Assessing the Vision Disabled Older Child with Specific Subtests of the Halstead-Reitan Neuropsychological Test Battery for Older Children

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LOYOLA UNIVERSITY CHICAGO

ASSESSING THE VISION DISABLED OLDER CHILD WITH
SPECIFIC SUBTESTS OF THE HALSTEAD-REITAN
NEUROPSYCHOLOGICAL TEST BATTERY FOR OLDER CHILDREN

A DISSERTATION SUBMITTED TO
THE FACULTY OF THE GRADUATE SCHOOL
IN CANDIDACY FOR THE DEGREE OF
DOCTOR OF PHILOSOPHY

DEPARTMENT OF CURRICULUM, INSTRUCTION,
AND EDUCATIONAL PSYCHOLOGY

BY

PAUL TAVIANI

CHICAGO, ILLINOIS

MAY, 1996
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CHAPTER I
INTRODUCTION

Today, many school psychologists are expected to perform psychological assessments on students with vision disabilities. These assessments generally require the administration of cognitive, achievement, adaptive, and personality measures. Psychomotor components, which may involve neuropsychological tests, are sometimes added to the standard battery depending upon the needs of the child (Anastasi, 1982; Hull & Mason, 1993).

The special population of students known as vision disabled are comprised of the partially sighted, those whose visual acuity is between 20/70 and 20/200 with best correction, the legally blind, those whose acuity is at 20/200 or worse with best correction but with residual vision to some degree, and the totally blind who have no functional vision. The partially sighted and legally blind student groups are sometimes collectively referred to as Low Vision students (Heward & Orlansky, 1992).

Finding appropriate assessment instruments developed or adapted for use with the vision disabled population is often a difficult task (Hull & Mason, 1993; Swallow, 1981). Because of the relatively small population of vision disabled students, there have been problems in sampling
accessibility, finding a large enough pool of interested researchers, and obtaining financial support for instrument development and revisions. These factors have long led to inadequate standardization and norming procedures (Scholl, 1986; Teare, 1984). The fact that approximately 49% of the vision disabled population is now multiply handicapped has further hindered the ability to locate and conduct research with "normal" vision disabled children (Hull & Mason, 1993).

Dean (1957) said that due to the sampling problem, a "shotgun approach" was frequently used in the psychoeducational study of children with visual disabilities. That is to say that students who were totally blind, legally blind, and partially sighted were too often lumped together as a single level independent variable for research purposes.

Jackson (1983) charged that this practice of not differentiating among the groups was due in large measure to the "sight-saving movement" that discouraged children with visual losses from using their remaining sight. For decades the established philosophy was to treat all visually disabled children as though they were totally blind since it was believed that using residual vision would actually cause a further loss of sight.

To a great extent, the work of Barraga (1964) caused an end to the "sight-saving movement" as her research brought about a recognition that low vision children could use their
residual sight quite well without any physical deterioration of the eye. Furthermore, Barraga also demonstrated that when visual training techniques were provided, children with even very low acuity measurements could improve upon their functional vision. More recent research has lent support to some of Barraga's findings (Travernier, 1993).

The death of the "sight-saving movement" emphasized the need to qualify instruments as being appropriate for use with both the blind and/or the Low Vision student. This led to the creation of some special tests for use exclusively with the totally blind (Newland, 1971). However, the problems related to finding a large core of researchers, adequate sample, and funding sources continued.

Adding to the problems noted above have been rapidly changing federal and state mandates. New disabling conditions have been defined that might be secondary to a vision impairment. For example, the Individuals With Disabilities in Education Act (IDEA) created a new special education category called Traumatic Brain Injury (Biehler & Snowman, 1993). To diagnose or corroborate this condition, psychologists need to have knowledge about neuropsychology and associated assessment techniques. Since a vision disabled child might suffer a physical insult to the brain that could be defined as a traumatic brain injury, it is recommended that neuropsychological assessment techniques be made available for use with this population.
Other forms of neurological impairment from disease, toxins, and/or structural/physiological aberrations also demand the availability of such techniques. The practitioner must be sure that these techniques can be administered in a standardized manner and that the normative values utilized are appropriate for the vision disabled child. The child's individualized special education plan hinges on proper diagnosis.

The problem exists that neuropsychology in the schools for the purpose of diagnosis and remediation of learning problems is not commonplace (Rourke, 1985). There has been some improvement in interest among school psychologists since Gaddes (1981) wrote about the need for such involvement. Much of the interest has focused on the application of neuropsychological assessment and remediation with the child who is diagnosed with learning disabilities. As a consequence, literature relevant to this particular disability is available to the school psychologist (Rourke, 1985; Rourke, Bakker, Fisk, & Strang, 1983).

Unfortunately, neuropsychological assessment with the vision disabled is not even in infant stages. A systematic search of the literature revealed only one study designed to evaluate the use of neuropsychological test instruments with this population (Daugherty & Moran, 1982).

Price, Mount, and Coles (1987) decried the lack of neuropsychological test research performed with vision
disabled children. They proposed that a series of subtests taken from the Halstead-Reitan Neuropsychological Test Battery for Older Children (HRNTB-OC), a major neuropsychological test battery in use with children (Reitan & Davison, 1974), be utilized with the vision disabled student population. The recommended subtest battery contains specific subtests that need no major adaptation in administration for the vision disabled since normally sighted subjects wear blindfolds or close their eyes while performing the tasks.

On the surface, the above proposal has much merit as applied to test selection and administration. However, there is a problem concerning test results that use sighted norms. One cannot assume that deviations in time or levels of performance on these non-visual tasks by vision disabled students are the direct result of impaired brain functions. There is a large body of literature that attributes any negative or positive differences found in non-vision related behaviors between sighted and blind children to be the result of environmental factors (Fraiberg, 1977; Warren, 1984) or intellectual levels (Bauman, 1973; Hayes, 1941; Hull & Mason, 1993).

Environmental factors such as socialization are reported to be influenced by parental knowledge, attitudes, and beliefs (Warren, 1984). Parental overprotection, because of unrealistic fears or guilt, can lead the parent
to drastically restrict the blind child's physical activity by keeping him or her in the crib or by limiting the type of toys and objects he or she experiences.

Failure to adequately negotiate affective components of development may lead to problems in bonding, esteem, self-confidence, and adventurousness (Fraiberg, 1977). All of these emotional components are theorized to have important influences on levels of sensory, motor, and perceptual functioning.

Just as there are potential negative factors influencing blind children's performances, there may be some positive factors present. Auditory processing may be stronger in vision disabled children as they are accustomed to utilizing this perceptual function in more concerted and generalized ways than the sighted child (Hayes, 1941; Koestler, 1976; Miller, 1992). Another factor in the blind child's favor not commonly recognized is that when the sighted child attempts tasks under the blindfold, he does so without the familiarity of functioning without vision. Mobility instructors for the blind have long pointed out that when you put a blindfold on someone sighted, they are initially apprehensive and sometimes distractible for a period of time (Welsh & Blash, 1980). One wonders how reliable are the results obtained by sighted subjects when they are required to perform tasks immediately after being blindfolded?
The factors outlined above emphasize the importance of addressing norming and administrative considerations in neuropsychological assessment with the vision disabled. The thrust of the research project to be described in what follows is to examine the appropriateness of using sighted norms with vision disabled children on specific neuropsychological tests taken from the HRNTB-OC. In order to more fully appreciate the nature of this research project, the following components were crafted: the rationale for the study; the relevant history of testing with vision impaired students; a review of the historical and philosophical orientation to neuropsychological assessment; the development of neuropsychological testing with children and the HRNTB-OC; a description of the nature of the tests to be used in this research project; and a review of the scoring procedures involved.

Given that which was reported above, the overall purpose of this dissertation research project was to investigate if non-brain damaged severe and profound vision disabled students scored comparably with blindfolded non-brain damaged sighted students on a subset of non-visual neuropsychological measures taken from the HRNTB-OC. It is expected that the results of this study will facilitate answering the question as to whether blind or legally blind children organize and encode non-visual sensory and motor stimuli similar to sighted children. Hopefully, such
knowledge will contribute to the psychological study of
vision disabled students.

As a secondary benefit, the results of the study should
provide some insight into the viability of using the HRNTB-
OC, specifically, and neuropsychological tests in general
with the vision disabled student population. There is a
need for such studies to be conducted since the cognitive
and perceptual instruments in use with the vision disabled
are often inadequately normed and many of the administration
procedures are poorly standardized.
CHAPTER II

REVIEW OF THE LITERATURE

Introduction

In this chapter a selective review of the relevant literature concerning the vision disabled, testing, and neuropsychology is presented. The historical development of formalized testing with the vision disabled student is presented in the first section. This is followed by a section in which the validation of test results with this special population is described and evaluated. An effort was made in the achievement test section to clarify test and measurement issues associated with the assessment of visually disabled persons. The history of neuropsychology and modern neuropsychological views are then described in considerable detail. In the final section of the chapter, the development and validation of the Halstead-Reitan Neuropsychological Test Battery for Children and neuropsychological assessment attempts with the vision disabled student population are discussed.

Background of Testing with Vision Disabled Children

Neuropsychological assessment procedures frequently include measures that were developed to address cognitive constructs such as intelligence. Since these constructs
reflect integral facets of brain functioning (Lezak, 1983; Luria, 1980; Reitan & Wolfson, 1992), the history of the development of cognitive and related measures in use with children who are vision disabled is considered to be an important area to investigate.

Initial work on cognitive testing of vision disabled children started in 1914 at Vineland, New Jersey, in what was called the Training School for the Feeble Minded (Koestler, 1976). This institution housed individuals who were cognitively disabled, deaf, blind, or otherwise severely disabled in some physical capacity. In 1914, Robert Irwin, a noted blind educator, attempted to collaborate with Henry Goddard, the director of the institute, to adapt Binet-type tests for the evaluation of blind children. Their efforts to develop appropriate verbal and tactual substitutes for the large number of pictures and diagrams on the Binet test were reported to be unsuccessful (Hayes, 1941).

In 1916, Goddard was asked by the Overbrook School for the Blind to renew his efforts to develop cognitive assessment methods for the vision disabled. This time Goddard recommended Samuel Perkins Hayes to head the research project (Koestler, 1976). Hayes was a professor of Psychology at Mount Holyoke College. He had written his doctoral dissertation on color blindness and was interested in working with the vision disabled population. Hayes not
only supervised the work at Overbrook, but he became the chief psychological consultant to seven other schools for the blind, including the famous Perkins Institute in Massachusetts (Vander Kolk, 1981).

Hayes focused on verbal items. He published his first standardized battery in 1930. Through consistent revision, he developed the Interim Hayes-Binet Intelligence Test for the Blind, 1942 (Tillman, 1973). The 1942 version was a highly verbal measure that utilized many tasks from the Binet Form L and Binet Form M. It was designed to assess subjects who ranged in age from three through adulthood. This test is still in use today. It continues to be a popular instrument with respect to assessing preschool and primary level blind children (Swallow, 1981).

Revision of the Hayes-Binet led to the creation of two forms in 1960 and a change in name (Vander Kolk, 1981). Now called the Perkins-Binet, Form N was developed for blind students (72 items are verbal and 23 are tactual). Form U was developed for students who had residual vision (33 out of the 99 Form U items are nonverbal). The Perkins-Binet was revised in the early 1980's. However, after initial publication was completed, criticisms concerning administration and norming procedures led to the test being withdrawn from the marketplace (Genshaft & Wward, 1983; Kaufman, 1982). The Perkins-Binet has not been reissued.

In addition to developing a separate Binet-type test
for the blind, the Stanford-Binet Form LM was used with low vision children after the publisher enlarged the original pictures and diagrams specifically for use with children who had low vision. No formal research on the validity of the enlarged version has been reported. However, many psychologists were quick to utilize the enlarged pictures, given the fact that so few instruments for this special population of children were available.

The practice of using standard tests that use visual formats for evaluating children with less than perfect vision is common. Instruments such as the Colombia Mental Maturity Scale, Ravens Coloured Matrices, The Berry Test of Visual-Motor Integration, and the Performance Scales of the Wechsler batteries are examples. The formalized incorporation of such instruments into a comprehensive case study evaluation is based on the functional vision of the visually impaired child as determined by evaluator judgment. The possible invalidity of results is usually qualified in the psychological report (Swallow, 1981; Vander Kolk, 1981).

