive and spatial GATB composites, not on the motor composite. An inquiry into better matching elements for the motor aptitudes and motor demands of occupations was done.

Additionally, to fully address the question of the GATB's usefulness for job matching, its ability to correctly classify participants based on the person-job fit measure was investigated.

A. Hypotheses Tested.

1. Hypothesis C1.

There will be a significant difference in the person-job fit of work-related aptitudes between occupations brain-injured individuals *can* perform and occupations they *cannot* perform.

2. *The Statistical Analysis Procedure Used.*

A non-parametric test of significance between differences observed using a randomization procedure (Edginton, 1987) was utilized to compare the differences between person-job fit for the two types of occupations (*can do* and *cannot do*) for each aptitude and for the three composites. A computer program was developed (Chadwick, 1991) to handle the particular research design. The number of participants in each category of occupation was not equal, and for some participants, information was available on the two types of occupations (within-subjects design), while for others information was available for only one type of occupation (between-subject design). The randomization procedure was the only procedure that allowed the statistical treatment of the type of data collected in this combined between-within-subjects study. The procedure is described in appendix I.

The randomization procedure refers to a method of determining statistical significance of observed results by permutating the data repeatedly using random assignment. The test statistic of interest, in this case a test of significance between differences, is calculated for all the data permutations. These form the theoretical distribution of the test statistic against which the observed value for the test statistic is compared to produce a P-value. In many instances, as in this case, the number of all possible permutations is very large and essentially impossible to use as a reference set. Consequently, a subset of permutations is randomly generated. In this case, reference subsets of 2,000, 10,000 and 50,000 were generated. Data analysis with all three reference subsets produced consistent results. The P-value is the probability of finding differences equal to or more extreme than those observed in the data collected among all possible differences based on a reference subset of all possible permutations.

3. *Results.*

Table 7 presents a summary of the measures of person-job fit for each type of job and how they differ. The person-job fit represents the mean difference observed between the measured aptitudes (GATB) and aptitude demands of occupations for each aptitude. A small difference indicates that on the average, the participant's aptitude score (GATB) is similar to the aptitude demand of the occupations (i.e. Table 7 person-job fit measure for GATB-S in jobs "*can do*"). Likewise, a large difference indicates a greater discrepancy

between the participant's average aptitude score and the aptitude demand of the occupations (i.e. Table 7 person-job fit measure for GATB-M in jobs "*cannot do*").

Table 7
Person-job Fit per Job Category for each GATB Aptitude

	1 Person-job fit* jobs "*can do*"	2 Person-job fit jobs "*cannot do*"	3 Difference 1 minus 2
G	-3.62	-24.77	21.15
V	-4.55	-21.69	17.14
N	-1.21	-24.27	23.05
S	0.98	-18.38	19.36
P	-2.55	-24.92	22.38
Q	-3.81	-21.81	18.00
K	-13.07	-38.04	24.97
F	-20.90	-44.48	23.58
M	-33.60	-64.44	30.84

Note. * Person-job fit refers to: GATB aptitude score - aptitude demand of the occupation.

The first column displays the mean differences observed between the measured aptitudes (GATB) and aptitude demands of occupation for "*can do*" jobs. The observed differences for the "*cannot do*" jobs are presented in column two. The third column presents the disparity between the first two columns — that is, how the person-job fit differs between the two categories.

The observed difference between the two measures of person-job fit, for occupations "*can do*" and "*cannot do*", was significant for each GATB aptitude and not due to chance. The hypothesis that expected a significant difference between measures of person-job fit of work-related aptitudes for occupations brain-injured individuals can perform and occupations they cannot perform was confirmed.

Traditionally, the cut-off score on the GATB for referral or selection for an occupation is one standard deviation (20 on the GATB). In this case, for the occupations people *could not do*, the differences between the GATB-measured aptitudes and the aptitude demands of the jobs were generally equal to or greater than one standard deviation, with the exception of spatial aptitude (S) for which the observed difference was equal to -18.38. In the group of "*can do*" occupations, the differences between the GATB aptitudes and the aptitude demands of the jobs were less than one standard deviation, with the exception of the motor aptitudes (F and M).

These findings question the appropriateness of using the traditional cut-off score of one standard deviation for the motor aptitudes in the process of job matching with this group of people. This is important to note, because, using the traditional cut-off score of one standard deviation, occupations participants are in fact able to perform may not have been selected based on their GATB scores on F and M. Clemmons (1985) observed a similar disparity with a group of individuals with epilepsy. It may be due to the stringent time limitations of the GATB and the limited practice at the test tasks, which are a new tasks versus the familiarity of the work situation. The weaknesses of the GATB-F and M mentioned earlier (reliability and convergent and predictive validity) may account in part, for the results obtained.

B. Hypotheses Tested.

1. Hypothesis C2.

There will be a significant difference on the person-job fit between occupations brain-injured individuals *can* perform and occupations they *cannot* perform for 2 of the aptitude composites: cognitive and perceptual.

2. The Statistical Analysis Procedure Used.

The same procedure used with the nine GATB aptitudes as described earlier was applied using the person-job fit for the three GATB composite scores. The person-job fit for each composite was obtained by calculating the difference between measured GATB aptitudes for the aptitudes included in the factor (according to the confirmatory factor analysis above) and the aptitude demands (PAQ) of the occupations, and computing the average.

3. Results.

Table 8 presents a summary of the measures of person-jobs fit for each type of job, for the three GATB composites, and how they differ. The first column displays the mean differences observed between the measured aptitude composites (GATB) and aptitude demands of occupation for the job category "*can do*". Similarly, the observed differences for the "*cannot do*" occupations are presented in column two. The third column presents the disparity between the first two columns — that is, how the person-job fit differs between the two categories.

The differences between the two measures of person-job fit, for occupations "*can do*" and "*cannot do*" were significant for all GATB composites and not due to chance. The hypothesis concerning the difference on the person-job fit for 2 of the GATB aptitude composites (cognitive and perceptual) was partially confirmed. The difference between the person-job fit measure was significant for the cognitive and spatial composites, as expected, and also for the motor composite. For reasons already mentioned, a significant difference was not expected for the GATB motor composite, although, as mentioned

Table 8
Mean Person-job Fit per Job Category for each GATB Composite

	1 Person-jobs fit* job "*can do*"	2 Person-jobs fit job "*cannot do*"	3 Difference 1 minus 2
GATB COMPOSITE COGNITIVE V/N/Q	-3.19	-22.59	19.40
GATB COMPOSITE SPATIAL S/P	-0.79	-21.65	20.87
GATB COMPOSITE MOTOR K/F/M	-22.52	-49.07	26.54

Note. * Person-job fit refers to:
GATB composite score – composite demand of the occupations.

earlier, the differences between measured GATB-F and M and the aptitude demands of the job (PAQ) are large (one standard deviation), even in the category of "*can do*" occupations.

C. Question Investigated.

1. Question C1.

Is there a relationship between the PAQ physically oriented attributes and the participants' scores on the GATB motor aptitudes? Is this relationship similar for occupations participants *can do* and *cannot do*?

2. The Statistical Analysis Procedure Used.

The matrix of bivariate correlations between the PAQ physically oriented attributes (#57, 61, 62, 63, 64, 65, 66, 68, 69, and 70) and the GATB Motor aptitudes K, F, and M and the GATB Motor composite scores was examined separately for each category of occupation.

3. Results.

In the category of "*can do*" occupations, none of the bivariate correlations were meaningful (p.01). In the category of "*can not do*" occupations, significant (p.01) moderate correlations (-.45 to -.47) between the PAQ attributes and the Motor composite were noted. GATB-K, the motor coordination aptitude, was the only one that consistently presented significant moderate correlation (-.46 to -.56) with the PAQ attributes.

This suggests that in occupations participants *could not do*, low scores on the motor composite, particularly on motor coordination (GATB-K), were consistently associated with greater demands on the physical attributes (PAQ). This provides limited information, and, in general, these findings corroborate the restricted relationship between the PAQ and GATB motor aptitudes reported in the PAQ manual. As previously mentioned, this may be due to the weaknesses of the GATB motor aptitudes F and M, as the PAQ physically oriented attributes were found to be good indicators of the importance of motor aptitude for job selection and were adequately correlated (.69 to .77) with the physical strength of occupations (Carter & Biesner, 1987).

D. Question Investigated.

1. Question C2.

On the basis of the difference between the GATB-measured aptitude and the aptitude demands of the job (PAQ), will occupations brain-injured individuals *can do* be selected and occupations they *cannot do* be rejected?

2. The Statistical Analysis Procedure Used.

A direct discriminant function analysis was performed to assess prediction of membership in the two categories of occupation. Predictors were the person-job fit measure for each of the three GATB composites and the groups were the two types of occupation, "*can do*" and "*cannot do*". Only data from participants who fitted just one category of occupation (between-subjects) were used in the analysis. Kappa was used to evaluate the percentage of agreement beyond chance.

A regression analysis was used to investigate the significance of the contribution of the person-job fit measure of each GATB composite. The person-job fit measures for the three GATB composites were the predictors and the category of occupation was the dichotomous criterion variable.

3. Results.

Table 9 presents the classification results obtained from the discriminant function analysis. Homogeneity of variance-covariance matrices revealed no threat to multivariate analysis.

Table 9
Classification per Category of Occupation Discriminant Function Analysis

Occupation	No. of Cases	Predicted Group Membership	
		Group 1	Group 2
Group 1 ("*can do*")	34	91.2% (31) correctly classified	8.8% (3) false negative
Group 2 ("*cannot do*")	18	11.1% (2) false positive	88.9% (16) correctly classified

Percentage of "grouped" cases correctly classified: 90.38%

The percentage of cases correctly classified (90.38%) is an absolute value representing the 31 (out of 34) individuals who had jobs they *could do* and the 16 (out of 18) who had jobs they *cannot do* that were correctly classified. This classification rate needs to be examined in light of the base rate found in the study sample and corrected for chance agreement. Using Kappa (Cohen, 1960), the proportion of correct classifications obtained is considered in relation to the proportion of correct classifications that could be obtained by chance alone. Kappa (K= .78) indicated that a 78% beyond chance agreement classification was achieved, compared to 54% that would be obtained by chance alone. In other words, the person-job fit measure correctly identified occupations the participants *could* or *could not do* notably more often than chance alone would have.

Multiple regression was used to examine the relationship between job category and the measure of person person-job fit for the three GATB composites. Table 10 presents the zero level correlations between the predictors and criterion.

Table 10
Correlations Between Measure of Person-Job Fit for GATB Composites and Job Type

	Cognitive	Spatial	Motor	Job Type
Cognitive	1.00	.551	.521	.678
Spatial			.544	.651
Motor				.571
Job Type				

Note. Job type refers to jobs "*can do*" and jobs "*cannot do*" .

Results of the multiple regression indicated a significant overall relationship (adjusted R-square = .57, F (3, 56) = 27.02, p < 01), and as shown in Table 11, the standardized beta weights indicate that significant unique variance is accounted for by the measure of person-job fit for the cognitive and spatial composites. The unique variance accounted for by the measure of person-job fit for the motor composite is not significant.

Table 11
Multiple Regression of Job Type onto Measure of Person-job Fit (Composite)

	Standardized Beta Weight	F	Sig F
Person-job fit Motor composite	.182	2.865	.096
Person-job fit Cognitive composite	.401	12.824	.0005
Person-job fit Spatial composite	.331	9.116	.0038
Adjusted Rsquare R^2 = .57			

Summary.

The measure of person-job fit was significantly different for occupations participants "*could do*" and "*could not do*". Both hypotheses postulated were confirmed. The second hypothesis was partially confirmed, as the difference between the person-job fit measure was significant for all composites, including the motor composite.

Use of the measure of person-job fit correctly indicated whether participants *could* or *could not do* an occupation in 78% of cases. This was notably better than chance level. The person-job fit measures on the cognitive and perceptual composites were more useful in predicting job ability than the motor composites. This is congruent with the earlier observations regarding the measure of person-job fit for the motor composite in the category of "*can do*" jobs. As already noted, the mean difference between a person's measured aptitude and the demand of the job for GATB-F and M was often greater than one standard deviation, the usual cut-off score for job selection. Therefore, the measure of

person-job fit for the motor composite should be used with caution in judging a person's ability or inability to perform an occupation.

It is still necessary to pay attention to the five individuals who were misclassified, as misclassification could prevent them from being referred to occupations they *could do*, or set them up for failure. As indicated in Table 9, 2 participants (11%) were thought to be able to perform occupations they in fact have been unable to do (false positive), and 3 participants (9%) were thought to be unable to do jobs they in fact performed (false negative).

IV. ADDITIONAL STATISTICAL ANALYSES

The relationship between the participants' GATB performance and the variables age, education, and employment status was examined. Selection of these particular analyses resulted from questions raised by the literature reviewed.

A. GATB Scores of the Study Sample and Age.

A relationship between GATB scores and age has been noted by some authors (Weiss, in Buros, 1972; Hunter, 1983a). The relationship between age and the GATB scores of this study sample was examined.

1. Statistical Analysis Procedure Used.

The bivariate Pearson correlations between the participants' GATB aptitude and composite scores and their age were calculated.

2. Results

Table 12 presents the Pearson correlation coefficients between the participants' ages and their GATB aptitude and composite scores.

Table 12
Correlation: GATB Aptitude and Age

APTITUDE / AGE	*r* (Pearson)
V	.165
N	.091
S	-.382*
P	-.276
Q	.028
K	-.083
F	-.102
M	-.218
COGNITIVE	.106
SPATIAL	-.352*
MOTOR	-.154

Note. * Significant correlation. The critical value of Pearson $r = .331$ (two tailed, degree of freedom = 58, p .01).

In this sample, a significant relationship between age and performance on GATB-S and the spatial composite was observed. Performance on the spatial subtest and the spatial composite declined as individuals advanced in age. Clemmons (1985) reported no relationship between GATB aptitudes and age with a group of individuals with epilepsy. The present finding for most GATB aptitudes and Clemmons' (1985) finding contrast with reports from various authors (Fozard, Nuttall, & Waugh, 1972; Hunter, 1983a; Weiss, in Buros, 1972) who found that the performance of regular job applicants generally declined with increasing age on all GATB aptitude and composites. It is possible that the effect of the injury generally outweighs the effect of age with neurologically impaired individuals.

B. GATB Scores of the Study Sample and Education at Intake.

The relationship between GATB scores and education level at intake was examined.

1. Statistical Analysis Procedure Used.

The bivariate Pearson correlation coefficients between the participants' GATB aptitude and composite scores and level of secondary and post-secondary education was calculated. An analysis of variance (ANOVA) was done to examine the relationship between GATB aptitude and composite scores and the post secondary education level, coded by type and level of education (Chapter Three Figure 5). The education levels "college" (1) and "university without a degree" (3) were grouped together because of the small number of participants in the latter group.

2. Results.

Table 13 presents the matrix of correlations between the GATB aptitude and composite scores of the study sample and the level of secondary education.

Table 13
Correlation: GATB Aptitude and Secondary Education at Intake

APTITUDE / Secondary education (at the time of intake)	*r* (Pearson)
V	.094
N	.195
S	.057
P	.163
Q	.250
K	.249
F	.216
M	.094
COGNITIVE	.212
SPATIAL	.125
MOTOR	.198

Note. The critical value of Pearson $r = .331$ (two tailed, degree of freedom = 58, p .01)

In this sample, no strong relationship was observed between GATB aptitude or composite scores and the level of secondary education attained. A significant relationship between post-secondary education and performance on GATB-V and the cognitive composite was observed (Table 14). As shown in table 14, 17% of the overall variance (Eta squared) in GATB-V scores is accounted for by type and amount of secondary education. The cognitive composite includes GATB-V, S, and Q, and 14% of the overall variance in the cognitive composite score is accounted for by type and amount of post-secondary education.

Table 14
Anova: GATB Aptitude and Post-Secondary Education at Intake

Aptitude	Eta Squared	*F*	*P*
V	.1668	3.7369	.0161*
N	.1021	2.1215	.1077
S	.1246	2.6560	.0572
P	.0971	2.0064	.1235
Q	.0964	1.9915	.1257
K	.0506	.9954	.4018
F	.0098	.1809	.9089
M	.0234	.4391	.7259
COGNITIVE	.1425	3.1027	.0338*
SPATIAL	.1239	2.6399	.0583
MOTOR	.0113	.2141	.8862

Note. * Significant F, $p < .05$.
Type and amount of post-secondary education denotes group membership and was coded as follows:
0 = no post-secondary education
1 = College degree/certificate and/or some years of university
2 = Trade school
3 = Completed B.A.

C. GATB Scores of the Study Sample and Employment Status at Intake.

The possibility of a relationship between aptitude and employment status is reasonable. The GATB scores of participants who were employed at the time of intake were compared to the GATB scores of those who were unemployed.

1. Statistical Analysis Procedure Used.

A multivariate analysis of variance (MANOVA) was done to compare the GATB aptitude and composite scores of participants who were employed (33) with those of the unemployed (27). The participant who was a student was placed in the unemployed group. The GATB aptitudes and composites were used as dependent variables, and employment status as the independent variable. The multivariate analysis was followed by a series of univariate analyses to compare our data with previous work (Tellegen, 1965). This was done using an independent t test with alpha set at .01 to protect for type I error while maintaining sufficient power.

2. Results.

The multivariate test of significance was non significant (Pillais = .23587 p .01). This indicates that there is no significant overall effect — that is, considering all the aptitudes of the battery (GATB), there is no overall significant difference between the scores of participants who were employed at intake and those who were unemployed. The significance of the difference of mean scores for individual aptitudes was nonetheless examined, using a more stringent p level (.01). As mentioned in the foregoing, this was done to compare the present data with previous work. Furthermore, the non-significance of the MANOVA may be due to the small number of subjects in relation to the number of variables. However, the lack of an overall effect cautions against any interpretation of significant difference found for individual aptitudes.

Table 15 presents the mean scores and standard deviation for each group, as well as the t value and the significance.

Table 15
Mean GATB Scores of Unemployed (G1) and Employed (G2) Participants at Intake

GATB APTITUDE	MEAN G1	SD	MEAN G2	SD	*t*	ALPHA.01
G	84.51	15.08	93.24	15.8	-2.17	NS
V	86.44	16.86	92.96	19.32	-1.38	NS
N	81.03	18.23	95.09	14.92	-3.28	S
S	93.37	20.08	98.21	15.16	-1.06	NS
P	85.81	22.09	97.03	19.99	-2.06	NS
Q	93.70	19.88	100.09	20.81	-1.21	NS
K	77.18	34.05	88.45	24.18	-1.50	NS
F	60.65	32.31	76.06	24.45	-2.09	NS
M	50.07	37.16	70.03	29.83	-2.29	NS
COG	87.06	15.62	96.05	15.82	-2.20	NS
SPA	89.59	19.90	97.62	15.70	-1.75	NS
MOT	62.85	31.62	73.18	22.45	-2.19	NS

Note. S = significant
NS = non-significant

COG= Cognitive composite
SPA = Spatial composite
MOT = Motor composite

A significant difference was observed between the mean GATB-N scores of participants who were employed at intake and those who were unemployed. No significant difference between the mean scores of the GATB composite was noted. This indicates that participants who were employed tended to have a higher score on numerical aptitude, GATB-N. This is reported as an observation without drawing any significant conclusion, as the sample of occupations analyzed in this study is restricted. Furthermore, as already mentioned, the lack of an overall main effect cautions against interpreting significant differences on individual aptitudes. Tellegen (1965) noted a significant difference (t, p.05) between employed and unemployed individuals with epilepsy on GATB-N and Q, using the GATB Form B-1001.

Summary.

In this sample, a significant relationship between age and performance on the GATB-S and spatial composite was observed. The possibility that the effect of the injury may outweigh the effect of age observed on all GATB aptitudes in some studies was raised. Clemmons (1985) reported that age did not affect the GATB scores of a group of individuals with epilepsy. A significant relationship was also observed between GATB-V and the Cognitive composite and post-secondary education level. Clemmons (1985) found a significant difference on all GATB aptitudes except the motor aptitudes, F and M, between a group of participants who had 12 years of education or less and groups with 13 to 14 years of education and 15 or more. The latter two groups also differed on GATB-V and Q.

The GATB scores of participants who were employed at intake differed from those of the unemployed only on the GATB numerical aptitude (N). Interpretation of these results is cautioned against by the restricted range of occupations analyzed with this study sample, and the lack of overall multivariate effect.

V. CLINICAL ANALYSIS

The measure of person-job fit correctly classified 55 of 60 participants in their respective job categories. From a clinical standpoint, the five misclassified cases are of particular concern because of the impact of misclassification on their vocational rehabilitation. In an attempt to identify factors that may lead to misclassification, a clinical case analysis was carried out.

It is necessary to acknowledge that such a post-hoc qualitative analysis will not explain the reasons for misclassification. It may, however, provide information about elements that should be considered when making clinical judgments during the vocational rehabilitation process.

The analysis required contacting the misclassified participants for their consent and accessing additional medical, neuropsychological, and vocational information about them. This was possible with one of the five misclassified participants, thus the case of participant A.F. (pseudonyme) was analyzed.

The framework used to facilitate a systematic analysis is the International Classification of Impairments, Disabilities and Handicaps (ICIDH).

