UNIVERSITY OF ALBERTA

THE PERFORMANCE OF CHILDREN WITH SPINA BIFIDA AND SHUNTED HYDROCEPHALUS ON THE STANFORD-BINET INTELLIGENCE SCALE (FOURTH EDITION)

by

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The undersigned certify that they have read, and recommend to the Faculty of Graduate Studies and Research for acceptance, a thesis entitled THE PERFORMANCE OF CHILDREN WITH SPINA BIFIDA AND SHUNTED HYDROCEPHALUS ON THE STANFORD-BINET INTELLIGENCE SCALE (FOURTH EDITION) submitted by GREGORY D. ERICKSON in partial fulfillment of the requirements for the degree of Master of Education in School Psychology.

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Dedication

This work is dedicated to the children with spina bifida, and their parents, who participated in the research it contains, for their unending patience and willingness to advance our knowledge in the area of spina bifida. Were it not for your courage, this work would not have been possible.

Abstract

The Stanford-Binet Intelligence Scale: Fourth Edition (Binet IV) is a recent revision of the Stanford-Binet Intelligence Scale: Form L-M. This study undertakes to investigate the use of the Binet IV with a specific population - children with spina bifida and hydrocephalus (SBH). Specifically, this study examines whether the Binet IV reflects the findings in the literature regarding the overall and specific intellectual functioning of SBH children, and it examines, in detail, the cognitive abilities of this population.

The Binet IV, Developmental Test of Visual-Motor Integration, and Peabody Picture Vocabulary Test-Revised, were administered by supervised graduate students to 28 SBH children registered with the Spina Bifida Clinic at the Glenrose Rehabilitation Hospital in Edmonton, Alberta. The subjects ranged in age from 5 to 11 years, with a mean age of 8.6 years. The results of the final SBH group (n = 23), were compared to those of the Binet IV standardization sample, or to the theoretical population means.

Results of the study reveal that the Binet IV does reflect the significantly lower overall intellectual abilities of SBH children, when compared to the Binet IV standardization sample. Scores on the four Area Standard Age Scores (Verbal Reasoning, Abstract/Visual Reasoning, Quantitative Reasoning, and Short-Term Memory) were also significantly below the means of the standardization sample. In addition, two of the three factor scores, as suggested by Sattler (1988), Verbal Comprehension, and Nonverbal Reasoning, were significantly lower than the theoretical

population mean. However, the third factor score, Memory, did not differ significantly from the theoretical population mean. In sum, the results confirm the utility of the Binet IV in identifying the general and specific intellectual strengths and weaknesses of SBH children.

Implications for further research and educational practice are discussed.

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To my parents, Dave and Jeanette, I can only say "thank you" for your support in all of my life's endeavors. You have been an endless source of encouragement, and you have given me one of the greatest gifts anyone could ever receive, an education.

To my loving wife, Carol, I owe the greatest thanks. You have endured one of the most difficult of all human experiences, marriage to a graduate student. Together we have reached a significant milestone, and together we will be able to strive for higher and greater things. Thank you for your patience, understanding, support, and love.

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Chapter 1

Introduction

Purpose of the Study

The condition now known as spina bifida was first referred to as early as 2000 B.C. (Anderson & Spain, 1977). Until recently, most children born with spina bifida, especially myelomeningocele, died within the first few years of life due to the effects of central nervous system infections, renal failure, or side effects associated with hydrocephalus. With the advent of antibiotics (in the 1940s) to reduce infection, and of shunting systems (in the late 1950s) to treat hydrocephalus, the reduction in mortality was dramatic (Lewis, 1987). Increased survival rates have resulted in its becoming, next to cerebral palsy, the second most common major physically handicapping condition of childhood (Anderson & Spain, 1977). As a result, there has been a growing population of children with spina bifida and hydrocephalus requiring the attention of medical staff, teachers, psychologists, and researchers. Intellectual assessment has played a major role in determining the learning needs of this population.

The population of focus for the present research has generally been characterized by lower than average overall intellectual functioning. These children, as a group, tend to exhibit specific intellectual deficits, most notably in the areas of fine-motor control, eye-hand coordination, figure-ground discrimination, attention, arithmetic, short-term memory for non-verbal material, and short-term memory for non-connective verbal material (i.e., words in isolation). In addition, it appears that performance on verbal tasks found on the Wechsler and other intelligence scales may represent a relative strength for SBH children, although the difference between their verbal and non-verbal abilities is not always significant.

The most recent revision of the Stanford-Binet Intelligence Scale, the Stanford-Binet Intelligence Scale: Fourth Edition (Binet IV), was published in 1986 (Thorndike, Hagen, & Sattler, 1986b). The potential exists that the Binet IV will be used extensively by practitioners dealing with special needs populations, such as those with spina bifida and hydrocephalus. As with any new measure, much research is needed to investigate its validity, along with its proper diagnostic, clinical, and educational uses for special populations (Meloff, 1987). The current research represents an investigation into the use of the Binet IV for children with spina bifida and hydrocephalus (SBH). This study is of particular importance given that at present, there is no data available regarding the performance of SBH children on the Binet IV. As this instrument shows considerable promise in delineating the learning profiles of children with spina bifida and hydrocephalus, research into its use is seen as important and timely.

Statement of Objectives

No literature regarding the performance of SBH children on the Binet IV is currently available. This research reveals new information with respect to the use of the Binet IV with this unique population of children. In addition to the overall objective of providing data regarding the performance of SBH children on the Binet IV, the present research has the following specific objectives:

Objective 1.

To determine whether the current Binet IV data reflects findings in the literature regarding the intellectual functioning of SBH children. Two broad areas are explored: (a) Overall level of intellectual functioning, as measured by the Binet IV Composite IQ, and (b) Specific areas of intellectual functioning (i.e., visual-motor and fine-motor skills, visual-perceptual skills, distractibility, verbal skills - language comprehension, memory, and numerical reasoning), as reflected by the four Binet IV Area scores, and the three factor scores.

To accomplish this objective, the performance of the SBH sample was compared to that of the Binet IV standardization sample. Data regarding the performance of the standardization sample was obtained from the Binet IV technical manual, corresponding to the same age range as that of the SBH sample (five to eleven years).

Objective 2.

To examine the utility of the Binet IV as a means of identifying both the overall level of intellectual functioning, and specific intellectual strengths and weaknesses with the SBH population. A significant focus was placed upon test interpretation with respect to the cognitive abilities of SBH children.

In addition, the performance of the SBH sample on the Binet IV was correlated with two supplementary tests. The Beery Developmental Test of Visual Motor Integration (Beery) and Peabody Picture Vocabulary Test - Revised (PPVT-R) were administered, and performance compared to the Binet IV. These supplementary tests are often used by practitioners to add to their assessment of children's cognitive functioning. It is hoped the present study represents a very practical investigation of the cognitive functioning of SBH children with the Binet IV.

Thesis Outline

The results of Binet IV assessments of SBH children are examined with respect to: (a) the Composite Standard Age Score (SAS), (b) the four Area Standard Age Scores, and (c) the three factor scores, as suggested by factor analysis (Sattler, 1988).

Although the primary focus of this research is the Binet IV, two supplementary instruments are utilized to provide cross-validation of certain Binet IV results. These instruments are the Beery Developmental Test of Visual-Motor Integration (Beery), and the Peabody Picture Vocabulary Test - Revised (PPVT-R).

The first chapter provides a statement of objectives for this study. A very brief discussion of the condition of spina bifida and hydrocephalus is followed by a statement regarding the new revision of the Stanford-Binet Intelligence Scale. The second chapter contains a detailed review of the literature pertaining to the general and specific intellectual functioning of SBH children. The Binet IV is discussed in greater detail and hypotheses are generated and presented. The third chapter outlines the research design and procedures utilized for this study. Sample characteristics, tests administered, procedures, data analysis, and limitations are discussed. The fourth chapter contains the results of the study. Hypotheses generated in Chapter 2 are discussed in relation to the results presented. Tables outline results from data analysis including z-tests and correlational data. The fifth and final chapter contains a discussion of the results presented in Chapter 4, along with recommendations for further research and educational implications. References and appendices follow this chapter.

Chapter 2

Review of the Literature & Hypotheses

Introduction

Spina bifida is a non-progressive congenital birth deficit caused by a defect in the developing spinal cord (Badell-Ribera, Shulman & Paddock, 1966). During the fourth week of pregnancy, the normal process by which the neural groove deepens and develops is interfered with, such that the folds of the neural groove fail to completely fuse to form the neural tube. In the normal development of the fetus, the neural tube differentiates into the brain and spinal cord, and is covered first by the meninges, and then by the spinal vertebrae. In the child with spina bifida, the arches of one or more of the vertebrae have failed to fuse together properly. The result is that the spine is 'bifid' (a Latin term meaning 'split in two') (Anderson & Spain, 1977).

Spina bifida is a *group* of developmental defects of the spinal cord, of which there are two major types: spina bifida *occulta* and spina bifida *aperta* (Anderson & Spain, 1977; Korabek & Cuvo, 1986). In spina bifida 'occulta' (a Latin term for 'hidden'), the arches of one or more vertebrae do not fuse, however there is usually not any distension of the meninges, and "the spinal cord and its membranes are generally (although not always) normal" (Anderson & Spain, 1977, p. 12). In spina bifida 'aperta' (a Latin term for 'open'), some of the spinal cord tissue protrudes into a cyst containing cerebro-spinal fluid (CSF) (Anderson & Spain, 1977). One of two types of lesions may result from spina bifida aperta: a meningocele, or (more commonly) a myelomeningocele. The former lesion involves the meninges, spinal nerve roots, and CSF protruding into the cyst (which is covered with skin), without damage to the function of the nerve pathways to the lower portion of the body or subsequent impairment (Anderson & Spain, 1977; Korabek & Cuvo, 1986). Myelomeningocele, the more severe form of spina bifida aperta, is 5 to 10 times more common than meningocele (Korabek & Cuvo, 1986). In this condition, the spinal cord protrudes into the cyst, with the result being, "permanent and irreversible neurological disability" (Anderson & Spain, 1977, p. 14). These children will have varying degrees of difficulty with respect to ambulation and incontinence.

Hydrocephalus is an accumulation of cerebro-spinal fluid (CSF) in the brain. It represents the most serious associated symptom of myelomeningocele, and occurs in approximately 70 to 95% of cases (Oakes, 1990; Korabek & Cuvo, 1986; Lewis, 1987). As Anderson and Spain (1977) note:

> Most if not all children with spina bifida myelomeningocele and hydrocephalus are born with an abnormality of the cerebellum (that part of the brain concerned in particular with the control of movement) and of other nearby lower brain-stem structures called the Arnold-Chiari malformation (p. 40).