In the 1960's, a number of cognitive assessment instruments specifically designed for the blind were developed. These tests emphasized non-verbal formats. Some of the instruments developed were tactual analogs to the Standard Progressive Matrices and the Block Design subtest of the Wechsler Performance Scale (Vander Kolk, 1981). The Blind Learning Aptitude Test (BLAT) was developed by Newland.
(1971) and was one of the matrices adaptations intended to be used with blind children aged six through 12. The Kohs-Owaki Block Design Test (1966) was standardized on both blind and low vision adolescents. It was designed to measure tactual-spatial block design skills for subjects 16 years of age and beyond.

Kathryn Maxfield was Hayes' protege. She developed an interest in preschool blind children and spent much of her life researching their development (Koestler, 1976). Along with Sandra Buchholz, Maxfield developed the Maxfield-Buchholz Social Maturity Scale for Blind Preschool Children in 1957. This rating scale was an adaptive measure of functional intelligence that followed the format of the Vineland Adaptive Behavior Scales.

Cognitive assessment of vision disabled children using verbal tests designed for sighted children has been an accepted practice (Sattler, 1988). The principle examples of this practice are the various Wechsler scales. The verbal sections of the Wechsler-Bellevue scale, Form I was used with little or no modification to assess the cognitive functioning of the vision disabled adolescent and adult population as far back as 1939 (Vander Kolk, 1981). Form II (published 1946) was later used with vision impaired adolescents. Application of the Wechsler Verbal Scale to assess children with vision disabilities began in 1949 with the publication of the Weschsler Intelligence Scale for
Children. These scales along with numerous revisions, have consistently been used with blind and partially sighted children.

**Validation of Cognitive Test Adaptations**

With some reservations, the aforementioned mental measurement tests have proven to be reliable measures for assessing the intellectual abilities of vision disabled students (Gilbert & Rubin, 1965; Lewis, 1957; Vander Kolk, 1981). Furthermore, it has been found that the intellectual abilities of blind and legally blind children assessed by these measures - in particular the Wechsler verbal scales - are comparable to sighted children's IQ scores when consideration of prior experiences and adaptations for perceptual deficiencies are taken into account (Hopkins & McGuire, 1966; Tillman, 1967a; Tillman, 1967b; Tillman, 1973; Vander Kolk, 1981).

Lewis (1957) administered the Hayes-Binet and the WISC Verbal Scale to 31 students at the Texas School for the Blind. She found a high correlation of .94 between the Hayes-Binet Test and the WISC. She also found a modest correlation between student grades and results of the Hayes-Binet Test.

Gilbert and Rubin (1965) found a correlation of .90 between the Hayes-Binet and the WISC Verbal Scale IQ when they tested 30 students from a residential school for the blind. They also discovered that while the overall Verbal
IQ of the WISC was within average levels for blind subjects when compared to sighted norms, there was a decided advantage in Digit Span scores for the blind. On the other hand, Comprehension and Similarities subtest scores tended to be lower. Similar results were found by Hopkins and McGuire (1986) who discovered that blind children performed better on Digit Span, somewhat higher on Information, but weaker on Comprehension. Tillman and Osborne (1969) also found blind children to be stronger at Digit Span but weaker in Similarities. The most recent research by Hull and Mason (1995) continues to support these findings.

The fact that blind children tend to be stronger on Digit Span may be related to the practice effect of using hearing as the primary source of information gathering. Lower comprehension scores possibly reflect the protectionism associated with raising blind children which shelters and prevents them from performing many responsible tasks typically expected of sighted children. Finally, Tillman (1973) believes that lower scores on Similarities is probably due to a concrete orientation towards problem solving. These theoretical viewpoints emphasize the experiential basis for subtest score variation as opposed to an orientation that neurological structural differences between blind and sighted are at work.
Achievement Tests

Related to cognitive testing is achievement testing. In spite of the fact that decades ago Hayes (1941) called for development of specialized achievement and learning rate measures for the vision disabled, standardized achievement tests developed for the sighted have remained the general method of evaluating educational performance. Such measures as the Wide Range Achievement Test and the Kaufman Tests of Educational Achievement are transcribed into Braille or put into large print format. Special norms are generally not provided. However, when these tests are timed, the standard is to allow large print users 50 percent more time than regular print users and braille readers twice as much time as sighted readers (Vander Kolk, 1981). These standards were recommended years ago by Hayes (1941). They are empirically anchored onto the research conducted by Hayes at the Perkins School for the Blind.

More recent attempts have been made to provide specially normed instruments in reading achievement measures for children who are blind and legally blind. The Stanford Achievement Test is available in Braille and large print formats and is frequently used in place of the Iowa Test of Basic Skills and other achievement batteries when school districts perform yearly standardized testing. The Stanford Achievement Test now provides norms for partially sighted students (Scholl, 1986).
Cognitive Development of the Vision Disabled

An alternative approach to intelligence testing to study cognitive development has been through studies using Piagetian reasoning tasks. Hatwell (1966) was the first to perform Piagetian tasks adapted for use with the vision disabled. Her pioneering work, performed in France, indicated that blind children experienced delays of about two years in the acquisition of conservation and classification abilities. Such results, however, are not consistent. Cromer (1973) and Gottesman (1973) studied conservation abilities in blind children, and they did not find large delays or deficits. Tobin (1972) discovered that the age range among vision disabled children for achieving conservation abilities varied with the nature of the tasks. When conservation of substance tasks were involved, a significant number of subjects did not conserve until age nine or ten.

Miller (1969) researched partially sighted subjects including the legally blind. He found that vision disabled children with residual sight were not as delayed as totally blind students in conservation tasks. Swallow and Paulson (1973) found that partially sighted subjects lagged normally sighted peers in spatial-conceptual tasks. These researchers attributed the lag to experiential deficits and not to the vision disability itself. Supporting this conclusion was the work of Brekke, Williams, and Taft
They compared institutionalized vision disabled children with those who lived in more community based settings. They found that place of residence was an important factor in determining the age at which conservation ability is reached. The institutionalized children were slower to achieve conservation skills. Higgins (1973) found that vision impaired students did not present delays that were due to development of intellectual structures per se. He found that the vision disabled child’s delays were due more to experiential deficits than to anything else.

Friedman and Pasnak (1973) discovered a link between age of the vision disabled student and the degree of lag in conservation abilities. As the student advanced in age he tended to lag progressively further behind in conservation tasks. The researchers theorized that such increases in delays could be obviated by formally training subjects in related problem solving techniques. Lopata and Pasnak (1976) tested this theory by implementing a training program that incorporated both substance and weight conservation concepts. The training group’s scores on both conservation abilities were significantly increased after training. Stephens and Simpkins (1974) also found significant delays in blind children’s abilities to conserve and classify. They found delays between four and eight years when compared to the normally sighted population. Like Friedman and
Pasnak (1973), Stephens and Simpkins found the greatest delays in the older student group. Stephens and Grube (1982) developed a training program that involved reasoning activities and classification tasks. They reported significant gains in conservation ability after training.

Taken together, the results reported above indicate that children who are blind and legally blind may lag sighted children in the ability to perform Piagetian tasks when they have been raised in sheltered environments. However, such delays are eliminated or greatly diminished when experiential limitations are compensated for by training, education, and environmental stimulation that includes responsible expectations being placed on the child. As with IQ, whatever differences in Piagetian performance that exist between vision disabled and normally sighted children are assumed to be the result of experiential and acculturation factors and not due to organic structures per se.

**History of Neuropsychology**

Interest in brain-behavior relationships has been an area of scientific study since earliest recorded history (Kolb & Whishaw, 1990). In the Fifth Century B.C., Hippocrates and Empedocles were the earliest known scholars to discuss the physiological bases of behavior. Hippocrates posited that mental processes were located in the brain, where Empedocles located mental processes in the heart.
This division was referred to as the brain hypothesis versus the cardiac hypothesis. Plato concurred with Hippocrates that the brain was the rational seat of behavior. In contrast, Empedocles was supported by Aristotle who posited that the brain's function was merely to cool the blood. Aristotle believed that the human brain had to be very large since human blood was the richest and hottest of all animal blood to cool (Heilman & Valenstein, 1979).

In the second century A.D., Galen advocated the brain hypothesis. He offered anatomical evidence for the brain's primacy in mental processes by pointing out that nerves travelled to the brain from the periphery and not to the heart. Galen’s practical knowledge of the effects of brain injury on behavior was extensive since he had been a physician for the gladiator games (Kolb & Whishaw, 1990).

After Galen, the brain hypothesis became the more accepted theory. However, the legacy of the cardiac hypothesis can still be found today when investigators attempt to intertwine emotions with behavior. For example, people are fond of equating love with the heart, or of attributing negative behavior to "bad blood."

Determining that the brain was the site in the body where mental processes occurred was a relatively easy first step in understanding the nature of brain-behavior relationships. The second step of determining where within the brain behaviors are controlled has been an ongoing
challenge to the present day.

Herophilus believed that the ventricles themselves were the seat of reason. The middle ventricle mediated cognition and the posterior ventricle housed memory (Heilman & Valenstein, 1979). Galen believed that both the cavities themselves and the fluid within the ventricles were where brain activity occurred. There was little recorded debate concerning this theory over the next 14 centuries. Luria (1980) pointed out that even Leonardo Da Vinci's anatomical drawings portrayed the three ventricles as the seat of the primary "faculties" of the mind.

The Sixteenth Century ushered in new vigor and viewpoints in the debate concerning the location of brain function. The principal theorists were Andreas Vesalius and Rene Descartes - the famous mathematician and philosopher (Kolb & Whishaw, 1990).

Through his research in dissection, Vesalius cast serious doubt upon Galen's ventricular theory by demonstrating that when relative size was taken into account, ventricles were not appreciably different in size between humans and other animals. It was the increased area of human brain tissue, and not cavities that accounted for the higher rational thought in humans (Kolb & Whishaw, 1990).

Descartes theorized that the pineal body in the brain was the site of rational thought. This was so because the
pineal body was near the center of the brain and it was the only non-symmetrical mass in the brain. Descartes considered the cortex to be a protective covering without a functional contribution to thought.

While asserting the primacy of the pineal body to thought, it was Descartes who qualified the function of this tissue. The pineal body itself was not to be confused with the "mind." According to Descartes, the true essence of mind was not found in any specific location of the brain. The mind influenced the body through the brain by causing certain sensory changes, but the mind itself was quite separate from the body. An animal brain could be considered mechanical but not the human mind (Heilman & Valenstein, 1979). This "dualist" philosophy posited that the mind and the body were two separate entities. Thus, Descartes' views became popular with those who believed that the brain worked uniformly without separate, distinct localizations of function.

While Descartes argued philosophically for a non-localizationist theory of mind, Haller and Flourens argued scientifically for the non-locationist concept. In 1769, Haller posited that all the parts of the brain worked together in equal proportion to carry out processes. He called this the "Sensorium Commune" (Luria, 1980). Haller admitted that some areas of the cortex appeared to be specialized for some specific functions; however, he
believed that his experiments gave strong indication that when one area of the brain is activated for a function, another area of the brain had to deactivate in order to compensate. This demonstrated the totality of brain function for every process.

Flourens in 1824 presented results of his experiments with birds. After extirpation of cortex parts, the birds did not demonstrate any appreciable loss in memory for previously displayed activity. Basing his views on this work, Flourens assumed that the cerebral cortex is generally just a mass of undifferentiated tissue similar to other undifferentiated organ tissue, such as those found when examining liver tissue (Luria, 1980).

Nearly simultaneous in time to the work of anti-locationists during the 18th Century, an antagonistic theory began. Here it was proposed that specific areas of the brain were responsible for particular faculties. The leading proponents were J. Meyer, Franz Gall, and Johann Spurzheim (Kolb & Whishaw, 1990; Luria, 1980).

Around 1779, the German physiologist Meyer claimed that memory and logical thought were produced by the cerebral cortex. Imagination and reason were to be found in the white matter of the brain, and the will in the basal portion of the brain. Integration of all these faculties were effected by the Corpus Callosum and the Cerebellum (Luria, 1980).
In the early part of the 19th century, Franz Josef Gall and Johann Casper Spurzheim pushed Meyer's theory to its limits. Gall and Spurzheim developed a revised theory of localized function that was called Phrenology (Kolb & Whishaw, 1990). They proposed that one could detect a relationship between the skull's surface features and the relative strengths or weaknesses of a person's faculties and personality. According to Gall and Spurzheim, a protrusion in an area of the skull was caused by a well-developed underlying gyrus or convolution of cortex that controlled a specific behavior. Large size generally represented strong development of the behavior in question. A depression in the skull at that point would mean limited size with a concomitant weakness in the related trait.