A. International Classification of Impairments, Disabilities and Handicaps (ICIDH).

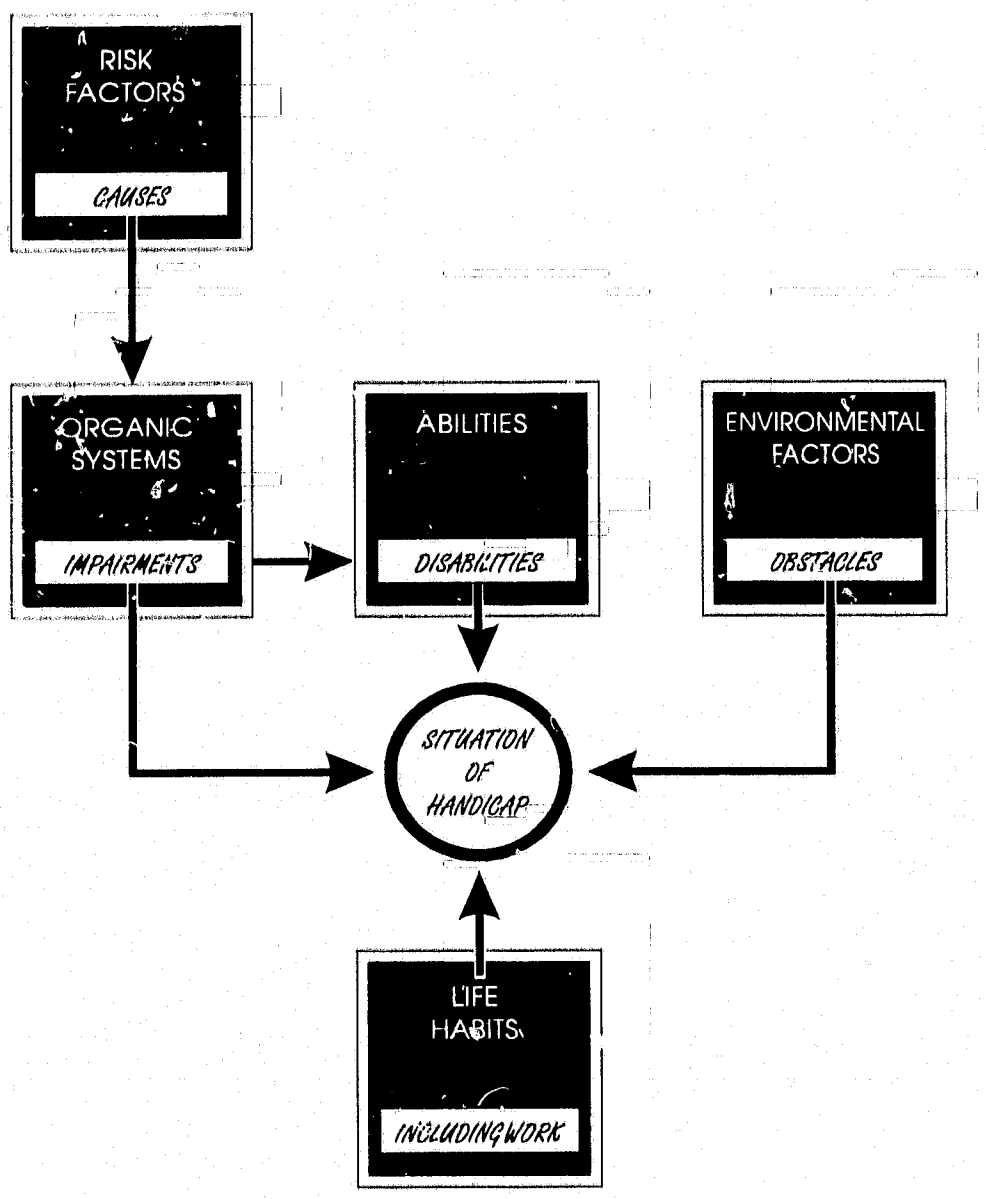
The ICIDH is a classification system that provides a conceptual model within which to analyze the wide range of elements (personal and environmental) that make up the clinical profile of the long-term consequences of traumatic brain injury.

The ICIDH is being developed by the World Health Organization (WHO). It is beyond the scope of this study to present a complete history of its development, although further information is contained in Appendix H.

For the purpose of presenting the overall plan of the clinical analysis, it is only necessary to know that the ICIDH is used as the framework, as at this stage of its development, the concepts and not the nomenclatures are endorsed by the WHO. Specific terminology proposed in 1990-91 is still being reviewed by the international community, and the revised classification needs to be validated. A brief description of the concepts illustrated in Figure 11 follows.

The ICIDH model redefines the concept of "handicap" as a dynamic process. A *situation of handicap* results from the interaction of a person's impairments consequent to disease or trauma, the abilities and disabilities resulting from the impairments, and the demands of the diverse situations within their living environment that present obstacles and/or resources. As such, the concept of handicap is no longer one-dimensional and permanent. A person experiences a diversity of situations of handicap, each of varying severity.

Figure 11. Handicaps Creation Process



Note. From "The Handicaps Creation Process - How to Use The Conceptual Model Examples", by the Canadian Society for the ICIDH and Québec Committee on the ICIDH, ICIDH International Network, 4(3), p. 13. Copyright 1991. Adapted by permission.

The conceptual model identifies five main concepts. Certain components of this systemic model are related in a cause-and-effect association, visualized by the arrows in Figure 11. Others are related in an interactive relationship, represented by the circle. Although not illustrated in the figure, the handicap creation process is continuous — that is, life habits and environmental factors can create risk factors and cause impairment.

Each concept is defined and organized into categories, which in turn include specific factors or terms and severity scales. For example, the first conceptual level, Risk Factors, groups causes of impairment into four major categories: Social and environmental organization; individual behavior; accidents; and biology. Each of these categories includes specific risk factors. These risk factors can cause anatomical, physiological, and histological irregularities or changes to the organic system.

The organic systems affected constitute the second conceptual level. This level is composed of 14 large categories, which in turn are specified by a nomenclature of organic systems and qualified by a scale of location of impairment and a scale of severity.

The third level, disabilities/abilities, refers to disruptions in a person's ability to perform physical or mental activities as a result of one or more impairments. The difference between an impairment and a disability is that the first refers to an organic deficit, while the second deals with an inability to perform a function normally executed by the organic system. For example, impairments to the nervous system (brain/cerebral cortex) affect abilities linked to intellectual activities, such as memory. Ten categories make up the third level. A nomenclature of abilities and a severity scale specify the categories.

The fourth level, situation of handicap, was described in the foregoing. The proposed nomenclatures of Environmental Factors and Life Habits classify the possible situation of handicap. The concepts and their general categories will serve as the framework for the analysis. The nomemclatures will be used broadly, to guide the organization of the content of the analysis, considering the developmental stage of their terms and scales.

Interest in using the ICIDH stems from the fact that this internationally accepted language provides an understanding of the long-term consequences of disease and trauma. Furthermore, the dynamic concept of various situations of handicap, related to a person's life habits and environment and changing throughout the rehabilitation process and the

person's life, better represents the reality of persons with disabilities. The model offers a positive language, talking about organic systems affected rather than disease and trauma, and about abilities as well as disabilities.

B. Clinical Analysis: Case of A.F.

1. Participant's Information.

Sex: male *Lateral Dominance*: right-handed
Age at the time of injury: 18
Age at the time of participation: 23
Classification status: misclassified as a false negative by the measure of person-job fit.

2. Vocational Profile.

At the time of injury (spring, 1986), A.F. was attending high school. His program consisted of Grade 11 and 12 academic courses and one vocational preparation course in automotives. A.F. was described as an average student (C+) until grade 7. In high school, his attendance was sporadic and his grades were poor. He was described as a difficult teenager who had problems with authoritarian attitudes. He was reported to have behavioral problems at school and at home.

While in high school, he worked part-time in a fast-food outlet (Counter Sales, Cleanup, and Food Preparation).

A.F. returned to school part-time five months *post-injury* (September, 1986). He did not graduate from high school.

He attended college on a part-time basis between September, 1987, and May, 1990, completing Grade 12 and additional college-level courses.

He had various part-time jobs between 1987 and 1990, including Gas Station Attendant, Bus Boy, Dishwasher, Banquet Waiter, Tree Planter, and pizza Delivery Man. He was unable to successfully perform some of these jobs (Gas Station Attendant, Tree Planter,

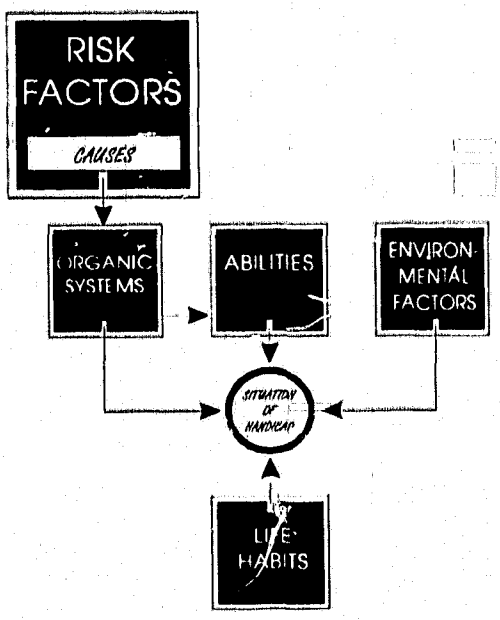
and one of the Bus Boy jobs), and generally held each of the other positions for a short period of time.

He was unsuccessful in some of these jobs due to his disabilities: diminished ability to work quickly, susceptibility to excessive fatigue, slowed learning of job requirements, poor memory, and poor initiative in the work environment.

A.F. enrolled in first-year science in university in September 1990, and attended full-time. He subsequently withdrew and continued on a part-time basis, auditing two arts courses. He left school and returned to paid employment in March 1991. He was employed by a truck rental company, to inspect, clean, refuel, and drive the vehicles. This occupation was analyzed with the PAQ.

At second follow-up (May, 1992), A.F. was not employed and was occupied with renovating a house he had recently purchased. He had left the truck rental company voluntarily after five months of employment. In a telephone interview, his supervisor noted that A.F. had limited stamina and difficulty remembering instructions given once orally.

3. Risk Factors: Causes

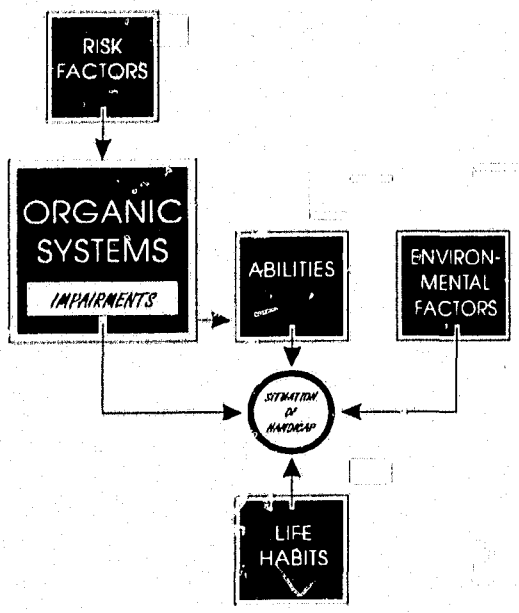


"The causes of impairment can be grouped into four major categories. For each category, a number of Risk Factors have been identified" (P. 14, ICIDH International Network, 4(3), 1991)

Causes	Risk Factors
(3). Accidents	(3.2) Traffic Accident

He was an unbelted passenger in a car.

4. Organic Systems: Impairments



"Impairment is any anatomical, physiological or histological anomaly or alteration. Impairment may have one or more causes" (P. 15, ICIDH International Network, 4(3), 1991).

A.F. suffered injuries to his nervous and integument systems.

(1). Nervous System
(1.1) - Brain
(1.1.2) - Cerebral Cortex

The emergency records indicate that A.F.'s level of consciousness deteriorated while he was under observation, and that he became unresponsive and semi-comatose. The neurologist reported that A.F. did not speak and presented elevated intracranial pressure and right ankle clonus. A CT scan at the time of admission was within the normal limits. The diagnosis was concussion, with some effect on his temperature-control mechanism. There was no measure of severity or duration of coma.

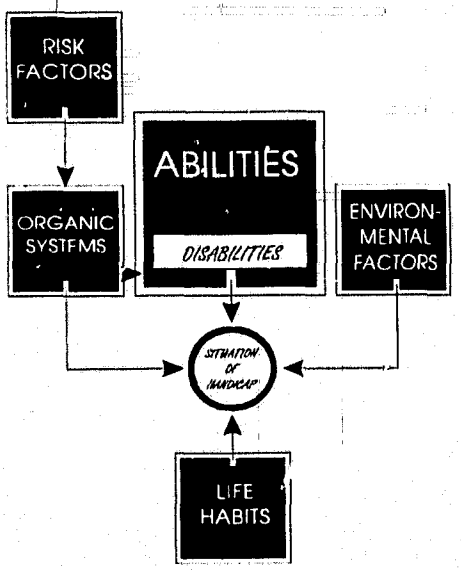
A.F. reported a period of post-traumatic amnesia of approximately one week.

The neuropsychological evaluation and occupational therapy assessment reported a lack of coordination.

(11) - Integument System
(11.2) - Skin
(11.3.1.8) - Chin

The initial evaluation reported a severe, deep laceration on A.F.'s chin.

5. Abilities: Disabilities



"Disability is any disturbance, resulting from an impairment, in the capacity to perform a physical or mental activity considered normal for a human being (depending on that person's biological characteristics)"
(P. 15, ICIDH International Network, 4(3), 1991).

Abilities and disabilities are assessed with the neuropsychological test information available. There is no direct correspondence between the ICIDH and the constructs measured by neuropsychological tests. The organization of the neuropsychological tests within the ICIDH is based on clinical judgment. Many neuropsychological tests measure more than one ability, and for that reason were repeated in different categories.

(1). Abilities related to intellectual activities

ABILITIES	TEST USED*	PERFORMANCE (Percentile)
Global Intelligence (psychometric)	WAIS-R Full scale IQ	60
	Verbal IQ	70
	Performance IQ	37
	Raven Standard Matrices	65
(1.1.3) - Attention	Stroop I	N**
	StroopII	N
	StroopIII	N
	Trail A	<10
	Trail B	<10
(1.1.4) - Concentration	WMS Mental Control	85
(1.2) - Mnesia		
Global measure	WMS Quotient	70
(1.2.1) - Propositional memory		
(1.2.1.1.1.2) - Short-Term Memory	Digit Span	50
	PASAT	70
	Sentence Repetition	14
(1.2.1.1.1.2) - Long-Term Memory	WMS Logical Stories	
	immediate recall	10
	delayed recall	15
	Rey Auditory Verbal Learning total	35
	WMS Verbal Paired Associate	
	immediate recall	88
	delayed recall	<1
	WMS Visual Reproduction	
	immediate recall	90
	delayed recall	20
	Rey Osterieth Complex Figure delayed recall	<1
	Benton Visual Retention Test	N

(Continue next page)

ABILITIES	TEST USED*	PERFORMANCE (Percentile)
(1.3) - Thought		
(1.3.1) - Logical thought		
(1.3.2) - Association	Word Fluency	15
(1.3.3) - Analysis and	WAIS-R Block Design	35
(1.3.4) - Synthesis	WAIS-R Object Assembly	10
	WAIS-R Picture Arrangement	35
	Hooper	N
(1.3.5) - Judgment	WAIS-R Comprehension	75
(1.3.7) - Calculia	WAIS-R Arithmetic	85
	WRAT Arithmetic	23
(1.3.9) - Abstraction	Category Test	p***
	WCST	N
	WAIS-R Similarities	50
ADDED - Processing Speed Ability		
	Stroop I	N
	StroopII	N
	PASAT	N
	WAIS-R Digit Symbol	<10
	Trail A	<10
	Trail B	<10
(2). Abilities linked to language		
(2.2) - Understanding		
(2.2.2) - Understanding Language	WAIS-R Vocabulary	25
(2.2.2.2) - Understanding written language	WRAT Reading Comprehension	35
	WRAT Spelling	75

(3). Abilities linked to behaviour

An MMPI profile performed three years and five months post-injury suggested immature, impulsive, and unreliable behaviour. The profile indicated a low tolerance for frustration and a tendency to resist rules and convention. These characteristics were consistent with pre- and post-injury behaviours.

A.F. participated in group counselling sessions focusing on self- awareness, self-monitoring, and perception of social situations.

The neuropsychologist's report indicated that A.F. had (1988) unrealistic vocational goals and needed to experience for himself the degree of his limitations.

A.F. talked about his emotional experiences following the injury. From his accounts, he moved from denial towards acceptance during his year away at university (1990-91), four to five years post-injury.

(4). Abilities linked to the senses and to perception

(4.3) - Exteroceptive functions		
(4.3.1) - Vision		
(4.3.1.13) - Size	Rey Complex Figure Copy	23
(4.3.1.14) - Shape	GATB-P	5
(4.3.1.18) - Constant perception		

(5). Abilities linked to motor activities

(5.5) - Simple manual activities		
(5.5.1) - Grasping		
(5.5.1.1) - Grasping with one hand		
(5.5.1.1.1) - Digital	Purdue Peg board	
	dominant hand	25
	non dominant hand	75
	both hands	15
Grasping	GATB - M	<1
	GATB - F	9

(Continue next page)

(5.5.1.1.2) - Palmar Grasping	Dynamometer	
	right hand	20
	left hand	55

Note. * Full names of tests in order of appearance: WAIS-R (Wechsler Adult Intelligence Scale Revised); Stroop Color Word Interference Test (stroop I, II, III) WMS (Wechsler Memory Scale); PASAT (Paced Auditory Serial Addition Test); Hooper (Hooper Visual Organization Test); WRAT (Wide Range Achievement Test); WCST (Wisconsin Card Sorting Test); MMPI (Minnesota Multiphasic Personality Inventory).

** N = normal performance (used when it was the only information available or based on a cut-off score).

*** P = poor performance based on cut-off score.

Summary: Abilities/Disabilities

The neuropsychological evaluation summarized A.F's disabilities and abilities as follows:

— A.F. shows the ability to control his attentional resources, maintaining his attention on the salient feature of the stimulus. However, he has difficulty shifting his attention from one concept to another within one task. The Occupational Therapist doing cognitive training noted that he is easily distracted by changes in his environment.

— A.F. presents memory problems: poor long-term memory performance in visual and verbal modalities when learning is done under time limits, or with more complex or disorganized material.

— When he is given more time to encode information organized in simple units, his performance is satisfactory. His short-term memory (working memory) capacity is adequate when he is dealing with a limited amount of information, and weaker when he is faced with more complex information.

— His speed of information processing is reduced.

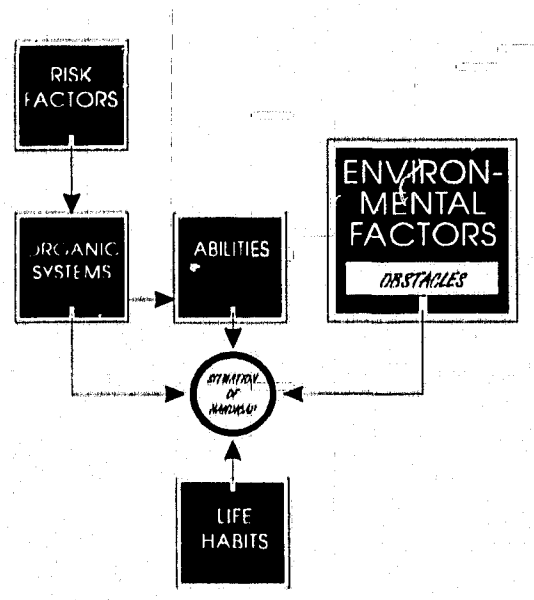
— He has problems organizing material.

— He exhibits right-hand weakness and incoordination.

— His ability to solve problems using analytical reasoning, his capacity for abstraction, and his judgment are fair. His arithmetic reasoning abilities are satisfactory, although his performance on calculation is weak. His understanding of language and his reading comprehension of written material are fair.

— A.F. presents behaviours (low tolerance for frustration, immaturity, and impulsiveness) that can be associated with some brain injuries. However, these behaviours were noted pre-injury, and may have been amplified following the injury.

6. Environmental Factors: Obstacles/Facilitators



"Environmental factors are all social, cultural and environmental dimensions that determine the organization and context of a society"
(p. 16, ICIDH International Network, 4(3), 1991).

(1). Social Factors
(1.1) - Socio-economic organizations
(1.1.1) - Family organization and structure:

A.F. was living with his family at the time of injury, and he lived with them post-injury until 1989. His family participated in counselling sessions with A.F. following the injury. A.F. remains in regular contact with his family, and recently worked with his father on renovating his house.

(1.1.5) - Health and Social Services

— A. F. underwent physiotherapy and speech therapy at a rehabilitation centre.

— He pursued cognitive skill training at a rehabilitation clinic for approximately one year (1987-1988).

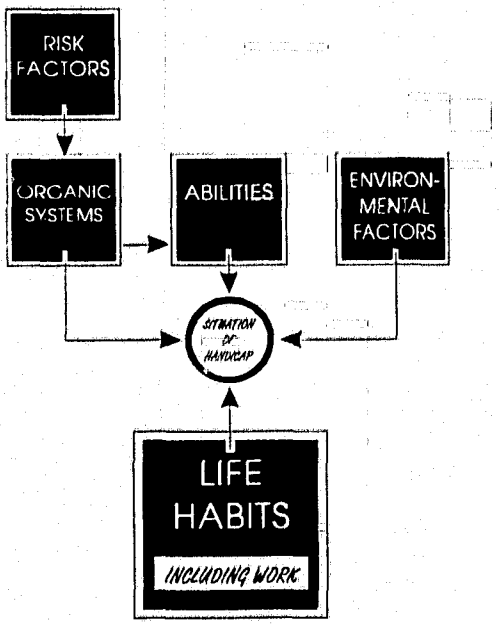
— He underwent group and individual counselling for approximately one year (1987-1988).

— He completed a work capacity evaluation at the rehabilitation centre. Two additional independent vocational assessments were completed (1987 and 1989).

— An initial neuropsychological evaluation was done at the rehabilitation centre one month post-injury, followed by another 18 months post-injury.

The cost of rehabilitation was covered by the provincial automobile insurance and medical insurance systems.

7. Life Habits: Situation of Handicap



"Life habits are those that ensure the survival and development of a person in society throughout the person's life. They are daily and domestic activities, as well as social roles recognized by the socio-cultural context for a person according to age, sex and social and personal identity"
(p. 17, ICIDH, International Network, 4(3), 1991)

The life habits of concern in this study are those related to work. The participant also provided information on the injury's impact on other life habits.

(2). Fitness
(2.1) - Sleep

A.F. reported needing a regular eight hours of sleep in order to function adequately.

(2.2) - Physical fitness

He mentioned poor coordination for aerobic exercise.

(11) - Education
(11.2) - School

A.F. successfully completed courses when he attended school part-time. He reported that he needed to read the course information many times to understand and retain it. He studied on a full-time basis with a reduced course load. He reported difficulties expressing his thoughts cohesively.

(12). Employment
(12.3) - Paid occupations

The interaction between a person's work aptitude and the aptitude demands of the job provides a micro-analysis of the situation of handicap at work.

A first analysis focused on work aptitude. A.F.'s GATB-measured work aptitudes were compared to the demands of the occupation as analyzed by the PAQ. The PAQ aptitude attributes were then examined in relation to his abilities/disabilities as assessed by neuropsychological tests.

(a) Situation of handicap at work: work aptitude.

Table 16 offers a visual representation of the measure of person-job fit for each GATB aptitude. The participant's performance on the GATB is contrasted with the estimated GATB scores of individuals successfully performing the duties of the occupation that A.F. was performing (Rental Truck Service Worker).

This clinical comparison allows a closer look at the fit between the person's work aptitude and the demands of the job. The measure of person-job fit used for statistical analysis only considers the person's measured aptitudes and the average aptitude demand of the occupation for each aptitude composite. The clinical comparison, on the other hand, allows for consideration of the range of the person's aptitude ability and of the aptitude demands of the occupation.