Hydrocephalus results from either overproduction of CSF, or from blockage of its normal circulation. The Arnold-Chiari malformation is an example of the latter, more common cause of hydrocephalus, and involves blockage of the flow of CSF from the fourth ventricle, or blockage of the space at the base of the brain through which the fluid must pass (Korabek & Cuvo, 1986). The result is a build-up of pressure within the brain which can cause extensive damage if not detected and treated early. As Oakes (1990) indicates: "The symptomatic Chiari malformation is currently the leading cause of death in the spina bifida population, particularly early in life" (p. 1).

The prevalence of spina bifida varies according to factors such as race, geographical location, and time of birth. Greenburg, James, and Oakley (1983) note:

> The rate of neural tube defects among white births is two to three times higher than among black births. Rates are higher in the eastern and southern United States than in the western United States, and there is a decreasing secular trend in rates in both races and in all geographic regions (p. 570).

Korabek and Cuvo (1986), report that in the United States there are "between one and two babies born with spina bifida out of every 1,000 live births" (p. 142). Bamforth and Baird (1990) report an average occurrence (from 1952-1986) in British Columbia, Canada, of 3.69 per 10,000 [sic] live births. Anderson and Spain (1977) report that in Britain the incidence is approximately 2.4 per 1,000 live births. Anderson and Spain refer to this figure as "very high" (p. 46), and note that the British Isles have one of the highest rates of neural tube defects in the world.

Increased survival rates, due mostly to advances in treatment, have resulted in a growing proportion of children with spina bifida in our schools (Jamison & Fee, 1978). Children with spina bifida represent an increasing challenge in education, "not only because of the increase in their numbers but because of apparent peculiarities in their intellectual development" (Jamison & Fee, 1978, p. 14). It is these unique characteristics which have become an increasing focus of research.

General Intellectual Functioning

The literature is consistent in reporting a strong association between hydrocephalus and intellectual impairment (Anderson & Spain, 1977). Numerous studies have established that children with spina bifida and hydrocephalus obtain lower than average mean IQ scores on the Wechsler and Stanford-Binet scales. Badell-Ribera et al (1966), studied a group of 75 subjects, ranging in age from 5 to 21 years, with varying degrees of spinal cord dysfunction as a result of spina bifida. Of this sample, 62% had non-progressive (arrested) hydrocephalus. The sample was divided into five groups according to lesion level, motor function, reflex responses, and degree of incontinence. Subjects were administered the Wechsler Intelligence Scale for Children (WISC), or when appropriate, the Wechsler Adult Intelligence Scale (WAIS).

The mean Full Scale IQ's of all five groups fell within the range of 81-108. The group with the greatest degree of physical handicap (and also the highest incidence of hydrocephalus) obtained the lowest mean Full Scale IQ of 81 (range 45-121). When hydrocephalic and non-hydrocephalic subgroups were compared, there were statistically significant differences between mean scores (Table 2.1).

TABLE 2.1

Comparison of Hydrocephalic and Non-Hydrocephalic Subgroups on Verbal, Performance, and Full Scale IQ Scores
(adapted from Badell-Ribera et al, 1966)

	Full Scale IQ	Verbal IQ	Performance IQ
Arrested Hydrocephalus	87	94	81
Non-Hydrocephalic	109	111	106

The data in Table 2.1 reveal that the hydrocephalic group not only obtained significantly lower mean Full Scale, Verbal, and Performance IQ scores ($p < .001$) than the non-hydrocephalic group, but also showed a statistically significant discrepancy between their verbal and performance scores. According to Badell-Ribera et al (1966), a significant verbal-performance discrepancy "can be considered a characteristic sign of brain damage" (p. 791). It was also found, that those who were severely disabled scored significantly lower than the less disabled, only when there was a history of hydrocephalus. This led to the conclusion that the lower mean Full Scale IQ, and large verbal-performance discrepancy were a result of the hydrocephalus rather than the physical disability.

Soare and Raimondi (1977), studied 173 children with myelomeningocele, 133 of whom had shunted hydrocephalus. In addition, 80 siblings were tested as a control group. The Stanford-Binet Intelligence Scale: Form L-M and the Cattell Infant Intelligence Scale, were used to obtain IQ scores. The following table (Table 2.2) summarizes their findings.

TABLE 2.2

IQ Scores of Myelomeningocele Children with Shunted Hydrocephalus (MM/SH) and without Hydrocephalus (MM) and their Siblings
(adapted from Soare & Raimondi, 1977)

	MM/SH	MM/SH Siblings	MM	MM Siblings
Mean	87.7	109.5	102.3	119.9
Standard Deviation	24.8	17.4	19.9	13.5

As can be seen from the results in Table 2.2, the myelomeningocele (MM) group had a significantly higher mean IQ than the myelomeningocele with shunted hydrocephalus (MM/SH) group ($p < .001$). In addition, the mean IQ of the shunted hydrocephalic's siblings was significantly higher than that of the shunted hydrocephalics themselves ($p < .01$), whereas the MM group did not differ significantly from their siblings. Soare and Raimondi's conclusions seem quite representative of findings in the literature with respect to the **overall** intellectual functioning of children with myelomeningocele and hydrocephalus:

> The presence of hydrocephalus in a child with myelomeningocele decreases his chances for normal intelligence. Though surgical treatment of the hydrocephalus increases the chances for normal intelligence, myelomeningocele children with hydrocephalus, *as a group* [italics added], are still significantly less intelligent than their normal siblings and also less intelligent than myelomeningocele children without hydrocephalus. (p. 202)

Keller, Banta, Whiteman, and Goldfarb (1979) studied the intellectual functioning of 76 children, ranging in age from 5 years, 6 months, to 15 years, 9 months. Of the total sample of 76, 40 were hydrocephalics (shunted), 16 were considered to have arrested hydrocephalus, and the remaining 20 were non-hydrocephalics. Each of the subjects had been administered either the WISC or WISC-R. The results of Keller et al are consistent with other results in the literature showing lower than average IQ scores for SBH children (Table 2.3).

TABLE 2.3

WISC Scores
(adapted from Keller et al, 1979)

	Full Scale IQ	Verbal IQ	Performance IQ
Total Sample	82 (SD 20)	85 (SD 20)	82 (SD 19)
Hydrocephalics	76 (SD 20)	81 (SD 20)	76 (SD 20)
Non-Hydrocephalics	90 (SD 19)	90 (SD 20)	91 (SD 18)
Arrested Hydrocephalics	86 (SD 17)	90 (SD 18)	85

The findings of Keller et al (1979), are most similar to those of Tew and Laurence (1975), in that children with shunted hydrocephalus scored in the borderline range of intelligence, the non-shunted in the lower average range, and the arrested in the dull normal range. In addition, like Tew and Laurence, Keller et al suggest that, "even spina bifida children without hydrocephalus have a lowered intelligence level" (p. 8).

Anderson (1973), summarizes the findings in the literature regarding the overall intellectual functioning of SBH children, noting that the majority of studies suggest that "the IQ scores of a substantial portion of children with spina bifida and hydrocephalus score within the range of 70-90." (p. 266)

An important characteristic of the intellectual functioning of SBH children is this: where there is evidence of intellectual impairment, all areas of functioning are not equally impaired (Anderson & Spain, 1977). Other researchers note that hydrocephalic children have specific learning difficulties (Kauffman and Hallahan, 1981).

Specific Areas of Intellectual Functioning

Fine-Motor.

Sand, Taylor, Hill, Kosky, and Rawlings (1974), note that in myelomeningocele children, paralysis and loss of sensation occur below the level of the lesion in the spinal cord, and that in the past it has been assumed that functioning in the upper extremities was normal. Sand et al investigated this assumption by studying the performance of 25 myelomeningocele children (aged 6-19) on the Developmental Hand Function Test (DEHFT) - a test which measures the time required for subjects to complete seven unilateral tasks sampling functional hand movements (Sand et al, 1974). To compute the DEHFT deviation scores for each task, the discrepancy between the time each myelomeningocele child took to complete a task and the mean time taken by a non-disabled child matched for age and sex, was calculated. Sand et al reported the following:

> Quantitatively higher deviation from age norms tended to be shown for the hydrocephalic group. Children with an IQ of less than or equal to 79 obtained higher mean deviation from age norms than children with and IQ greater than or equal to 80. *An assumption of unimpaired hand function of dexterity in children with myelomeningocele, appears to be unwarranted, judging from results obtained in the present study* [Italics added]. Myelomeningocele children included in this study tended to show deviant performance on the hand function measures used. This deviancy occured more uniformly and was of greater magnitude for MM children with hydro. [sic] or with an IQ of less than or equal to 79. (p. 90)

The authors offered three possible explanations for the impairment in hand function observed in their sample. First, that the impairment may have been a direct or indirect result of the hydrocephalic condition. They noted that hydrocephalus often results in lower intellectual functioning, and that deficiencies in coordination often occur with mental retardation. Their results did reflect significant differences between the hydrocephalus-present and hydrocephalus-absent patients. However, the performance of 80% of the hydrocephalic-absent patients "exceeded two standard deviations from the mean score obtained in the normal normative sample at their age level" (p. 90). Second, that the impairment may be linked to the level of the spinal cord lesion. However, due to a high level of correlation between lesion level and hydrocephalus in their study, the authors were unable to differentiate between the two causes. Finally, they noted that "an absence of usual experiences which stimulate upper extremity motor skill development" (p. 90), may also offer an explanation for the impairment. During both early and later developmental periods, "paraplegia restricts these children's postural and gross movement alternatives" (p. 90). Thus, a lack of practice may play a role in these children's impairment. Whatever the cause, it is clear from the results of Sand et al, that an assumption of normal upper limb function in children with myelomeningocele is tenuous at best. Their findings appear to have the support of other research.

Anderson (1976) found that the quality of writing of SBH children was significantly poorer than that of controls matched for IQ, age, and sex. This poor writing ability was seen as being influenced by three main factors: (a) impaired muscular control - a result of damage to the cerebellum (which is involved in voluntary muscle control) and motor cortex (which affects upper limb functioning); (b) restricted mobility of SBH pre-schoolers - who often must use one hand as a prop, thus limiting their opportunities for fine motor practice; and, (c) difficulties in both the processing of sensory information, and in organizing their movements according to intentions. Anderson further noted the influence of distractibility and lack of motivation (due to discouragement).

Turner (1986) reported many studies as having shown that upper limb function in children with myelomeningocele (MM) and hydrocephalus is "poorer" (p. 790), than that of children with MM and no associated hydrocephalus. Turner cites studies which note the presence of neurological difficulties such as ataxia, unilateral and bilateral pyramidal tract dysfunction, dyspraxia, and cerebellar dysfunction. In each of the studies cited, the presence of hydrocephalus, whether shunted and untreated, was associated with poorer performance on tasks measuring upper limb function.