Gall and Spurzheim were respected anatomists (Luria, 1980). They had made numerous discoveries involving connections between cortex cells and subcortical structures such as the crossing of fibers of the pyramidal tract and the recognition that the spinal cord was divided into white and gray matter (Kolb & Whishaw, 1990). Gall was actually the first individual to give an account of a relationship between left frontal lobe damage and aphasia. Because of the reputations of Gall and Spurzheim, phrenology took hold among many theorists of the day which provided support for location of brain function.

Gall and Spurzheim's work drew criticism when major
flaws in their theory were brought to light. By using human subjects, Gall and Spurzheim used examples from life, but they did not have explanations for the numerous exceptions found within the population. For example, people with prominent protrusions in given areas did not always express the same traits as the prototypes. Another major problem with phrenology was in the nature of the psychology of faculties as delineated by Gall. The faculties were defined by contemporary ideas of personality and traits. Gall's localizations included areas for "instinct for continuation of the race," "love of parents," and "ambition" (Heilman & Valenstein, 1979). With an absence of set standards for such generalized faculties, quackery ensued which soon became associated with phrenology. Finally, anatomists were to show that the external skull does not mirror the inner surface features of the cortex. Gall and Spurzheim failed to thoroughly check gyral size and cortex configuration with corresponding parts of the skull (Luria, 1980).

With its criticisms extant, phrenology waned and support for anti-locationists' views returned. However, some important discoveries associating brain site with function continued. Broca in 1861 began his study of patients who had impaired speech. Through post-mortem, Broca was able to demonstrate a relationship between frontal left hemisphere lesions and loss of expressive speech. In 1863, Hughlings-Jackson observed that there were two types
of aphasic patients, fluent and non-fluent. A year later, Bastian postulated that there were connections between various visual, kinesthetic, and verbal centers of the brain. He was the first to speak of the brain as a processor and coined terms such as "word deafness" and "word blindness" that described syndromes developed when connections between centers of the brain were damaged (Heilman & Valenstein, 1979).

In 1874 Wernicke published his discovery that lesions of the posterior part of the superior temporal region of the left hemisphere left an individual with intact speech expression but no comprehension (Luria, 1980). Wernicke theorized that Broca's area was somehow linked with the posterior temporal region through commissaries. Wernicke's theories reportedly accounted for many motor, conduction, and sensory aphasias. Lichtheim (Kolb & Whishaw, 1990) attempted to logically explain seven types of aphasia by expanding upon Wernicke's work.

The locationists (sometimes referred to as connectionists) had laid down a convincing argument to combat dualism. It was becoming apparent that localized brain-behavior relationships were present and related to specific syndromes and lesions. Yet, locationist detractors were ever present and held great influence into the twentieth century.

Two such detractors were Head and Lashley. They
believed in more diffuse brain functions such as those proposed by Descartes (Luria, 1980). However, there is a difference between Head and Lashley's holistic brain action theory and Descartes' dualism. While holistic theory advances the concept of unitary brain action, it ascribes thought to the concrete functions of the brain. Remember that dualistic theory posits uniform action but separates mind from concrete brain functions.

Head (Luria, 1980) claimed that Wernicke and Broca contrived their case reports by twisting facts and perceptions to fit their theories. He believed that specific cortical areas of function were not so circumscribed. Lashley's (1938) experiments demonstrated that engrams were not localized but found diffusely spread in various parts of the brain. Because of this diffusion, Lashley proposed a theory of mass action. From this point of view, the behavioral result of a lesion depends on the amount of brain tissue removed or damaged rather than where the lesion was located.

The period just before and after World War II was to bring about a subtle change in the anti-locationist view. Improvements in diagnostic methods, assessment techniques, and advances in knowledge concerning the central nervous system confirmed many of the relationships between behavior and brain locations posited by Broca, Wernicke, and others (Reitan & Davidson, 1974). As a consequence, specific
brain-behavior relationships were to be recognized by the holistic researchers, albeit with certain modifications that emphasized the dominance of mass action by directing specific actions.

**Modern Neuropsychological Theories**

Developments in neurology, anatomy, technology, and psychology during the middle of the twentieth century led to dramatic growth in neuropsychology (Reitan & Davidson, 1974). Three prominent theories of neuropsychology evolved from this period. The principal authors of these theories were Aleksandr Luria, Ward Halstead, and Ralph Reitan (Reitan, 1988). While some observational techniques were utilized by all three theorists, Luria emphasized clinical approaches, whereas, Halstead and Reitan focused on experimental research and standardized assessment.

In Russia, Aleksandr Luria and his colleagues developed a theory of neuropsychology that was based on the holistic view. Luria viewed neuropsychology as concerned with the role of individual brain systems that work in coordinated fashion to organize human psychological activities. It is the coordination of these systems that justifies the holistic conceptualization. Not relying on experimental research methods that are marked by controlled studies, Luria used the individual case study method with patients who had suffered brain damage. He criticized American approaches as being too quantitatively oriented and not
driven by a strong theoretically grounded conceptual anchor (Luria & Majovsky, 1977).

Luria's system theory divided the brain functions into three main blocks. The first block was considered to be responsible for regulating the energy level, attention, and overall tone of the cortex so that incoming stimuli can be quickly recognized. The second block was considered to be responsible for the analysis, coding, and storing of incoming information to effect integration of information and establish connections with the third block. The third block was considered to perform the executive functions involved with the formulation of intentions, plans, and programs for action, emphasizing output forms of behavior that are generally attributed to the frontal part of the cortex (Luria, 1973).

Within each block, there are assumed to be three zones of activity corresponding to specialized activities. Primary zones are responsible for alerting the particular sense that incoming information specific to that particular sense is arriving. Secondary zones code, recognize, and organize information relative to the specific sense. Tertiary zones synthesize information arriving through various senses in order to make complex behavioral activities possible. Visual disorientation in space would be an example of a tertiary deficit since reception of the stimuli is not impaired (primary zone) and coding is
adequate (secondary zone), but the individual cannot conceptually construct meaning from the accurately apperceived information (third zone). As can be gleaned from the aforementioned, a variety of behavioral consequences can be manifested in any one general type of function (Luria, 1973).

Reitan is skeptical of Luria’s zone theory as a basis for diagnosing specific locations of lesions since the premise upon which the theory is built is not firm. Reitan posits that in his study of thousands of persons with cerebral lesions, hardly any lesions are so highly specific that they fall exclusively in the primary or secondary zones of particular senses if indeed such zones exist (Reitan, 1988).

Luria’s approach in diagnosis was to initially look for disturbances of the higher cortical processes such as those involving perception and speech. A set of tests would then be selected to discriminate brain-behavior relationships related to these functions to confirm or disaffirm organic damage (Luria & Majovsky, 1977). It is interesting to note that in spite of allegiance to non-locationist views, many of the brain-behavioral relationships implied in Luria’s theory are highly specific to certain locations within the brain.

In America, Luria’s assessment approach is referred to as the process approach (Kaplan, 1990). The process
approach emphasizes flexibility in test selection as the presenting problem with respect to selecting the battery to be used. Tests are selected based upon obvious symptomatology. Attempts to operationalize Luria’s approach based upon the predominant subtests and diagnostic techniques used by the Russian neuropsychologists have taken place (Christensen, 1975; Golden, 1981). However, the caveat that follows these batteries is that they are methods used by Luria and not a standardization of Luria’s methods.

Contrary to Luria’s claims that American neuropsychology was almost atheoretical, Ward Halstead (1947) developed a theory of neuropsychology from his pioneering work at the University of Chicago with brain damaged adults. Halstead’s theory, which he referred to as "biological intelligence," emphasized a biological basis for adaptability to the environment. Halstead believed that the brain evolved to mediate and resolve basic stresses, problems, and needs imposed by the environment onto the individual. The theory intimates that the brain is not just a "black box" but an organ predisposed to interact with the environment (Reitan, 1988).

Unlike Luria who used case studies to derive the basis of his theory, Halstead derived his theory of biological intelligence by performing factor analytic studies based upon a battery of 13 tests from which he extracted four factors: the Central Integrative Field factor, the
Abstraction factor, the Power factor, and the Directional factor (Halstead, 1947).

The Central Integrative Field Factor (C) represents the organized experience of the individual. It is the basis for comparing the familiar with the novel or new stimulus that enters the brain. It is a function of adaptive intelligence and as such is probably reflected in standardized intelligence test measurements.

The Factor of Abstraction (A) relates to the basic capacity to conceptualize by categorizing information along a certain criterion. Comprehension of essential similarities and differences among and between things is a powerful component of this factor.

The Power Factor (P) reflects the undistorted power factor of the brain. That is, it operates to counterbalance and/or regulate the affective or emotional forces impinging upon the individual so that he or she can focus clearly on the more cognitive and rational experiences that facilitate growth of the ego.

A Directional Factor (D) constitutes the medium through which the process factors above are channeled at any given moment. On the motor side it specifies the final common pathway, while on the sensory side it specifies the avenue and/or modality of experience.

In considering Halstead’s theoretical stance, Reitan (1988) pointed out that there have been no replications of
Halstead's factorial theories nor any cross-validations of the theory of biological intelligence as proposed by Halstead.

The tests used to measure these factors were selected from various assessment instruments extant at the time and/or were developed by Halstead. For example, Halstead himself developed a visual processing measure called the Category Test to assess abstraction ability and concept formation. On the other hand, Halstead utilized the Wechsler scales to measure adaptive intellectual factors as well as contribute to the other factors. The Seashore Rhythm test and the Seguin-Goddard formboard were included in the battery to assess attention and spatial reasoning and memory. Halstead even adapted the Trail Making test which was used in the Armed Services (Reitan, 1955).

Reitan (1988) summarized the similarities and differences between Luria's and Halstead's theories. These two major theories of brain-behavior relationships posit that the brain is the basis for thought, action, and behavior. They both utilize concepts of power levels, the integration of activity, and the importance of the frontal lobes in directing activity. They differ in that Halstead emphasized abstraction and reasoning as the central processing feature of the brain while Luria emphasized sensory-motor integration. Another differentiating feature was Halstead's emphasis on accumulated experience as a
memory factor against which all input stimuli were to be evaluated.

It should be noted that Reitan's neuropsychological theoretical concepts and test grew out of his association with Ward Halstead. Halstead was Reitan's mentor (Boll, 1974). Reitan continued revising, refining, and adding new tests to Halstead's original battery. The continuity and character of Halstead's work is reflected in Reitan's continued use of the title Halstead-Reitan Neuropsychological Test Battery. This test battery has been reported to be the most popular and influential assessment technique in American neuropsychology (Dean, 1982).

In developing a theory, Reitan collaborated with Deborah Wolfson with respect to analyzing the effects of brain damage on specific behavior. The Reitan-Wolfson theory of brain-behavior relationships developed from assessments performed on thousands of persons with various types of brain disease or damage (Reitan & Wolfson, 1992). Comparisons were made with results of neuropsychological assessments performed on normal control subjects. An approach to validation of Reitan's methodology that differed from Luria's and Halstead's was the use of prediction. Assessments were performed on subjects with terminal central nervous system illnesses and/or on those who were to enter brain surgery. Through surgery or autopsy, the biological condition of the brain was assessed by neurologists,
neurosurgeons, and neuropathologists to determine if pathology existed in the area of the brain as predicted by the Halstead-Reitan assessment battery.

In the Reitan-Wolfson model of brain-behavior relationships, there are three levels of information processing that involve a mixture of generalized and localized areas of the brain. At the first level, incoming information is initially registered and integrated with the individual's past experiences. The second level of processing depends largely upon content of incoming material and is organized according to the lateralized functions of the cerebral hemispheres. The third level or stage of central processing, especially directed to more complex and difficult tasks, consists of concept formation, reasoning, and logical analysis which are believed to represent the highest features of human brain functioning. A further examination of Reitan-Wolfson's levels of processing reveal differences between this theory and those of Halstead and Luria in particular.