In Table 16, A.F.'s GATB scores (measured score and the score plus one standard error of measurement) are presented on the left. The estimated GATB scores from the PAQ data are on the right; the first letter refers to the GATB aptitude in question, and the remaining two letters indicate the score range: low (LW), average (AV), and high (HG). The scores required to successfully perform the duties involved in the job are estimated for each GATB aptitude.

Table 16
Situation of Handicap at Work: Work Aptitude and Aptitude Demand of Occupation
Rental Truck Service Worker

Measured GATB (Person) [p]		Estimated GATB Aptitude Scores (PAQ) (Job demands range)		
Score	+1sem	Low	Average	High
G		GLW	GAV	GHG
80	86	70	86	101
		[80 p 86]		
V		VLW	VAV	VHG
74	80	70	87	101
		[74 p 80]		
N		NLW	NAV	NGH
81	87	68	85	102
		[81 p 87]		
Q		QLW	QAV	QGH
62	71	81	95	110
[62 p 71]				
S		SLW	SAV	SGH
87	95	74	92	110
		[87 p 95]		
P		PLW	PAV	PGH
66	75	72	90	109
[66 p 75]				
K		KLW	KAV	KGH
70	77	77	94	112
[70 p 77]				
F		FLW	FAV	FGH
72	84	70	89	109
		[72 p 84]		
M		MLW	MAV	MGH
42	53	80	101	121
[42 p 53]				

Note. The PAQ Low, Average, and High scores are based on the mean aptitude scores and standard deviations of successful incumbents for the occupation concerned.

***Summary*: Situation of handicap at work: work aptitude**

The visual comparison of person-job fit for each GATB aptitude juxtaposes the person's abilities and the range of the aptitude demands of the occupation.

A.F.'s aptitude scores are within the low range for the verbal (GATB-V) and numerical (GATB-N) aptitudes. However, his abilities are below the minimal aptitude requirement of the occupation for clerical perception (GATB-Q), a measure of speed and accuracy processing written information. This translates into a large value of person-job fit for aptitude Q, and increases the mean value of person-job fit for the cognitive composite. This tends to classify him in the "*cannot do*" job category.

A.F.'s aptitude score indicates ability within the average range of the demands of the occupation for spatial aptitude (GATB-S). However, his level of performance on perceptual aptitude (GATB-P) is borderline with the demands of the occupation. Performance on GATB-P can be affected by speed of processing information and the ability to maintain two concepts in mind at one time. The poor fit of abilities and demand for GATB-P affects the fit for the perceptual composite.

A.F.'s aptitude score for motor coordination reaches the lower limit of the aptitude demands of the occupation. His finger dexterity is within the lower range, while his motor abilities are outside the range of the occupational demand. However, as seen in the statistical analysis, large differences between individuals' motor aptitudes and the aptitude demands of the job can be found for occupations they are able to do.

According to the measure of person-job fit for the GATB composites, A.F. cannot successfully work at this occupation. However, there is a close fit between some of his aptitude scores and the aptitude demands of the job (GATB - V, N, S, and F). It is possible that A.F. did perform the job because these aptitudes (GATB - V, N, S and F) are particularly important to the job.

To investigate this possibility, the aptitude attributes of the occupation were examined in light of A.F.'s abilities and disabilities.

(b) Abilities/disabilities and aptitude attributes of the occupation.

The PAQ aptitude attributes measure a broad range of aptitudes important to the occupation. The PAQ examines 30 aptitude attributes (described in Appendix B) involved in the job. The analysis produces a percentile score that reflects how important a particular aptitude attribute is to the analyzed occupation as compared to the world of work.

A clinical examination of a person's abilities and disabilities in light of the aptitude attributes of the job provides a more in-depth analysis of the situation of handicap in a specific occupation.

There is no direct correspondence between the classification of abilities (ICIDH), neuropsychological tests, and the aptitude attributes measured by the PAQ. The percentile score obtained from the neuropsychological tests situates a brain-injured individual in relation to people of his or her age group who do not have brain damage (or other neurological deficits). The aptitude attributes, on the other hand, situate the analyzed occupation in relation to the world of work. The comparison of A.F.'s abilities and disabilities and the aptitude attributes of his job is based on clinical judgment of the relationship between the constructs involved.

A.F.'s abilities and disabilities as assessed by neuropsychological tests were examined in relation to the job attributes of his occupation.

(1) Abilities related to intellectual activities.

<u>Attention</u>

Abilities/disabilities: A.F. has the ability to control his attentional resources. However, he has difficulty shifting his attention from one concept to another, and keeping more than one thing in mind. He is easily distracted by changes in his environment.

Job attributes: PAQ aptitude attributes 40 (7%tile) and 41 (10%tile) measure selective attention and time sharing, respectively. The latter refers to the ability to shift between two or more channels of information. Neither aptitude is critical to this job.

Mnesia

Abilities/disabilities: A.F. presents deficits in long-term memory in visual and verbal modalities for more demanding learning conditions (limited time, or more complex or disorganized material). His short-term memory (working memory) capacity is adequate dealing with a limited amount of information, and weaker with more complex information.

Job attributes: PAQ aptitude attributes 36 (7%tile) and 37 (13%tile) pertain to long-term and short-term memory. The general description of the attributes limits their comparison with memory abilities (immediate, delayed, verbal, visual) as measured by neuropsychological tests.

It is interesting to note, however, that although the global memory demands of the occupation are minimal compared to the world of work, A.F.'s memory deficits affected his ability to perform this job and others. The difficulties reported at work are congruent with A.F.'s performance on psychometric measures of memory.

Thought (Analysis, synthesis, judgment, calculia, abstraction).

Abilities/disabilities: A.F.'s ability to solve problems using analytical reasoning, his capacity of abstraction, and his judgment are fair.

Job attributes: PAQ aptitude attributes 33 (8%tile) and 34 (10%tile) measure convergent and divergent thinking. Aptitude attribute 35 (8%tile) assesses the level of abstraction or symbolic complexity required. The low percentiles reflect relatively minimal occupational demands in these areas.

PAQ aptitude attributes 31 (26%tile) and 32 (10%tile) assess the demands for numerical computation and arithmetic reasoning respectively. A.F.'s pattern of abilities fits the priority of demands of the occupation. His arithmetic reasoning abilities are satisfactory, although his performance on calculation is weak.

PAQ aptitude attribute 29 (12%tile), unlike other attributes, measures an ability directly related (construct) to a neuropsychological measure: Word Fluency. Compared to individuals of his educational level, A.F.'s performance was limited (15%tile), as was the demand of the occupation.

(2) Abilities linked to language.

Abilities/disabilities: A.F.'s understanding of language and his reading comprehension of written material are fair.

Job attribute: PAQ aptitude attribute 28 (10%tile) assesses verbal comprehension, and indicates limited demand for this aptitude in the occupation.

(4) Abilities linked to the senses and perception and
(5) Abilities linked to motor activities.

These two areas of ability are examined together, as many of the PAQ aptitude attributes relate to both types of ability.

An examination of these attributes' percentiles indicates that they are the most important for this occupation as compared to the world of work. This is illustrated by the following presentation of the PAQ aptitude attributes with percentiles of 75 or more. An aptitude attribute percentile of 75 or more indicates that few occupations (25% or less) require a greater level of ability for the attribute concerned.

AT69 (%L 92)	Simple reaction time (abilities linked to senses and perception and motor activities)
AT75 (%L 89)	Rate control (abilities linked to senses and perception and motor activities)
AT47 (%L 89)	Far visual acuity (abilities linked to senses and perception)
AT54 (%L 88)	Body orientation (abilities linked to senses and perception)
AT73 (%L 88)	Stamina (abilities linked to motor activities)
AT67 (%L 88)	Eye-hand-foot coordination (abilities linked to senses and perception and motor activities)
AT72 (%L 87)	Static strength (abilities linked to motor activities)
AT68 (%L 85)	Speed of limb movement (abilities linked to motor activities)
AT74 (%L 85)	Explosive strength (abilities linked to motor activities)

AT44 (%L 84)	Movement detection (abilities linked to senses and perception)
AT48 (%L 84)	Depth perception (abilities linked to senses and perception)
AT64 (%L 83)	Continuous muscle control (abilities related to motor activities)
AT45 (%L 81)	Spatial visualization (abilities related to perception and intellectual activities)
AT71 (%L 82)	Dynamic strength (abilities related to motor activities)
AT70 (%L 80)	Response integration (abilities related to motor activities)
AT55 (%L 79)	Spatial orientation (abilities linked to senses and perception)
AT66 (%L 76)	Eye-hand coordination (abilities related to senses and perception and motor activities)
AT56 (%L 75)	Kinaesthesis (abilities linked to senses and perception)

There is limited information available on A.F.'s ability for many of the motor and sensory-perceptual demands of the occupation assessed by the aptitude attributes. The medical information that is available does not indicate impairments that would cause sensory and/or perceptual deficits.

The first neuropsychological evaluation, performed one month post-injury, reported normal performance on finger localization and right-left orientation. The neuropsychological evaluation completed one year and four months post-injury reported right-hand weakness and lack of coordination.

A.F.'s performance on the GATB spatial composite subtests indicates satisfactory ability to recognize sizes and shapes and manipulate them visually (GATB-S). His poor performance on GATB-P may have been due to the speededness of the test and/or the fact that he had to deal with two concepts simultaneously.

A.F. worked at a variety of physically oriented occupations following his injury. Reports of his vocational performance note that his diminished ability to work quickly and his susceptibility to fatigue affected his ability to maintain some jobs. A.F. reported that he had left a job as a tree planter because it was too physically demanding. His last supervisor indicated that A.F. had limited stamina compared to his co-workers.

***Summary*: Abilities/disabilities and aptitude attributes of the occupation.**

While A.F.'s cognitive strengths most likely helped him do the job, they do not correspond to many of the critical demands of the occupation. On the other hand, his memory deficits adversely affected his ability to do the job, even though the memory demands of this occupation are relatively minimal compared to those of other occupations. These deficits also affected other post-injury occupations he tried. However, A.F. developed the ability to utilize memory aids to compensate for his deficits.

The most important attributes (percentile 75) of this job are linked primarily to sensory/perceptual and motor (physical) abilities. A.F. does not present serious sensory, perceptual, or motor deficits. However, slowness, incoordination, and susceptibility to fatigue have affected his performance in other jobs. His last supervisor mentioned that A.F. had "limited stamina," but was able to meet all the physical demands of the job.

The comparison of A.F.'s abilities/disabilities and the aptitude attributes of the job complemented the GATB aptitude measure of person-job fit. The weak fit between the person and the job was related to the demand for speed of processing information and perceptual and motor abilities. This broader person-job fit measure pointed out the need to address the memory demands of the job in the presence of memory deficits, even though the importance of memory abilities may be minimal compared to other occupations.

C. Conclusion

Although a satisfactory rate of correct classification (55 out of 60 study participants) was achieved with the measure of person-job fit for work aptitudes, the five misclassifications demonstrate that the measure is not infallible.

A clinical case analysis was conducted in order to identify factors that may have led to misclassification. The analysis of A.F. did not reveal any obvious elements that account for his misclassification. In fact, the clinical judgment that would be made from the detailed analysis of the situation of handicap at work would <u>not be</u> that A.F. could definitely do the job.

From a clinical standpoint, in the context of a vocational evaluation, the fit between A.F.'s abilities/disabilities and the demands of the job would be judged borderline. A.F.'s defi-

ciencies in speed of processing and perceptual abilities, as well as his motor slowness and susceptibility to fatigue, imply a poor fit, considering the high occupational demands in these areas. A.F. would therefore not be referred for the position of rental truck service worker outside a vocational rehabilitation program.

In a job placement intervention, however, in which the position of rental truck service worker was available to the individual, and the employer was open to a rehabilitation intervention, a work assessment would be suggested.

The analysis of the vocational situation of handicap using the GATB-PAQ and neuropsychological tests-PAQ provides information useful for designing such a work assessment program. It identifies the possible areas of difficulty in a specific occupation. The job analysis (PAQ) facilitates the identification of duties requiring specific abilities that may be areas of disability for the individual. This information can be used to plan on-the-job training and the gradual introduction of new duties. It can also be used to suggest job modifications and compensatory aids to assist the individual.

It is interesting to note that the vocational assessments conducted in 1987 and 1989 concluded that A.F. would have difficulties in a competitive employment setting. His series of short-term jobs supports this conclusion. Both assessments recommended vocational rehabilitation intervention, including placement, job coaching, and on-the-job training. Both evaluations noted that demands on speed of processing and memory needed to be minimal, and that susceptibility to fatigue would continue to be a problem. As previously noted, the analysis of the vocational situation of handicap provides information useful for designing vocational rehabilitation interventions.

Chapter Five

DISCUSSION

In this chapter, the clinical implications of the findings reported in the preceding chapter are considered. The order in which information is presented is consistent with that of Chapter Four — the structure of the GATB, the GATB and traumatically brain-injured individuals, and the measure of person-job fit.

This chapter concludes with a statement of the limitations of the present study and considerations for future research.

It is necessary to acknowledge that the conclusions that can be drawn from the data analysis are restricted by the fact that study participants were not randomly selected. However, the similarity between this sample and those described in the literature indicates that it is probably representative of the subpopulation of individuals with traumatic brain injuries. Although one can be confident that the same results would be achieved with a larger, representative sample, cross-validation is necessary for definite generalization. In presenting the clinical implications of the findings, the limitations to this study sample are always presumed.

I. GATB STRUCTURE

Findings from this study corroborated the statement made by many authors that the eight GATB aptitudes can be regrouped into composites without losing important information. The results from this research confirmed that the GATB aptitudes can be regrouped into three composites: A cognitive/information processing composite (V, N, Q); a spatial perception composite (S, P); and a motor composite (K, F, M). This particular model of the stucture of the GATB had been proposed by Fozard et al. (1972) and fitted a sample of regular (blue collar) job applicants as well as a sample of individuals with traumatic brain injuries.

For research purposes, using the GATB composites instead of the eight individual aptitudes allows a wider choice of statistical techniques. Some procedures demand that attention be paid to the variable/subject ratio; the more variables one has, the more subjects there must be. Studies of disabled individuals often have fewer participants, and thus demand fewer variables.

From a clinical standpoint, use of the composite scores facilitates comparing the GATB to other psychological tests that are believed to measure similar abilities. There are several psychological measures of cognitive, perceptual, and motor abilities. This does not mean that the GATB composites and psychological tests measure exactly the same abilities. More information about the relationship between the GATB subtests and psychological tests is contained in the analyses by Cole (1984) and Clemmons (1985), reviewed in chapter two (page 39-41). Their analyses can serve as a clinical guideline.

In the vocational assessment process, the GATB composites, particularly when used in conjunction with the PAQ, are useful for making an initial, broad selection of occupational possibilities. Although the composites are useful for research, comparisons with other psychometric measures, and initial occupational selection, for a vocational rehabilitation process, use of all eight GATB aptitudes is recommended. This is because it is important to obtain the most information possible, in order to focus the job selection process and accurately judge an individual's ability to perform a specific occupation. In the succeeding steps of the process, the GATB aptitudes are most effective when the GATB is used in conjunction with the PAQ to design work reintegration programs, suggest compensatory aids for the individuals, and consider job modifications.

For example, it is possible (as seen in the case presented in Chapter Four, page 116) that an individual's abilities will meet the aptitude demands of an occupation for two out of three of the GATB aptitudes making the composite. This information is useful in situations where it may be possible to identify and modify the job duties that require abilities beyond the person's capacity. The possible clinical applications of the measure of person-job fit are discussed further in Section III.

II. THE GATB WITH BRAIN-INJURED INDIVIDUALS

A. Performance of Brain-Injured Individuals

Brain-injured individuals in this sample tend to score lower than the General Working Population on GATB-G, V, N, K, F, and M. The lowest scores are usually obtained on the motor tests. It is important to remember, however, that this is a group pattern, and not all individuals in this sample will fit this pattern. Likewise, it cannot be assumed that a pattern of low motor scores is an indicator of the presence of brain injury. The fact that great variations in study participants' motor scores were noted indicates that a wide range of performance is possible.

When GATB scores are used for selection purposes in the competitive labour market, brain-injured people will likely experience substantial difficulties, especially if they are subjected to a selection system such as the VG-GATB (Chapter Two, pages 29-30). Clemmons (1985) reported that individuals with epilepsy were at a similar disadvantage in the face of competitive personnel selection based on aptitude testing.

This concern was clearly addressed by the NAS Committee on the GATB (Hartigan & Wigdor, 1989), which concluded that the VG-GATB referral system is not adequate for disabled applicants and that "job counsellors are essential to the referral process for handicapped applicants" (p. 233).

The low motor scores observed in this study sample and reported in the literature call into question the efficacy of using the motor subtests to assess the vocational aptitudes of brain-injured individuals.

The speededness of these subtests has been cited as the major cause of the poor performance by individuals with epilepsy (Clemmons, 1985). The GATB motor tests also have low reliability, poor convergent validity, and low predictive validity for job performance, and the PAQ has a weak ability to predict F and M scores (Chapter Two, pages 41 and page 50).

Neuropsychologists using the GATB in vocational rehabilitation must take these limitations into account. When assessing a traumatically brain-injured person's ability to do a job for which motor ability is a concern, additional evaluation techniques are recommended, such

as other psychometric measures, vocational measures (work samples, for example), situational assessments. and/or occupational therapy evaluations.

In this study sample, a significant relationship between GATB performance and age was observed for GATB-S and the spatial composite (GATB - S and P). However, Neuropsychologists should be aware that other studies of regular job applicants (Weiss, in Buros, 1972; Hunter, 1983a) have revealed performance declines with increasing age on all GATB aptitudes. The lack of relationship between GATB performance and age reported by Clemmons (1985) in his study of individuals with epilepsy and findings from the present study, raised the possibility that the impact of the brain damage itself generally has a more adverse effect on GATB performance than age does.

The significant relationship observed in this study between post-secondary education level and GATB-V and the cognitive composite (GATB-V, N, and Q) is logical. Verbal and numerical aptitudes are often used as measures of academic achievement, and GATB-Q also evaluates speed of reading. Similarly, Clemmons (1985) found a significant difference between the GATB-V and Q scores of individuals with epilepsy who had completed 13 to 14 years of education and those who had completed 15 or more. Unlike the present study, both Clemmons (1985, individuals with epilepsy) and Stoelting (1990, individuals with disabilities, but no brain injuries) reported a significant relationship between GATB aptitudes and education level for all aptitudes except GATB-F and M. There is no clear explanation for the lack of significant relationship between GATB-S, P, and K and education level in the present sample.

Although participants in this study who were employed at intake scored higher on numerical aptitude (GATB-N) than unemployed participants did, interpretation of this difference is not recommended; a limited number of occupations were analyzed, and there were no overall significant differences between employed and unemployed people when all GATB aptitudes were considered.

B. Suggestions for Clinical Use of the GATB with Brain-Injured Individuals

In this section, alternative procedures for administering the GATB to brain-injured individuals are presented. If a brain-injured individual is to be compared to the published norms, the standard administration must be followed. In a clinical situation, however,

where the intervention focuses on testing a person's limits rather than on a normative comparison, an alternative administration may be used. Suggestions for possible modifications to the GATB and considerations for future research are also offered, drawn from the Literature Review (Chapter Two, pages 21-43) and from clinical experience using the GATB in the vocational rehabilitation of brain-injured individuals.

1. Speededness

Low scores on the motor subtests have been attributed to the speededness of the tests, and the stringent time limits on all of the GATB subtests may obscure those intended as power tests. In a clinical evaluation, an alternative administration may be used to obtain separate information on speed and accuracy. The examiner notes the number of answers provided within the standard time limit, then allows the individual to continue working until four or five consecutive errors are made. If the errors are made before the standard time limit is reached, the examiner may wish to stop the test and verify that the individual understands the instructions. This approach was found useful in the study for the nonmotor subtests (not K, F, and M) which include several items.

In future development of the GATB, it is worth considering removing the time limit on the subtests intended as power tests.

An alternative scoring procedure based on the number of consecutive false answers, such as that used in the Woodcock Johnson Psycho-Educational Battery, would provide more information about the *abilities* of individuals with brain injuries, as their performance is often adequate, but slow. Differentiating between the ability to perform correctly and the ability to perform rapidly is useful for job modification; in some instances, it may be possible to alter the speed of machinery or the quota of production as long as the person can perform the task correctly.

It is also valuable to measure how long it takes individuals to perform a new cognitive task. This can be done by noting the time required for them to complete the first answer and the total time they use to complete the entire test.

2. Answer Sheet

Various deficits consequent to a brain injury can affect a person's ability to fill out the answer form. Some people find it visually confusing, particularly for the Form Matching subtest. In other instances, perseverant tendencies lead individuals to darken answer circles to perfection and erase them completely when they make mistakes, even though they have been instructed otherwise. Spasticity and motor limitations can also hinder a person's ability to answer rapidly. In such cases, filling out the answer sheet for the person provides a better estimate of his or her abilities.

3. Subtest # 3, Spatial Perception Aptitude, GATB-S

The verbal explanation and two-dimensional visual presentation of the Spatial subtest make the instructions difficult for many brain-injured individuals to understand. A demonstration of the instructions, using a three-dimensional model made by cutting and folding paper, is often more efficient. Revising the instructions to incorporate this format, which the subtest of the Stanford-Binet uses, is an alternative to be worth considering in future development of the GATB.

4. Subtest #7, Form Perception Aptitude, GATB-P

The format of the Form Matching subtest creates difficulties for some brain-injured individuals. The complexity of the figure, with the stimuli presented in one box and the matching choices presented in another, is problematic for individuals with perceptual and attentional difficulties. As an alternative to the standard administration, duplicates of the individual shapes that are to be matched can be handed to the person one at a time, so that he or she can more easily compare them to the box containing the matching figures. The difference in the person's performance between administrations, as well as the strategies he or she uses, are also revealing. This approach may be the option to consider in future development of the GATB.

5. Motor Aptitudes, GATB-F and M

As already mentioned, GATB-F and M present psychometric weaknesses and limitations when they are used with individuals who have sustained traumatic brain injuries. Neuro-

psychologists using the GATB must take these factors into account. In future development of the GATB, it may be wise to consider alternative measures of motor ability that address these weaknesses. It might also be useful to investigate the relationship between other measures of motor ability and the PAQ motor demands of jobs.