Turner also noted several factors, many similar to those of Sand et al (1974) and Anderson (1976), which may play a role in the abnormal upper limb functioning of these children. These include: (a) abnormality in the position and structure of the hindbrain, particularly of the cerebellum; (b) ventricular dilation secondary to hydrocephalus, with cortical damage and damage to other structures; (c) superimposed epilepsy and cerebral palsy; (d) abnormalities in the position and structure of the cervical spinal cord; (e) other factors - visual defects, poor hand-eye coordination. poor intelligence, sensory deprivation, restricted mobility and poor trunk control.

Dennis, Fitz, Netley, Sugar, Harwood-Nash, Hendrick, Hoffman, and Humphreys (1981), studied the patterns of intellectual functioning in a group of 78 hydrocephalic children. With respect to the effect of hydrocephalus on the ability to complete motor tasks, they concluded:

> Hydrocephalic children with myelomeningocele perform poorly on tasks of persistent motor control and eye-hand coordination. Bimanual manipulations and intermanual transfer are also impaired in hydrocephalus, possibly as a result of distention of the corpus callosum. These impairments in fine motor control will make it difficult for the hydrocephalic child to perform normally on time-limited nonverbal intelligence tasks. (p. 614)

Visual-Motor/Visual-Perceptual Functioning.

In children with spina bifida, hydrocephalus most often results from blockage of the free flow of cerebrospinal fluid due to the Arnold-Chiari malformation, a malformation of the cerebellum. In this malformation, the cerebelar vermis and some portion of the brain stem descend into the cervical spine (Oakes, 1990). Anderson (1973), notes that since the cerebellum is implicated, "poor eye-hand coordination, and deficits in other tasks with a motor component can be expected" (p. 265). Anderson also notes that these difficulties may not be present in children, without spina bifida, whose hydrocephalus is of a different etiology.

Other research reports eye-hand coordination problems in SBH children. Keller et al (1979), found shunted hydrocephalics received lower scores than non-hydrocephalics on all of the WISC subtests measuring perceptual-motor skills. In addition, tasks which combined visual-perceptual and motor skills caused considerable difficulty, such as the WISC coding subtest.

Sand, Taylor, Rawlings, and Chitnis (1973), reported that both hydrocephalic and non-hydrocephalic children with myelomeningocele showed deficits in the eye-hand coordination test of the Frostig Developmental Tests of Visual Perception. Of their 37 subjects (age range 4 - 16 years), 59% had Frostig Perceptual Quotients (PQ) which fell below the cut-off for screening (PQ < 90). Although the majority of these children were hydrocephalic, there was nearly equal representation of hydrocephalic and non-hydrocephalic cases with PQ ≥ 91. From the research presented, for children with myelomeningocele, the presence of hydrocephalus is likely to be associated with greater deficits in visual-motor skills.

The most frequently cited research addressing the effect of hydrocephalus on perception, is that of Miller and Sethi (1971). They investigated visual perception in 16 school-age hydrocephalic children aged 5 to 15 years, with and without spina bifida (although they do not distinguish between the groups). The Bender Gestalt Test (Bender), and the Frostig Developmental Test of Visual Perception (Frostig) were administered. These tests involved tasks such as copying geometric figures, and tracing the outline of a shape against a conflicting background. Miller and Sethi's results indicated severe deficits in the functions measured by the Bender and the Frostig. The age-equivalent scores subjects obtained were significantly lower than their chronological ages. For the Bender, no subject obtained an age-equivalent score within 18 months of his chronological age. The authors noted two primary areas of difficulty: (a) failure to perceive a shape in its totality or 'gestalt', and (b) difficulty in figure-ground discrimination.

In further investigating these findings, Miller and Sethi attempted to account for the influence of poor motor ability (through the use of a task with no significant motor requirement), and impaired verbal mediation (through the use of stimuli which were difficult to verbalize). The results further suggested that difficulties in perceiving visuo-spatial relationships, and figure-ground discrimination, were not artifacts of poor mobility or verbal mediation.

Distractibility and Inattentiveness.

Many SBH children experience difficulty in the area of distractibility and inattentiveness (Agness & McLone, 1987), which would appear to interfere with their learning. Culatta (1980) states that SBH children, "have been observed to exhibit perceptual problems, characterized by distractibility, which are believed to interfere with academic achievement." Tew and Laurence (1975) reported results from teacher reports of "how many minutes the child was usually able to concentrate on basic school-learning" (p. 132). While they admit to the crudeness of this non-standardized method, it did reveal a rather interesting pattern of results:

> A pattern of scores emerged which was similar to the distribution found on both the intelligence and attainment tests. The mean concentration spans were: controls, 18 minutes; spina bifida without hydrocephalus, 15 minutes; arrested hydrocephalus, 13 minutes; and shunt-treated hydrocephalus, 9 minutes. The shunt-treated children had significantly shorter powers of concentration than the control cases ($p < .001$). (p. 132)

Tew, Laurence, & Richards (1981), found that children with neural tube deficits, such as spina bifida, were more impulsive, and had difficulty maintaining attention. The suggestion was made that the attention problems may be related to information processing deficits such as visual-perceptual problems and limited short-term memory. This was also supported by Horn et al (1985), who noted that, "Children with spina bifida and hydrocephalus are more distractible than control children and this greater distractibility is partly responsible for their deficiencies in vocabulary comprehension" (p. 717).

Shaffer, Friedrich, Shurtleff, and Wolf (1985) reported WISC results of 60 children with myelomeningocele (42% of whom had shunts, and 57% of whom were female). They calculated this group's scores on the Kaufman (1979) WISC factors of: Verbal Comprehension Abilities (VCA), Perceptual Organization Abilities (POA), and Freedom From Distractibility (FFD). Their results are outlined in Table 2.4.

TABLE 2.4

Mean Scores of Children with
Myelomeningocele on Kaufman WISC Factors
(adapted from Shaffer et al, 1985)

WISC Factor	Mean (S.D.)	One-Tailed T-test	p
Verbal Comprehension	9.6 (3.7)	-0.858	NS
Perceptual Organization	8.9 (2.6)	-3.176	.005
Freedom From Distractibility	8.0 (2.2)	-6.350	.001

Shaffer et al's sample differed from the norms on both the Perceptual Organization and Freedom From Distractibility factors. With respect to the current discussion, these results provide support to the position that myelomeningocele children have difficulty concentrating and remaining attentive.

Numerical Reasoning Ability.

Shaffer et al (1985), studied 60 patients with uncomplicated myelomeningocele, 25 of whom had shunted hydrocephalus. Of the total sample, 42 had been administered the Wide Range Achievement Test (WRAT). The performance of these children on the WRAT was compared to the actual test norms. The resulting analysis indicated that, "scores for the total sample were significantly lower than the published norms for spelling ($M = 88.8$, $p < .001$), and arithmetic ($M = 85.5$, $p < .001$), but not for reading ($M = 96.8$)" (p. 331). They further reported that the presence or absence of a shunt was not a significant differentiating factor in their findings.

In a study by Agness and McLone (1987), 45 myelomeningocele children from the second to the ninth grades were administered the Woodcock Reading Mastery Test (Form A), the KeyMath Diagnostic Arithmetic Test, and the spelling subtest of the Wide Range Achievement Test. They found that learning disabilities in the area of math were far more common than reading or spelling disabilities. Of their sample of 45 children, 20% showed learning disabilities in math calculation, while 36% showed learning disabilities in math reasoning skills. This led the researchers to conclude that children with spina bifida have much greater difficulty with math (especially math reasoning) than with language. As Agness and McLone note:

> The problems that children with spina bifida have with perceptual, visual-motor, and motor problems may make it difficult for a child to carry out arithmetic operations as well as to understand the principles behind the operations. The ability to manipulate numbers and to discover the relationship between numbers is dependent on visual-spatial sequencing and organization. (p. 8)

Memory.

Research indicates that children with spina bifida and hydrocephalus have differential abilities depending upon the nature of the memory task. Parsons (1969), compared hydrocephalic and non-hydrocephalic children on a task involving memory of connective verbal material, rather than random digits. Specifically, the task involved nine sequences of 15 words, which were progressively broken down. They were first presented in a simple sentence, then broken down (according to a method described by Miller and Selfridge, 1950), and finally, presented as single words in random order. Parsons had 71 children, aged six to eight years, divided into four groups: (a) congenital hydrocephalus with no physical handicap; (b) spina bifida with congenital hydrocephalus, paraplegia and/or incontinence; (c) spina bifida with paraplegia and/or incontinence; and, (d) children under hospital care during the investigation, otherwise behaviorally normal. The results indicated no significant differences among the groups. When compared to their non-hydrocephalic counterparts, the hydrocephalic children appeared to perform equally well on this short-term memory task involving recall of connective verbal material.

In similar research, Cull and Wyke (1984), studied the memory function of children with spina bifida and shunted hydrocephalus. In addition to their group of hydrocephalic children, they had a group of children with no physical handicaps who were matched for IQ (mean = 76). A third group consisted of children with no physical handicaps and average intelligence. All three groups consisted of eight boys and two girls, ranging in age from seven to nine years. They assessed four types of memory function: (a) verbal and non-meaningful (unrelated words - nouns); (b) verbal and meaningful (short story); (c) non-verbal and non-meaningful (nonsense shapes); and, (d) non-verbal and meaningful (faces).

In summarizing their results, Cull and Wyke stated that, "In comparison with children of normal intelligence, the group with spina bifida and treated hydrocephalus showed deficits in their ability to learn, store and retrieve information - except for their ability to learn and store meaningful verbal information." (p. 180) Regarding this exception, Cull and Wyke noted a difference in the hydrocephalic children's performance on verbal memory tasks, when compared with children of normal intelligence versus the group matched for IQ level. On a task involving the retelling of a short story over a short period of time, the hydrocephalic children did as well as the children of normal intelligence. However, on a task involving the learning and recalling of a list of unrelated words, the hydrocephalic children did worse than the matched IQ control group. This suggests that the presence of contextual cues plays an important role in the memory abilities of hydrocephalic children with spina bifida. As the researchers noted:

> When meaningful connected material is presented, learning is efficient because contextual cues are present. On the other hand, when recalling a list of unrelated words, learning will depend on the ability to use semantic strategies in order to encode and retain the stems . . . It is possible, therefore, that poor performance by hydrocephalic children in recalling unconnected nouns reflects a lack of ability to use appropriate semantic strategies at the level of encoding. (p. 181)

Verbal Abilities.