In level one, registration and attention follow from input sensations just as noted in Luria's theory. However, the location of arousal is not specified as the reticular activating system as it is in Luria's model. In Reitan-Wolfson's model, attention centers are localized in higher centers of the brain as well. These centers are found in parietal, temporal, and occipital lobes so that incoming
sensations can immediately stimulate memory components related to sensory/perception locations and lateralization effects. In the Reitan-Wolfson model, memory is not a unidimensional characteristic that can be tapped by a memory test per se. Memory is generalized and interwoven with brain functions. How initial information is perceived and associated with memory will determine how well the individual can utilize the messages he or she receives. Assumed memory loss can be the result of poor registration, and poor registration of stimuli can be the result of faulty localized memory systems (Reitan, 1988).

At the second level of processing, the brain proceeds to process most verbal information in the left cerebral hemisphere and most visual-spatial information in the right cerebral hemisphere. Hemispheric specialization is more emphasized than in other theorist's views. That is to say that Reitan-Wolfson contend that some problem solving can be performed exclusively in one hemisphere. Another important point made by Reitan-Wolfson is that the neurological routing of information to each hemisphere is less firmly established early in life than when the individual is older (Wheeler & Reitan, 1962). The maturational development of brain-behavior relationships is an important consideration in assessment since expected differences in hemispheric levels of performance may not be present in children as they are in adults.
The third and highest level of central processing is represented by abstraction, reasoning, concept formation, and logical analysis. Luria emphasized the role of the frontal lobes in his third stage of brain action, but Reitan does not localize his third level to any particular area or areas. Research evidence indicates that these functions are generally presented throughout the cerebral cortex, although particular tasks (depending upon their verbal or visual-spatial content), may establish a lateralizing effect (Doehring & Reitan, 1962). Reitan uses the Category test from Halstead’s original battery to evaluate overall higher processing. The sensitivity of the Category Test to cerebral cortical damage is reported to be quite high regardless of localization of the lesion (Jarvis & Barth, 1984; Reitan, 1988; Reitan & Wolfson, 1992). These results indicate that higher reasoning levels are diffusely located within the brain.

Reitan favors an assessment format that requires that a battery of tests be selected to evaluate the complete neuropsychological functioning of the individual. He is concerned that addressing a specific problem that is readily perceived may lead to oversimplification of the treatment and overlooking of further neurological problems that might not surface without thorough testing of all neuropsychological functions (Reitan, 1988).
The Halstead-Reitan Battery for Older Children

Reitan began his research for the eventual development of the Halstead-Reitan Test Battery for Older Children in 1951 at the University of Indiana Medical Center. Reitan realized the need for the use of quantifiable methodological principles of neuropsychological research with children. Following Halstead's principles, Reitan did not believe that a single test such as the Bender-Gestalt could adequately predict brain damage. As was the case with adult subjects, it was assumed that the entire spectrum of neuropsychological functions would have to be assessed (Reitan & Wolfson, 1992). This could perhaps best be done by using the diagnostic approach used with adults that was made up of four factors: levels of performance; patterns of performance; pathognomonic signs; and left-right differences. Cut-off scores could be applied to all four factors that would differentiate normal from brain-damaged results (Jarvis & Barth, 1984).

Levels of Performance is simply the sum total of right or wrong responses on a given task. For example, the subject's score on the Seashore Rhythm Test is calculated by counting the number of correct responses. A score of 25 would mean that the subject correctly answered 25 out of 30 sound patterns (Reitan & Wolfson, 1992).

Patterns of Performance refers to comparing results of scores that reflect different sites of sensory/motor and
verbal/spatial central nervous system processing functions. For example, comparison of Verbal IQ versus Performance IQ can indicate if specific centers of the brain are better suited to process language than spatial information and/or if these centers are functioning appropriately. By comparing test results that involve activities monitored by the anterior portion of the brain as opposed to the posterior portion, it is possible to detect areas of suspected atypical functioning. For example, a pure motor test such as the Finger Tapping Test can be compared to another motor test that involves complex activity with a sensory component such as the Tactual Performance Test. Success on one task but failure on another task can provide important information on the site and extent of cortical damage (Jarvis & Barth, 1984).

Pathognomonic Signs are assessed by the presence or absence of certain dysfunctions in auditory, tactual, visual, and/or speech patterns in terms of sensory/motor functioning. For example, aphasias are not readily measured by a level of performance format since it is hard to quantify the exact degree of impairment. However, when a deficit is observed it is often indicative of an underlying organic problem since aphasias of any type are rare in terms of normal speech functioning. Other examples of pathognomonic signs are suppressions of sensory stimuli and problems in visual-motor integration.
Left-Right differences in functioning may reflect lateralized effects of lesions. When the dominant and nondominant sides of the body alternately perform the same task, predictable differences are observed. When differences in performance, memory, and learning are noted that are different from the norm, an indication of impaired functioning exists in one or both of the hemispheres. The Finger tapping test is an example. If the dominant hand does not perform at a higher rate of tapping than the nondominant hand (approximately 10% higher), there is reason to seek an explanation for the discrepancy and/or perform further testing (Reitan & Wolfson, 1992).

Finally, cut-off scores for each of the above diagnostic procedures serve to discriminate between those with and without brain damage. Raw scores for each test or variable are converted to a number between zero and three which conform to certain categories. The first category indicates a perfectly normal performance and receives a score of zero. The second category is scored as one, and it indicates a normal but not excellent result. The third category is numbered two and it indicates that a mild or moderate impairment could be present. The final score of three indicates the presence of definite neurological impairment.

Utilizing the above approaches, Reitan started testing children by administering the adult battery to children
below the age of 15. Through repeated administrations, Reitan discovered that modifications and simplifications of the original Halstead tests rather than radical changes produced an acceptable format for assessment of children down through the age of nine. Children below this age level were too overwhelmed by the complexity of the battery. One of the simplifications that Reitan made was to omit four of the shapes from the Tactual Performance Test. Finally, it should be noted that by 1954, Reitan had completed his initial research and used what he called the Halstead Neurological Test Battery for Children in his work (Reitan & Davidson, 1974).

Neuropsychological Studies with Vision Disabled

As previously stated in this text, there has been little, if any, research conducted related to neuropsychological assessment with the vision disabled students. The few studies involving related areas (Dodds, Hellawell, & Lee, 1991; Norris, Spaulding, & Brodie, 1957; Novikova, 1973) and one direct application of the HRNTB-OC (Daugherty & Moran, 1982) that have been performed are reviewed below.

Four decades ago, there was conjecture that Retinopathy of Prematurity (ROP), a cause of severe to profound vision disability occurring in premature infants through unregulated oxygen therapy techniques, was associated with brain damage as well as structural damage to the retina of the eye (Norris, Spaulding, & Brodie, 1957). One of the
then popular theories proposed that the cause of brain injury in children was attributed to abnormal blood vessel development and hemorrhages in the brain in the premature infant (Strauss & Lehtinen, 1947). It is not difficult to see how some theorists could make inferential leaps associating blood vessel anomalies in the eye to be symptomatic of brain involvement as well.

Norris, Spaulding, and Brodie (1957) provided evidence against the theory that vision disabled children with ROP were brain damaged. Norris' group studied over 295 preschool children between the ages of two months and six years of age. Using the Hayes-Binet and the Maxfield-Field adaptation of the Vineland, the authors found no significant differences between children vision disabled by ROP and those vision disabled by other causes. To some extent, the children with ROP performed better on Hayes-Binet IQ measures than the other children in the study. Norris and colleagues theorized that delays in development and aberrations in behavior among vision disabled children were due primarily to a lack of opportunities, simulation, and poor parenting skills and not to any generalized brain damage.

Cohen (1966) found that ROP children did perform lower on IQ measures in his limited sample study; however, Warren (1984) pointed out that some of these ROP children were probably lower functioning due to prematurity and lower
birthweight factors in and of themselves since premature
infants are at higher risk for slower development.

Dodds, Hellawell, and Lee (1991) performed their own
analysis of Wechsler verbal scale scores and specially
designed spatial tasks and found no significant differences
between ROP students and students severely vision disabled
from other causes. Results support the conclusions of
Norris et al. as the Dodds’ group suggested that early
childhood factors were more important in determining healthy
development than the cause of blindness.

Novikova (1973) discovered that children who had been
born with very little vision (light perception) or who were
totally blind, had limited or an insignificant number of
alpha waves. The earlier the vision disability occurred and
the more severe the vision loss, the fewer alpha waves
present. Results linked alpha waves to visual reference
thinking and not just to quiet alert states of arousal in
sighted people. Novikova’s findings could not be related to
any theory of generalized or localized brain-damaged
thinking patterns in the vision disabled population.

In the only research study reported in the research
literature that utilized subtests from the HRNTB-OC,
Daugherty and Moran (1982) focused their efforts on the Low
Vision child and not the blind. Their sample consisted of
61 Low Vision students taken from the Pittsburgh public
schools. Twenty-seven were between the ages of nine and 14
to which HRNTB-OC interpretations are appropriate. The Category Test, Tactual Performance Test, Finger Tapping, Rhythm Test, Speech-Sounds Perception Test, and Aphasia Screening assessment were administered as representative subtests from the HRNTB-OC. Using the Seltz and Reitan (1979) rules for classifying children as brain-damaged, the authors found that eight of the children scored positive for neurological damage, 16 were classified as learning disabled, and only three were classified as normal. Unfortunately, the authors did not control for IQ, degree of vision impairment, or cause of vision impairment (cortical vs. anterior visual tract) in analyzing their data. Neither did they identify specifically which subtests of the Halstead-Reitan battery were failed under the Seltz-Reitan rule system. Daugherty and Moran stated their sample consisted of children with IQs between 51 and 123. Furthermore, they took as accurate indicators of spatial functioning with the vision disabled population Performance IQ scores, even though this practice is not conventionally accepted (Hayes, 1941; Hull & Mason, 1993; Vander Kolk, 1980; Swallow, 1981). The authors assumed that poor results on visual neuropsychological tests reflected deficits in neurological functioning or organization. They did not consider the fact that deficits could well have been due to the fact that the children simply could not see all of the stimuli.
CHAPTER III

METHOD

Hypotheses

The following null hypotheses were tested:

1. There are no significant differences in the 16 dependent measures obtained from the administration of six subtests from the HRNTB-OC across subject groups (the totally blind, legally blind, and normally sighted samples).

2. There are no significant differences in the dependent measures within groups and across genders.

3. There are no significant differences in the dependent measures within groups and across races.

4. There are no significant differences in the dependent measures within groups and across ages.

Sample

A random sample procedure was followed in the selection of normally sighted children. Due to difficulty in finding a sufficient number of blind children, a convenience sampling procedure was employed. Systematic efforts were made to select subjects with varied vision disability etiologies as well as equality of age, gender, and racial distributions within the vision disabled groups. The results of the study are considered applicable to the
general population of vision disabled children because those children selected conformed to the criteria concerning cognitive functioning and generally acceptable academic progress to be described in what follows.

The sample consisted of 85 students between the ages of nine years, two months and 14 years, 10 months. The students were categorized into three subgroups. Twenty-five totally blind students comprised the first group, 30 legally blind students made-up the second group, and 30 normally sighted students formed the third group. There were 41 male students and 44 female students. Forty-six students were European-Americans, 23 students were African-Americans, and 16 students were Hispanic-Americans or Asian-Americans.