6. Computerizing the GATB

Most of the suggestions for alternative administrations and scoring of the GATB could be accommodated with a computerized version of the GATB. The benefits of a computerized instrument are many:

- It would make it possible to record the time taken to answer each test item and the total time used to complete the entire test.
- It would facilitate an administration procedure in which the length of a subtest would be based on the number of consecutive errors.
- It would more accurately measure multiple components of a traumatically brain--injured person's performance.
- It would allow for a presentation of the instructions in a way that ensures that the person's attention is engaged and the instructions understood before proceeding.
- It would enable examiners to concentrate on clinical observations of the strategies individuals use when faced with new learning situations. As such, a computerized version of the GATB is viewed as a tool for the examiners, not as a replacement for their clinical intervention.

A computerized version of the standard form of the GATB is currently being developed. This is promising, as it will facilitate research into alternative forms of the GATB, possibly and hopefully leading to production of a GATB-R.

III. MEASURE OF PERSON-JOB FIT

A. The Concept of "Situation of Handicap" (ICIDH)

The person-job fit measure is related to the concept of "situation of handicap" as defined by the International Classification of Impairments, Disabilities and Handicaps (ICIDH). This dynamic conceptualization of the interaction between people's abilities and

disabilities and the demands of their various daily activities reflects more accurately the complexity of the long-term effects of traumas such as traumatic brain injuries.

The handicap creation process is also a useful conceptual framework for neuropsychological research focused on developing clinical assessment procedures, as there is a parallel between this conceptual model and the development of clinical neuropsychology. Neuropsychology is broadly defined as the study of brain-behaviour relationship: the relationship between impairments (brain damage) and disabilities (cognitive, motor, language, etc.). As the role of clinical neuropsychology has developed over the past decade, moving from diagnosis to assessment to rehabilitation intervention, it has followed the successive levels of the handicap creation process to situation of handicap: the interaction between a person's impairments and abilities/disabilities and his or her daily activities.

Rehabilitation intervention deals with situations of handicap. Examining rehabilitation within the framework of the ICIDH illustrates the point made by Costa (1983) that there is a need to reexamine the basic premises regarding the nature of neuropsychological testing.

Traditionally, neuropsychological tests have been used to locate brain damage and/or relate damage to a specific area of the brain (impairments) to the mediated cognitive, sensory, or motor functions (abilities/disabilities). As already pointed out by Prigatano, Pepping & Klonoff (in Uzzell & Gross (Eds), 1986; Chapter Two, p. 19), neuropsychological evaluations attempting to deal with rehabilitation must integrate the impact of brain injuries as assessed by neuropsychological tests with the demands of the person's daily living. In order to do this, neuropsychology must bridge the gap that exists between it and other disciplines interested in evaluating the demands of daily living activities (organizational psychology, vocational rehabilitation, and occupational therapy).

The conceptual framework of the handicap creation process is also useful within the clinical rehabilitation setting for developing, implementing, and monitoring a multidisciplinary rehabilitation program. The model provides a common language, and addresses the multiple long-term effects of disabilities that must be dealt with by all professionals on the rehabilitation team. Within the vocational rehabilitation process, working with measures inspired by the model facilitates the collaboration between neuropsychology and vocational rehabilitation.

B. The Measure of Person-Job Fit with the Study Sample

The measure of person-job fit — that is, the difference between a person's work aptitude (GATB) and the aptitude demands of the job (PAQ) — for each GATB aptitude composite generally provided an accurate indicator of that person's ability or inability to do a specific job.

When there is a small difference — or good fit — between a person's score on GATB aptitude or composites and the aptitude demands of a job, he or she can generally do the job. Conversely, a large discrepancy between the aptitude scores and the aptitude demands of the job means that he or she generally cannot do the job.

It is necessary, however, to comment on what are considered small and large differences in the context of the GATB aptitudes. Traditionally, the standard cut-off score is one standard deviation (1 sd) below the published norms — that is, as long as the person-job fit measure for the aptitude in question is not more than one standard deviation below the published norms, the individual will likely be able to do the job.

The average absolute value of the measure of person-job fit for the cognitive and spatial composites was small (less than 1 sd) for jobs people did, and large (greater than 1 sd) for jobs they were unable to do. For the motor aptitudes composite, however, the average absolute value of person-job fit was large, and greater than the standard cut-off score traditionally used in job selection, even in jobs people could do.

At the individual aptitude level, the standard cut-off score of one standard deviation below the published norms is adequate for most GATB aptitudes, with the exception of F and M. This cut-off score cannot be applied to the motor aptitudes (GATB - F and M) or to the motor composite (GATB-K, F, and M). Differences greater than one standard deviation between individuals' measured motor aptitudes and the demands of jobs they *could* do were noted in this study and in others described in the literature review.

Neuropsychologists using the measure of person-job fit must take this into account during the job-matching process. This finding also indicates a need to use other instruments or techniques when there is concern about a person's motor abilities and/or particular motor aptitude demands of a specific job.

In making vocational rehabilitation decisions, Neuropsychologists should give the most weight to the person-job fit obtained from the *Cognitive* and *Perceptual* composites and aptitudes. This is not surprising, given the psychometric weaknesses of the GATB motor aptitudes tests and the limited ability of the PAQ to predict motor aptitudes (GATB-F and M).

Using the measure of person-job fit with participants in this study, Neuropsychologists can make an appropriate judgement on their suitability for specific occupations 78% of the time. This is greater than predictions by chance or by GATB scores alone when the cut-off score of one standard deviation is applied to all aptitudes.

This high prediction rate is most likely due to the fact that the measure takes both sides of the equation into account — the person's aptitudes and the demands of the job. The fact that the GATB and the PAQ measure the same work aptitudes also contributes to this accurate measure of fit.

Nevertheless, the possibility of misclassification remains. Although few (five) participants in this study were misclassified, the ramifications of these errors would have been great had these individuals been in an actual vocational rehabilitation setting. They may not have been referred to jobs they were capable of doing, or they may have been set up for failure.

A closer examination of a misclassified case did not provide clear indications of factors that may have led to inaccurate prediction of work ability. This was not surprising, considering the limitations of a post-hoc analysis. The clinical case analysis did, however, illustrate the clinical use of the measure of person-job fit within the framework of the handicap creation process.

C. Clinical Use of the Measure of Person-Job Fit

The process of job matching with a traumatically brain-injured individual usually begins with a broad question: what job(s) could this person do? The initial goal is to identify general areas of employment that might be suitable for the person. The existing job-matching programs, using the GATB and the CCDO or the DOT, are useful at this stage,

considering all the factors involved (physical abilities, environmental conditions, interests, aptitudes, local labour market, and so on).

To further narrow down vocational options, the measure of person-job fit for work aptitude composites (GATB-PAQ), as used in this study, is suggested. Following this selection, personal and environmental factors (possibility of placement, geographic location, access to transport, etc.) will determine the final vocational choice.

When a specific job is under consideration, or to determine whether a person can return to his or her pre-injury occupation, it is important to go beyond the aptitude composites and consider the person-job fit with each individual aptitude. This reveals any overlaps of the person's work aptitudes and the aptitude demands of the job, providing additional useful information for completing the job-matching profile.

A broader measure of person-job fit using abilities/disabilities as measured by neuropsychological tests and the aptitude attributes of the job (PAQ) also adds useful details to carry on the vocational rehabilitation process. However, because we do not know empirically the relationship between neuropsychological tests and the aptitude demands of jobs as assessed by the PAQ, we can only use this broader measure of person-job fit as a guide for making clinical decisions.

The measure of person-job fit, for work aptitudes and for broader cognitive abilities, can serve to develop a gradual work reintegration program. It provides the information needed to identify which duties of a specific job mesh with the person's abilities. Starting a gradual return to work with these duties increases the chance of positive reinforcement and success. Conversely, the measure can be used to identify those duties requiring abilities for which the person's skills may be marginal. These job duties may be introduced later and supported by on-the-job training. When the fit between the person's abilities and the demands of the job is questionable, it may be useful to consider job modifications or compensatory aids.

IV. CONCLUSION

This study examined the GATB as an aptitude test battery for use with individuals with brain injuries, and its usefulness for job matching with this population.

In examining the structure of the GATB, previous suggestion that the eight GATB aptitudes can be regrouped into three composites without losing important information was confirmed. Although this is useful for some applications (research, comparisons with other psychometric tests, and initial occupational selection), it does not imply that individual aptitude scores are not valuable. Information from all eight GATB aptitudes is important for developing vocational rehabilitation strategies, as the individual aptitudes provide a more detailed picture of an individual's abilities/disabilities. The risk of oversimplifying the GATB and thereby reducing its usefulness, as expressed by Cronbach (1984, Chapter Two, page 28), is very real in clinical work.

This study indicated that a sample of individuals with traumatic brain injuries tend to score lower than the General Working Population on many of the GATB aptitudes (G,V, N, K, F, and M), and thus would have difficulty obtaining and maintaining employment on the competitive labour market. This finding reinforces the need for vocational rehabilitation intervention to help brain-injured persons enter or reenter the work force following their injuries. Additionally, it underscores the need for support to help them maintain employment when situations of handicap are experienced throughout their lives.

The central question addressed in this study was the GATB's usefulness for job matching with traumatically brain-injured individuals. Results indicate that it is a useful tool in the vocational rehabilitation process, particularly when it is used in conjunction with the PAQ to provide a measure of person-job fit. The GATB measures the *worker* side of the equation in the job-matching process — that is, a person's work aptitudes — while the PAQ measures the *work environment* side of the equation — the aptitude demands of jobs.

Using the measure of person-job fit, a satisfactory rate of correct classification was obtained: study participants' ability or inability to do specific jobs was assessed correctly 78% of the time. The measure is not infallible, however: 5 of the 52 participants were misclassified. The person-job fit measures obtained from the GATB cognitive and perceptual aptitude composites are the best predictors of ability to work with this sample. The usefulness of the GATB motor aptitude and composite is questionable.

This study contributes to the search for an appropriate instrument with which to assess the vocational handicaps consequent to traumatic brain injuries. The person-job fit provided by the GATB/PAQ is a measure of vocational situation of handicap as defined by the

International Classification of Impairments, Disabilities and Handicaps (ICIDH, 1991). Traditionally, clinical neuropsychology has focused on measuring the impairment and disability consequent to disease or trauma. The emphasis has been on diagnostic issues — identifying brain pathologies and related cognitive deficits. Recently, the focus has begun to shift toward rehabilitation, and as Ben-Yishay and Prigatano (in Rosenthal, Griffith, Bond & Miller (Eds), 1990) have pointed out, there is a need to "bridge the existing gaps between rehabilitation and neuropsychology" (p. 394) in order to rehabilitate persons with traumatic brain injuries.

The concept of person-job fit offers one way to bridge the gap between vocational rehabilitation and neuropsychology. The aptitude attributes assessed by the PAQ measure a broad range of the abilities that successful work performance requires. Many of these abilities (attention, verbal comprehension, dealing with people, etc.) can be affected by a traumatic brain injury. Identifying these abilities is useful for linking vocational evaluations and neuropsychological assessments. Furthermore, this information is helpful for developing work assessments and considering job modifications.

The NAS Committee on the GATB (Hartigan & Wigdor, 1989) suggested that the present form of the GATB be used with disabled individuals, but noted a need for research with individuals in situations of handicap. In general, we in Canada are in a particularly favourable position with respect to GATB research. We have recent (1985) norms for all of the GATB subtests except the motor subtests (K, F, and M). The CCDO is in the process of being upgraded; the new National Occupational Classification (NOC) is scheduled to be completed in 1993, and will continue to use the GATB aptitudes to describe occupational demands. There is ongoing GATB research in a variety of areas, and a computerized version of the GATB is ready to be tested in the field. This may facilitate the use of the GATB with individuals with traumatic brain injuries.

V. LIMITATIONS OF THE PRESENT STUDY AND FUTURE RESEARCH

It is important to acknowledge that the present study focused only on the aptitude-related portion of the job-matching process. Achieving an appropriate worker-job match includes appraising other significant elements as well, such as work behaviours, interests, and physical abilities. Moreover, job matching is but one of the components in the vocational

rehabilitation process, and applications resulting from this study are therefore limited to this one step.

It is hoped, however, that this study has contributed to improving the whole process. As the literature review and this study sample have shown, a large number of individuals remain unemployed following traumatic brain injuries. This fact confirms the need for ongoing research in this area.

The NAS has suggested further research with the GATB and individuals in situations of handicap, including persons with neurological disorders. With respect to the vocational rehabilitation of traumatically brain-injured individuals, it is important to pursue the investigation and development of measures of vocational situations of handicap.

The relationship between the abilities/disabilities as measured by neuropsychological tests and the aptitude attributes of occupations as measured by the PAQ is worth exploring. Such research could broaden and refine the measure of person-job fit, and provide valuable information to suggest vocational rehabilitation interventions for individuals with traumatic brain injuries. It would be useful to conduct a study of the measure of person-job fit that parallels single case study research set out to examine the misclassified cases.

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APPENDICES

Appendix A

The General Aptitude Test Battery (GATB)

The GATB is one of the most widely used measures of vocational aptitudes. The current version of the GATB consists of 12 tests (Part 1 to 12) designed to measure 9 aptitudes.

A description of the aptitudes measured with their specific subtests follows:

Aptitude G- General Learning Ability: The ability to "catch on" or understand instructions and underlying principles; the ability to reason and make judgments. Aptitude G is a composite of Verbal, Numerical and Spatial aptitudes measured by Parts 3, 4, and 6. These Parts will be described under their respective aptitudes below.

Aptitude V- Verbal Aptitudes: The ability to understand meaning of words and to use them effectively. The ability to comprehend language, to understand relationships between words and to understand meanings of whole sentences and paragraphs. Measured by Part 4.

Part 4 - *Vocabulary*. This test consists of sets of four words. The examinee indicates which two words have either the same or opposite meanings.

Aptitude N- Numerical Aptitude: Ability to perform arithmetic operations quickly and accurately. Measured by Parts 2 and 6.

Part 2 - *Computations*. This test consists of a number of arithmetic exercises requiring the addition, subtraction, multiplication, or division of whole numbers. The examinee can use paper and pencil to perform the operations.

Part 6 - *Arithmetic Reason*. This test consists of a number of arithmetic problems expressed in writing. The examinee can use paper and pencil to perform the solution.

Aptitude S- Spatial Aptitude: Ability to think visually of geometric forms and to comprehend the two-dimensional representation of three-dimensional objects. The ability

to recognize the relationships resulting from movement of objects in space. Measured by Part 3.

Part 3 - *Three-dimensional space*. This tests consists of a series of exercises containing a stimulus figure and four drawings of three-dimensional objects. The stimulus figure is pictured as a flat-piece of metal which is to be either bent, or rolled, or both. The examinee indicates which one of the four drawings of three-dimensional objects can be made form the stimulus figure.

Aptitude P- Form Perception: Ability to perceive pertinent detail in objects or in pictorial of graphic material. Ability to make visual comparisons and discriminations and see slight differences in shapes and shadings of figures and widths and lengths of lines. Measured by Parts 5 and 7.

Part 5 - *Tool Matching*. This test consists of a series of exercises containing a stimulus drawing and four black-and-white drawings of simple shop tools. The examinee indicates which of the four black-and-white drawings is the same as the stimulus drawing. Variations exist only in the distribution of black and white in each drawing.

Part 7 - *Form Matching*. This test consists of two groups of variously shaped line drawings. The examinee indicates which figure in the second group is exactly the same size and shape as each figure in the first or stimulus group.

Aptitude Q- Clerical Perception: Ability to perceive pertinent detail in verbal or tabular material. Ability to observe differences in copy, to proffread words and numbers, and to avoid perceptual errors in arithmetic computation. A measure of speed of perception which is required in many industrial jobs even when the job does not have verbal or numerical content. Measured by Part 1.

Part 1 - *Name comparison*. This test consist of two columns of names. The examinee inspects each pair of names and indicates whether the names are the same or different.

Aptitude K- Motor Coordination: Ability to coordinate eyes and hands or fingers rapidly and accurately in making precise movements with speed. Ability to make a movement response accurately and swiftly. Measured by Part 8.

Part 8 - *Mark Making*. This test consists of a series of squares in which the examinee is to make three pencil marks, working as rapidly as possible.

Aptitude F- Finger Dexterity: Ability to move the fingers, and manipulate small objects with the fingers, rapidly or accurately. Measured by Parts 11 and 12.

Part 11 - *Assemble*. The equipment used for this test consists of a small rectangular board containing 50 holes, and a supply of small metal rivets and washers. The examinee takes a small metal rivet from a hole in the upper part of the board with his preferred hand and at the same time removes a small metal washer form a vertical rod with the other hand; examinee puts the washer on the rivet, and inserts the assembled piece into the corresponding hole in the lower part of the board using only his preferred hand. The examinee works rapidly to move and place as many rivets and washers as possible during the time allowed.

Part 12 - *Disassemble*. The equipment used for this test is the same as that described for Part 11. The examinee removes the small metal rivet of the assembly from a hole in the lower part of the board, slides the washer to the bottom of the board, puts the washer on the rod with one hand and the rivet into the corresponding hole in the upper part of the board with the other (preferred) hand. The examinee works rapidly to move and replace as many rivets and washers as possible during the time allowed.

Aptitude M- Manual Dexterity: Ability to move the hands easily and skilfully. Ability to work with the hands in placing and turning motions. Measured by Parts 9 and 10.

Part 9 - *Place*. The equipment used for this test and for Part 10 consists of a rectangular pegboard divided into two sections. The upper section contains 48 cylindrical pegs. The examinee removes the pegs from the holes in the upper part of the board and inserts them in the corresponding holes in the lower part of the board working, moving two pegs simultaneously, one in each hand. This performance is done three times, with the examinee working rapidly to move as many of the pegs as possible during the time allowed for reach of the three trials.

Part 10 - *Turn*. The equipment described under Part 9 is also used for this test. For Part 10, the examinee removes a peg form a hole, turns the peg over so that the opposite end is up, and returns the peg to the hole from which it was taken, using only his preferred hand. The examinee works rapidly to turn and replace as many of the 48 cylindrical pegs as possible during the time allowed. Three trials are given for this performance.

Appendix B

Position Analysis Questionnaire (PAQ)

The PAQ was briefly described in chapter 2 (pp. 44 to 52). The review concentrated on the psychometric properties of the instrument and a summary of the research done with the PAQ pertinent to this study. This appendix will provide additional information on the instrument itself and it's use. Information presented in this appendix is from the PAQ manuals and newsletters obtained from the PAQ Services, Inc.

In general terms, job analysis is the process of obtaining information about jobs. It provides a taxonomy of aptitudes, abilities or characteristics that describe a job. The job analysis identifies any requirements that differentiate the particular occupation from other jobs. There are two types of job analysis: task analysis and worker-oriented analysis.

The PAQ is a structured, standardized job analysis questionnaire. It contains 187 items that characterize directly, or imply the basic human behaviours involved in jobs. Each of these questions are numerically rated using scales. These ratings are computer processed to derive job dimension scores. The questionnaire is briefly described with examples and job dimensions and aptitude attributes are presented.

The PAQ questionnaire is organized in six major divisions. The divisions provide a natural flow for the structured interview. The divisions and subdivisions are presented.

DIVISION

A. Information input: how a worker obtains information and from what sources.

A1. Visual sources of job information
A2. Nonvisual sources of job information
A3. Sensory & perceptual processes
A4. Estimating Activities

B. Mental processes: types of thinking activities required: reasoning, decision-making, planning, information-processing.

B1. Decision making, reasoning & planning/scheduling

B2. Information processing activities

B3. Use of learned information

C. Work output: what is produced and the tools and physical activities required to produce it.

C1. Use of hand-held tools or instruments

C2. Use of other hand-held devices

C3. Use of stationary devices

C4. Use of control devices on equipment

C5. Transportation & mobile equipment

C6. Manual Activities

C7. Full body activities

C8. Level of physical exertion

C9. Body positions & postures

C10. Manipulation & coordination activities

D. Relationships with other persons: who these people are and the importance and type of relationship.

D1. Oral communication

D2. Written or print communication

D3. Other communications

D4. Miscellaneous interpersonal relationships

D5. Amount of job-required personal contact

D6. Types of job-required personal contact

D7. Supervision & direction given

D8. Coordination & organizational activities

D9. Supervision & direction received

E. Job context: The physical and social environment in which the work is performed.

E1. Outside physical working conditions
E2. Indoor physical working conditions
E3. Physical Hazards
E4. Personal & Social Aspects

F. Other job characteristics: additional relevant aspects of the job not covered in previous points.

F1. Apparel worn
F2. Licensing
F3. Yearly continuity of work
F4. Regularity of work hours
F5. Day-Night schedule
F6. Job demands
F7. Responsibility
F8. Job structure
F9. Criticality of position
F10. Pay or income
F11. Exempt status

As mentioned in chapter 3 (p. 67) the questionnaire is administered by a Job Analysist. The items are not answered directly by the informant. It is necessary to follow the recommended training procedure to utilize the PAQ adequately and obtain relevant and reliable information. The PAQ User's Manual (System II), 1990 provides steps to plan and conduct a project using the PAQ. For individuals that may not be familiar with job analysis, training sessions are offered.

The counsellor/Job Analyst, uses the questionnaire as a reference guide to conduct a structured interview with the informant. The interview usually takes one hour and can require up to two hours. The exchange usually starts with an explanation of the goals of the job analysis and the format of the interview. The analyst initiates the interview by asking the informant to describe their occupation in five to ten statements that would summarize the main duties of the job. The informant is then asked to estimate the

proportion of time spent in each of these functions. The analyst will then fill out this general outline by asking more precise questions following the format of the PAQ divisions.

The Analyst scores the PAQ following the interview, using the rating scales. The practical examples provided in the PAQ Job Analysis Manual Second Edition (1989) for each items in relation to the rating scales are useful guidelines. During the training period, analysts can develop strategies, following a decision tree process, to use the rating levels consistently and reliably.

The scored PAQ items are computer processed to compute job dimension scores. As mentioned in chapter 2, two types of job dimensions scores can be derived from the PAQ: one based on the attribute profiles of the elements and another on the job data.

There are 32 "divisional" job dimensions and 13 "overall" job dimensions. These can be thought of as the factors measured by the PAQ. The divisional and overall dimensions are attached to this appendix.

The overall job dimensions scores are used to estimate the GATB scores required to successfully perform the occupation analyzed.

The job attribute concept is related to the notion of human traits. The PAQ measures forty-nine "aptitudinal" attributes that reflect specific aptitudes and twenty-seven "situational" attributes reflecting the personality, temperament, and interests required to do the job. These occupational attributes describe the occupation analyzed in relation to other jobs in the world of work. These measures were not used in the statistical data analysis for this study. However, they were found useful for the clinical case analysis.