If there is one area of intellectual functioning in which children with spina bifida and hydrocephalus, and children with spina bifida in general, *appear* to have a relative strength, it is in the area of verbal skills. However, despite fairly good skills in the areas of acquisition of vocabulary and the development of syntax, their comprehension still tends to be below average (Anderson & Spain, 1977). As Anderson and Spain note, "About 20% of spina bifida children show markedly hyperverbal behavior. Although superficially fluent, their comprehension of language is often very poor and the content of what they say inappropriate and even bizarre." (p. 303)

Kauffman and Hallahan (1981) suggested that SBH children often show a wide discrepancy between their verbal and performance abilities. However, the research is by no means unanimous regarding the statistical significance of such a verbal/performance discrepancy. Some researchers have suggested that children with hydrocephalus obtain significantly lower Performance than Verbal IQ's on the Wechsler scales (Badell-Ribera et al, 1966; Tew & Laurence, 1975; Mayers, 1976). Other research however, fails to support such a finding (Keller et al, 1979; Tew, 1973).

Table 2.5 contains IQ scores from a number of studies using a variety of standardized intelligence measures. This table also indicates the major characteristics of the samples in each of the studies. As can be seen from the results presented, the verbal scores of children with spina bifida are not always significantly lower than their nonverbal scores. It would seem safe to conclude however, that SBH children's Verbal scores are *generally* superior to their Performance (non-verbal) scores (Anderson, 1973), although this difference may or may not reach statistical significance.

Table 2.5 also reveals that, in children with arrested or shunted hydrocephalus, Verbal IQ scores fall between 78 and 90 (Hurley et al, 1973; Keller et al, 1979; Tew & Laurence, 1975), with only one exception (a Verbal score of 94 reported by Badell-Ribera et al, 1966). It would appear that even if verbal abilities are a relative strength for SBH children, when compared to non-SBH children, their scores are still significantly below average.

TABLE 2.5

IQ Scores from Various Studies

Author	Instrument	Scores (SD)	Sample Char.'s
Anderson ('76)	WISC	FS = 88	Spina Bifida (SB)
Dennis et al ('81)	WISC, WISC-R	FS = 90.8 (13.3) V = 96.2 (13.8) P = 86.6 (13.7)	Hydrocephalic (Hydro.)
Hurley et al ('83)	WISC-R, WAIS	FS = 77.6 (12.4) V = 82.4 (12.8) P = 75.4 (13.8)	SB/Hydro.
Tew & Laurence ('75)	WPPSI	FS = 70 (21.8) V = 78.1 (20.2) P = 67.1 (19.0)	SB/Shunted Hydro.
		FS = 83.9 (21.7) V = 87.5 (21.6) P = 81.5(20.2)	SB/Arrested Hydro.
		FS = 89.9 (25.1) V = 89.3 (22.7) P = 92.3 (24.4)	SB/Non-Hydro.
Sand et al ('74)	IQ	FS = 87.7 (16.2)	Myelomeningocele (MM)/Hydro.
	IQ	FS = 112.1 (12.1)	MM/Non-Hydro.
Tew ('77)	WISC	FS = 84.5 (22.9) V = 89.1 (21.6) P = 82.3 (22.6)	SB
Shaffer et al ('85)	WISC	FS = 92 (17.6) V = 95.6 (18.3) P = 89.4 (16.7)	MM/Hydro. & Non-Hydro.

TABLE 2.5
(Cont'd)
IQ Scores from Various Studies

Author	Instrument	Scores (SD)	Sample Char.'s
Parsons ('69)	SB:L-M	IQ = 91 (13)	SB/Hydro.
Soare & Raimondi ('77)	SB:L-M	IQ = 88	MM/Hydro.
		IQ = 102	MM/Non-Hydro.
Badell-Ribera et al ('66)	WISC	FS = 87 V = 94 P = 81	SB/Arrested Hydro.
		FS = 109 V = 111 P = 106	SB/Non-Hydro.
Keller et al ('79)	WISC	FS = 76 V = 81 P = 76	SB/Hydro.
		FS = 86 V = 90 P = 85	SB/Arrested Hydro.
		FS = 90 V = 90 P = 91	SB/Non-Hydro.

Summary of Intellectual Functioning of SBH Children

Although direct comparison between studies is sometimes hampered by methodological differences (sample characteristics, diagnostic criteria, measurement tools, etc.), some findings seem to persist. The literature reported suggests the following areas of weakness in the functioning of SBH children, *as a group*: overall intellectual ability, fine-motor control, eye-hand coordination, figure-ground discrimination, attention, verbal comprehension, arithmetic, short-term memory for non-verbal material, and short-term memory for non-connective verbal material (i.e., words in isolation). In addition, it appears that verbal tasks found on the Wechsler and other intelligence scales may represent a relative strength for SBH children, although the difference between their verbal and non-verbal abilities may or may not be significant. Anderson and Spain (1977) offer the following summary:

> The main intellectual impairments of spina bifida children, especially those with hydrocephalus are in perceptual and visuo-motor skills. Distinguishing figure from background is difficult for many, and the children tend to be slower than normal in other perceptual tasks. Impairment on tasks requiring eye-hand coordination ability is evident from an early age; poor hand function is partly responsible but the children almost certainly have impaired ability in planning and organizing their movements in space. (p. 303)

The research presented thus far suggests that SBH children, in general, have lower than average IQ scores on standardized assessment measures. In addition, the research implicates the associated hydrocephalus more strongly than the physical disability. However, the absence of hydrocephalus does not appear to be a guarantee of average intellectual functioning. Finally, one must always be mindful of the fact that not all SBH children will exhibit, to the same degree, the aforementioned intellectual strengths and weaknesses. This population is characterized by a great degree of within-group variability, with intelligence levels ranging from profound retardation to giftedness (Korabek & Cuvo, 1981).

Binet IV Subtest Rationale

In order to formulate hypotheses as to the performance of SBH children on the Binet IV, factors involved in performance of the Binet IV subtests must be addressed. Sattler (1988) discusses the rationale for the Binet IV subtests, grouped together here according to Area Standard Age Scores (SAS), and including only those subtests appropriate for ages 5-11 (the age range of the present SBH sample).

Verbal Area SAS.

Vocabulary - Oral Vocabulary (Part 1): measures learning ability, fund of information, richness of ideas, memory, concept formation, and language development; Picture Vocabulary (Part 2): involves visual perception, verbal retrieval, and word recall abilities.

Comprehension - Responses reflect knowledge of conventional standards of behavior, level of development of moral sense. Pointing items involve an understanding of the proper location of body parts.

Absurdities - Success depends on perception of detail, alertness, concentration, and social understanding, understanding right and wrong, and the ability to delay impulses.

Abstract/Visual Reasoning Area SAS.

Pattern Analysis - A nonverbal concept formation task involving perceptual organization, spatial visualization, abstract conceptualization; also a constructional task requiring spatial relations and figure-ground separation. Form board items measure visual-motor ability and recognition and manipulation of forms.

Copying - Involves visual-motor ability and eye-hand coordination; appropriate fine-motor development, perceptual discrimination, and integration of perceptual and motor processes.

Matrices - Measures perceptual reasoning ability, analogic reasoning; attention to detail and concentration are required; spatial ability may be involved.

Quantitative Reasoning Area SAS.

Quantitative - Involves numerical reasoning, ability to solve math problems; taps memory and prior learning, requires concentration; measures information-processing strategies; requires use of non-cognitive functions (concentration and attention) in conjunction with cognitive factors (knowledge of numerical operations). Subtest items 1-3, and 6-8 require perceptual discriminations and appear to measure nonverbal reasoning ability.

Number Series - Involves logical reasoning, concentration when using numbers, and an understanding of relationships between sets of numbers.

Short-Term Memory Area SAS.

Bead Memory - Involves short-term memory for visual stimuli, form perception and discrimination, spatial relations and alertness to detail. Success requires attention and concentration, and eye-hand coordination to place beads on a stick.

Memory for Sentences - Measures immediate recall and attention. Short-term auditory memory is involved which includes attention, concentration, listening comprehension, and auditory processing.

Memory for Digits - Measure of short-term auditory memory and attention. Digits forward involves rote learning and memory; digits reversed requires more transformation of stimulus input prior to recall.

Memory for Objects - Measures immediate recall and attention. This task measures short-term visual memory which involves attention, concentration, visual comprehension, and visual processing.

Binet IV Factor Scores

Factor analysis of the Binet IV has identified three factors: Verbal Comprehension, Nonverbal Reasoning/Visualization, and Memory (Sattler, 1988). The Memory factor, however, does not operate in the two to six year old range. Sattler describes the three factors as follows:

> The Verbal Comprehension factor score measures verbal knowledge and understanding obtained by formal and informal education and reflects the ability to apply verbal skills to new situations. The Nonverbal Reasoning/Visualization factor scores reflects the ability to interpret and organize visually perceived material, to perform basic arithmetic operations using visual cues or verbal cues, to visualize patterns, to demonstrate visual-motor skills, and to use reasoning to solve problems. Both reasoning and visualization are key components of this factor. The Memory factor measures the ability to attend and concentrate, or short-term memory, but also may involve sequencing skills. (p. 256)

Sattler suggests analysis of Binet IV results on the basis of the factor scores, stating: "The most reliable estimates of specific abilities are derived from the Verbal Comprehension factor, Nonverbal Reasoning/Visualization factor, and Memory factor, not from the individual subtest scores" (p. 275). Sattler also lists the appropriate combinations of subtests to obtain the various factor scores. The combinations, for the age range of the present sample (5-11), are outlined in Table 2.6.

TABLE 2.6

Binet IV Subtest Combinations for Factor Scores
at Various Age Levels
(adapted from Sattler, 1988)

FACTOR	AGE RANGE	SUBTESTS
Verbal Comprehension	2-7	Vocabulary Comprehension Absurdities Memory For Sentences
	8-14	Vocabulary Comprehension Absurdities
Nonverbal Reasoning/ Visualization	2-11	Pattern Analysis Copying Quantitative Bead Memory
Memory	7	Memory For Digits Memory For Objects
	8-23	Memory For Sentences Memory For Digits Memory For Objects

Hypotheses

The following hypotheses are generated on the basis of what has been reported in this literature review regarding: (1) the overall and specific intellectual functioning of SBH children, (2) the Binet IV subtest rationale, and (3) the Binet IV Area and factor scores.

Hypothesis #1: The mean Composite Standard Age Score (SAS) of the SBH group will be significantly lower than the mean of the standardization sample sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

Hypothesis #2: The mean Abstract/Visual Reasoning Area SAS of the SBH group will be significantly lower than mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

Hypothesis #3: The mean Quantitative Reasoning Area SAS of the SBH group will be significantly lower than the mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

Hypothesis #4: The mean Nonverbal Reasoning/Visualization factor score of the SBH group will be significantly lower than the theoretical mean of 100 (SD 16).