All 55 students with vision disabilities were either born with the disability or suffered visual loss before the age of three. This set of characteristics yielded a classification category of congenital vision loss. Diverse etiologies for vision loss were present among many of the students. Ten were diagnosed with Retinopathy of Prematurity, two with Retinoblastoma, eight with optic nerve atrophy related disorders, eight with Retinitis Pigmentosa related disorders, seven with infectious disease consequences, eight with Albinism, seven with congenital cataracts, and five subjects were diagnosed with high myopia (see Table 1).
Table 1

**Etiology of Vision Disability**

<table>
<thead>
<tr>
<th>Name of Disability</th>
<th>Number of Students Totally Blind</th>
<th>Number of Students Legally Blind</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Retinopathy of Prematurity</td>
<td>7</td>
<td>3</td>
<td>10</td>
</tr>
<tr>
<td>Retinoblastoma</td>
<td>2</td>
<td>0</td>
<td>2</td>
</tr>
<tr>
<td>Optic Nerve Disorders</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Retinitis Pigmentosa Disorders</td>
<td>5</td>
<td>3</td>
<td>8</td>
</tr>
<tr>
<td>Infectious Diseases</td>
<td>6</td>
<td>1</td>
<td>7</td>
</tr>
<tr>
<td>Albinism</td>
<td>0</td>
<td>8</td>
<td>8</td>
</tr>
<tr>
<td>Congenital Cataracts</td>
<td>0</td>
<td>7</td>
<td>7</td>
</tr>
<tr>
<td>High Myopia</td>
<td>0</td>
<td>5</td>
<td>5</td>
</tr>
<tr>
<td>Totals</td>
<td>25</td>
<td>30</td>
<td>55</td>
</tr>
</tbody>
</table>

No students who would have been classified as mentally retarded were included in the sample. In addition, those students who had a history of neurological involvement such as traumatic brain injury, Cerebral Palsy, or a seizure disorder were not included in the sample. Students who were considered to be behaviorally and/or emotionally disordered were also not included in the sample. For many of the vision disabled children, the investigator could easily screen for a cognitive dysfunction and/or other disabling conditions because he had access to the student's psychological records. The normally sighted children were systematically screened for sample inclusion by the classroom teachers. There were no psychological records available for these children. The recommendation for
inclusion in the sample was based on the student’s recorded history of grade appropriate classroom deportment and achievement. Normally sighted students were then interviewed about their health histories to insure that there were no neurological involvements from trauma and/or disease.

It should be noted that children with no neurological or cognitive disabling conditions were required for the study since one of the goals of the study is to determine if vision disabled children score within normal limits on the selected HRNTB-OC subtests when using sighted children as the norm.

**Setting**

All 30 of the normally sighted students, 20 of the totally blind students, and 27 of the legally blind students were from the Chicago Public Schools. Five of the totally blind students and three of the legally blind students were from suburban schools. One of the totally blind students was from a Chicago Catholic school.

There are several reasons for using sighted subjects as a comparison group and not published norms. Reitan came under criticism concerning the norms he used in classifying older students as brain-damaged or normal (Bornstein, 1985). Reitan’s classification system was based on three groups of 25 individuals in each group. Group membership was comprised of subjects with no diagnosed brain impairment,
subjects who were Learning Disabled, and subjects with a known neurological malady. These numbers are hardly sufficient for a national reference group (Borg & Gall, 1983). Reitan himself reported that there was a need for replication studies (Selz & Reitan, 1979). In addition, an analysis of his treatment groups raises some questions. The children classified as Learning Disabled included individuals with IQ scores at or near 80. This is a problematic situation since individuals with very low average functioning levels may have been compared to average cognitive functioning controls. One can make a case for including lower overall IQ's in the learning disabled group if significant discrepancies between Verbal and Performance IQ's were present. However, the study does not specify that this was the case. Therefore, it is possible that individuals with Verbal IQ's in the 70's and Performance IQ's in the 80's (or vice versa) could have made up a major portion of the Learning Disabled group. This is problematic in that children with lower IQ's are known to score lower than average IQ children on neuropsychological tests (Reitan & Davidson, 1974). Finally, while group norms for sighted children are available, these norms are broken down for age for each year and not consistent with Reitan's clustering procedure for children within a multiple year range. Nor are there any indications with respect to race, socioeconomic level, or other factors that can be matched to
the present sample of children from Chicagoland public schools.

**Instruments**

This section describes the subtests used in obtaining the 16 scores from the Halstead-Reitan Neuropsychological Test Battery for Older Children (HRNTB-OC).

Table 2

**Dependent Measures**

<table>
<thead>
<tr>
<th>I. Levels of Performance</th>
<th>A. Motor Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Finger Tapping - Dominant Hand</td>
<td></td>
</tr>
<tr>
<td>2. Finger Tapping - Nondominant Hand</td>
<td></td>
</tr>
<tr>
<td>3. Tactual Performance Test - Total Time</td>
<td></td>
</tr>
<tr>
<td>4. Tactual Performance Test - Dominant Hand Time</td>
<td></td>
</tr>
<tr>
<td>5. Tactual Performance Test - Nondominant Hand Time</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>B. Sensory Functions</th>
</tr>
</thead>
<tbody>
<tr>
<td>6. Bilateral Sensory Imperception - Right Hand/Left Hand Errors</td>
</tr>
<tr>
<td>7. Bilateral Sensory Imperception - Right Hand/Left Face Errors</td>
</tr>
<tr>
<td>8. Bilateral Sensory Imperception - Left Hand/Right Face Errors</td>
</tr>
<tr>
<td>9. Bilateral Sensory Imperception - Right Ear/Left Ear Errors</td>
</tr>
<tr>
<td>10. Finger Location - Right Hand Errors</td>
</tr>
<tr>
<td>11. Finger Location - Left Hand Errors</td>
</tr>
<tr>
<td>12. Tactile Form Recognition - Right Hand Errors</td>
</tr>
<tr>
<td>13. Tactile Form Recognition - Left Hand Errors</td>
</tr>
</tbody>
</table>

| C. Attention and Concentration |
| 14. Seashore Rhythm Test - Number Correct |

<table>
<thead>
<tr>
<th>D. Right/Left Differences</th>
</tr>
</thead>
<tbody>
<tr>
<td>15. Finger Tapping</td>
</tr>
<tr>
<td>Dominant to Nondominant Hand Score Decreases</td>
</tr>
<tr>
<td>16. Tactual Performance Test</td>
</tr>
<tr>
<td>Dominant to Nondominant Hand Time Decreases</td>
</tr>
</tbody>
</table>
The Tactual Performance Test (TPT) is an adaptation of the Seguine-Goddard formboard. The formboard has six openings into which six complementary block shapes fit. The sighted subject is blindfolded and is not permitted to see the formboard or blocks at any time. The first task is to tactually fit the blocks into their proper spaces on the board using only the dominant hand. The subject is timed. After completing the task with the dominant hand, the subject again performs the task with the nondominant hand under timed conditions. Following this, the subject is allowed to use both hands to complete the task. Timing is important since total time for all trials is used as one measure of motor function on the Level of Performance area and differences between right and left hand times are used as Left-Right Difference factors.

The Finger Tapping Test is a measure of finger tapping speed. A special manual tapper is utilized in recording the number of times within a ten second interval that the subject pushes down the lever of the device. The dominant hand performs first for five consecutive trials (with rests in between attempts). In the event that there is too much variation in the number of taps made, extra trials are given until the five consecutive attempts are completed. No more than a five tap count difference among the trials is allowed. After the dominant hand trials are completed, the subject uses his or her nondominant hand for five
consecutive trials. Results are included under motor functions of the Levels of Performance category and as a separate measure on the Right-Left Differences category.

The Tactual Form Recognition Test requires the subject to identify through touch four different plastic shapes (cross, circle, square, and triangle). The subject is shielded from visual perception of the shapes by a box apparatus that allows one hand to be placed through an opening. The examiner places in the subject's hand one of the shapes which the examinee must identify. All four shapes are presented to the right hand then to the left hand. The process is repeated again with the order of shape presentation being different. Total errors are recorded. The score contributes to the Sensory-Perceptual functions under the Levels of Performance category and as a separate score on the Right-Left Differences category.

The Rhythm Test is taken from the Seashore Measures of Musical Talent. The examinee is required to differentiate between 30 pairs of rhythmic beats. The beats are presented to the examinee from a standardized tape recording. After hearing each paired beat pattern, the examinee indicates if the pattern was the same or different for each element of the pair. The task requires attention to nonverbal auditory stimuli, concentration, and the ability to perceive and compare different rhythmic sequences. Results contribute to the Attention-Concentration functions of the Levels of
Performance category.

Tactual Bilateral Simultaneous Perception testing is performed in several steps. The procedure involves the examiner touching the back of the examinee’s hand (or hands) and the touching of the side (or sides) of the examinee’s face. Initially, the examiner establishes that the examinee can detect unilateral light pressure to each hand. Following this, the examiner tests to see if the examinee can detect sensation to both hands while not being warned ahead of time that both will be touched. Then the examiner proceeds to touch hand and face unilaterally and simultaneously. Scores contribute to the Sensory-Perceptual functions of the Levels of Performance category and the Total Sensory Imperception score under the Right-Left Differences category.

Bilateral auditory simultaneous sensory perception is also tapped under the Sensory Imperception category. This testing is performed by having the examiner rub two fingers (thumb and forefinger) gently together several times at the sides of the examinee’s ears. Each ear is tested individually and then simultaneously to determine if the examinee can detect the soft sound. As above, results contribute to the Sensory-Perceptual screening functions of the Levels of Performance category and the Total Sensory Imperception score under the Right-Left Differences category.
The Tactile Finger Recognition Test assesses the individual's ability to identify which finger on each hand has been gently stimulated. The examiner asks the subject to place his or her right hand palms-down on the table. The examiner then proceeds to name each finger (thumb through little finger) by number, one through five, in consecutive order until the subject remembers the order. Then, the examiner touches each finger four times in random fashion, but never two fingers that are adjacent to each other on consecutive trials. The procedure is repeated with the left hand fingers so that when completed the subject is given a total of 20 trials on each hand. Results are used to measure Sensory-Perceptual functions on the Level of Performance category and as a separate score on the Right-Left Difference category score.

The children from all the groups were individually administered the preceding subtests from the Halstead-Reitan Neuropsychological Battery. It should be noted that these subtests do not require vision. Sighted students are normally blindfolded during test administration. This blindfolding procedure was followed with both the normally sighted and the legally blind students during this investigation.

Research Design

The overall design depicted in Figure 1 is comparative and descriptive. The ANOVA procedure was used to test for
differences in the 16 dependent measures listed in Table 2 across subject groupings. A post-hoc evaluation statistic (Tukey Test) was then applied to the data set. A Chi-Square technique was employed to determine if there were relationships among the student groups and the remaining two categorical variables (Dominant and Nondominant Hand Score/Time Differences) listed in Table 2. The authors of the HRNTB-OC claimed that when there is no brain damage or some other irregularity, dominant hand scores on the tapping test should be higher than nondominant hand scores. Whereas, on the TPT test, there should be a decrease in the amount of time that it takes the nondominant hand to complete the tactual formboard than it did the dominant hand since a learning effect should have occurred. A dummy variable was used to categorize an increase or decrease in performance.

Figure 1

Analytic Paradigm

<table>
<thead>
<tr>
<th>Totally Blind (n = 25)</th>
<th>Legally Blind (n = 30)</th>
<th>Normal Sighted (n = 30)</th>
</tr>
</thead>
<tbody>
<tr>
<td>X1</td>
<td>X2</td>
<td>X3</td>
</tr>
<tr>
<td>Y1</td>
<td>Y2</td>
<td>Y3</td>
</tr>
</tbody>
</table>

Where:
Independent Variable = Subject Type (X1, X2, X3)
Dependent Variables = 16 measures taken from the six subscales of the HRNTB-OC
In addition to the analysis of the 16 measures above, an inspection of the data was made to determine if any of the means or individual scores fell above the cut-off scores that would indicate possible brain damage. Reitan and Wolfson (1992) provided cut-off scores for eight of the measures tested in this study. These measures included: dominant and nondominant hand finger tapping; TPT total time; right and left hand finger recognition; right and left hand tactile form recognition; and the number correct on the seashore rhythm test.

**Description of Data-Gathering Procedures**

Subjects selected were individually administered the six Halstead-Reitan subtests using the same procedures and scoring rules prescribed by the test authors (Reitan & Wolfson, 1992). Responses and/or times were recorded for these subtests by the examiner. The only exception to the above procedures was that minor modifications had to be made in recording the seashore rhythm test responses since the individual subject recorded his or her own responses. While normally sighted subjects recorded their responses on standard protocols, the legally blind used enlarged print versions upon which to record responses and the totally blind used a braille format to write down their responses. Neither procedure was believed to significantly alter the standardization administration procedures. The only other change in administration involved not requiring the totally...
blind subjects to wear blindfolds which the sighted and legally blind subjects were required to do during certain subtest administrations.

Data was gathered during the school year in the schools the children attended. The examiner contacted principals and teachers in the schools in order to make appointments with them to discuss the project and collect data on prospective subjects from which the sample for the study could be drawn.