The analysis from the PAQ aptitude attributes (48) provide a more detailed analysis of the job demands. The aptitude attributes percentile scores are of interest. They indicate how important the attribute is for this occupation compared to the world of work. This information can be used to query the information obtained form the neurospychological assessment, design a work assessment, consider job modifications, or alternative work. The aptitude attributes include many cognitive and motor abilities that will be of interest Neuropsychologist working in vocational rehabilitation. Copies of the PAQ attributes are attached to this appendix.

The PAQ is used for a variety of purposes including personnel selection and placement, training, performance evaluating, job evaluating and job design. Accordingly, a diversity of computer processing options are available from the PAQ services. These options are described in the PAQ User's Manual (System II), (1990) which can be obtained from the PAQ Services, Inc. 1625 North 1000 East, Logan, Utah, U.S.A, 84321.

PAQ JOB DIMENSIONS
Based on Principal Components
Analyses of PAQ Data for 2,200 jobs

"DIVISIONAL" JOB DIMENSIONS

1. Perceptual interpretation
2. Input from representational sources
3. Visual input form devices/materials
4. Evaluating/judging sensory input
5. Environmental awareness
6. Use of various senses
7. Decision making
8. Information processing
9. Using machines/tools/equipment
10. General body vs. sedentary activities
11. Control and related physical coordination
12. Skilled/technical activities
13. Controlled manual/related activities
14. Use of miscellaneous equipent/devices
15. Handling/manipulating/related activities
16. Physical coordination
17. Interchange of judgmental/related information
18. General personal contact
19. Supervisory/coordination/related activities
20. Job-related communications
21. Public/related personal contacts
22. Potentially stressful/unpleasant environment
23. Personally demanding situations
24. Potentially hazardous job situations
25. Non-typical vs typical day work schedule
26. Businesslike situations
27. Optional vs. specified apparel
28. Variable vs salary compensation
29. Regular vs. irregular work schedule
30. Job demanding responsibilities
31. Structured vs. unstructured job activities
32. Vigilant/discriminating work activities

"OVERALL" JOB DIMENSIONS

33. Decision/communication/general responsibilities
34. Machine/equipment operation
35. Clerical/related activities
36. Technical/related activities
37. Service/related activities
38. Regular day schedule vs. other work schedules
39. Routine/repetitive work activities
40. Environmental awareness
41. General Physical activities
42. Supervising/coordinating other personnel
43. Public/customer/related contact activities
44. Unpleasant/hazardous/demanding environment
45. Non-typical schedule/optional apparel style

DEFINITIONS OF ATTRIBUTES[1]

ATTRIBUTES RATINGS OF AN INTEREST OR TEMPERAMENT NATURE (characterized by different types of job situations to which people must adjust.)

1. Variety of duties: duties often characterized by frequent change.
2. Repetitive/short-cycle operations: operations carried out according to set procedures or sequences.
3. Dealing with things/objects: preference for situations involving activities which deal with things and objects rather than activities concerned with people or the communication of ideas.
4. Processes/machines/techniques: situations which are non-social in nature, being primarily concerned with methods and procedures often of a mechanical or chemical nature.
5. Scientific/technical activities: using technical methods or investigating natural phenomena using scientific procedures.
6. Dealing with people: i.e., personal contacts beyond giving and receiving instructions.
7. Social welfare: working with people for their presumed good.
8. Influencing people: influencing opinions, attitudes, or judgements about ideas or things.
9. Directing/controlling/planning: operations involving the activities of others, or processes with which others are involved.
10. Empathy: seeing things from another person's point of view.
11. Personal risk: risk of physical or mental illness or injury.
12. Conflicting/ambiguous information: ability to tolerate and critically evaluate information of an uncertain or opposing nature.
13. Pressure of time: working in situations where time is a critical factor for successful job performance.

14. Sensory alertness: alertness over extended periods of time.

15. Attainment of set standards: attainment of set limits, tolerances, or standards.

16. Working under specific instructions: i.e., those that allow little or no room for independent action or judgement in working out job problems.

17. Working alone: working in physical isolation from others, although the activity may be integrated with that of others.

18. Separation from family/home: separation for extended periods of time.

19. Stage presence: speaking to or performing for an audience.

20. Prestige/esteem from others: working in situations resulting in high regard from others.

21. Tangible/physical end-products: working with material elements or parts which ultimately result in a physical product.

22. Sensory/judgemental criteria: arriving at generalizations, judgements, or decisions which require sensory discrimination or cognitive appraisal.

23. Measurable/verifiable criteria: arriving at generalizations, judgements, or decisions based on known or obtainable standards, characteristics, or dimensions.

24. Interpretation from personal viewpoint: interpretation of feelings, ideas, or facts in terms of personal viewpoint or values.

25. Susceptibility to fatigue: diminished ability to do work, either physical or mental, as a consequence of previous and recent work done.

26. Dealing with concepts/information: preference for situations that involve conceptual or informative ideas and the possible communication of these ideas to others.

27. Creative activities: preference for situations involving the finding of new solutions to a problem or new modes of artistic expression.

ATTRIBUTE RATINGS OF AN "APTITUDE" NATURE

28. Verbal comprehension: ability to understand the meaning of words and the ideas associated with them.

29. Word fluency: ability to rapidly produce words associated with a given word.

30. Oral communication: ability to communicate ideas with gestures or with spoken or written words.

31. Numerical computation: ability to manipulate quantitative symbols rapidly and accurately, as in various arithmetic operations.

32. Arithmetic reasoning: ability to reason abstractly using quantitative concepts and symbols.

33. Convergent thinking: ability to select from possible alternative methods, the method of processing information that leads to the potentially best answer or solution to a problem.

34. Divergent thinking: ability to generate or conceive new or innovative ideas or solutions to a problem.

35. Intelligence: the level of abstraction or symbolic complexity with which one can ultimately deal.

36. Long-term memory: ability to learn and store pertinent information and selectively retrieve or recall, much later in time, that which is relevant to a specific context.

37. Short-term memory: ability to learn and store pertinent information and selectively retrieve or recall, within a brief period of time, that which is relevant to a specific context.

38. Aesthetic judgement: ability to make sensitive evaluations of artistic quality in one or more of the following: music, style, painting, sculpture, photography, architecture, etc.

39. Visual form perception: ability to perceive pertinent detail or configuration in a complex visual stimulus.

40. Selective attention: the ability to perform a task in the presence of distracting stimulation or under monotonous conditions without significant loss in efficiency.

41. Time sharing: the ability to utilize information obtained by shifting between two or more channels of information. The information obtained from these sources is either integrated and used as a whole or retained and used separately.

42. Perceptual speed: ability to make rapid discriminations of visual detail.

43. Closure: ability to perceptually organize a chaotic or disorganized field into a single perception.

44. Movement detection: ability to detect physical movement of objects and to judge their direction.

45. Spatial visualization: ability to manipulate visual images in two or three dimensions mentally.

46. Near visual acuity: ability to perceive detail at normal reading distance.

47. Far visual acuity: ability to perceive detail at distances beyond normal reading distance.

48. Depth perception: ability to estimate depth of distances or objects (or to judge their physical relationships in space).

49. Color discrimination: ability to perceive similarities or differences in colors or in shades of the same color, or to identify certain colors.

50. Auditory acuity: ability to perceive relevant cues by sound.

51. Olfactory acuity: ability to perceive relevant cues by smell.

52. Gustatory acuity: ability to perceive relevant cues by taste.

53. Tactual acuity: ability to perceive relevant cues by touch.

54. Body orientation: ability to maintain body orientation with respect to balance and motion.

55. Spatial orientation: the ability to maintain one's orientation with respect to objects in space or to comprehend the position of objects in space with respect to the observer's position.

56. Kinesthesis: ability to sense position and movement of body members.

57. Finger dexterity: ability to manipulate small objects (with the fingers) rapidly and accurately.

58. Ideational fluency: the ability to produce a number of ideas concerning a given topic. This attribute is only concerned with the number of ideas produced and does not extend to the quality of those ideas.

59. Originality: the ability to produce unusual or clever responses related to a given topic or situation. This attribute is concerned with the degree of creativity of responses and does not deal with the number of responses made.

60. Problem sensitivity: the ability to recognize or identify the existence of problems. This attribute does not include any of the reasoning necessary for the solution of a problem.

61. Manual dexterity: ability to manipulate things with the hands.

62. Arm/hand positioning: ability to make precise, accurate movements of the hands and arms.

63. Arm/hand steadiness: ability to keep the hands and arms immobilized in a set position with minimal tremor.

64. Continuous muscular control: ability to exert continuous control over external devices through continual use of body limbs.

65. Rate of arm movement: ability to make gross, rapid arm movements.

66. Eye-hand coordination: ability to coordinate hand movements with visual stimuli.

67. Eye-hand-foot coordination: ability to move the hand and foot coordinately with each other in accordance with visual stimuli.

68. Speed of limb movement: this ability involves the speed with which discreet movements of the arms or legs can be made. The ability deals with the speed with which the movement can be carried out after it has been initiated; it is not concerned with the speed of initiation of the movement.

69. Simple reaction time: the period of time elapsing between the appearance of any stimulus and the initiation of an appropriate response.

70. Response integration: ability to rapidly perform various appropriate psychomotor responses in proper sequence.

71. Dynamic strength: ability to make repeated, rapid, flexing movements in which the rapid recovery from muscle strain is critical.

72. Static strength: ability to maintain a high level of muscular exertion for some minimum period of time.

73. Stamina: this ability involves the capacity to maintain physical activity over prolonged periods of time. It is concerned with the resistance of the cardio-vascular system to break down.

74. Explosive strength: ability to expend a maximum amount of energy in one or a series of explosive or ballistic acts (as in throwing, pounding, etc.)

75. Rate control: ability to make continuous anticipatory motor adjustments, relative to change in speed and direction of continuous moving objects.

76. Mechanical ability: ability to determine the functional interrelationships of parts within a mechanical system.

---

[1] Taken from Attribute Ratings and Profiles of the Job Elements of the Position Analysis Questionnaire (PAQ) by Lloyd D. Marquardt and Ernest J. McCormick, published by Purdue University, West Lafayette, Indiana, June 1972.

The PAQ job dimensions and definitions of attributes are provided in the Position Analysis Questionnaire PAQ Users Manual (System II), (2nd ed.), (Mecham et al. 1989).

Appendix C

Information Mailed out to Potential Participants

Assessment of the vocational aptitudes of traumatically brain injured individuals

Most people who suffered a traumatic brain injury are unable to return to their pre-injury occupation and need vocational counselling and rehabilitation. It has been difficult to predict a person's ability to work following a brain injury because:

1. The tests traditionally used by Neuropsychologist were constructed without regard for the specific abilities required for successful job performance.
2. The vocational aptitude battery most widely used in vocational assessment and counselling is the General Aptitude Test Battery (GATB). The GATB was not designed to identify damage following a brain injury. However, research carried out with epileptics showed that different patterns of response on the GATB appear related to employment status and the neurological dysfunction.

I plan to examine the usefulness of the GATB for vocational counselling (job matching) with individuals who have suffered a traumatic brain injury.

This will be done by examining the performance on the GATB of a group of persons with brain injuries who have returned to work and others who have not been able to maintain employment post-injury. An analysis of the demands of the present occupation and/or last occupation will be done by contacting the employer and performing a job analysis on site when appropriate.

Therefore if you agree to participate as a subject in the research project you may be asked, if it was not done at least 18 months after your injury to:

1. Complete the GATB: a paper/pencil aptitude test which takes approximately two and a half hour.

You would also be asked to:

1. Sign a consent to participate to the research project which also state that you can withdraw at any time.
2. Sign release of information forms to enable us to contact you present or past employer, a co-worker and/or professionals who have been involved in your rehabilitation program.

We will offer a follow-up session to provide you with interpretation of the results of the test battery administered and/or the job analysis performed.

This research will facilitate our understanding of the impact of a traumatic brain injury on a person's ability to work. It will also enable us to improve our ability to provide vocational counselling and rehabilitation services for people who suffered a traumatic brain injury. For these reasons, I would appreciate your participation in the project.

Thank you for taking the time to read the above information.

note: The above was attached to a covering letter from the referral source.

Appendix D

Consent Forms

UNIVERSITY OF VICTORIA

DEPARTMENT OF PSYCHOLOGY
Neuropsychology PROGRAM

CONSENT TO ACT AS A RESEARCH SUBJECT

Ms. J. Lacroix, M.A., is conducting a study for her Ph. D. research project related to the assessment of the vocational aptitudes of traumatically brain injured individuals. All patients who have sustained a traumatic brain injury are potential participants in this research. If I agree to participate, the following will happen to me:

1. I will be asked to sign a special consent form to release relevant portions of my medical, educational and work history to the investigators. I will also be asked to consent to the investigator's contacting my present and/or past employer to perform a job analysis of my present and/or last occupation.
2. If I accept to participate, Ms. Lacroix and her associates will outline the purpose of the research project to me and any other family members I wish to invite to the initial interview session.
3. In addition, an aptitude test (General Aptitude Test Battery) may be administered if this had not occurred at least eighteen months post-injury.
4. A post-test and/or Job Analysis consultation will be provided for me and my family regarding the results.

Other than the time involved, there are no real risks associated with participation in this study. I may benefit directly form taking part in this study. The new knowledge gained will probably lead to improved vocational assessment and rehabilitation for head injured patients.

Research records will be kept confidential to the extent provided by law. Each patient will be identified by a code number and neither their names and/or employer's name will be known to others beyond the investigator and her associates.

UNIVERSITY OF VICTORIA

DEPARTMENT OF PSYCHOLOGY
Neuropsychology PROGRAM

CONSENT TO ACT AS A RESEARCH SUBJECT

IN THE STUDY

ASSESSMENT OF THE VOCATIONAL APTITUDES OF TRAUMATICALLY BRAIN INJURED INDIVIDUALS

Ms. Jocelyne Lacroix and/or her Research Assistant has explained this study to me and answered my questions. If I have other questions or research related problems, I may reach the investigators at 721-8590.

Participation in research is entirely voluntary. I may refuse to participate or withdraw at any time without jeopardy to the services I will receive from the referring institution or private clinic.

I have received a copy of this consent document to keep.

I agree to participate.

_____

Subject's signature

_____

Date

_____

Witness

Appendix E

Inter-Rater Reliability PAQ

The analyses are presented in chronological order.

Table 17
Inter-Rater Reliability (PAQ enter-Act)

Average reliability (r) and average standard error (SE_M)

Occupation analyzed	# of Analysts	(r)	SE_M
Initial Training Phase			
Painter	3	.67	.62
Student, B.A. Arts	3	.65	.85
Homemaker/Parent	3	.72	.77
Receptionist	3	.74	.60
R.E. Assistant Manager	2	.82	.63
R.E. Basic Accounting	2	.87	.43
Kitchen Supervisor	3	.77	.63
Cook	3	.87	.42
Horticulturist	3	.85	.49
Horticulturist Modified	3	.88	.43
Follow-up/data Collection Phase			
Trade Consumer Consultant	2	.96	.31
Project Leader/Analyst	2	.95	.30
Programmer Analyst	2	.92	.34
Coordinator Co-op Housing	2	.85	.50
Seniors' Activity Assistant	2	.93	.27
Society Coordinator	2	.90	.38
Student Pilot	2	.92	.40
Garnment Sorter/hanger	2	.92	.36
Elementary School Counsellor	2	.96	.30
Tours Reservation Agent	2	.93	.29

The Pearson correlation informs us of the similarity between the rank ordering of the items and the spacing between the two raters' scores independently of an absolute agreement between the ratings. For example, two raters may score a group of items as follows:

Item	Rater X	Rater Y
a.	.0	2
b.	.5	2.5
c.	.1	3.5
d.	.2	4.5
e.	.3	5.5

In this example, the Pearson r_{xy} is equal to 1, although the raters differ by two points in rating the items.

The intraclass correlation allows a comparison of two or more raters at a time, and provides a measure of agreement. Computation of the intraclass correlation is not provided by the PAQ computer data analysis; it is done with SPSSX ANOVA, repeated measure. The same items are rated by all raters, and in this case the raters are the conditions, and the items are the subjects. The ANOVA source table provides an F ratio for the effect of raters and the effect of subjects. These values are used in the following formula for intraclass correlation (RI):

$$RI = \frac{N\ Fs}{(K-1)\ (Fr-1) + N\ Fs + N\ (K-1)}$$

or

$$RI = \frac{Msbetween - Mswithin}{Msbetween + Mswithin}$$

Note that the Fs absorbs the differences between subjects and provides information about the ranking and spacing of the items score. The Fr absorbs the mean differences in raters, which in this context is considered error, and provides information about the absolute difference between raters.

Therefore, the intraclass correlation (RI) provides information about both the rank ordering and spacing and the absolute difference between raters in one number. The value of RI increases as the absolute difference between raters decreases.

Table 18 presents the intraclass correlation for the 10 occupations analyzed during the initial training phase and the data collection phase.

Table 18
Inter-Rater Reliability Intraclass Correlation (RI)

Occupation Analyzed	# of Analysts	RI
Initial training phase		
Painter	3	.73
Student, B.A. Arts	3	.72
Homemaker/Parent	3	.74
Receptionist	3	.81
R.E. Assistant Manager	2	.80
R.E. Basic Accounting	2	.87
Kitchen Supervisor	3	.82
Cook	3	.90
Horticulturist	3	.89
Horticulturist Modified	3	.91
Follow-up/data Collection Phase		
Trade Consumer Consultant	2	.96
Project Leader/Analyst	2	.94
Programmer Analyst	2	.91
Coordinator Co-op Housing	2	.84
Seniors' Activity Assistant	2	.93
Society Coordinator	2	.89
Student Pilot	2	.91
Garnment Sorter/hanger	2	.91
Elementary School Counsellor	2	.95
Tours Reservation Agent	2	.93

Appendix F

Data Collection Questionnaire

Page 1.

DEMOGRAPHIC:

Identification #: _____ Source: _____

Handedness: R: [ ] L: [ ] Both: [ ]
is there a difference pre and post injury? if so note:

DEMOGRAPHIC:

Last name: _____ Sex: F ____ M ____

First name: _____

Address: _____
city province

_____
postal code

Tel. Home: _____ Work: _____

D.O.B: _____ / _____ / _____ Age: _____
day month year

Do you want a debriefing session: YES [ ] NO [ ]

EDUCATION:

Pre injury
Last grade completed: Number of years/months and certificate, diploma or degree obtained.

(Indicate the grade)

[ ] A) less than grade 8
[ ] B) grade 9 to 12
[ ] C) ged equivalency
[ ] D) college
[ ] E) trade schools
[ ] F) university

Special programs: YES [ ] NO [ ]
(name)

Assistance received in school: YES [ ] NO [ ]
(specify)

Learning difficulties: YES [ ] NO [ ]
(specify)

Technical training: YES [ ] NO [ ]
(in institution and/or on-the-job)

Post injury
Last grade completed: Number on years/months and certificate, diploma or degree obtained.

(Indicate the grade)

[ ] A) less than grade 8
[ ] B) grade 9 to 12
[ ] C) ged equivalency
[ ] D) college
[ ] E) trade schools
[ ] F) university

Special programs: YES [ ] NO [ ]
(name)

Assistance received in school: YES [ ] NO [ ]
(specify)

Learning difficulties: YES [ ] NO [ ]
(specify)

Technical training: YES [ ] NO [ ]
(in institution and/or on-the-job)

WORK HISTORY INFORMATION:

Pre injury
Employed [ ] Unemployed [ ] Student [ ]

If unemployed:
Unemployed, supported on U.I.C.: [ ]
Unemployed, supported on social welfare: [ ]
Unemployed, supported on disability pension: [ ]

Looking for work: YES [ ] NO [ ]
Describe what type: _____

If employed: Pre injury vocational profile

	Occupation	Years	Reason for leaving	CCDO #	Employer
1.	_____	_____	_____	_____	_____

If employed at time of injury or last occupation prior to injury

2.	_____	_____	_____	_____	_____

(continue back)
Hourly wages: (range):

Post injury
Have-you tried to work since the injury: YES [ ] NO [ ]
if any employement: POST INJURY VOCATIONAL PROFILE (follow model above)
At the time of interview:
Employed [ ] Unemployed [ ] Student [ ]

If unemployed:
Unemployed, supported on U.I.C.: [ ]
Unemployed, supported on social welfare: [ ]
Unemployed, supported on disability pension: [ ]

Looking for work: YES [ ] NO [ ]
Describe what type: _____

Want/need to work? YES [ ] NO [ ]
Judged competitively unemployable? YES [ ] NO [ ]
If student: Describe school program:
If has worked after the injury fill out page 4.

Page 4.

In last 12 months: # days / weeks / months worked _____ = _____
days / weeks / months could have worked

Please check: for current or last job post injury.
Employed, full time (more than 35 hours a week): [ ]
Employed, part time (less than 35 hours a week): [ ]
Job description: _____
(comments on back)

If currently employed:
Date you started current job: _____ / _____
month year

Has the job been modified because of your injury? YES [ ] NO [ ]

Hourly wages: (range):

How did you obtain your present or last job (post injury):
Newspaper AD.: [ ]
Through a friend or relative: [ ]
Canada manpower: [ ]
Cold call (i.e. going door to door): [ ]
Vocational rehabilitation placement: [ ]
Describe: _____
(i.e. Rehabilitation centre, ICBC, WBC, others: describe)

What training did you do for this work: Please Check
On-the-job training: [ ]
Trades school: [ ]
Short term courses (less than 6 months): [ ]
Diploma course (1 to 2 years of college): [ ]
Other, describe: _____

Have you received any promotions since your injury? YES [ ] NO [ ]

Can we contact the employer (present or last) supervisor or experienced co/worker for measure of work duties? If yes: please note name, address and phone number and sign release of information.

Volunteer Work?: _____

MEDICAL INFORMATION:

Date of injury: _____ / _____ / _____ Age at time of injury:
day month year

Cause: MVA [ ] WKA [ ] Sport accident [ ] Others [ ] specify: _____

Diagnosis: _____

From: Neurologist [ ] GP [ ] or: _____

(indicate X if available and brief summary if possible)

CT scan: [ ] _____

MRI : [ ] _____

Glasgow coma scale: (0-16) [ ]

Coma: no. of hours /_____ / days /_____ weeks / _____

Post traumatic amnesia: no. of hours /_____ / days /_____ weeks / _____

Did you attend a rehabilitation centre:
G.F. Strong: [ ] George Road Hospital [ ] Head work [ ]
Others: name: _____

For how long: days / _____ / weeks / _____

AT PRESENT:

SEIZURES: YES [ ] NO [ ]

if yes:
Describe: _____

MEDICATION: _____

name and what for: _____

Appendix G

Template of Letter Sent With Release of Information

Victoria, Date , 199*.