Hypothesis #5: The mean Verbal Reasoning Area SAS of the SBH group, will be significantly lower than the mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

Hypothesis #6: The mean Verbal Comprehension factor score of the SBH group will be significantly lower than the theoretical mean of 100 (SD 16).

The null hypothesis was adopted for hypotheses 7 through 10, as the research investigated was not conclusive enough to warrant a directional hypothesis.

Hypothesis #7: Ho: There will be no statistically significant difference between the mean Short-Term Memory Area SAS of the SBH group, and the mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

Hypothesis #8: Ho: There will be no statistically significant difference between the mean Memory factor score (for those ages 7-10) of the SBH group, and the theoretical mean of 100 (SD 16).

Hypothesis #9: Ho: There will be no statistically significant difference between the Verbal Reasoning SAS and Abstract/Visual Reasoning SAS of the SBH group.

Hypothesis #10: Ho: There will be no statistically significant difference between the Verbal Comprehension and Nonverbal Reasoning factor scores of the SBH group.

Hypothesis #11: As the Binet IV Memory for Sentences subtest involves verbal connective material, the mean Memory for Sentences subtest score for the SBH group will not differ significantly from the mean Memory for Sentences subtest score of the standardization sample as reported in the Binet IV Technical Manual.

Hypothesis #12: There will be a significant positive correlation between the mean Binet IV Copying subtest score, and the mean Beery standard score.

Hypothesis #13: There will be a significant positive correlation between the mean Binet IV Vocabulary subtest score, and the mean PPVT-R standard score.

Hypothesis #14: There will be significant positive correlations between the mean Binet IV Composite SAS, and the four mean Area SAS's.

Hypothesis #15: There will be significant positive correlations between the mean Binet IV Composite SAS, and the three mean factor scores.

Chapter 3

Research Design and Procedures

Procedure

Following approval of the ethics committees of the Glenrose Rehabilitation Hospital and the University of Alberta, a letter outlining the purpose and scope of the proposed research was sent to the parents or guardians of the 28 children in the original SBH sample (see p. 39 and Appendix A). These letters were sent out through the Glenrose Rehabilitation Hospital, and were followed by a phone call to confirm the letter had been received, and to discuss parental consent. No assessments were conducted without the fully informed and voluntary consent of the children's parents or guardians. Once parental consent was obtained, appointments for assessments were arranged through the Glenrose Rehabilitation Hospital and University of Alberta Education Clinic. Only 2 of the 28 children in the original SBH sample were not assessed, due to lack of parental consent.

Data collection for the remaining 26 subjects, involved the administration, according to standardized procedures, of the Stanford-Binet Intelligence Scale: Fourth Edition (Binet IV), the Beery Developmental Test of Visual-Motor Integration (Beery), and the Peabody Picture Vocabulary Test-Revised (PPVT-R). The assessments took place over a six month period, commencing in November, 1988. The assessments were conducted by the author and student clinicians enrolled in Educational Psychology at the Master's Level at the University of Alberta. All student clinicians were attending the Fall/Winter 1988-1989 session of the Educational Psychology 524 assessment course. As previously noted, the administration time for the Binet IV varied from one to one and one-half hours depending on the age of the child. Both supplementary tests, the Beery and PPVT-R, required approximately ten to fifteen minutes each to administer, thus bringing the total assessment time to between one and one-half to two hours. The assessments took place either at the child's school or at the Glenrose Rehabilitation Hospital. Three cases were not included in the final data analysis: the results from two of the cases were considered outliers - one with an extremely high Composite IQ (124) and one with an extremely low Composite IQ (36); the results from the other case were not included due to insufficient data required to accurately calculate the Quantitative Area SAS, and the Composite IQ. As a result, the final SBH group consisted of 23 cases.

Data collected in this study were treated with the utmost confidentiality. The parents of the participating children were made aware that the assessment results would only be available to the researcher, the University of Alberta Department of Educational Psychology, and Dr. David Erickson (Psychologist at the Glenrose Rehabilitation Hospital Spina Bifida Clinic). Subject's names were recorded in order that Dr. Erickson could identify the children and thus make use of the assessment results. No names were reported, or used in any way, by the Department of Educational Psychology or the researcher, only the results themselves were reported.

<u>Sample</u>

As noted earlier, the original sample consisted of 28 children with spina bifida and hydrocephalus (SBH) from five to eleven years of age, inclusive, at the time the research was initiated. All of these children were registered with the Spina Bifida Clinic at the Glenrose Rehabilitation Hospital in Edmonton, Alberta. This group represented the entire population of such children in Northern Alberta, and slightly over 50 % of the entire provincial total (D. V. Erickson, personal communication, February, 1988). All of the children with spina bifida in this group had been diagnosed as having shunted hydrocephalus - the presence of a shunt being the most accurate indicator of significant hydrocephalus for this group (Keller et al, 1979). The diagnosis of shunted hydrocephalus was made by the Spina Bifida Clinic on the basis of a review of medical records.

The final sample for which data will be reported, consisted of 23 SBH children. Of these, 17 were female (74%), and 6 were male (26%). Table 2 in Appendix B outlines the distribution of the sample by Gender. The greater percentage of female subjects in the current sample reflects the trend in the population of a higher incidence of spina bifida among females. As Anderson and Spain (1977) note:

> It is a well-established finding in the literature on handicap that the incidence of handicapping conditions (for example cerebral palsy, severe subnormality, autism or speech disorders) is higher among boys. Surprisingly, this relationship does not hold for spina bifida or related congenital malformations where more girls are born than boys (the ratio being appx. 1.3:1)." (p. 121)

In the present sample, the ratio of females to males is approximately 2.8:1. Although this ratio is higher than that reported in the literature, it does reflect the general finding of a greater incidence of spina bifida among females.

Lonton (1985) investigated sex differences between male and female spina bifida patients. In that study, there was a 4% greater incidence of females with myelomeningocele, a difference which "barely achieves statistical significance" (p.34). Lonton concluded by noting:

> The marked similarity of male and female characteristics is the most outstanding impression gained from analysis of the physical and intellectual data on the four groups of patients with neural tube malformations. Hardly any significant differences between the sexes were found with the meningocele, encephalocele and lipoma groups. Myelomeningocele females had significantly lower IQ's, smaller heads, thinner brains and higher lesions, but the differences were very small in absolute terms, and are very similar to reported sex differences in the non-handicapped population. The differences though statistically significant were clinically inconsequential. (p.36)

The mean age of the present sample was 8.6 years (Females - 8.8 years, Males - 8.2 years). The ages ranged from five years, three months, to eleven years, one month. Table 1 in

Appendix B outlines the distribution of the sample by age. The mean grade level for the sample was 2.5. Grade levels ranged from kindergarten to grade four for the males (mean grade = 2.3), and kindergarten to grade five for the females (mean grade = 2.6). Tables 1 and 2 (Appendix B), summarize the demographic characteristics of the current sample.

Tests Administered

Stanford-Binet Intelligence Scale: Fourth Edition.

The Stanford-Binet Intelligence Scale: Fourth Edition (1986) (Binet IV), was administered to each of the children in the research sample. This instrument represents an extensive revision of the 1960 Stanford-Binet Intelligence Scale: Form L-M. Continuity with the earlier edition was maintained in part by the retention of many of the item types from the earlier form. The adaptive-testing format was retained, so that individuals are administered only those items whose difficulty is appropriate to his or her performance level. In addition, the Binet's continuous scale for measuring cognitive development from ages two to adult was retained (Thorndike, Hagen & Sattler, 1986b). Sweetland and Keyser (1986) provide a thorough and concise description of the Binet IV:

> [A] Verbal and nonverbal performance test assessing mental abilities in four areas: verbal reasoning (vocabulary, comprehension, verbal relations, absurdities), abstract/visual reasoning (pattern analysis, matrices, paper folding and cutting, copying), quantitative comprehension (quantitative, number series, equation building), and short-term memory (memory for sentences, memory for digits, memory for objects, and bead memory). Items are arranged according to item type and order of difficulty. (p. 32)

The administration time is approximately one to one and one-half hours for individuals ages two to eight, and one and one-half hours for individuals eight years and up (Meloff, 1987). The following scores may be obtained on the Binet IV: raw and scaled scores (Standard Age Scores) for each of the 15 subtests: four Area scores, a composite of the four Area scores, a composite of any combination of the four Area scores, and a profile on all 15 subtests (Sweetland & Keyser, 1986). For the purposes of the present research, the scores of interest were the Composite score, the four Area scores, and three factor scores obtained through various combinations of subtest scores.

The standardization sample for the Binet IV consisted of five thousand individuals between the ages of two and twenty-three years inclusive, tested in forty-seven U.S. states. The sample was stratified to match proportions on the 1980 U.S. Census on five variables: geographic region, community size, ethnicity, sex, and age.

The reliability of the Binet IV was reported on the basis of internal consistency and test-retest reliability (Meloff, 1987). The Kuder-Richardson Formula 20 was used to assess internal consistency. The Composite Standard Age Score was found to have reliabilities ranging from .95 to .99 as the age of the individual increases. Area scores (Verbal reasoning, Abstract/Visual reasoning, Quantitative reasoning, and Short Term Memory) had reliabilities ranging from .91 to .97, as the number of subtests within each category increased. Individual subtest reliabilities were in the .80's and .90's, except for Memory for Objects at .73, and, according to the authors, may yield important diagnostic information. In general, reliabilities tended to increase with age.

Test-retest reliabilities were obtained by retesting 112 children, 57 five-year-olds and 55 eight-year-olds. For the five-year-olds, test-retest correlations for Area scores ranged from .71 to .88, with a correlation of .91 for the Composite score. The correlations for the eight-year-olds were .51 to .87 for the Area scores, and .91 for the composite. The technical manual provides information regarding correlations of the Binet IV with the Stanford-Binet L-M, WISC-R, WAIS-R, WPPSI, and K-ABC. Correlations between the Area scores of the Binet IV and L-M range from .56 to .76, and .81 for the Composite of Binet IV with L-M. The correlations between the Binet IV Composite and the WISC-R Verbal is .78, Performance .73, and Full Scale .83. The Binet IV Composite correlation with WPPSI Verbal is .78, Performance .71, and Full Scale .80. For the Binet IV Composite and WAIS-R, the correlation with Verbal is .90, Performance .85, and Full Scale .91. Correlations between Binet IV Composite and K-ABC range from .82 to .89.

Tables 3.1 and 3.2 contain correlations, as reported by Janzen (1988), between the Binet IV and the WISC-R for children ages 6 to 9, and 9 to 13, respectively. Children were referred for psychoeducational testing to the Education Clinic at the University of Alberta.