Normally sighted, totally blind, and legally blind students who met the criteria for subject selection as described in the "Sample" section were systematically selected. Students whose parents consented were then administered the subtest battery in a room of the school where other students could not observe and where the testing would cause no distractions nor interfere with the normal routine of the school.
CHAPTER IV
RESULTS

Statistical Tests of Hypotheses

First of all, chi-square procedures were applied to the data set to test for significant differences in genders, races, and age across the totally blind, legally blind, and normally sighted groups. A critical value equal to or exceeding the .05 level of significance was previously determined as the value at which the null hypotheses would be rejected. As indicated in Tables 3 through 5, there were no statistically significant differences found across subject groups.

Table 3
Frequencies and Percentages for Gender Among Groups

<table>
<thead>
<tr>
<th>Gender</th>
<th>Totally Blind</th>
<th></th>
<th>Legally Blind</th>
<th></th>
<th>Normally Sighted</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency %</td>
<td></td>
<td>Frequency %</td>
<td></td>
<td>Frequency %</td>
</tr>
<tr>
<td>Male</td>
<td>13</td>
<td>52</td>
<td>14</td>
<td>47</td>
<td>14</td>
</tr>
<tr>
<td>Female</td>
<td>12</td>
<td>48</td>
<td>16</td>
<td>53</td>
<td>16</td>
</tr>
</tbody>
</table>

$X^2 = .20103 \ p < .90437 \ (NS)$
Table 4

Frequencies and Percentages for Race Among Groups

<table>
<thead>
<tr>
<th>Race</th>
<th>Totally Blind Frequency</th>
<th>Legally Blind Frequency</th>
<th>Normally Sighted Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>White</td>
<td>13</td>
<td>14</td>
<td>19</td>
</tr>
<tr>
<td>Black</td>
<td>6</td>
<td>10</td>
<td>7</td>
</tr>
<tr>
<td>Other</td>
<td>6</td>
<td>6</td>
<td>4</td>
</tr>
</tbody>
</table>

\[X^2 = 2.33447 \ p < .67451 \ \text{(NS)}\]

Table 5

Frequencies and Percentages for Age Among Groups

<table>
<thead>
<tr>
<th>Age in Years</th>
<th>Totally Blind Frequency</th>
<th>Legally Blind Frequency</th>
<th>Normally Sighted Frequency</th>
</tr>
</thead>
<tbody>
<tr>
<td>9-10</td>
<td>3</td>
<td>9</td>
<td>4</td>
</tr>
<tr>
<td>11-12</td>
<td>13</td>
<td>13</td>
<td>21</td>
</tr>
<tr>
<td>13-14</td>
<td>9</td>
<td>8</td>
<td>5</td>
</tr>
</tbody>
</table>

\[X^2 = 14.70270 \ p < .14328 \ \text{(NS)}\]

Within the blind group, 52% of the students were European-Americans, 24% were African-Americans, and 24% were from other ethnic backgrounds (Asian-Americans or Hispanic-Americans). Fifty-two percent were males and 48% were females. The age range was between 10 years and zero months to 14 years, 10 months. The average age was 11 years, nine
months.

Within the legally blind group, 47% were European-Americans, 33% were African-Americans, and 20% were from other ethnic backgrounds. Forty-seven percent were males and 53% were females. The students ranged in age from nine years, two months to 14 years, five months. The average age was 11 years, 10 months.

Within the normally sighted group, 63% were European-Americans, 24% were African-Americans, and 13% were from other ethnic backgrounds. Males made up 53% of the group and females 47%. The students ranged in age from nine years, two months to 14 years, zero months. Average age was 11 years, 11 months. Given these results, the null hypotheses that there were no differences across the groups with respect to genders, races, and ages was not rejected.

A chi-square analysis was also performed on two of the 16 dependent measures selected for comparison testing across subject groups. The two selected measures were the number of students in each group whose finger tapping scores were higher for the dominant hand than for the nondominant hand, and the number of students in each group whose TPT time score on the nondominant hand trial decreased after attempting the task with the dominant hand. These are the predicted directions for these two dependent measures. As indicated in Tables 6 and 7, there were no statistically significant differences found across the subject groups on
these two dependent measures. Given these findings, the null hypothesis was not rejected.

Table 6

Frequencies and Percentages for Increase or Decrease in Finger Tapping Score Between Dominant Hand and Nondominant Hand by Groups

<table>
<thead>
<tr>
<th>Direction</th>
<th>Totally Blind</th>
<th></th>
<th>Legally Blind</th>
<th></th>
<th>Normally Sighted</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>Higher</td>
<td>8</td>
<td>32</td>
<td>9</td>
<td>30</td>
<td>4</td>
<td>14</td>
</tr>
<tr>
<td>Score</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lower</td>
<td>17</td>
<td>68</td>
<td>21</td>
<td>70</td>
<td>26</td>
<td>86</td>
</tr>
</tbody>
</table>

$X^2 = 2.33447 \ p < .67451 \ (NS)$

In the totally blind group, 68% of the students performed more taps on average with the dominant hand. In the legally blind group, 70% of their members performed higher on dominant hand tapping. In the normally sighted group, 86% of the students displayed higher dominant hand finger taps. These comparative results were not found to be statistically significant ($p < .19663$). On the finger tapping differential, eight of the blind children, nine of the legally blind students, and four of the normally sighted students actually increased their finger tapping scores when they used their nondominant hand. Even though the great majority of children had higher finger tapping scores with
the dominant hand, it was unexpected that such a high number of students would have had higher nondominant hand tapping scores.

Table 7

<table>
<thead>
<tr>
<th></th>
<th>Totally Blind</th>
<th></th>
<th>Legally Blind</th>
<th></th>
<th>Normally Sighted</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
<td>Frequency</td>
<td>%</td>
</tr>
<tr>
<td>Higher Time</td>
<td>2</td>
<td>8</td>
<td>6</td>
<td>20</td>
<td>7</td>
<td>23</td>
</tr>
<tr>
<td>Lower Time</td>
<td>23</td>
<td>92</td>
<td>24</td>
<td>80</td>
<td>23</td>
<td>77</td>
</tr>
</tbody>
</table>

\[ X^2 = 2.38270 \quad p < .30381 \quad (NS) \]

In the totally blind group, 92% of their members improved on their time with the nondominant hand. Eighty percent of the Legally Blind group improved their time with the nondominant hand. In the normally sighted group, 77% of their members improved their time with the nondominant hand. These results were not found to be statistically significant across groups \( p < .30381 \). The totally blind had the fewest number of group members display an increase in time (two students). The legally blind group had six members perform better with the dominant hand, and the normally sighted had seven members perform better with the dominant hand. The fact that 15 students who were theoretically free
from brain damage would score higher with the dominant hand in this task was unexpected.

ANOVA procedures were applied to test if there were significant differences across the three groups on the remaining 14 of the 16 dependent measures compared. As with the Chi-square procedures, a critical value equal to or exceeding the .05 level of significance was determined as the value at which the null hypotheses would be rejected. Significant differences were found across groups on three of the 14 measures tested (dominant/nondominant hand finger tapping, and TPT total time).

On the dominant hand finger tapping test, the normally sighted performed best with an average of nearly 49 taps in ten seconds (see Table 8). The totally blind performed second best with nearly 38 taps, and the legally blind performed at the lowest level with an average of nearly 37 taps with the dominant hand. These comparative results were found to be statistically significant \( p < .0108 \). Tukey test results indicated that the normally sighted groups performed significantly better than both the totally blind and the legally blind groups.
Table 8
Analysis of Variance Summary Dominant Hand Finger Tapping

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>445.78</td>
<td>222.89</td>
<td>4.7856(.0108)*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>3819.21</td>
<td>46.57</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>4264.99</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*significant

The normally sighted students completed on average nearly 39 taps per ten seconds with the nondominant hand (see Table 9). The totally blind students completed almost 36 taps on average, and the legally blind students completed almost 34 taps on average with the nondominant hand. A statistically significant difference was found between the normally sighted students and the legally blind students (p < .0106), but not between the normally sighted and the totally blind students.
Table 9

Analysis of Variance Summary Nondominant Hand Finger Tapping

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>332.57</td>
<td>166.29</td>
<td>4.3488 (.0160)*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>3135.47</td>
<td>38.24</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>3468.05</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*significant

The TPT total time measure across groups was found to be statistically significant at the five percent level (p < .0290). Tukey results revealed that the totally blind students scored significantly better with an average of only 207.56 seconds than both the normally sighted students and the legally blind students whose mean times were 287.50 and 288.87, respectively (see Table 10).

TPT times for dominant hand and nondominant hand performances were not found to be statistically significant across groups. However, with a mean of 103.68 seconds in dominant hand time and a mean of 69.64 in nondominant hand time, the blind students held a strong relative superiority (dominant hand p < .0678; nondominant hand p < .0671). The normally sighted students' mean time of 134.67 was found to
Table 10

Analysis of Variance Summary TPT: Total Time for all Trials

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>114736.05</td>
<td>57368.02</td>
<td>3.6895(.0292)*</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>1275009.13</td>
<td>15548.89</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>1389745.18</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

*significant

be second in dominant hand ability. The legally blind students' mean time of 148.67 seconds placed this group third in dominant hand time scoring. The legally blind students' mean of 92.30 seconds in nondominant hand time placed this group second, ahead of the normally sighted students whose mean nondominant hand time was found to be 100.37 seconds (see Tables 11 and 12).

No significant differences were found between groups on the number of correct responses to the Seashore test (p < .5308) (see Table 13). The totally blind group mean of 25.43 correct was the highest. The legally blind group scored second highest with a mean of 24.43 correct responses. The normally sighted group scored in the last place with a mean of 24.80 correct responses.
Table 11

Analysis of Variance Summary TPT: Time for Dominant Hand

<table>
<thead>
<tr>
<th></th>
<th>Totally Blind</th>
<th>Legally Blind</th>
<th>Normally Sighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>n:</td>
<td>25</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>M:</td>
<td>103.68</td>
<td>148.67</td>
<td>134.20</td>
</tr>
<tr>
<td>SD:</td>
<td>59.09</td>
<td>89.21</td>
<td>59.45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>28291.87</td>
<td>14145.93</td>
<td>2.7813(.0678) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>417064.91</td>
<td>5086.16</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>445356.78</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 12

Analysis of Variance Summary TPT: Time for Nondominant Hand

<table>
<thead>
<tr>
<th></th>
<th>Totally Blind</th>
<th>Legally Blind</th>
<th>Normally Sighted</th>
</tr>
</thead>
<tbody>
<tr>
<td>n:</td>
<td>25</td>
<td>30</td>
<td>30</td>
</tr>
<tr>
<td>M:</td>
<td>69.64</td>
<td>92.30</td>
<td>100.37</td>
</tr>
<tr>
<td>SD:</td>
<td>40.75</td>
<td>47.93</td>
<td>56.45</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Source</th>
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<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>13550.20</td>
<td>6775.10</td>
<td>2.7932(.0671) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>198897.03</td>
<td>2425.57</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>212447.22</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 13

Analysis of Variance Summary Seashore: Number of Correct Responses

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>15.17</td>
<td>7.58</td>
<td>.6383(.5308)(NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>974.41</td>
<td>11.88</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>989.58</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

The number of errors committed in the finger location task were not found to be statistically significant across groups (p < .5793 right hand; p < .4764 left hand). All means were below one error per group (see Tables 14 and 15). The normally sighted group had the fewest errors with the right hand (.17) and the legally blind group had the fewest errors with the left hand (.27). No significant differences were found on tactile form recognition errors across groups regardless of the hand used (right hand p < .5739; left hand p < .3047). All means were less than one error (see Tables 16 and 17).
Table 14
Analysis of Variance Summary Right Hand Finger Location

Errors

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>.6125</td>
<td>.3063</td>
<td>.5496 (.5793) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>45.6933</td>
<td>.5572</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>46.3059</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 15
Analysis of Variance Summary Left Hand Finger Location

Errors

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>1.3208</td>
<td>.6604</td>
<td>.7482 (.4764) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>72.3733</td>
<td>.8826</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>73.6941</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
### Table 16

#### Analysis of Variance Summary Right Hand Tactile Form

**Recognition Errors**

<table>
<thead>
<tr>
<th>Source</th>
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<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>0.0263</td>
<td>0.0131</td>
<td>0.5591 (.5739) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>1.9267</td>
<td>0.0235</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>1.9529</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 17

#### Analysis of Variance Summary Left Hand Tactile Form

**Recognition Errors**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>0.0282</td>
<td>0.0141</td>
<td>1.2059 (.3047) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>0.9600</td>
<td>0.0117</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>0.9882</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
There were no significant differences found across groups on any of the imperception tests (see Tables 18 through 21). Means for right hand/left hand imperception were found to be zero for the totally blind and normally blind groups and .67 for the legally blind group (p < .1568). Means for the right hand/left face errors were .16 for the totally blind and normally sighted groups and .10 for the legally blind group (p < .8371). Means for the left hand/right face errors were .08 for the totally blind group, .13 for the legally blind group, and .30 for the normally sighted group (p < .2791). No right ear/left ear errors were made by the totally blind and normally sighted groups. The mean for the legally blind group was almost equivalent at .03 (p < .4046).