Name and Address
of Professional

RE: Name of participant

D.O.B.

Name repeated.

The above named client has agreed to participate in the study concerned with the vocational rehabilitation of individuals who have sustained a brain injury. A brief description of the study and your client's involvement is enclosed. As mentioned, some of the data collected for each "subject" are ....

The above named client mentioned having .....at your office. I would appreciate if you coud provide ..... You will find enclosed a release of information signed by your client .

I thank you very much for your cooperation. Should you have any question please do not hesitate to contact me at the University of Victoria 721-8590.

Yours truly,

Jocelyne Lacroix, M.A.
Vocational Rehabilitation
Consultant, Psychologist.
Department of Psychology,
University of Victoria,
Box 1030, Victoria, B.C.
V8W 2Y2

Attached: Release of information

UNIVERSITY OF VICTORIA **DEPARTMENT OF PSYCHOLOGY**

AUTHORIZATION FOR RELEASE OF INFORMATION
FOR THE STUDY
ASSESSMENT OF THE VOCATIONAL APTITUDES
OF TRAUMATICALLY BRAIN INJURED INDIVIDUALS

I _____, hereby

authorize _____

(name of the institution or clinic or employer releasing the information)
to release the following information: (describe below)

_____

_____

_____

to Ms. Jocelyne Lacroix M.A., Psychologist and principal investigator of the research project entitled "Assessment of the Vocational Aptitudes of Traumatically Brain injured individuals".

From the records of:

_____

born: _____

I consent to the use of this information by the authorized recipient only for the purposes of the present study.

I hereby release the health care facility and/or private clinic or employer authorized to release information as named above, it's employees and agents, form any and all claims whatsoever which may arise as a result of the release of the above information.

I am nineteen years of age or older.

Dated: _____

Witness: _____

This authorization will expire ten months form the above date.

Appendix H

International Classification of Impairments Disabilities and Handicaps

History of the CSICIDH and the CQCIDIH

The CSICIDH and the CQCIDIH are non-governmental organizations.

Their **mission** is to promote the application, promotion and development of the conceptual framework of the ICIDH as support for decision-making on programs and policies regarding persons with an impairment or a disability and experiencing a situation that creates a handicap.

The CQCIDIH was founded in 1986 by persons who had been actively involved for years in the field of policies and services for the benefit of persons with a disability. It is a non-profit corporation constituted under Part III of the Quebec Companies Act. Its objectives are:

- to promote awareness, application, validation and improvement of the ICIDH;
- to promote and develop research in this field of activity;
- to maintain links with experts and organizations in various countries interested in the ICIDH.

The CSICIDH was constituted in 1988 under a federal charter. The objectives of this new organization are the same as those of the CQCIDIH.

In June 1987, a conference among international experts was held in Quebec City to identify applications and improvements to be made to the definitions and classifications proposed in 1980 by the WHO.

This meeting resulted in a consensus that the level of the ICIDH that creates the most difficulties for its users is the level of the handicap. Conference participants them gave the CQCIDIH and the OPHQ the mandate of proposing a revision of the WHO definition of the concept of handicap and of the proposed classification, which turned out to be very brief.

Following an international call for proposed revisions and research projects conducted by the CSICIDH and the CQCIDIH with the financial support of the OPHQ, a proposed revision of the concept of handicap, developed by the CSICIDH and the CQCIDIH, was published in the winter of 1989 in the journal "ICIDH International Network".

Under this proposed revision, handicap is now considered to be the *situational result* of an ***interactive process*** between two sets of causes:

- **the characteristics of a person's impairments and disabilities** resulting from *diseases or trauma* ;
- the **characteristics of the environment** that create *social or environmental obstacles* in a given situation.

This proposed revision of the level of the handicap was widely distributed to members and international experts, and was the subject of an international consultation. A CSICIDH and CQCIDIH task force analysed the comments received, and the results were distributed in the spring 1991 issue of "ICIDH International Network".

The results of this consultation have already provided material for and influenced the CSICIDH and the CQCIDIH in their capacity as members of a new WHO committee composed of Philip Wood and the centres co-operating on the ICIDH. The objective of this committee is to revise the ICIDH; it held its first meeting in November 1990.

This clarification of the definitions and the resulting framework for intervention constitute a goal to be reached in order to mark the end of the Decade of Disabled Persons.

The current concerns of the CSICIDH and the CQCIDIH, then, can be summarized as follows:

- to distribute their proposed conceptual model of the classification and set up a network of collaborators in all parts of Quebec and Canada;
- to encourage testing and validation of the proposed model in order to contribute to the process of revision of the ICIDH being co-ordinated by the WHO;
- to design and distribute tools for the promotion, popularization and application of the proposal;
- to consolidate the operation and facilitate the development of the two organizations

CONCEPTUAL MODEL PROPOSED BY THE CSICIDH AND THE QCICIDH (1991)

While the ICIDH proposed by the WHO in 1980 states that handicap is the consequence of disabilities and impairments, the conceptual model proposed by the CSICIDH and the QCICIDH argues that handicap is the ***situational result*** of an interactive process between two sets of causes:

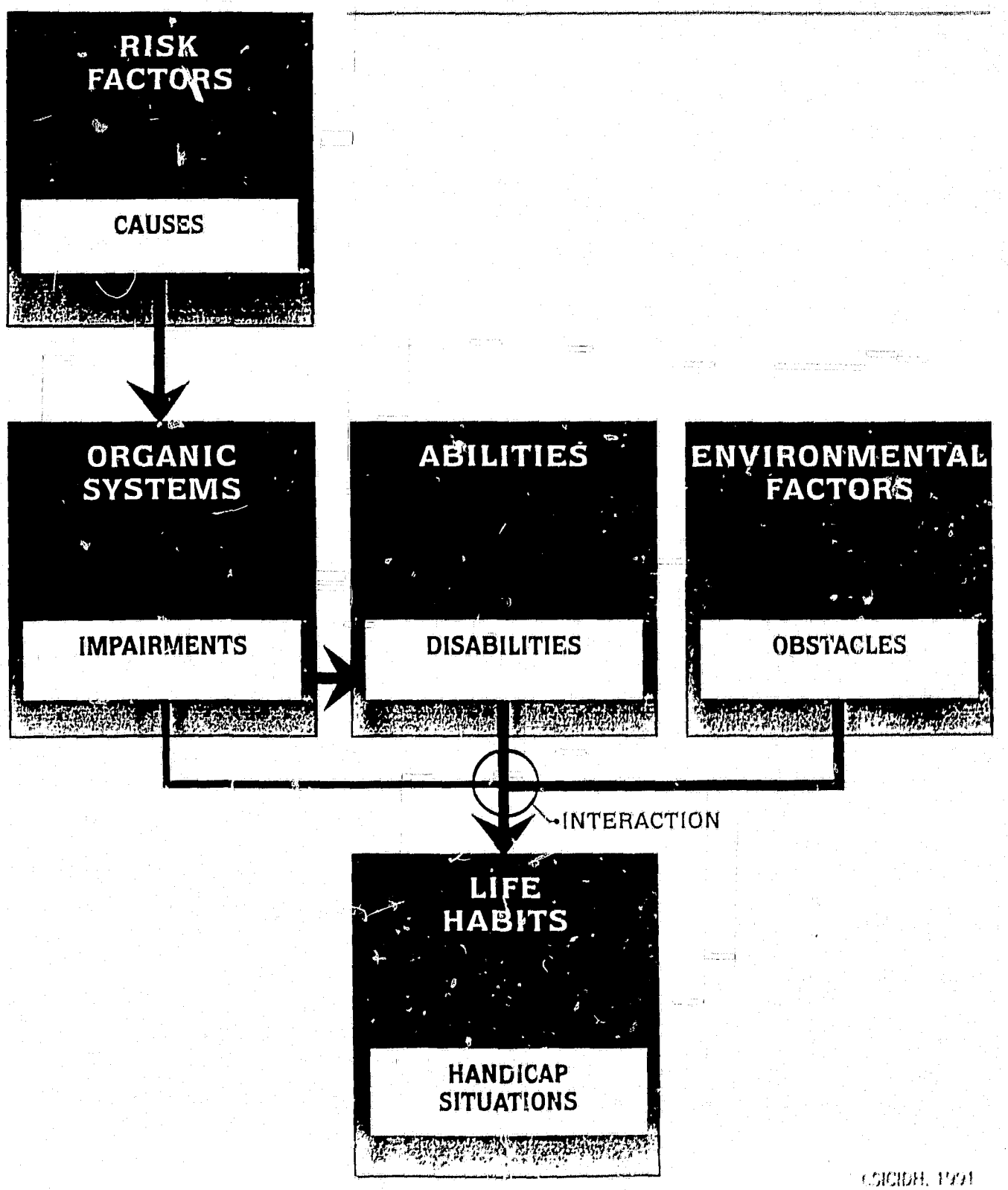
- the **characteristics of a person's impairments and disabilities** resulting from *diseases or trauma*;
- the **characteristics of the environment** that create *social or environmental obstacles* in a given situation.

In concrete terms, this view means that, depending on the environmental obstacles they face, persons with an impairment or a disability may or may not experience a **SITUATION CREATING A HANDICAP**. It is no longer appropriate, then, to refer to the "permanent status" of a person with a disability. It is more appropriate to speak of *a person experiencing one or more situations creating a handicap.*

The five main concepts contained in the Canadian proposal are **causes, impairments, disabilities, environmental obstacles** and **handicap situations** . The proposal therefore identifies:

1. *risk factors* (**causes**);
2. *organic systems* (**impairments**);
3. *abilities to accomplish physical or mental activities* (**disabilities**);
4. *environmental factors* that can create obstacles (**environmental obstacles**);
5. *disruption in the accomplishment of a person's life habits* (**handicap situations**).

HANDICAPS CREATION PROCESS



(SICIDH, 1991

IMPACT OF THE PROPOSED MODEL ON IMPAIRMENTS: PROPOSAL OF A NOMENCLATURE OF ORGANIC SYSTEMS.

By Hélène Bergeron, Ginette St-Michel, René Cloutier and Patrick Fougeyrollas — Mars 1991.

New proposed definition of impairment:

An impairment is any physiological, anatomical or histological anomaly or alteration.

Characteristics:

Impairments is characterized by anomalies that may be either temporary or permanent.

Impairments include the existence or appearance of anomalies related to certain stades of the organic structure that separate it from the biological norm, or from the mean standard, as in the case of morphological variations. These include changes in structure among which are losses of substances, i e. total or partial absence of an organ. They concern an organic system, a limb, a part of organ, some tissue, cell or other structure of the human organisme *excluding* mental and physiological functions.

This proposal therefore concentrates on precising the conceptual distinction between impairment and disability. This has the important implication of removing from the level of impairments any function considered as *the result* of the internal structural integrity of organ and their physical composents.

Our proposal is partially corroborated by two groups that have made similar proposals: the Spanish group in its alternative proposal for the WHO manual on ICIDH, submitted to the Expert Committee on Applications of ICIDH in june 1989 at Madrid, and the essay in handicap taxonomy, a working document prepared by Professor Claude Hamonet and his team at the University of Paris-Val-de-Marne, France.

We have also adopted a positive approach by proposing a nomenclature of *organic systems* with a severity scale and a location scale of impairments of organic systems.

This *working document* is proposed for experimentation, validation and *improvements* in relation with the three others nomenclatures in order to have a complete proposal which can be compared to the current ICIDH.

1- NERVOUS SYSTEM

1.1- brain

1.1.1- meninges
1.1.2- cerebral cortex (right, left)
1.1.2.1- frontal lobe (right, left)
1.1.2.2- parietal lobe (right, left)
1.1.2.3- temporal lobe (right, left)
1.1.2.4- occipital lobe (right, left)
1.1.3- basal ganglia
1.1.4- brain stem
1.1.4.1- pons
1.1.4.2- medulla oblongata
1.1.5- cerebellum

1.2- cerebrospinal fluid

1.3- cranial nerves (right, left)

1.3.1- olfactory nerve (right, left)
1.3.2- optic nerve (right, left)
1.3.3- oculomotor nerve (right, left)
1.3.4- trochlear nerve (right, left)
1.3.5- trigeminal nerve (right, left)
1.3.6- abducens nerve (right, left)
1.3.7- facial nerve (right, left)
1.3.8- vestibulocochlear nerve (right, left)
1.3.9- glosso-pharyngeal nerve (right, left)
1.3.10- vagus nerve (right, left)
1.3.11- accessory nerve (right, left)
1.3.12- hypoglossal nerve (right, left)

1.4- spinal cord

1.4.1- cervical area
1.4.2- dorsal area
1.4.3- lumbar area

1.5- peripheral nervous system
1.5.1 nerve roots
1.5.1.1- anterior nerve roots
1.5.1.2- posterior nerve roots
1.5.2- spinal nerves (right, left)
1.6- myoneural junction
1.7- autonomic nervous system
1.7.1- sympathetic
1.7.2- parasympathetic

2- AURICULAR SYSTEM

2.1- auricle (right, left)
2.2- external auditory canal (ceruminous glands) (right, left)
2.3- eardrum (right, left)
2.4- auditory ossicles (right, left)
2.5- eustachian tube (right, left)
2.6- cochlear duct (right, left)
2.7- organ of Corti (right, left)
2.8- vestibule (right, left)
2.9- semicircular canals (labyrinth) (right, left)

3- OCULAR SYSTEM

3.1- eye muscles (right, left)
3.2- cornea (right, left)
3.3- anterior chamber of the eye (right, left)
3.4- iris (right, left)
3.5- lens (right, left)
3.6- vitreous body (right, left)
3.7- retina (right, left)
3.8- ciliary muscles (right, left)
3.9- sclera (right, left)
3.10- choroid (right, left)
3.11- lacrimal gland (right, left)
3.12- lacrimal duct (right, left)

4- DIGESTIVE SYSTEM

4.1- teeth
4.2- muscles of mastication
4.3- temporomandibular joint
4.4- jaw
4.4.1- maxilla
4.4.2- mandible
4.5- tongue
4.6- salivary glands
4.7- soft palate
4.8- epiglottis
4.9- pharynx
4.10- esophagus
4.11- stomach
4.12- intestines
4.13- liver, bile duct and gall bladder
4.14- exocrine functions of the pancreas
4.15- anal sphincter

5- RESPIRATORY SYSTEM

5.1- nose
5.1.1- roof of the nasal cavity
5.1.2- nasal septum
5.1.3- sinuses
5.1.3.1- ethmoidal
5.1.3.2- sphenoidal
5.1.3.3- frontal
5.1.3.4- maxillary
5.2- larynx
5.2.1- vocal cords
5.2- trachea
5.3- bronchial tree
5.4- lung (right, left)
5.4.1- bronchus (right, left)
5.4.2- bronchiole (right,left)
5.5- pleura (right, left)
5.6- respiratory muscles
5.6.1- diaphragm (right, left)
5.6.2- muscles between the ribs

6- CARDIOVASCULAR SYSTEM

6.1- heart
6.1.1- pericardium
6.1.2- myocardium
6.1.3- left atrioventricular opening (including mitral valve)
6.1.4- right atrioventricular opening (including tricuspid valve)
6.1.5- aortic opening (including aortic valve)
6.1.6- pulmonary opening (including pulmonary valve)
6.2- system regulating the heartbeat
6.3- arterial system
6.3.1 coronary arteries
6.3.2- arteries supplying the limbs
6.3.3- arteries supplying the brain
6.3.4- arteries supplying the other organs
6.4- arterial blood pressure
6.5- peripheral venous system
6.6- lymphatic system

7- URINARY SYSTEM

7.1- kidney (right, left)
7.2- ureter (right, left)
7.3- bladder
7.4- urethra
7.5- vesical sphincter

8- ENDOCRINE SYSTEM (EXCLUDING THE SEX GLANDS)

8.1- pituitary gland
8.2- thyroid gland
8.3- parathyroid glands
8.4- endocrine functions of the pancreas
8.5- adrenal glands

9- HEMATOPOIETIC AND IMMUNE SYSTEM

9.1- red blood cells
9.2- white blood cells
9.3- platelets
9.4- system of lymph nodes
9.5- spleen
9.6- bone marrow
9.7- other blood components (hemogram)

10- REPRODUCTIVE SYSTEM

10.1- female sexual organs
10.1.1 ovary (right, left)
10.1.2 fallopian tube (right, left)
10.1.3 uterus
10.1.4 vagina
10.1.5 clitoris
10.1.6 vulva
10.1.7 breast (right, left)
10.1.8 menstrual cycle

10.2- male sexual organs
10.2.1 testicle (right, left)
10.2.2 seminal vesicle (right, left)
10.2.3 epididymis (right, left)
10.2.4 ductus deferens (right, left)
10.2.5 penis
10.2.6 prostate

11- INTEGUMENT SYSTEM

11.1- nails
11.1.1- fingernails
11.1.2- toenails

11.2- skin
11.2.1- head and face
11.2.1.1- scalp
11.2.1.2 forehead
11.2.1.3 eyelid (right, left)
11.2.1.4 nose
11.2.1.5 cheek (right, left)
11.2.1.6 lip (upper, lower)
11.2.1.7 ear (right, left)
11.2.1.8 chin
11.2.2 neck
11.2.3 trunk and pelvis
11.2.4 lower limb (right, left)
11.2.5 upper limb (right, left)

11.3- receptors
11.3.1 head and face
11.3.1.1 scalp
11.3.1.2 forehead
11.3.1.3 eyelid (right, left)
11.3.1.4 nose
11.3.1.5 cheek (right, left)
11.3.1.6 lip (upper, lower)
11.3.1.7 ear (right, left)
11.3.1.8 chin
11.3.2 neck
11.3.3 trunk and pelvis
11.3.4 lower limb (right, left)
11.3.5 upper limb (right, left)

11.4- abdominal wall

11.5- hair

11.6- sweat glands

11.7- sebaceous glands

12- MUSCULAR SYSTEM

12.1- head and face

12.2- neck

12.3- trunk and pelvis

12.4- upper limb (right, left)
12.4.1- shoulder (right, left)
12.4.2- arm (right, left)
12.4.3- forearm (right, left)
12.4.4- hand (right, left)

12.5- lower limb (right, left)
12.5.1- buttock (right, left)
12.5.2- thigh (right, left)
12.5.2- calf (right, left)
12.5.3- foot (right, left)

13- SKELETAL SYSTEM AND JOINTS

13.1- cranial and other bones of the head

13.2- trunk and pelvis
13.2.1- spine
13.2.1- cervical area
13.2.1.1- vertebrae
13.2.1.2- disks
13.2.2- dorsal area
13.2.2.1- vertebrae
13.2.2.2- disks
13.2.3- lumbar area
13.2.3.1- vertebrae
13.2.3.2- disks
13.2.4- sacral area

13.3- rib cage
13.3.1- sternum
13.3.2- ribs

13.4- upper limb (right, left)
13.4.1- joints of the upper limbs (right, left)
13.4.1.1- shoulder (right, left)
13.4.1.2- elbow (right, left)
13.4.1.3- forearm (right, left)
13.4.1.4- wrist (right, left)
13.4.1.5- joints of the fingers (right, left)
13.4.2- bones of the upper limbs (right, left)
13.4.2.1- scapula (right, left)
13.4.2.2- clavicle (right, left)
13.4.2.3- humerus (right, left)
13.4.2.4- radius (right, left)
13.4.2.5- ulna (right, left)
13.4.2.6- carpal bones (right, left)
13.4.2.7- metacarpal bones (right, left)
13.4.2.8- phalanges of the fingers and thumbs (right, left)

13.5- lower limb (right.left)
13.5.1- joints of the lower limbs (right, left)
13.5.1.1- hip (right, left)
13.5.1.2- knee (right, left)
13.5.1.3- ankle (right, left)
13.5.1.4- joints of the toes (right, left)
13.5.2- bones of the lower limbs (right, left)
13.5.2.1- femur (right, left)
13.5.2.2- patella (right, left)
13.5.2.3- tibia (right, left)
13.5.2.4- fibula (right, left)
13.5.2.5- tarsal bones (right, left)
13.5.2.6- metatarsal bones (right, left)
13.5.2.7- phalanges of the toes (right, left)

14- MORPHOLOGY

14.1- height

14.2- weight

IMPAIRMENT SEVERITY SCALE

4- Integrity.

3- Minor impairment.

2- Moderate impairment.

1- Severe impairment.

0- Non-qualified impairment.

IMPAIRMENT LOCATION SCALE

1- Right.

2- Left.

3- Right and left.

4- Non specified.

IMPACT OF THE PROPOSED MODEL ON DISABILITIES: PROPOSAL OF A NOMENCLATURE OF ABILITIES.

By Hélène Bergeron, Ginette St-Michel, René Cloutier and Patrick Fougeyrollas.

NOTE

This classification of abilities is a working proposal compatible with the classifications of life habits and environmental factors published in "International ICIDH Network" (CQCIDIH VOL. 2 NO.1 1989). This proposal is being circulated for experimentation by members of the Comité québécois sur la CIDIH and the Société canadienne de la CIDIH. This version of the proposal is also published for international consultation.

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STANDARDS FOR THE ESTABLISHMENT OF ABILITIES CLASSIFICATION

1 — Positive Approach: Ability/Disability

Disability manifests itself as a degree of modification, in excess or default of the ABILITY to accomplish a physical or mental activity, as a result of a deficiency or deficiencies. There is, therefore, a need to classify abilities and define a severity scale.

2 — Strict Segmentation

The concept of ability excludes socially determined activities and variables such as domestic activities, day-to-day activities and social roles included in the nomenclature of living habits.

The concept of ability EXCLUDES THE INTERNAL STRUCTURE OR FUNCTION of the organ whose anomalies constitute deficiencies.

3 — Thoroughness

The classification of abilities must include EVERYTHING the human body is organically capable of doing, VOLUNTARILY OR INVOLUNTARILY.

This corresponds to every exteriorized bodily function.

4 — Objectivity-reproductivity

The various stages in the development and evolution of human abilities, including behaviour, should be measured in terms of assessment contexts that are controlled, neutral and reproducible for every individual.

5 — Clarity

Category definitions must permit specific identification of each item.

6 — Practical Terminology

Exact "scientific" terms shall be used when they exist, rather than more common but generally less specific synonyms.

But because definitions should facilitate comprehension, the authors have made a practical compromise between the needs of expert users and those of general users.

Proposed new definition of disability:

A disability is any disturbance, resulting from an impairment, in the capacity of perform a physical or mental activity considered normal for a human being (depending on his biological characteristics).