TABLE 3.1

Correlations Between Binet IV and
WISC-R for Six to Nine Year Olds
(adapted from Janzen, 1988)

BINET IV	'r'	WISC-R
Verbal Reasoning IQ	.81	Verbal IQ
Abstract/Vis. Reas. IQ	.69	Performance IQ
Quantitative Reas. IQ	.69	Verbal IQ
Short-Term Memory IQ	.59	Verbal IQ
Composite IQ	.87	Full Scale IQ

TABLE 3.2

Correlations Between Binet IV and
WISC-R for Nine to Thirteen Year Olds
(adapted from Janzen, 1988)

BINET IV	'r'	WISC-R
Verbal Reasoning IQ	.89	Verbal IQ
Abstract/Vis. Reas. IQ	.80	Performance IQ
Quantitative Reas. IQ	.81	Verbal IQ
Short-Term Memory IQ	.79	Verbal IQ
Composite IQ	.91	Full Scale IQ

The Binet IV appears to have good validity for children with spina bifida, since the nature of the disability does not prevent them from attempting all appropriate tasks on the Binet IV. Generally, "as the major physical handicaps in spina bifida are usually below the waist, pencil and paper tests appear to be suitable" (Parsons, 1972, p. 101). Standardized procedures were therefore not altered in administration of the instrument.

Beery Developmental Test of Visual-Motor Integration.

The Beery Developmental Test of Visual-Motor Integration (Beery) is a measure of perceptual-motor skills. The test requires the examinee to copy up to 24 geometric figures of increasing developmental difficulty. According to Cosden (1985), the Beery is used:

> To assess children's or adult's perceptual motor skills by obtaining measures of their ability to copy designs in a structured format (i.e., within given boundaries on a page). Using an objective scoring system, the test can be used to determine a child's developmental level with regard to this perceptual motor skill. (p. 230)

Raw scores on the Beery are converted into standard scores with a mean of ten and standard deviation of three. In addition, percentile ranks and age equivalent scores are provided (Sattler, 1988).

Peabody Picture Vocabulary Test - Revised.

The Peabody Picture Vocabulary Test - Revised (PPVT-R) is a non-verbal test of receptive vocabulary. According to Umberger (1985), the PPVT-R can also be viewed as:

> 1) a scholastic aptitude test in that it gives a quick estimate of one aspect of verbal ability; 2) a measurement of one facet of general intelligence: vocabulary; 3) one of the best single indices of school success, due to the vocabulary; and 4) an achievement test in that it shows the extent of English vocabulary acquisition. (p. 491)

A major advantage of this test is that the designs are clearly drawn and free from fine detail (eliminating figure-ground confusion), therefore individuals with perceptual impairments are able to perform the tasks (Umberger, 1985). Raw scores on the PPVT-R are converted to standard scores with a mean of 10 and a standard deviation of 15, and range from 40 to 160 (Sattler, 1988).

Data Analysis

A sequential testing strategy was chosen to investigate differences between the means of the SBH group and standardization sample. First, a Hotelling T^2 test was utilized to measure for significant differences between the SBH group and standardization sample on the following sets of variables: Area scores (4), subtest scores (12). The SBH group means were compared to the theoretical population means for the three factor scores using a method of analysis which takes into account the correlations between all of the variables involved. The author of the computer program utilized for this analysis (Hunka, 1987), provides the following description:

> The dependent sample T^2 test is the multivariate equivalent of the univariate 't' test for dependent samples. When a number of measurements have been made on the same subjects, the multivariate test is preferred to the repeated application of the univariate 't' test. This program also calculates the Scheffe confidence interval for each variable. (p. 1)

Second, in the case of a significant Hotelling T^2 test, further univariate 'z' tests were performed. For directional hypotheses, one-tailed z-tests ($z = \pm 1.65$) were performed; and for null hypotheses, two-tailed tests ($z = \pm 1.96$) were utilized (Glass & Hopkins, 1984). For the Binet IV Composite IQ score, a univariate z-test (one-tailed) was used to test for a significant difference between the SBH and normative sample means.

In order to tests for significant differences between Area and factor scores within the SBH group, t-tests were performed. These were calculated using the SPSS-X 3.0 statistical package for IBM-MTS.

Pearson-Product Moment Correlation matrices were created to analyze correlations within the SBH group on the various Binet IV results, and results from the supplementary tests (Beery, PPVT-R).

The three factor scores for the SBH group were calculated using the method outlined in Sattler (1988). Sattler's method is based upon "the results obtained from principal components analysis with varimax rotation of the 15 subtests of the SB:FE" (p. 255). He notes that this analysis differs from that presented in the technical manual. He notes further that factors developed using the principal components analysis are more useful in guiding interpretations necessary for clinical and psychoeducational assessment. A key feature of the factor structure of the Binet IV is that it differs across various age groups. This is due to the fact that the subtests on the Binet IV are not continuous throughout the scale, in that different subtests are administered to subjects of different ages. In particular, for ages 2-6, a two factor structure (Verbal Comprehension and Nonverbal Reasoning/Visualization) is utilized. For ages 7-23, a third factor, Memory, is added. Table 2.6 summarizes Sattler's suggested subtest configurations for the various ages and factors.

To calculate the factor scores, the "Worksheet for Computing Factor Scores", found on pp. 260-261 of Sattler (1988), was utilized. This method involves: (1) adding the standard scores of the appropriate subtests (as per Table 2.6), and grouping them according to the Areas within which they fall; (2) accessing the appropriate tables (pp. 183-186), in the *Guide for Administering and Scoring* (Thorndike, R., Hagen, E., & Sattler, J., 1986a), to calculate the Area SAS's for the subtests involved; (3) adding these SAS's and using the figure, and number of Area scores, to calculate the factor score using the appropriate table (pp.187-188) in the *Guide*. For example, the following steps were taken to calculate the

Nonverbal Reasoning/Visualization factor score for the male case study to be presented at the end of Chapter Four:

Step 1: Sum of subtest Standard Scores. As per Table 2.6, add the standard scores of the Pattern Analysis (51), and Copying (35) subtests = 86. The standard score of the Quantitative subtest = 43. Finally, the standard score of the Bead Memory subtest = 34.
Step 2: Area Standard Age Scores (SAS). Page 184 of the Guide indicates that the Abstract/Visual Reasoning SAS for two subtests totalling 86 = 84. For the Quantitative and Bead Memory subtests, the subtest standard scores can be multiplied by 2 to calculate the Quantitative (86), and Short-Term Memory (68) Area SAS's, respectively.
Step 3: Factor score. Add the Area SAS's calculated in Step 2, and refer to page 187 (for children ages 2-0-0 to 9-11-15) to calculate the score for three Area SAS's with a total of 238 (84+86+68). Therefore, in this example the Nonverbal Reasoning/Visualization factor score = 76.

Delimitations and Limitations of the Study

The focus of the present study was upon the intellectual functioning of a specific group of special needs children. Children with spina bifida and shunted hydrocephalus (SBH) were assessed using the recently published Binet IV. The age range of the sample was restricted to those SBH children who were of school entry and elementary school age. Only those SBH children who were registered with the Spina Bifida Clinic at the Glenrose Rehabilitation Hospital in Edmonton were included in the sample.

Several limitations must be noted when considering the results of the present research:

1. No distinction was made between hydrocephalus of varying degree or severity, nor for the timing of shunt insertion, nor for any complications which may have arisen around the shunt insertion or apart from it (i.e. CNS infection). Clearly, such issues could have a potentially large impact on a child's performance on the Binet IV or any other instrument.

2. Due to the age range and cognitive functioning of the SBH sample, only a small number of subjects obtained results for the Matrices (n = 6) and Number Series (n = 9) subtests.

3. As there was no non-hydrocephalic spina bifida group to compare to the SBH group, statements regarding the specific effect of hydrocephalus must be made cautiously.

Chapter 4

Results

The findings are presented in six main sections, corresponding to the hypotheses presented earlier (see Chapter Two). The intent of the objectives and hypotheses was to focus principally upon the similarities and differences between the results of the present sample of children with spina bifida and hydrocephalus (SBH), and the Binet IV standardization sample. The variables addressed included the Binet IV Composite score, four Area scores, three factor scores, and selected subtest and supplemental test results. In the case of the three factor scores, the SBH group results were compared to the theoretical mean and standard deviation, as no results were reported regarding the standardization sample's factor scores. Appendix C contains correlational results which do not correspond to any research questions or hypotheses.

SBH Group Results

Table 4.1 summarizes the test data from the present sample of 23 SBH children. As noted earlier, this sample consisted of 17 females (74%), and 6 males (26%), giving a female:male ratio of 2.8:1. The age range for the total sample was between five years, three months to eleven years, one month. The mean age of the total sample was 8.6 years, with a mean of 8.8 for the females, and 8.2 for the males. Tables 1 and 2 in Appendix B summarize these results. The grade levels for the males ranged from kindergarten to grade four, and for the females from kindergarten to grade five. The average grade level for the sample was 2.5.

The overall mean Binet IV Composite IQ was 88.0, with a standard deviation of 11.4. The Composite IQ scores ranged from a low of 65 to a high of 110. According to Sattler (1988), these scores would fall within the Mentally Retarded and Average ranges, respectively. The mean Composite of 88.0 would fall within the Low Average range.

With respect to the four Area SAS's, the SBH group's mean scores ranged from a high of 92.9 on Visual Reasoning, to a low of 85.0 on Abstract/Visual Reasoning. The group's mean scores on the remaining two Areas of Quantitative Reasoning and Short-Term Memory were 92.2 and 89.5, respectively.

On the three factor scores, the highest mean score was obtained on the Memory factor (94.4). The Verbal Comprehension mean score was 90.4, while the lowest factor score was obtained on the Nonverbal Reasoning/Visualization factor (85.9).

At the subtest level, the mean standard scores ranged from a low of 41.5 on Copying, to a high of 49.7 on Matrices. It is important to keep in mind however, that not all subjects were administered all of the 12 subtests listed. Only 6 were administered the Matrices subtest, 9 were given Number Series, 18 Memory for Digits, and 14 Memory for Objects.

The results of the PPVT-R revealed a mean standard score of 94.0, with a standard deviation of 13.0. The mean percentile and stanine were 39 and 4.3, respectively. The mean age-equivalent was 8.1 years.

The results of the Beery DTVMI revealed a mean standard score of 5.7, with a standard deviation of 2.5. The mean percentile score was 16.6. The mean age-equivalent was 6.2 years.

Following are the results of detailed analysis of the performance of the SBH group relative to the Binet IV standardization sample.