Table 18

Analysis of Variance Summary Right Hand/Left Hand Tactile Imperception Errors

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>.0863</td>
<td>.0431</td>
<td>1.8950(.1568)(NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>1.8667</td>
<td>.0228</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>1.9529</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

| n:               |    |        |        |               |
| Totally Blind    | 25 |        |        |               |
| Legally Blind    | 30 |        |        |               |
| Normally Sighted | 30 |        |        |               |
| M:               |    | .0000  | .0667  | .0000         |
| SD:              |    | .0000  | .2537  | .0000         |
### Table 19

**Analysis of Variance Summary Right Hand/Left Face Tactile Imperception Errors**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>.0792</td>
<td>.0396</td>
<td>.1782 (.8371) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>18.2267</td>
<td>.2223</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>18.3059</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

### Table 20

**Analysis of Variance Summary Left Hand/Right Hand Tactile Imperception Errors**

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>ss</th>
<th>ms</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>.7463</td>
<td>.3731</td>
<td>1.2961 (.2791) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>23.6067</td>
<td>.2879</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>24.3529</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Table 21

Analysis of Variance Summary Right Ear/Left Ear Tactile Imperception Errors

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>SS</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Between Groups</td>
<td>2</td>
<td>.0216</td>
<td>.0108</td>
<td>.9148(.4046) (NS)</td>
</tr>
<tr>
<td>Within Groups</td>
<td>82</td>
<td>.9667</td>
<td>.0118</td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>84</td>
<td>.9882</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Cut-off Scores

As previously noted, rules for establishing cut-off scores for suspected brain damage performances on many of the HRNTB-OC tests were formulated by Selz and Reitan (1979). Reitan and Wolfson (1992) provided cut-off scores for eight of the dependent measures tested in this investigation. By comparing the research groups' mean scores against the Reitan-Wolfson norm reference group's normal and organically impaired cut-off levels, further determination beyond ANOVA procedures can be made to test the appropriateness of using selected HRNTB-OC subtests with the vision disabled.

In Table 22, the cut-off scores for the eight measures (dominant and nondominant hand tapping, TPT total time,
### Table 22

**Cut-off Scores from Reitan and Wolfson Compared to Research Group Means**

<table>
<thead>
<tr>
<th>Subtest</th>
<th>Reitan &amp; Wolfson Cut-off Scores</th>
<th>Research Group Means</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Finger Tapping (# Taps)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Dominant Hand:</td>
<td>≥40</td>
<td>36-39</td>
</tr>
<tr>
<td>Nondominant Hand:</td>
<td>≥36</td>
<td>32-35</td>
</tr>
<tr>
<td>TPT: Total Time (minutes)</td>
<td>≤7.1</td>
<td>7.2-</td>
</tr>
<tr>
<td></td>
<td>9.9</td>
<td>17.5</td>
</tr>
<tr>
<td>Seashore (# correct)</td>
<td>≥27</td>
<td>24-26</td>
</tr>
<tr>
<td>Finger Location Errors:</td>
<td>0</td>
<td>1</td>
</tr>
<tr>
<td>Right Hand:</td>
<td>0-1</td>
<td>2</td>
</tr>
<tr>
<td>Left Hand:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Form Recognition:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Right Hand:</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Left Hand:</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

0 = Perfectly Normal
1 = Normal
2 = Mild to moderate impairment
3 = Severe impairment
Seashore Rhythm Test, right/left hand finger location test, and right/left hand form recognition tests) are presented. The means for all three research groups were reported to be within categories 0 or 1. This puts the group means above cut-off score levels for the Reitan-Wolfson mild to severe brain-damaged levels (categories 2 and 3).

Inspection of the table shows that TPT total time is by far the one measure in which all three research groups performed extremely well. All groups performed in Category 0. The same can be said for finger location errors and form recognition errors. The normally sighted group was the only group to score in Category 0 for both dominant and nondominant hand tapping. The biggest surprise was in the Seashore results in which none of the research groups scored in Category 0.

Additional Statistical Analyses

Two-way ANOVA procedures were performed on the data set in order to determine the reason why significant score differences on the finger tapping test existed which placed only the normally sighted group into category 0 of the cut-off score matrix. The Seashore Test results were also carefully analyzed because of the fact that no group scored in the 0 category. The TPT data set was also analyzed using two-way ANOVA procedure to enhance the clarity of results.

Since gender and race are binary variables and had not been found to be significant across all groups, the most
logical approach left was to control for age since this variable is continuous. Accordingly, each group was split between those under 12 years old and those older than 12 years old to see if the age factor was a contributor to differences.

Tables 23 and 24 summarize the two-way ANOVA results for dominant and nondominant hand finger tapping, respectively. A highly significant difference was found across ages ($p < .001$) in both cases. Inspection of Tables 25 and 26 shows that the Under Age 12 means for both the totally blind and the legally blind students are dropped to category 2 (mild to moderate impairment) but are at or near the bottom of category 0 for Over Age 12.

Table 23

Analysis of Variance of Dominant Hand Finger Tapping

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Membership (A)</td>
<td>2</td>
<td>185.933</td>
<td>4.456*</td>
</tr>
<tr>
<td>Age: Over/Under 12 (B)</td>
<td>1</td>
<td>509.577</td>
<td>12.213**</td>
</tr>
<tr>
<td>Interaction (A X B)</td>
<td>2</td>
<td>6.662</td>
<td>.85</td>
</tr>
</tbody>
</table>

*p < .05    **p < .001
Table 24

Analysis of Variance of Nondominant Hand Finger Tapping

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Membership (A)</td>
<td>2</td>
<td>125.070</td>
<td>4.401*</td>
</tr>
<tr>
<td>Age: Over/Under 12 (B)</td>
<td>1</td>
<td>793.430</td>
<td>12.213**</td>
</tr>
<tr>
<td>Interaction (A X B)</td>
<td>2</td>
<td>48.561</td>
<td>1.709</td>
</tr>
</tbody>
</table>

*p < .05  **p < .001

Table 25

Means for Under/Over Age 12 on Dominant Hand Finger Tapping

<table>
<thead>
<tr>
<th>Group</th>
<th>Under Age 12 Mean</th>
<th>Over Age 12 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totally Blind</td>
<td>34.58</td>
<td>40.54</td>
</tr>
<tr>
<td>Legally Blind</td>
<td>34.38</td>
<td>39.36</td>
</tr>
<tr>
<td>Normally Sighted</td>
<td>39.62</td>
<td>43.59</td>
</tr>
</tbody>
</table>
Table 26
Means for Under/Over Age 12 on Nondominant Hand Finger Tapping

<table>
<thead>
<tr>
<th>Group</th>
<th>Under Age 12 Mean</th>
<th>Over Age 12 Mean</th>
</tr>
</thead>
<tbody>
<tr>
<td>Totally Blind</td>
<td>31.17</td>
<td>40.31</td>
</tr>
<tr>
<td>Legally Blind</td>
<td>31.06</td>
<td>37.00</td>
</tr>
<tr>
<td>Normally Sighted</td>
<td>36.78</td>
<td>40.18</td>
</tr>
</tbody>
</table>

Two-way ANOVA procedures were performed on TPT tasks to test for age differences in performance across groups (see Table 27). In Figure 2, the interaction results of TPT Dominant Hand Time are displayed. A significant interaction was found between group membership and age (p < .05).

Table 27
Analysis of Variance of TPT Dominant Hand Time

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Membership (A)</td>
<td>2</td>
<td>13857.452</td>
<td>2.865</td>
</tr>
<tr>
<td>Age: Over/Under 12 (B)</td>
<td>1</td>
<td>3051.223</td>
<td>.631</td>
</tr>
<tr>
<td>Interaction (A X B)</td>
<td>2</td>
<td>15963.797</td>
<td>.042*</td>
</tr>
</tbody>
</table>

*p < .05
The results reported in Figure 2 indicate that the time for the dominant hand actually increases as the age goes up for the legally blind and the normally sighted. However, the totally blind group's mean dramatically drops.

Significant age differences were found for age on TPT times for the nondominant hand, but no interaction effects were noted (see Table 28). The difference between dominant and nondominant hand results is probably due to the fact
that both age groups across all three groups benefitted from the dominant hand trial. That is to say that a learning effect probably occurred across all groups. The most dramatic learning effect for all groups took place within the totally blind group.

Table 28

Analysis of Variance of TPT Nondominant Hand

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Membership (A)</td>
<td>2</td>
<td>7181.539</td>
<td>3.288*</td>
</tr>
<tr>
<td>Age: Over/Under 12 (B)</td>
<td>1</td>
<td>21413.439</td>
<td>9.804*</td>
</tr>
<tr>
<td>Interaction (A X B)</td>
<td>2</td>
<td>2468.763</td>
<td>.328</td>
</tr>
</tbody>
</table>

*p < .05

Table 29

Analysis of Variance of Seashore Rhythm Test

<table>
<thead>
<tr>
<th>Source</th>
<th>df</th>
<th>MS</th>
<th>F</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group Membership (A)</td>
<td>2</td>
<td>.633</td>
<td>.534</td>
</tr>
<tr>
<td>Age: Over/Under 12 (B)</td>
<td>1</td>
<td>3.685</td>
<td>.059</td>
</tr>
<tr>
<td>Interaction (A X B)</td>
<td>2</td>
<td>3.353</td>
<td>.040*</td>
</tr>
</tbody>
</table>

*p < .05
The two-way ANOVA procedure for the Seashore test indicated that there was an interaction effect ($p < .05$). As the blind and legally blind students increased in age, their ability to detect rhythmic patterns increased. The strongest increase was displayed by the legally blind group students whose under age 12 performance was found to be in the category 2 level (mild to moderate impairment). This performance was elevated to high category 1 level by the older legally blind students. There was a slight relative decrease in the normally sighted groups' ability to discriminate the rhythmic patterns (see Figure 3). Of special note was the fact that none of the older student groups (like the younger students) could on average reach category 0.

Figure 3

**Seashore Rhythm Test by Age**

<table>
<thead>
<tr>
<th>Number Correct</th>
<th>Under 12</th>
<th>Over 12</th>
</tr>
</thead>
<tbody>
<tr>
<td>26</td>
<td>B (26.4)</td>
<td></td>
</tr>
<tr>
<td>25</td>
<td>L (26.2)</td>
<td></td>
</tr>
<tr>
<td>24</td>
<td>(25.4) S</td>
<td></td>
</tr>
<tr>
<td>23</td>
<td>(24.5) B</td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>(22.9) L</td>
<td></td>
</tr>
</tbody>
</table>

B = Totally Blind
L = Legally Blind
S = Normally Sighted

Means are in parentheses
Finally, a discriminant function analysis procedure was performed on the data set in an effort to clearly differentiate the three groups. Six variables were measured (TPT Total Time, TPT Dominant Hand Time, TPT Nondominant Hand Time, Finger Tapping Dominant Hand Rate, Finger Tapping Nondominant Hand Finger Rate, and Seashore Rhythm Test Number of Correct).

Table 30 presents a comparative summary of the predicted group membership using the discriminant analysis procedure. The overall percent of grouped cases correctly classified was only 52.94%. Given these very limited findings, classifying by groups according to the use of these six variables could not be confidently done.