ABILITIES

1- ABILITIES LINKED TO INTELLECTUAL ACTIVITIES:

Abilities linked to the initiation and organization of ideas, concepts and representations, and their use.

1.1- CONSCIOUSNESS AND WAKEFULNESS:
The ability to be aware of one's own mental activity.

1.1.1- Vigilance (wakefulness):
The ability to react: impressions received from outside or inside the body are perceived and controlled by the senses and thought, and voluntary action is possible.

1.1.2- Sleep:
The ability to suspend vigilance temporarily.

1.1.3- Attention:
The ability to have an elective mental orientation leading to more acute consciousness of a limited variety of stimuli.

1.1.4- Concentration:
The ability to focus one's attention forcefully on a single object.

1.1.5- Consciousness of Reality:

The ability to be in a mental state that allows the individual to understand the meaning of sensations transmitted by the senses and the reactions these cause, and to be aware of one's own existence with everything that entails.

1.1.5.1- Somatognosis:
The ability to be conscious of the structure of the body, to recognize its parts and their inter-relations.

1.1.5.1.1- Integration of Both Sides of the Body:
The ability to integrate and use information from both sides of the body and the environment.

1.1.5.1.2- Crossing the Median Line:
The ability to use each hand from the opposite side of the body.

1.1.5.1.3- Left/Right Discrimination:
The ability to understand and use the concepts of right and left.

1.1.5.1.4- Autotopognosis:
The ability to orient oneself on one's body and to designate the different parts on demand.

1.1.5.1.5- Digital Gnosis:
The ability to recognize the fingers.

1.1.5.1.6- Nosognosis:
The ability to recognize one's physical limitations.

1.1.5.2- Self-Awareness:
The ability to be conscious of one's existence.

1.1.5.3- Spatial Awareness:
The ability to assess precisely the physical relationship between the body and the environment and to deal with modifications in this relationship during movement.

1.1.5.4- Temporal Awareness:
The ability to assess precisely the chronological relationship between events and to locate events temporally

1.2- MNESIA:
The ability to preserve and recall past states of awareness and that which is associated with them.

1.2.1- Propositional Memory:
The ability to learn about and evoke facts, objects or persons.

1.2.1.1- Episodic Memory:
The ability to recall on the basis of spatial and temporal contextual indices.

1.2 1.1.1- Explicit Memory:
The ability to recall information that is immediately accessible to consciousness.

1.2.1.1.1.1- Sensory Memory:
The ability to retain briefly an impression deposited by sensory stimulus.

1.2.1.1.1.2- Short-term Memory:
The ability to access information for a few seconds.

1.2.1.1.1.3- Long-term Memory:
The ability to access information beyond a few seconds or minutes

1.2.1.1.2- Implicit Memory:
The ability to recall information that is present but inaccessible by conscious voluntary action.

1.2.1.2- Semantic Memory:
The ability to recall in relation to a knowledge system.

1.2.2- Procedural Memory:
The ability to learn and evoke skills and procedures.

1.2.2.1- Skills Memory:
The ability to learn and evoke the perceptual and motor strategies required to carry out a task.

1.2.2.2- Procedural Memory:
The ability to learn and evoke learning strategies.

1.3- THOUGHT:
The ability to initiate and organize ideas, concepts and representations, and to use them.

1.3.1- Logical Thought:
The ability to generate hypotheses by testing them and drawing conclusions, and to link ideas hierarchically.

1.3.2- Association:
The ability by which representations and concepts are likely to be mutually evoked (e.g. associations of ideas).

1.3.3- Analysis:
The ability to break a whole down into its essential elements, to grasp the relationships within it and to draw up a plan of the whole.

1.3.4- Synthesis:
The ability to move from simple to complex concepts, from the simple to the whole (as opposed to analysis).

1.3.5- Judgement:
The ability to analyze a situation and reach a conclusion or decision.

1.3.6- Anticipation:
The ability to imagine or experience an event in advance.

1.3.7- Calculia:
The ability to carry out an operation or operations using mathematical symbols.

1.3.8- Creativity:
The ability to imagine, to invent, to be original.

1.3.9- Abstraction:
The ability to form concepts on the basis of qualities and relationships not the concrete.

2- ABILITIES LINKED TO LANGUAGE:

Abilities to communicate using the body, speech or writing.

2.1- EXPRESSION:
The ability to emit a message to express thought.

2.1.1- Nonverbal Expression:
The ability to express oneself using means other than speech.

2.1.1.1- Pre-Language:
Child's ability to produce differentiated cries, prattling and babbling.

2.1.1.2- Miming:
The ability to express oneself using facial expression.

2.1.1.3- Gesture:
The ability to express oneself using natural gestures.

2.1.1.4- Weeping:
The ability to express sadness using tears and plaintive sound.

2.1.1.5- Laughter:
The ability to express gaiety using lip movement and relatively noisy jerky breaths.

2.1.1.6- Graphic Expression:
The ability to express oneself using drawings and symbols excluding written language.

2.1.2- Verbal Expression:
The ability to express oneself in code, a conventional system used to communicate ideas and concepts.

2.1.2.1- Content:
The ability to represent objects, events or relationships linguistically.

2.1.2.2- Form:
The ability to associate sounds with words or signs with their meaning and to use all these linguistic units and the various rules for their combination.

2.1.2.2.1- Phonology:
The ability to use language sounds (phonemes) to form meaningful units (words) or morphemes (suffixes, prefixes, etc.).

2.1.2.2.2- Syntax:
The ability to combine words to make phrases.

2.1.2.2.3- Suprasegmental Features
The ability to emphasize syllables in the appropriate locations and to vary prosody (height, intensity, intonation, pauses) in terms of meaning.

2.1.2.3- Language Use:
The ability to use language for a purpose while taking the context and the person being spoken to into account.

2.1.3- Written Language Expression (Writing):
The ability to express oneself in a written code.

2.1.4- Gestural Language Expression:
The ability to express oneself in coded gestures governed by a conventional system used to communicate ideas and concepts.

2.2- UNDERSTANDING:
The ability to understand a message.

2.2.1- Understanding Nonverbal Expression:
The ability to understand messages expressed by means other than written language.

2.2.1.1- Understanding Mime:
The ability to understand the facial expressions of a person with whom one is speaking.

2.2.1.2- Understanding Gestures:
The ability to understand the natural gestures of a person with whom one is speaking.

2.2.1.3- Graphic Understanding:
The ability to understand drawings or symbols excluding written language.

2.2.2- Understanding Language:
The ability to understand a code, a conventional system used to communicate ideas and concepts.

2.2.2.1- Understanding Verbal Language:
The ability to understand spoken language.

2.2.2.2 Understanding Written Language (Writing):
The ability to understand a written code.

2.2.2.3- Understanding Gestural Language:
The ability to understand coded gestures.

3- ABILITIES LINKED TO BEHAVIOUR:

Abilities linked to volition, affectivity and behaviour.

3.1- VOLITION:
The ability to mobilize one's personal forces to achieve an objective.

3.1.1- Motivation:
The individual's ability to be encouraged to act in terms of conscious or unconscious forces.

3.1.2- Decision:
The ability to make choices in terms of available information.

3.1.3- Initiative:
The ability to act spontaneously or on one's own initiative.

3.1.4- Perseverance:
The individual's ability to remain firm, constant and tenacious in action.

3.1.5- Interest:
The ability to develop an attraction to environmental stimuli (objects, situations, persons).

3.1.6- Flexibility:
The ability to modify one's attitudes or knowledge in terms of contextual change.

3.1.7- Patience:
The ability to wait for the results of an action or situation.

3.2- AFFECTIVITY:
The ability to experience emotions and other personal feelings.

3.2.1- Emotion:
The ability to feel or express a pleasant or unpleasant feeling.

3.2.2- Self-esteem:
The ability to experience a feeling that is favourable to oneself, arising from a good opinion of oneself and the value one ascribes to oneself.

3.2.3- Empathy:
The ability to put oneself in another's place and experience that person's feelings and emotions.

3.2.4- Independence:
The capacity for independent feelings, based on a degree of emotional stability.

3.2.5- Feeling of Belonging:
The ability to consider oneself and to feel like an integral part of a group, a family or a gathering.

3.3- BEHAVIOUR:
The ability to direct oneself, to behave under given circumstances.

3.3.1- Sense of Responsibility:
The ability to meet one's obligations, to fulfil one's duties and to bear the consequences of one's actions.

3.3.2- Imitation:
The ability to reproduce willingly or to attempt to reproduce another's appearance, gesture or action.

3.3.3- Self-presentation:
The ability to present a favourable image of oneself in certain social situations.

3.3.4- Personal Safety:
The ability to safeguard oneself against risks and danger.

3.3.5- Adaptation to Situations:
The capacity for behavioral flexibility and personal adjustment in a variety of situations.

3.3.6- Sociability:
The ability to maintain pleasant human relations and to seek the company of peers.

3.3.7- Intimacy:
The ability to develop close and affective ties with someone.

3.3.8- Self-affirmation:
The ability to assert or to express frankly one's own emotions or opinions.

3.3.9- Respect for Rules:
The ability to comply with what is imposed or adopted as behavioral guidelines.

3.3.10- Competitiveness
The ability to confront competitive situations, to rival another person.

3.3.11- Cooperation:
The ability to cooperate and participate in a joint project.

3.3.12- Impulse Control:
The ability for emotional control, self-control and mastery of one's emotions.

3.3.13- Spontaneity:
The ability to act naturally, without being prompted or constrained by anyone.

3.3.14- Relaxation:
The ability to reduce or eliminate one's pressures.

3.3.15- Speech:
The ability to express oneself verbally and to sustain a conversation in terms of quality and quantity of expression.

3.3.16- Listening:
The ability to pay attention to messages.

4- ABILITIES LINKED TO THE SENSES AND TO PERCEPTION:

Abilities linked to sensory recognition of objects.

4.1- INTEROCEPTIVE FUNCTIONS:
The ability to feel variations in one's body.

4.1.1- Hunger:
The ability to feel the need to eat.

4.1.2- Thirst:
The ability to feel the need to drink.

4.1.3- Satiety:
The ability to feel satiated.

4.1.4- Internal Pain:
The ability to feel discomfort or pain originating in the internal structures of the body such as the abdominal and thoracic viscera, the muscles and the bones.

4.1.5- The Need to Eliminate:
The ability to feel the need to evacuate urine and feces.

4.2- PROPRIOCEPTIVE FUNCTIONS:
The ability to feel the position or movement of parts of the body.

4.2.1- Sense of Limb Position:
The ability to feel the position of different parts of the body in relation to each other.

4.2.2- Kinesthesia:
The ability to feel the movements of different parts of the body.

4.2.3- Muscle Tension:
The ability to feel muscle contraction or extension.

4.2.4- Head Position:
The ability to feel the spatial position of the head.

4.2.5- Body Movement:
The ability to feel body movement.

4.2.6- Balance:
The ability to integrate the information derived from deep sensation, the vestibular apparatus and vision that is required to maintain balance.

4.3- EXTEROCEPTIVE FUNCTIONS:
The ability to feel stimuli from outside the body.

4.3.1- Vision:
The ability to perceive light, colour and shape.

4.3.1.1- Detail Vision:
The ability to distinguish the smallest possible detail of a physical element.

4.3.1.2- Colour Identification
The ability to distinguish and recognize colours

4.3.1.3- Spatial and Movement Vision:
The ability to perceive the extent of physical space perceived by an eye in a given position when objects are stationary or immobile.

4.3.1.4- Adaptation to Light Intensity
The eye's ability to adapt to variations in light.

4.3.1.5- Photopic Vision:
The ability to use visual skills when the eyes are adapted to photopic light conditions (photopic field $1x10^{7}$ to $1x10^{-2}$).

4.3.1.6- Mesopic Vision:
The ability to use visual skills when the eyes are adapted to mesopic light conditions (mesopic field [illegible] to $1x10^{-3}$).

4.3.1.7- Scotopic Vision:
The ability to use visual skills when the eyes are adapted to scotopic light conditions (scotopic field $1x10^{-3}$ to $1x10^{-7}$).

4.3.1.8- Sensitivity to Contrast:
The ability to see objects in the environment under low or high contrast conditions.

4.3.1.9- Binocular Vision:
The ability to use both eyes alternately or simultaneously such that each image contributes to the ultimate perception.

There are three recognized degrees of this type of vision: simultaneous monocular perception, fusion and stereoscopy.

4.3.1.10 Accommodation:
The ability to adjust ocular power to perceive an environment with objects and their details at various distances

4.3.1.11 Depth
The ability to perceive the absolute distance separating us from an object or the relative distance between objects

4.3.1.12 Verticality
The ability to perceive apparent vertical on the basis of visual and labyrinthine sensorial data

4.3.1.13 Size
The ability to assess different sizes

4.3.1.14 Shape
The ability to recognize shapes

4.3.1.15 Background
The ability to discriminate foreground from background

4.3.1.16 Spatial Position
The ability to distinguish the spatial disposition of objects

4.3.1.17 Spatial Relation
The ability to perceive the position of two or more objects in relation to each other and oneself.

4.3.1.18- Constant Perception
The ability to recognize objects despite changes in their characteristics such as shape, size or colour

4.3.1.19- Gnosis of Objects
The ability to recognize the nature, meaning or use of an object.

4.3.1.20- Gnosis of Symbols:
The ability to recognize graphic symbols.

4.3.1.21- Prosopognosis
The ability to recognize differences in faces or to recognize familiar or known faces.

4.3.1.22 Simultanognosis.
The ability to interpret a visual stimulus as a whole.

4.3.2- Hearing:
The ability to perceive sounds.

4.3.2.1- Auditory Clarity
The ability to hear sounds clearly.

4.3.2.2- Frequential Sound:
The ability to perceive a range of sound frequencies.

4.3.2.3- Field of Intensity:
The ability to perceive sounds of different intensities.

4.3.2.4- Identification of Sounds:
The ability to distinguish and recognize sounds.

4.3.2.4.1- Noises:
The ability to identify noises.

4.3.2.4.2- Music:
The ability to identify music.

4.3.2.4.3- Voice:
The ability to identify voice.

4.3.2.5- Location of Sounds:
The ability to locate the origin of sounds.

4.3.2.6- Temporal Resolution:
The ability to integrate sounds at normal speed.

4.3.2.7- Dichotic Listening:
The ability to integrate sounds heard simultaneously by both ears.

4.3.2.8- Identification of Sounds in Noise:
The ability to recognize sounds in the presence of noises or reverberation.

4.3.2.9- Persistence of Sound Sensation:
The ability to maintain sound sensation in time.

4.3.2.10- Auditory Substitution:
The ability to compensate mentally when listening to a distorted message.

4.3.3- Taste:
The ability to perceive flavour.

4.3.3.1- Salty:
The ability to perceive salty flavour.

4.3.3.2- Sweet:
The ability to perceive sweet flavour.

4.3.3.3- Bitter:
The ability to perceive an unpleasant flavour.

4.3.3.4- Acid:
The ability to perceive an acidic flavour.

4.3.4- Smell:
The ability to perceive odours.

4.3.5- Touch:
The ability to perceive stimuli on the skin.

4.3.5.1- Superficial Touch:
The ability to feel a light touch on the skin with no pressure.

4.3.5.2- Pressure:
The ability to feel firm pressure on the skin.

4.3.5.3- Topesthesia:
The ability to locate a stimulus on the skin.

4.3.5.4- Distinguishing two Points:
The ability to distinguish two simultaneous stimuli on the skin.

4.3.5.5- Pallesthesia:
The ability to feel vibrations.

4.3.5.6- Superficial Pain:
The ability to feel a painful sensation on the skin.

4.3.5.7- Temperature:
The ability to feel ambient temperature or the temperature of an object on the skin.

4.3.5.7.1- Heat:
The ability to feel heat on the skin.

4.3.5.7.2- Cold:
The ability to feel cold on the skin.

4.3.5.8- Stereognosis:
The ability to determine shapes by touch.

4.3.5.9- Hylognosis:
The ability to recognize and identify different textures.

4.3.5.10- Baresthesia:
The ability to discern weights.

4.3.5.11- Graphesthesia:
The ability to recognize a figure or symbol traced on the skin.

5- ABILITIES LINKED TO MOTOR ACTIVITIES:

Abilities linked to movement and to the maintenance of body position.

5.1- MOVEMENT OF BODY PARTS:
The ability to move body parts.

5.1.1- Eye Movement:
The ability to move the eyes in every direction.

5.1.2- Eyelid Movement:
The ability to open and close the eyelids.

5.1.3- Mouth and Larynx Movements:
The ability to move the structures of the mouth and larynx.

5.1.3.1- The Jaw:
The ability to make lateral, lowering, raising, propulsion, rotation and retraction movements of the lower jaw.

5.1.3.2- The Lips:
The ability to make lip movements such as closing, narrowing, drawing the corners apart, pursing, rounding and retraction.

5.1.3.3- The Tongue:
The ability to make tongue movements such as raising, lowering different parts, protrusion, retraction and lateral movement.

5.1.3.4- The Soft Palate:
The ability to contract (raise) and relax (lower) the soft palate.

5.1.3.5- The Larynx:
The ability to vibrate the vocal cords.

5.1.4- Neck Movements:
The ability to flex, extend, flex laterally (left and right), rotate (left and right) and circumduct the neck.

5.1.5- Trunk Movements:
The ability to flex, extend, flex laterally (left and right), rotate (left and right) and circumduct the trunk.

5.1.6- Shoulder Movements:
The ability to flex, extend, rotate in, rotate out, abduct and adduct the shoulders.

5.1.7- Elbow Movements:
The ability to flex and extend the elbows.

5.1.8- Forearm Movements:
The ability to pronate and supinate the forearms.

5.1.9- Wrist Movements:
The ability to flex, extend, abduct, adduct and circumduct the wrists.

5.1.10- Finger Movements:
The ability to flex, extend, abduct and adduct the fingers, and to oppose the thumbs.

5.1.11- Hip Movements:
The ability to flex, extend, abduct, adduct, rotate in, rotate out and circumduct the hips.

5.1.12- Pelvic Movements:
The ability to invert and retrovert the pelvis.

5.1.13- Knee Movements:
The ability to flex and extend the knees.

5.1.14- Ankle Movements:
The ability to flex the ankles downward and upward, and to evert, invert and circumduct them.

5.1.15- Toe Movements:
The ability to flex, extend, abduct and adduct the toes.

5.2- REFLEX MOVEMENTS:
The ability of a body part to react automatically, involuntarily and immediately to a stimulus.

5.2.1- Primitive Reflexes:
The ability to have phasic reflexes that coordinate the muscles in total extension or flexion, normally integrated during the first months of life.

5.2.2- Postural Reflexes:
The ability to have static reflexes prompted by changes in the spatial position of the head or the body, normally present during the first four months of life.

5.2.3- Straightening Up Reactions:
The ability to have reflexes permitting the child to roll over, sit up, crawl and creep, normally present to five years of age.

5.2.4- Protection Reactions:
The ability to protect oneself in reaction to a harmful stimulus or during imbalance.

5.2.5- Balance Reactions:
The ability to have balancing reactions used to maintain equilibrium when carrying loads or walking.

5.2.6- Exteroceptive Medullary Reflexes:
The ability to have a withdrawal reaction after a cutaneous nociceptive excitation.

5.2.7- Proprioceptive (or Myotatic) Medullary Reflexes:
The ability to have a reflex contraction of a muscle caused by that muscle being stretched.

5.2.8- Pupil Reflexes:
The visual system's ability to react to environmental light variations.

5.3- STATIC POSTURAL POSITION:
The ability to maintain a single position.

5.3.1- Head Carriage:
The ability to keep the head in a given position.

5.3.2- Lying Down:
The ability to remain lying down.

5.3.2.1- Ventral:
The ability to remain lying down in an unassisted ventral position, supported on the forearms and hands.

5.3.2.2- Dorsal:
The ability to remain lying down in a dorsal position.

5.3.2.3- Lateral
The ability to remain lying down in a lateral position.

5.3.3- Sitting:
The ability to maintain a seated position.

5.3.4- Kneeling:
The ability to remain on one or both knees.

5.3.5- Quadruped Position:
The ability to remain on hands and knees.

5.3.6- Crouching:
The ability to maintain a crouching position.

5.3.7- Standing:
The ability to remain standing.

5.3.7.1- On Both Legs:
The ability to remain standing on both legs.

5.3.7.2- On one Foot:
The ability to remain standing on one foot.

5.4- MOVEMENT:
The ability to move the entire body in space.

5.4.1- Changing Position:
The ability to move from one given position to another.

5.4.1.1- Stretched Out on the Back to Stretched Out on the Side:
The ability to move from a position stretched out on the back to stretched out on the side.

5.4.1.2- Stretched Out on the Side to Stretched Out on the Back:
The ability to move from a position stretched out on the side to stretched out on the back.

5.4.1.3- Stretched Out on the Stomach to Stretched Out on the Side:
The ability to move from a position stretched out on the stomach to stretched out on the side.

5.4.1.4- Stretched Out on the Side to Stretched Out on the Stomach:
The ability to move from a position stretched out on the side to stretched out on the stomach.

5.4.1.5- Stretched Out on the Stomach to Stretched Out on the Back:
The ability to move from a position stretched out on the stomach to stretched out on the back.

5.4.1.6- Stretched Out on the Back to Stretched Out on the Stomach:
The ability to move from a position stretched out on the back to stretched out on the stomach.

5.4.1.7- Stretched Out on the Back to Seated:
The ability to move from a position stretched out on the back to a sitting position.

5.4.1.8- Seated to Stretched Out on the Back:
The ability to move from a sitting position to stretched out on the back.

5.4.1.9- Stretched Out on the Side to Seated:
The ability to move from a position stretched out on the side to a sitting position.

5.4.1.10- Seated to Stretched Out on the Side:
The ability to move from a sitting position to stretched out on the side.

5.4.1.11- Stretched Out on the Stomach to Hands and Knees:
The ability to move from a position stretched out on the stomach to hands and knees.

5.4.1.12- Hands and Knees to Stretched Out on the Stomach:
The ability to move from a hands and knees position to stretched out on the stomach.

5.4.1.13- Seated to Standing:
The ability to move from a sitting to a standing position.

5.4.1.14- Standing to Seated:
The ability to move from a standing to a sitting position.

5.4.1.15- Standing; Bending Forward:
The ability to bend forward from the standing position.

5.4.1.15- Standing, Bending Forward; Straightening Up:
The ability to straighten up from the standing position, bending forward.

5.4.1.17- Crouching:
The ability to crouch.

5.4.1.18- Rising from a Crouch:
The ability to rise from a crouch.

5.4.1.19- Kneeling to Genuflecting:
The ability to move from a kneeling position to genuflecting.