TABLE 4.1

Frequencies, Means and Standard Deviations
for All Variables (SBH Group)

	N	Mean	SD
BINET Composite IQ	23	88.0	11.4
BINET Verbal Reasoning IQ	23	92.9	11.8
BINET Abstract/Vis. Reas. IQ	23	85.0	10.3
BINET Quantitative Reas. IQ	23	92.2	11.2
BINET Short-Term Memory IQ	23	89.5	13.6
BINET Vocabulary	23	47.8	6.3
BINET Comprehension	23	47.5	6.7
BINET Absurdities	23	45.3	6.9
BINET Pattern Analysis	23	45.1	6.0
BINET Copying	23	41.5	5.7
BINET Matrices	6	49.7	3.9
BINET Quantitative	23	46.1	5.5
BINET Number Series	9	47.0	5.5
BINET Bead Memory	23	43.3	7.8
BINET Memory For Sentences	23	46.5	8.0
BINET Memory For Digits	18	46.6	5.4
BINET Memory For Objects	14	48.9	6.1
Verbal Comprehension Factor	23	90.4	13.3
NVerb/Visual. Factor	23	85.9	11.3
Memory Factor	17	94.4	11.8
Age in Months	23	103.7	20.1

TABLE 4.1 (cont'd)

Frequencies, Means and Standard Deviations
for All Variables (SBH Group)

	N	Mean	SD
PPVT-R Standard Score	23	94.0	13.0
PPVT-R Percentile	23	39.0	24.9
PPVT-R Stanine	23	4.3	1.7
PPVT-R Age-Equivalent (Mnths)	23	97.3	29.7
BEERY Percentile	23	16.6	18.5
BEERY Standard Score	23	5.7	2.5
BEERY Age-Equivalent (Mnths)	23	74.2	17.8

The first section will focus on the Binet IV Composite IQ, and hypothesis one. Hypotheses two, three, five, and seven, are discussed in the second section, dealing with the four Binet IV Area scores. The third section focuses on the three factor scores from the Binet IV and upon hypotheses four, six, and eight. The fourth section focuses upon the only hypothesis (eleven), which addresses an individual Binet IV subtest result. The fifth section, and hypotheses nine and ten, address the verbal/performance discrepancy, in terms of the SBH group's Verbal Reasoning and Abstract/Visual Reasoning SAS's, and Verbal Comprehension and Nonverbal Reasoning factor scores. The sixth, and final section, focuses upon correlational relationships between various Binet IV results, and supplemental test results. Hypotheses twelve through fifteen are addressed in this section.

Means and standard deviations for the SBH group and the Binet IV standardization sample on the Binet IV Composite, Area and factor scores are contained in Table 4.2. Table 4.3 contains the results of the multivariate Hotelling T^2 tests utilized to examine the four Area scores, twelve subtest scores, and three factor scores. Tables 4.4, 4.5, 4.6, and 4.7, contain the results of z-tests conducted on the SBH and standardization samples for the Composite, Area, factor, and subtest scores, respectively. Tables 4.8 and 4.9 contain the results of t-tests comparing the SBH group's Area and factor scores, respectively. Table 4.10 contains the Beery and PPVT-R results for the SBH group. Tables 4.11 and 4.12 contain the results of Pearson-Product Moment Correlations (SBH group) between selected Binet IV subtests, and standard scores from the Beery and PPVT-R, respectively. Finally, Tables 4.13 and 4.14 contain the correlations between the SBH group's Binet IV Composite IQ and four Area scores, and three factor scores, respectively.

Table 4.2 contains the results of the comparison between the children with spina bifida and hydrocephalus (SBH), and the Binet IV standardization sample (or in some cases comparing the SBH results to the theoretical norms). This table summarizes the major findings of the present study.

TABLE 4.2

Comparison of SBH and Binet IV Standardization Sample on Binet IV Composite IQ, Area Scores, and Factor Scores

	SBH Group			Standardization Sample*		
	N	Mean	SD	N**	Mean	SD
COMPOSITE IQ	23	88.0	11.4	2385	99.8	15.7
Verbal Reasoning	23	92.9	11.8	2385	99.9	15.8
Abst./Visual Reasoning	23	85.0	10.3	2385	99.6	16.2
Quantitative Reasoning.	23	92.2	11.2	2385	100.1	15.1
Sh.-Term Memory	23	89.5	13.6	2385	99.6	16.2
Verbal Comp. Factor	23	90.4	13.3	3824	100.0	16.0
NonVerb. Reas. Factor	23	85.9	11.3	3030	100.0	16.0
Memory Factor	17	94.4	11.8	3034	100.0	16.0

*Composite and Area Scores adapted from Thorndike et al (1986b), p.33, Table 4.4
**For Composite and Area Scores, based on ages 5-11 only. For Factor Scores, based on all age groups, using lowest N from subtests included in the calculation of that score

Table 4.3 contains the results of the Hotelling T^2 analysis comparing the SBH group with the standardization sample and theoretical population means on the 4 Area and 12 subtest, and the 3 factor scores, respectively. As is revealed in the Table, the differences were significant ($p < .01$) in all three comparisons. Therefore, further analysis of the differences between the individual Area, subtest, and factor scores was supported. The results of these analyses follow.

TABLE 4.3

Hotelling T^2 Tests
Comparing SBH Group and Standardization Sample on Area and Subtest Scores Comparing SBH Group and Theoretical Population Mean on Factor Scores

	T^2	F	DF1	DF2	p
Area Scores	31.46	6.79	4	19	<0.0014
Subtest Scores	191.66	7.99	12	11	<0.0008
Factor Scores	40.95	12.41	3	20	<0.0001

Binet IV Composite IQ Score

The first set of results focus upon the most reliable of the scores calculated from the Binet IV, the Composite IQ. Hypothesis one addresses this result.

Hypothesis 1

The mean Composite Standard Age Score (SAS) of the SBH group will be significantly lower than the mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

TABLE 4.4

Z-Test
SBH Group and Binet IV Standardization Sample
on Binet IV Composite IQ

	SBH Group			Standardization Sample*				
	N	Mean	SD	N**	Mean	SD	z	p
COMPOSITE IQ	23	88.0	11.4	2385	99.8	15.7	-3.60	.05

*Composite IQ adapted from Table 4.4, Thorndike et al (1986b), p.33.
**N for Composite score, based on ages 5-11 only.

Mean scores and standard deviations for the SBH group (all variables), have been calculated and reported in Table 4.1 of this study. Table 4.2 contains the means and standard deviations of the SBH and Binet IV standardization sample on the Binet IV Composite, Area, and factor scores. Table 4.4 contains z-test results for the SBH group and Binet IV standardization sample on the Composite IQ.

The data in Table 4.4 reveals that the mean Composite IQ for the SBH group to be 88.0 (SD 11.4), as compared to 99.8 (SD 15.7) for the Binet IV standardization sample (ages 5 through 11). Using z-tests, the Composite IQ for the SBH group was found to be significantly lower ($z = -3.60$, $p < .05$), than that of the Binet IV standardization sample.

Therefore, hypothesis 1 is accepted.

Binet IV Area Standard Age Scores (SAS)

The second area of focus involves the four Area Standard Age Scores (SAS) from the Binet IV. Hypotheses two, three, five, and seven, address the SBH group and standardization sample scores on the four Area SAS's.

Hypothesis 2

The mean Abstract/Visual Reasoning Area SAS of the SBH group will be significantly lower than mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

TABLE 4.5

Z-Tests
SBH Group and Binet IV Standardization Sample
on Binet IV Area Scores

	SBH Group			Standardization sample*			
	N	Mean	SD	N**	Mean	SD	z	p
Verbal Reasoning	23	92.9	11.8	2385	99.9	15.8	-2.13	.05
Abst./Visual Reason.	23	85.0	10.3	2385	99.6	16.2	-4.32	.05
Quantitative Reason.	23	92.2	11.2	2385	100.1	15.1	-2.51	.05
Sh.-Term Memory	23	89.5	13.6	2385	99.6	16.2	-2.99	.05

*Area Scores adapted from Table 4.4, Thorndike et al (1986b), p.33
**N's for Composite and Area Scores, based on ages 5-11 only.

Table 4.5 contains the means, standard deviations, and z-test results for the SBH group and standardization sample on the four Area SAS's. The mean Abstract/Visual Reasoning Area SAS for the SBH group was 85.0 (SD 10.3), as compared to 99.6 (SD 16.2) for the standardization sample. Z-tests revealed that the SBH group's score was significantly lower ($z = -4.32$, $p < .05$) than that of the standardization sample.

Therefore, hypothesis 2 is accepted.

Hypothesis 3

The mean Quantitative Reasoning Area SAS of the SBH group will be significantly lower than the mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

The mean Quantitative Reasoning Area SAS for the SBH group was 92.2 (SD 11.2), as compared to 100.1 (SD 15.1) for the standardization sample. Z-tests revealed that the SBH group's score was significantly lower ($z = -2.51$, $p < .05$) than that of the standardization sample.

Therefore, hypothesis 3 is accepted.

Hypothesis 5

The mean Verbal Reasoning Area SAS of the SBH group, will be significantly lower than the mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

The mean Verbal Reasoning Area SAS for the SBH group was 92.9 (SD 11.8), as compared to 99.9 (SD 15.8) for the standardization sample. Z-tests revealed that the SBH group's score was significantly lower ($z = -2.13$, $p < .05$) than that of the standardization sample.

Therefore, hypothesis 5 is accepted.

The null hypothesis was adopted for the Short-Term Memory SAS, as the research investigated was not conclusive enough to warrant a directional hypothesis.

Hypothesis 7

Ho: There will be no statistically significant difference between the mean Short-Term Memory Area SAS of the SBH group, and the mean of the standardization sample (for the age group of 5 to 11 years) as reported in the Binet IV Technical Manual.

The mean Short-Term Memory Area SAS for the SBH group was 89.5 (SD 13.6), as compared to 99.6 (SD 16.2) for the standardization sample. Z-tests revealed that the SBH group's score was significantly lower (z = -2.99, p < .05) than that of the standardization sample.

Therefore, hypothesis 7 (Ho) is rejected.

Binet IV Factor Scores

The third area of focus involves the three factor scores calculated from the Binet IV. Hypotheses four, six, and eight, address the SBH group and standardization sample scores on the three Binet IV factors.

Hypothesis 4

The mean Nonverbal Reasoning/Visualization factor score of the SBH group will be significantly lower than the theoretical mean of 100 (SD 16).

TABLE 4.6

Z-Tests
SBH Group and Binet IV Standardization Sample
on Binet IV Factor Scores

	SBH Group			Standardization	Sample			
	N	Mean	SD	N**	Mean	SD	z	p
Verbal Comprehension Factor	23	90.4	13.3	5013	100.0	16.0	-2.88	.05
Nonverbal Reasoning Factor	23	85.9	11.3	5013	100.0	16.0	-4.23	.05
Memory Factor	17	94.4	11.8	5013	100.0	16.0	-1.68	NS

**N's for Factor Scores, based on all age groups, using total N from standardization sample, and using the theoretical population mean and standard deviation (SD).