Table 30

Discriminant Function Classification Results for Totally Blind, Legally Blind, and Normally Sighted

<table>
<thead>
<tr>
<th>Actual Group</th>
<th>Total Number of Cases</th>
<th>Predicted Group Membership</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Totally Blind</td>
</tr>
<tr>
<td>Totally Blind</td>
<td>25</td>
<td>14 56</td>
</tr>
<tr>
<td>Legally Blind</td>
<td>30</td>
<td>12 40</td>
</tr>
<tr>
<td>Normally Sighted</td>
<td>30</td>
<td>8 27</td>
</tr>
</tbody>
</table>
Selected Cases

While the sampling process eliminated most students who would have scored in impaired ranges on the HRNTB-OC tests, there were some students among the vision disabled who had attentional/learning problems even though they were free from a history of brain damage and were not mentally retarded. A description of the first two cases demonstrates how the HRNTB-OC tests did predict these problems. The last two cases are presented as caveats to hasty judgments concerning using tests to make decisions.

Case Study #1

R.H. is an 11 year-old totally blind student. Psychological reports indicated an average verbal I.Q. Overall academic progress had been average, but some lower grades in math and social studies were on his record. Teachers noted that R.H. had problems in concentrating, self-starting, and staying on-task behaviors. Teacher supervision and guidance were necessary to keep R.H. performing at grade level. R.H.'s orientation and mobility instructor reported that R.H. had difficulty in learning travel routes while receiving instruction in long cane mobility techniques. Would HRNTB-OC test results indicate any of the problem areas that R.H. reportedly experienced?

R.H. scored only 17 on the Seashore Test. This score, which is in the severely impaired range, would indicate that R.H. has neurologically based attentional difficulties. A
further indication of problems was found on TPT test results. The student showed almost no improvement in time between dominant hand and nondominant hand on the TPT test. This finding would indicate that there may exist difficulties in spatial organization since R.H.’s nondominant hand was the left one. There is a contralateral relationship to the right hemisphere of the brain with left hand involvement. The right hemisphere is associated with spatial organization. With this student, HRNTB-OC test results would have clearly predicted the type of problems the student is reportedly experiencing.

Case Study #2

D.T. is a nine year-old totally blind child whose test results were the most dramatic in terms of impaired overall performance. Her verbal intelligence was in the average range (Verbal IQ: 89), but D.T. had displayed many difficulties related to learning to read. She reversed braille dot positions, had problems remaining focused on abstract symbolic tasks, and at times became disoriented in travelling around the school. Seashore results were reported to be 22 which is in the mild to moderate impaired range. TPT times were found to be in acceptable ranges overall. However, the nondominant hand was slower than the dominant hand. Finger tapping was in the severely impaired range for both dominant and nondominant hands with the nondominant hand being stronger. In the case of D.T., the
HRNTB-OC would have correctly predicted that this student would have had difficulty in attentional, conceptual, and laterality tasks.

**Case Study #3**

T.P. is a legally blind 11 year-old student with a Verbal IQ of 100. T.P. is an honor roll student with no behavioral problems noted. T.P.'s Seashore test results were found to be unremarkable at 25. However, while rate of tapping and TPT times were both within satisfactory levels of performance, T.P. actually had an increase in tapping rate for the nondominant hand and a slight increase in time for the nondominant hand on the TPT. These results are opposite of the expected directional influences. Further interviewing of T.P. along with consultation with the teacher indicated that T.P. is ambidextrous. She can write with either hand (although she prefers the right) and she is facile at throwing or kicking with whatever limb she chooses. Therefore, results in this case simply indicate either mixed dominance or a delay in cerebral dominance development. Since the tapping rates and times with either hand are above impaired ranges, results are not negative even though they are opposite of the predicted direction. In sum, the HRNTB-OC results could be rationally explained.

**Case Study #4**

E.F. is a 13 year-old totally blind student whose grades are generally above average. Her Verbal IQ is well
into the average range (94). She has presented no attentional or behavioral problems. As might be expected, E.F. scored in the 0 category for dominant and nondominant hand finger tapping and for total time on the TPT test. However, for some inexplicable reason, she scored only 15 on the Seashore Rhythm Test. No plausible explanation for her low score could be found. E.F. may simply have an incredibly poor concept of rhythm that has no correlate to impaired brain functioning for concentrational factors, or she perhaps may have had a "bad day." E.F.'s results demonstrate the need for corroborative and supportive evaluation procedures less one test be given too much consideration.

Conclusions

With regard to the original 16 measures tested, the null hypothesis could not be rejected for 13 of the 16 measures. This revealed that there were no significant differences on test results among the totally blind, legally blind, and normally sighted on the 13 measures. The three measures where the null hypothesis was rejected at the .05 level were TPT total time, Dominant Hand Finger Tapping, and Nondominant Hand Finger Tapping. However, further investigation using two-way analysis of variance procedures indicated that age was a significant factor with respect to determining most of the differences. The totally blind subjects, who were superior on the TPT to the other two
groups at all ages, even more dramatically improved their ability to perform on the TPT as they got older. In contrast, the normally sighted subjects were consistently better on finger tapping tasks at all ages. However, the blind and legally blind subjects demonstrated the ability to almost "catch-up" on finger tapping tasks as they advanced in age. Furthermore, on the finger tapping task, the vision disabled subjects elevated themselves from sub-average performances while under 12 years of age, to soundly average performances after age 12. The Seashore results also displayed an age sensitive weakness on the part of the legally blind subjects whose below age 12 students scored at impaired levels. Group membership could not be significantly predicted by employing the Discriminant Analysis procedures on the data set for a selected set of six predictor variables. Taken together, the results indicate favorable use of the HRNTB-OC nonvisual subtests with the vision disabled.
Issues Clarified

Overall, the results indicated that HRNTB-OC tests that do not require vision may be used with vision disabled students almost with as much assurance as when employed with the sighted. Certainly the tactile and hearing imperception tests, finger recognition tests, and form recognition tests were readily passed by almost all subjects. Only a few students in each group made any errors on these tasks. Discounting age for the moment, only three significant differences were revealed through use of one-way ANOVA procedures. But the means of these three measures (TPT total time and finger tapping - dominant hand and nondominant hand) were all found to be above Reitan's and Wolfson's cut-off scores for impaired functioning. Given these findings, differences were not of practical importance. It should be noted that the TPT results were in favor of the totally blind.

Several issues surfaced during the analysis of the data sets. These issues involved the impact of age on results, the validity of Reitan's and Wolfson's norms, the unique experiences of totally blind and sighted students that
effect performances, and the generally consistent weaker performance of the legally blind.

Age was found to be an important factor. On the finger tapping tasks, all groups improved their performances as they became older. In the case of the two vision disabled groups, the improvement was strong enough to move them from unsatisfactory levels in the lower age group to average performances when they reached the age of 12 and older.

To some extent, age was used to clarify the issue of why times on the TPT did not always decrease for the nondominant hand after initial trial with the dominant hand. Likewise, age also appeared to have something to do with why the nondominant hand was sometimes stronger at tapping than the dominant hand. The clustering of nine year-olds through 14 year-olds into the same norm bracket may be problematic. The results of this study shed some doubt on the validity of the clustering practice. If brain damage is truly responsible for weak performances on the HRNTB-OC subtests, then how is it possible for older children to score average when while at younger ages they performed at the impaired levels? The answer to age differences may be that many of the younger children had not achieved cerebral dominance to the level necessary to demonstrate clear mastery of one hand over the other. We know that the plasticity of brain function is great in younger children. The findings
reviewed in the literature section concerning delayed
cognitive/social developmental among the vision disabled is
relevant here.

The Seashore results were rather puzzling. While all
groups performed satisfactorily, none of the groups could on
average reach the highest range of functioning according to
Reitan's and Wolfson's cut-off score standards. One might
suspect that the totally blind would since they rely on
hearing so much and score higher on Digit Span related tests
of attention. Yet they scored only relatively higher, not
significantly higher. It might be appropriate to question
the interpretation of the Seashore Test as a simple task of
attention. While the cut-off scores used by Reitan and
Wolfson and the general diagnostic indications of the
specific tests appear to be generally appropriate, some
cautions appears to be appropriate here.

Another factor related to performance on the HRNTB-OC
tests is in the unique experiences of children. The totally
blind children were clearly superior on TPT timed tests.
They were much better at finding and fitting shapes into a
formboard without sight than the legally blind or the
sighted students. The totally blind were found to be far
more experienced with problem solving in the tactual-spatial
realm than the other students. The complex nature of the
TPT requires tactual perceptual, motor performance, and
memory. It was obvious that the legally blind and sighted
children were not accustomed to using their hands without sight.

Braille is another factor in the blind child's experiential background that may have positively influenced the results of this investigation. The braille students use their dominant and nondominant hands to strike the braillewriter keys. This may explain why the totally blind students were not significantly weaker than the sighted students on nondominant hand finger tapping. It could also be used to explain why some of the totally blind students improved on nondominant hand finger tapping from their score on dominant hand finger tapping. In contrast, the normally sighted students probably have an advantage on tapping tasks both as young students and as older students because they use their eye-hand coordination for so many more tasks than the other two groups (writing, drawing, throwing, manipulating tools, etc.). They are more experienced in motor tasks, so one would expect stronger tapping scores early on. That is to say that experience will effect neuropsychological test scores.

Legally blind students generally performed the poorest on the most complex tasks. However, as a group they generally performed at acceptable levels above cut-off scores indicating brain damage. The fact that the group tends to underperform the sighted and the totally blind on blindfolded tasks is not surprising. As reported in Chapter
II, the legally blind tend to underperform other groups on most measures. There is much to be said for the notion that these children do not clearly know to which world they belong (the sighted or the blind)! They are often not encouraged to use their residual vision to its highest potential, and they frequently do not receive the visual training that they should.

An important conclusion emerging from this study is that vision disabled students do not suffer from more "brain-damage" simply by virtue of being vision disabled. Once sufficient maturational/experiential levels have been reached, vision disabled children perform satisfactorily on HRNTB-OC nonvisual tasks. With regard to the legally blind in particular, if deficiencies in visual-perception are present, it would appear that they are due to a lack of visual training and/or visual acuity problems, and not to any inherent irreversible cerebral organic factor unless such can be documented by medical history.

Future Research

There is a need for studies as this to be replicated. A larger sample would clarify some of the age-related issues that surfaced. In addition, research should be conducted that compares results of the non-brain damaged vision disabled students (such as in this study) with vision disabled students who have a documented history of brain damage or neurological impairment. Blind children under the
age of nine can be the subject of neuropsychological research by using appropriate subtests from the Halstead-Reitan Neuropsychological Test Battery for Younger Children. Also, blind adolescents should be researched through the adult version of the Halstead-Reitan Battery as well as with other neuropsychological tests such as the Luria-Nebraska. There is also a need for the aphasia components of neuropsychological testing to be researched with the vision disabled population.

In addition to the above, intercorrelational studies that are designed to examine relationships among some of the tactual reasoning tests such as the Blind Learning Aptitude Test and the Kohs-Owaki Block Design Test with the HRNTB-OC should be conducted. This may provide some insight into the use of these tests to supplant each other and to further validate diagnostic interpretations. Verbal scales also need to be systematically compared.
APPENDIX A

PARENTAL PERMISSION FORM
Parental Permission Form

Dear Parent:

Your son/daughter has been selected to participate in a research project that was designed to investigate how well vision disabled students perform on neuropsychological tests compared to sighted students. These tests are simply activities requiring the manipulation of shapes, finger tapping exercises, recognition of being touched on the hand or finger, and paying attention to sound stimuli. If your child is sighted or has some residual vision, he/she will be blindfolded while taking the tests.

There is no physical danger to your child. Testing should take no longer than an hour. In no way will this project effect your child’s grade or placement and permission may be withdrawn at any time. Results are strictly confidential. If you have any questions, please call ________________, your child’s teacher. Please check below:

_____ You may include my child in the research project.

Signed: ________________________________

Date: ________________________________
REFERENCES


VITA

The author, Paul Arnold Taviani, was born on March 7, 1942, in Chicago, Illinois. He graduated from St. Patrick High School in Chicago. He received his Bachelor of Science degree in January, 1965, from the University of Illinois, Champaign-Urbana, with a major in Physical Education. In December of 1966 he earned a Master of Arts degree from Western Michigan University, Kalamazoo, Michigan, in the field of special education for individuals with vision disabilities. In addition, the author has earned advanced degrees in Educational Administration from the University of Illinois and in School Psychology from National-Louis University. In 1991, he began studies for his doctorate in School Psychology at Loyola University in Chicago.

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Date

3/29/56

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