5.4.1.20- Genuflecting to Kneeling:
The ability to move from genuflecting to kneeling.

5.4.1.21- Genuflecting to Standing:
The ability to move from genuflecting to standing.

5.4.1.22- Standing to Genuflecting:
The ability to move from standing to genuflecting.

5.4.2- Locomotion:
The ability to move from one place to another.

5.4.2.1- Rolling Over:
The ability to return to the stretched out position repeatedly.

5.4.2.2- Creeping:
The ability to pull oneself along on one's stomach.

5.4.2.3- Crawling:
The ability to move forward with successive weight on hands and knees.

5.4.2.4- Walking on the Knees:
The ability to move forward with successive weight on the knees.

5.4.2.5- Swimming:
The ability to move while floating on water or in water with arm, leg and trunk movements.

5.4.2.6- Walking:
The ability to move with successive leg motions and support and one foot on the ground at all times.

5.4.2.6.1- Walking Forward:
The ability to move forward with successive leg motions and support and one foot on the ground at all times.

5.4.2.6.2- Walking Backward:
The ability to move backward with successive leg motions and support and one foot on the ground at all times.

5.4.2.6.3- Walking Sideways:
The ability to move sideways with successive leg motions and support and one foot on the ground at all times.

5.4.2.7- Pivoting:
The ability to turn in a standing position, as if on a pivot.

5.4.2.8- Jumping:
The ability to leave the ground for an instant by launching oneself into the air.

5.4.2.8.1- Jumping on One Foot:
The ability to leave the ground for an instant by launching oneself into the air using one foot.

5.4.2.8.2- Jumping on Two Feet:
The ability to leave the ground for an instant by launching oneself into the air using both feet.

5.4.2.9- Running:
The ability to move quickly, bounding from one leg to the other.

5.4.2.10- Hurdling:
The ability to move over an obstacle by extending the legs.

5.4.2.11- Mounting:
The ability to move toward a higher location using the legs.

5.4.2.12- Descending:
The ability to move toward a lower location.

5.4.2.13- Climbing:
The ability to mount using hands and feet.

5.4.2.14- Dancing:
The ability to move rhythmically or in harmony with music.

5.5- SIMPLE MANUAL ACTIVITIES:
The ability to use one's hands.

5.5.1- Grasping:
The ability to seize with one or both hands.

5.5.1.1- Grasping with one Hand:
The ability to grasp an object with one hand.

5.5.1.1.1- Digital Grasping:
The ability to grasp an object using only the fingers.

5.5.1.1.2- Palmar Grasping:
The ability to grasp an object using the fingers and the palm.

5.5.1.1.3- Centred or Directional Grasping:
The ability to grasp firmly using the thumb and the last three fingers, with the index finger used to guide the tool.

5.5.1.2- Simultaneous Grasping:
The ability to grasp an object with both hands or to grasp objects in each hand simultaneously.

5.5.2- Releasing:
The ability to release an object held in the hand voluntarily.

5.6- OTHER MANUAL ACTIVITIES:
The ability to use one's hands in a complex activity.

5.6.1- Carrying to one's Mouth:
The ability to grasp an object and bring it to one's mouth.

5.6.2- Scratching:
The ability to scratch with the nails.

5.6.3- Rubbing:
The ability to exert repetitive manual pressure on a surface.

5.6.4- Hitting:
The ability to touch relatively roughly one or more times.

5.6.5- Handshaking:
The ability to move the hand in a lively fashion in several directions.

5.6.6- Pointing:
The ability to point a finger in a direction.

5.6.7- Touching:
The ability to bring one's hand into contact with a surface.

5.6.8- Transferring an Object from One Hand to the Other:
The ability to move an object from one hand to the other.

5.6.9- Pushing:
The ability to move an object forward.

5.6.10- Pulling:
The ability to bring an object toward oneself.

5.6.11- Throwing:
The ability to project an object away from oneself, generally in a given direction.

5.6.12- Catching:
The ability to grasp an object travelling through the air.

5.6.13- Raising:
The ability to raise an object.

5.6.14- Transporting:
The ability to carry an object from one location to another.

5.6.15- Depositing:
The ability to set an object down.

5.7- PRAXIS:
The potential to carry out movements designed for a given purpose on command in a given manner.

5.8- SPEECH:
The ability to communicate one's thoughts with articulate sounds.

5.8.1- Articulation:
The ability to pronounce sounds distinctly.

5.8.2- Voice:
The ability to speak with intonation, intensity and vocal quality.

5.8.3- Fluidity:
The ability to speak without interruption in delivery and rhythm.

6- ABILITIES LINKED TO EXTERNAL RESPIRATION:

Abilities linked to air circulation in the respiratory passages.

6.1- BREATHING:
The ability to aspirate air into the lungs, then expel it.

6.1.1- Thoracic Breathing:
The ability to breath using the thoracic muscles.

6.1.2- Abdominal Breathing:
The ability to breath using the abdominal muscles.

6.1.3- Diaphragmatic Breathing:
The ability to breath solely from the diaphragm.

6.2- COUGHING:
The ability to expel the air contained in the lungs suddenly and explosively, usually to clear the respiratory tract of any substance irritating it or hampering respiration.

6.3- SNEEZING:
The ability to carry out a sudden, noisy reflex expulsion of air through the nose and mouth, caused by an irritation of the nasal mucus membrane.

6.4- YAWNING:
The ability to open the mouth widely and involuntarily with a full inspiration followed by a prolonged expiration of air and contraction of the facial muscles.

6.5- BLOWING:
The ability to expel air voluntarily through the mouth or nose.

7- ABILITIES LINKED TO DIGESTION:

Abilities linked to the assimilation of food in the digestive tract

7.1- SUCKING:
The ability to aspirate with the lips, creating a vacuum in the mouth

7.2- LICKING:
The ability to pass the tongue over something.

7.3- CHEWING:
The ability to seize and condense something forcefully with the teeth, in such a way as to cut into it, hold it, cut it up or tear it.

7.4- SALIVATING:
The ability to secrete and control saliva.

7.5- MUNCHING:
The ability to chew repetitively, using the gums and teeth.

7.6- MASTICATING:
The ability to grind and divide solid food in the mouth.

7.7- SWALLOWING:
The ability to move food mechanically from the mouth to the stomach.

7.8- DIGESTING:
The ability to process food in the digestive tract.

7.9- VOMITING:
The ability to expel stomach contents suddenly

7.10- REGURGITATION:
The ability to have food return from the stomach or the esophagus to the mouth without nausea or effort.

7.11- SPITTING:
The ability to project the contents of the mouth.

8- ABILITIES LINKED TO EXCRETION:

Abilities linked to the excretion of wastes from the body

8.1- CONTROLLING MICTION:
The ability to control urine elimination.

8.2- CONTROLLING DEFECATION:
The ability to control the elimination of fecal matter.

8.3- PERSPIRATION:
The ability to excrete sweat.

8.4- CRYING:
The ability to secrete tears.

9- ABILITIES LINKED TO REPRODUCTION:

Abilities linked to the generation of other individuals.

9.1- GENITALITY:
The sex organs' ability to react to stimulation.

9.1.1- Erection:
The ability to increase the volume of the genital organs and harden them.

9.1.2- Ejaculation:
The physiological reflex by which the sperm, having reached the urethra, is expelled from the penis.

9.1.3- Lubrication:
The ability to have vaginal lubrication.

9.1.4- Sexual Pleasure:
The ability to feel sexual excitement, the most intense point of which is orgasm.

9.2- PROCREATING:

9.2.1- Fertility:
The ability to fertilize or to be fertilized.

9.2.2- Pregnancy:
The ability to carry the development of a fetus to term.

9.2.3- Delivery:
The ability to give birth to a child.

9.2.4- Lactation:
The ability to breastfeed.

10- ABILITIES LINKED TO PROTECTION AND RESISTANCE:

Abilities linked to protection from and resistance to a constraint, an effort or an environmental factor.

10.1- TOLERANCE:

10.1.1- Tolerance to Temperature:

The ability to withstand temperature exposure without significant harm.

10.1.1.1- Cold Tolerance:
The ability to withstand low temperature without significant harm.

10.1.1.2- Heat Tolerance:
The ability to withstand high temperature without significant harm.

10.1.2- Tolerance to Ultraviolet Radiation:
The ability to withstand normal exposure to ultraviolet radiation without significant harm.

10.1.3- Tolerance to Humidity:
The ability to withstand humidity without significant harm.

10.1.4- Tolerance to Significant Variations in Barometric Pressure:
The ability to withstand significant variations in barometric pressure without significant harm.

10.1.5- Tolerance to Other Environmental Factors:
The ability to withstand other environmental factors without significant harm. These include viruses, bacteria and food-linked allergenic substances, chemical agents or ionizing radiation.

10.2- RESISTANCE:
The body's ability to withstand effort, shock or pressure.

10.2.1- Resistance to Timely Effort:
The ability to withstand short-term overall physical effort.

10.2.2- Endurance:
The ability to withstand prolonged overall physical effort.

10.2.3- Resistance to Shock and Pressure:
The ability to withstand shock or pressure.

SEVERITY SCALE

5- Ability beyond usual defined limits

4- Unlimited ability

3- Unlimited ability with compensation

3.3- Unlimited ability with technical aid and human assistance

3.2-Unlimited ability with human assistance

3.1- Unlimited ability with technical aid

2- Limited unaided capability

1- Limited aided ability

1.3- Limited ability with technical aid and human assistance

1.2- Limited ability with human assistance

1.1- Limited ability with technical aid

0- No ability

PROPOSAL OF A REVISED NOMENCLATURE OF LIFE HABITS

By Patrick Fougeyrollas and Ginette St-Michel.

No modification has been done to the definitions of the concepts of handicap and life habits as they were published in our 1989 proposal. (International ICIDH Network — Fougeyrollas, P.; St-Michel, G.; Blouin, M.; Vol. 2 no 1).

The proposed modifications of the nomenclature come from the analysis of the received comments and from the experimental use.

1- NUTRITION:

This category covers habits related to food consumption.

1.1- DIET:

Includes choice of the nature, quality and quantity of foods that make up the individual's diet.

1.2- FOOD PREPARATION:

Includes habits related to the preparation of meals, such as the storing and processing of foods, and involving the use of the appropriate utensils.

1.3- MEALS:

Includes habits related to the eating of meals, such as the use of drinking and eating utensils (for example, plates, glasses, knives and forks) and general table manners.

2- FITNESS:

This category covers habits related to fitness of body and mind. It does not include habits related to Personal Care (3).

2.1- SLEEP:

Includes habits related to sleep, such as using accessories in order to sleep. This category does not include habits related to Personal Care (3).

2.2- PHYSICAL FITNESS:

Includes habits related to prevention and to the maintenance and recovery of physical fitness, such as physical exercises and relaxation. This category does not include habits related to Health Care (3.4), Hygiene (3.1) or Sports (13.1).

2.3- MENTAL FITNESS:

Includes habits related to prevention and to the maintenance and recovery of mental fitness, such as exercises related to mental relaxation and meditation.

3- PERSONAL CARE:

This category covers habits that ensure the physical well-being of the individual.

3.1- HYGIENE:

Includes habits related to grooming, such as washing, brushing one's hair and brushing one's teeth.

3.2- EXCRETORY HYGIENE:

Includes habits related to the excretory functions, such as the use of bathroom facilities.

3.3- DRESSING:

Includes habits related to choosing clothing, getting dressed and using make-up, accessories and jewelry.

3.4- HEALTH CARE:

Includes habits related to prevention and to the maintenance and recovery of personal health, such as taking medication, using bandages and using therapeutic equipment. This category does not include habits related to Physical Fitness (2.2) or to health care services included in Community (10).

4- COMMUNICATION:

This category covers habits that enable to convey messages and receive them from others and from society.

4.1- EXPRESSION OF INFORMATION:

Includes communication habits related to oral and written expression and any other means of communicating with others, such as speaking, using the telephone and other electronic communication equipment, writing, and using nonverbal communication.

4.2- RECEPTION OF INFORMATION:

Includes means of communication the individual uses to receive information, such as the mass media (newspapers, television and radio) and road signs.

5- RESIDENCE:

This category covers habits related to the individual's place of residence.

5.1- HOUSING:

Includes habits related to obtaining housing and being able to occupy it, such as finding a suitable dwelling (house, apartment or home care centre, for example) and assessing a building and its facilities.

5.2- MAINTENANCE:
Includes habits related to maintaining the dwelling and means of access to it, such as doing housekeeping, heavy chores, laundry and outdoor chores.

5.3- FURNISHINGS AND OTHER HOUSEHOLD APPLIANCES:
Includes habits related to using furnishings and other household appliances not included in other categories such as Nutrition (1), Personal Care (3), Communication (4), Housing (5.1) or Maintenance (5.2).

6- MOBILITY:

This category covers habits related to the individual's mobility.

6.1- LIMITED MOBILITY:
Includes habits related to moving short distances and to changing body position (seated, lying, standing) in a specific situation.

6.2- TRANSPORTATION:
Includes habits related to using modes of transportation such as walking, cycling and travelling by car, bus, boat, plane, train or animal.

7- RESPONSIBILITY:

This category covers habits related to taking responsibility.

7.1- FINANCIAL RESPONSIBILITY:
Includes habits related to preparing and following a budget, and to debts and other financial obligations.

7.2- RESPONSIBILITY TOWARD OTHERS:
Includes habits related to respect for others, civic responsibility or citizenship, care of the individual provided by that person or another, and the individual's care of others, such as children or a family member.

8- FAMILY RELATIONS:

This category covers habits having to do with the relations between children and their parents or those considered by society as substitutes.

8.1- AFFECTIVE FAMILY RELATIONS:
Includes habits having to do with all aspects of affective relations between parents and children.

8.2- MARITAL RELATIONS:
Includes habits having to do with relations between spouses or those considered by society as substitutes.

8.3- PARENTAL CARE:
Includes habits that enable parents to care for and raise children. This category does not include Preschool (11.1).

8.4- OTHER PARENTAL RELATIONS:
Includes other habits having to do with parent-child relations not included in Affective Family Relations (8.1) or Parental Care (8.3), such as care of elderly or handicapped parents by the children.

8.5- RELATIONS WITH OTHER RELATIVES:
Includes habits having to do with relations with relatives other than children, parents and spouses.

9- INTERPERSONAL RELATIONS:

This category covers habits having to do with relations with persons other than family members.

9.1- SEXUAL RELATIONS:
Includes sexual habits other than marital ones (8.2).

9.2- AFFECTIVE RELATIONS:
Includes habits related to all aspects of affective relations, such as friendships

9.3- SOCIAL RELATIONS:
Includes habits having to do with the individual's relations with people such as neighbours, co workers and school friends.

10- COMMUNITY:

This category covers habits related to the consumption of community goods and services, other than educational, occupational and recreational ones.

10.1- CONSUMPTION OF GOODS AND SERVICES:
Includes habits related to the consumption of goods and services such as those provided by banking and commercial institutions, hospitals and social, medical and government services.

10.2- VOLUNTARY ASSOCIATIONS:
Includes habits related to participating in social organizations, such as social clubs, advocacy groups or political parties.

10.3- RELIGIOUS GROUPS:
Includes habits related to the individual's religious practice.

11- EDUCATION:

This category covers habits related to the individual's psychomotor, intellectual, social and cultural development.

11.1- PRESCHOOL:
Includes habits related to education in early childhood (up to five years of age).

11.2- SCHOOL:
Includes habits related to basic learning in the school environment.

11.3- OCCUPATIONAL:
Includes habits related to learning a trade or profession, for example, by means of apprenticeships or training provided by trade schools, colleges, universities or other forms of occupational training.

11.4- OTHER TRAINING:
Includes habits related to general training courses not included in Preschool (11.1), School (11.2) or Occupational Training (11.3).

12- EMPLOYMENT:

This category covers habits related to the primary occupation of the adult individual, usually a paid occupation.

12.1- COUNSELLING:
Includes habits related to the choice of a career, career counselling and re-orientation of a career.

12.2- SEARCH FOR EMPLOYMENT:
Includes habits related to seeking and finding employment.

12.3- PAID OCCUPATION:
Includes habits related to performing a paid occupation.

12.4- UNPAID OCCUPATION:
Includes habits related to pursuing a principal occupation that is unpaid.

13- RECREATIONAL AND OTHER HABITS:

This category covers habits related to recreational activities and other ones made during free time.

13.1- SPORTS AND GAMES:
Includes habits related to sports and games.

13.2- ARTS AND CULTURE:
Includes habits related to arts and culture.

13.3- OTHER HABITS:
Includes habits not included in other categories.

SCALE FOR THE PERFORMANCE OF LIFE HABITS.

3- Habit performed.

3.6- Habit performed without difficulty, without compensation.

3.5- Habit performed with difficulty, with no need for compensation.

3.4- Habit performed with difficulty; compensation exists but is not accessible.

3.3- Habit performed with difficulty; no compensation exists.

3.2- Habit performed with compensation, without difficulty.

3.1- Habit performed with compensation, with difficulty.

2- Habit partially performed.

2.6- Habit partially performed without difficulty, without compensation.

2.5- Habit partially performed with difficulty, with no need for compensation.

2.4- Habit partially performed with difficulty; compensation exists but is not accessible.

2.3- Habit partially performed with difficulty; no compensation exists.

2.2- Habit partially performed with compensation, without difficulty.

2.1- Habit partially performed with compensation, with difficulty.

1- Habit not performed.

1.2- Habit not performed; compensation exists but is not accessible.

1.1- Habit not performed; no compensation exists.

0- Handicap situation non qualified.

PROPOSAL OF A REVISED NOMENCLATURE OF ENVIRONMENTAL FACTORS

By Patrick Fougeyrollas and Ginette St-Michel.

No modification has been done to the definition of environmental factors as it was published in our 1989 proposal (International ICIDH Network — Fougeyrollas, P.; St-Michel, G.; Blouin, M.; Vol. 2 no 1).

The proposed modifications of the nomenclature come from the analysis of the received comments and from the experimental use.

1- SOCIAL FACTORS:

These are the elements that make up the systems and structures of social functioning and collective organizations.

1.1- SOCIO-ECONOMIC ORGANIZATIONS:

This category covers the various systems and structures governing the organization of human societies.

1.1.1- Family organization and structure:
Includes the composition and operation of the family unit, including the extended family but not including relations of mutual assistance in the community.

1.1.2- Organization of political systems and government structures:
Includes everything related to the organization of power in societies, as expressed by institutions and representations of political authority.

1.1.3- Legal services:
Includes everything related to access to and use of institutions with the power of jurisdiction, including courts of law and administrative tribunals, for example, but not including Law (1.2.1).

1.1.4- Economic organization and services:
Includes access to and organization of activities related to the production, distribution and use of wealth; includes access to and organization of the labour market and access to and use of income from employment, social assistance programs, public and private insurance and placements, for example. This category does not include access to and organization of commercial services.

1.1.5- Health and social services:
Includes everything related to access to and organization of health services, including preventive care, medical care, hospital care, rehabilitation, social support, home care, shelters and residences.

1.1.6- Educational services:
Includes everything related to access to and organization of private and public educational institutions.

1.1.7- Public infrastructure services:
Includes everything related to access to and organization of commercial, transportation, communication, accommodation and other services having to do with the infrastructure of the local community (energy supply, road maintenance and water supply, for example).

1.1.8- Community organizations:
Includes access to and organization of group activities in the community, such as religious, recreational, sports and mutual assistance activities and any group of citizens brought together by common interests not included in other categories.

1.2- SOCIAL RULES:

This category covers ideologies, concepts, views, philosophies and judgments, for example.

1.2.1- Law:
Includes legislation, regulations and official social statutes such as laws, collective agreements and regulations governing social assistance.

1.2.2- Values and attitudes:
Includes mores, philosophies, customs and beliefs and the resulting behaviours.

2- ECOLOGICAL FACTORS:

These are the elements of the individual's physical environment.

2.1- NATURE:

This category covers natural elements, on which human beings generally have no impact.

2.1.1- Geography:
Includes physical elements such as mountains, steep inclines, forests, plains, deserts, distances and waterways.

2.1.2- Climate:
Includes the elements of climate, such as the seasons, rain, snow, storms, heat and cold.

2.1.3- Time:
Includes the elements of time in terms of duration.

2.2- DEVELOPMENT:
This category covers development owing to the direct impact of human beings on their environment.

2.2.1- Architecture:
Includes buildings.

2.2.2- Land development:
Includes urban and rural land development.

2.2.3- Technology:
Includes other forms of development by human beings such as furnishings, technical equipment and technology in general.

SCALE FOR MEASURING THE EXTENT OF THE OBSTACLES CREATED BY ENVIRONMENTAL FACTORS.

4- No obstacle.

3- Obstacle slightly impeding the performance of habits.

2- Obstacle seriously impeding the performance of habits.

1- Insurmountable obstacle.

0- Non qualified obstacle.

Appendix I

Non Parametric Test of Significance Using a Randomization Procedure

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The randomization procedure was briefly described in Chapter Four (p. 86). This appendix will provide additional information on the procedure followed to develop the computer program (Chadwick, 1991) to handle the data.

This procedure was used to suit the mixed, within-subject and between-subject design of the study. Usually, a matched *t* test would assess the significance of the differences in a within-subject design and an independent *t* test the between-subject design. Even with a non-parametric statistical analysis, using a randomization method, each of these *t* tests have their own sampling distribution and there is not a single sampling distribution that can be used for both these *t* tests at once.

A possible solution to this obstacle is to apply the randomization procedure to the sample as a whole. The randomization procedure refers to a method of determining statistical significance of observed results by permuting the data repeatedly using random assignment. A procedure of random assignment [(34 + 18)!/34!*18!] to 2 separate groups is used to permute the data for the subsample of the independent group design. A different random assignment is involved for the repeated design subgroup that is the group of participants for whom information is available for both jobs they can do and jobs they cannot do. In such a case, the permutation of all possible pairs is done (2 @ the power of 8). These two sets of permutations are subsequently regrouped as follows:

each permutation of the repeated design (that is each of the 2 @ the power of 8) can be associated with all the possible permutations of the independent group (that is (34 + 18)!/34!*18!). It is the combination of all these possible associations that makes the reference set. This total set of all possible permutations is the primary reference set.

Such a set would theoretically contain a very large number of possible permutations (10x10@ the power of 15). Therefore, a subset is ranndomly generated from this primary

reference set. The validity of the reference subset is assessed by producing many subsets and verifying for consistency. The reference subset is the distribution of the statistic of interest against which the observed value of the statistic is compared. The significance of the observed statistic is obtained directly from calculating the probability of finding a value equal to, or more extreme than the observed data.