Table 4.6 contains the mean and standard deviation of the SBH group's results on the three Binet IV factors. Table 4.6 also contains z-test results from comparisons between the SBH group scores and the theoretical mean and standard deviation. The mean Nonverbal Reasoning factor score for the SBH group was 85.9 (SD 11.3). Z-tests revealed that the SBH group's score was significantly lower ($z = -4.23$, $p < .05$) than the theoretical mean.

Therefore, hypothesis 4 is accepted.

Hypothesis 6

The mean Verbal Comprehension factor score of the SBH group will be significantly lower than the theoretical mean of 100 (SD 16).

The mean Verbal Comprehension factor score for the SBH group was 90.4 (SD 13.3). Z-tests revealed that the SBH group's mean score was significantly lower ($z = -2.88$, $p < .05$) than the theoretical population mean.

Therefore, hypothesis 6 is accepted.

The null hypothesis was adopted for the Memory factor score, as the research investigated was not conclusive enough to warrant a directional hypothesis.

Hypothesis 8

Ho: There will be no statistically significant difference between the mean Memory factor score (for those ages 7-10) of the SBH group, and the theoretical mean of 100 (SD 16).

The mean Memory factor score for the SBH group was 94.4 (SD 11.8). Z-tests revealed that the SBH group's score did not differ significantly ($z = -1.68$) from the theoretical mean, although it was lower.

Therefore, there is failure to reject hypothesis 8 (Ho).

Binet IV Subtests

The fourth area of focus is upon the subtests of the Binet IV. Given the nature of the research investigated, only a single hypothesis was made regarding the subtest results. Hypothesis eleven addresses this subtest result.

Hypothesis 11

As the Binet IV Memory for Sentences subtest involves verbal connective material, the mean Memory for Sentences subtest score for the SBH group will not differ significantly from the mean Memory for Sentences subtest score of the standardization sample as reported in the Binet IV Technical Manual.

TABLE 4.7

Z-Tests: SBH Group and Binet IV Standardization Sample on Binet IV Subtest Scores.

	SBH Group			Standardization Sample*				
	N	Mean	SD	N**	Mean	SD	z	p
Vocabulary	23	47.8	6.3	5013	50.0	8.1	-1.30	NS
Comprehension	23	47.5	6.7	5013	50.1	8.4	-1.48	NS
Absurdities	23	45.3	6.9	3824	50.0	8.2	-4.27	.05
Pattern Analysis	23	45.1	6.0	5013	49.6	8.1	-2.66	.05
Copying	23	41.5	5.7	3381	49.5	8.1	-4.74	.05
Matrices	6	49.7	3.9	3030	50.0	7.9	-0.09	NS
Quantitative	23	46.1	5.5	5013	49.6	8.4	-2.00	.05
Number Series	9	47.0	5.5	3020	49.9	7.8	-1.12	NS
Bead Memory	23	43.3	7.8	5013	49.9	8.5	-3.72	.05
Mem. for Sentences	23	46.5	8.0	5013	49.5	8.5	-1.69	NS
Mem. for Digits	18	46.6	5.4	3054	50.2	8.0	-1.91	NS
Mem. for Objects	14	48.9	6.1	3034	49.8	7.8	-0.43	NS

*Subtest information adapted from Table 4.3, Thorndike et al (1986b), p.32.
**N's for Subtest Scores, based on all age groups as no differentiation noted in Thorndike et al (1986b).

Table 4.7 contains the subtest scores of the SBH group and the Binet IV standardization sample, as well as the results of z-tests comparing the means. The mean Memory for Sentences subtest score for the SBH group was 46.5 (SD 8.0), as compared to the standardization sample score of 49.5 (SD 8.5). Z-test results indicated that the SBH group score did not differ significantly ($z = -1.69$) from that of the standardization sample, although it was lower.

Therefore, hypothesis 11 is accepted.

Table 4.7 also reveals the following mean subtest scores to be lower than those of the standardization sample, but not to be statistically significant: Vocabulary , Comprehension, Matrices, Number Series, Memory for Digits, and Memory for Objects. The remaining mean subtest scores were significantly lower (at the .05 level): Absurdities, Pattern Analysis, Copying, Quantitative, and Bead Memory.

Verbal-Performance Discrepancy (SBH Group)

The fifth section of results focuses upon the verbal-performance discrepancy as reflected in the SBH group's Verbal Reasoning and Abstract/Visual Reasoning SAS's, and the Verbal Comprehension and Nonverbal Reasoning factor scores. Hypotheses nine and ten will be addressed.

Hypothesis 9

Ho: There will be no statistically significant difference between the Verbal Reasoning SAS and Abstract/Visual Reasoning SAS of the SBH group.

TABLE 4.8

T-Tests
Comparison of Area Scores Within the SBH Group

	t	p
Verbal Reasoning vs. Abstract/Visual Reasoning	3.24	0.004
Verbal Reasoning vs. Quantitative Reasoning	0.35	NS
Verbal Reasoning vs. Short Term Memory	1.79	NS
Abstract/Visual Reasoning vs. Quantitative Reasoning	-2.91	0.008
Abstract/Visual Reasoning vs. Short Term Memory	-1.97	NS
Quantitative Reasoning vs. Short Term Memory	1.11	NS

Table 4.8 contains the results of t-tests comparing the four Area scores within the SBH group. The Verbal Reasoning SAS mean of 92.9 (SD 11.8) was significantly higher ($t = 3.24$, $p < .01$) than the Abstract/Visual Reasoning SAS mean of 85.0 (SD 10.3).

Therefore, hypothesis 9 (Ho) is rejected.

Table 4.8 also reveals that the only other significant difference between any of the Area scores was the significantly higher Quantitative versus Abstract/Visual Reasoning SAS ($t = -2.91$, $p < .01$).

Hypothesis 10

Ho: There will be no statistically significant difference between the Verbal Comprehension and Nonverbal Reasoning factor scores of the SBH group.

TABLE 4.9

T-Tests
Comparison of Factor Scores Within the SBH Group

	t	p
Verbal Comprehension vs. Nonverbal Reasoning	1.84	NS
Verbal Comprehension vs. Memory	-0.75	NS
Nonverbal Reasoning vs. Memory	-2.92	0.01

Table 4.9 contains the results of t-tests comparing the three factor scores within the SBH group. The Verbal Comprehension mean of 90.4 (SD 13.3) did not differ significantly ($t = 1.84$) from

the Nonverbal Reasoning/Visualization mean of 85.9 (SD 11.3), although it was higher.

Therefore, there is failure to reject hypothesis 10 (Ho).

Table 4.9 also reveals that the only significant difference between any of the factor scores within the SBH group, was between the means of the Nonverbal Reasoning (85.9), and Memory (94.4) scores ($t = -2.92$, $p < .01$) in favor of the latter.

Correlational Hypotheses

The sixth, and final section of results, focuses upon correlational relationships between various Binet IV results, and supplemental test results. Hypotheses twelve through fifteen will be addressed in this section. The following hypotheses, based on correlational data, apply to the SBH group only:

Hypothesis 12

There will be a significant positive correlation between the mean Binet IV Copying subtest score, and the mean Beery standard score.

TABLE 4.10

PPVT-R & Beery Results for the SBH Group

	N	Mean	SD
PPVT-R Standard Score	23	94.0	13.0
PPVT-R Percentile	23	39.0	24.9
PPVT-R Stanine	23	4.3	1.7
PPVT-R Age-Equiv. (Mos.)	23	97.3	29.7
BEERY Percentile	23	16.6	18.5
BEERY Standard Score	23	5.7	2.5
BEERY Age-Equiv.(Mos.)	23	74.2	17.8

TABLE 4.11

Correlations Between Beery Standard Scores
and Selected Binet IV Subtest Scores

	Copying	Pattern Analysis	Bead Memory
BEERY	.42 (.05)	.33 (.06)	.52 (.01)

* Significance levels appear in brackets.

Table 4.10 contains the SBH group results on the Beery and PPVT-R. Table 4.11 contains the results of Pearson Product Moment Correlations between the Beery standard score, and the Pattern Analysis, Copying, and Bead Memory subtests of the Binet IV. Table 4.11 indicates that there is a significant positive correlation of .52 ($p < .01$) between the mean Binet IV Copying subtest score, and the Beery standard score.

Therefore, hypothesis 12 is accepted.

Although not corresponding to any hypotheses, the Beery Standard Scores were also compared to the Binet IV Pattern Analysis, and Bead Memory subtest results. Table 4.11 reveals that a correlation of .33 between the Beery and Pattern Analysis subtest failed to reach significance at the .05 level. Conversely, the correlation of .52 between the Beery and Bead Memory subtest was significant at the .01 level, and was even higher than the correlation between the Beery and the Copying subtest.

Hypothesis 13

There will be a significant positive correlation between the mean Binet IV Vocabulary subtest score, and the mean PPVT-R standard score.

TABLE 4.12

Correlations Between PPVT-R Standard Scores and Selected Binet IV Subtest Scores

	Vocabulary	Comprehension	Absurdities
PPVT-R	.62 (.001)	.49 (.01)	.20 (.19)

Table 4.10 contains the SBH group results on the Beery and PPVT-R. Table 4.12 contains the results of Pearson Product Moment Correlations between the PPVT-R standard score, and the Vocabulary, Comprehension, and Absurdities subtests of the Binet IV. Table 4.12 indicates that there is a significant positive correlation of .62 ($p < .001$) between the mean Binet IV Vocabulary subtest score, and the PPVT-R standard score.

Therefore, hypothesis 13 is accepted.

Although not corresponding to any hypotheses, the PPVT-R Standard Scores were also compared to the Binet IV Comprehension and Absurdities subtest results. Table 4.12 [illegible]s that a correlation of .49 between the PPVT-R and Comprehension subtest was significant at the .01 level. Conversely, the correlation of .20 between the PPVT-R and Absurdities subtest failed to reach significance at the .05 level.

Hypothesis 14

There will be significant positive correlations between the mean Binet IV Composite SAS, and the four mean Area SAS's.

TABLE 4.13

Correlations Between the Binet IV
Composite IQ and Area Scores
(SBH Group Only)

	Verbal Reasoning	Abstract/Visual Reasoning	Quantitative Reasoning	Short-Term Memory
Composite	.88	.72	.79	.90

*All correlations are significant at the .001 level

Table 4.13 contains correlational data regarding the Binet IV Composite, Area, and factor scores. Table 4.13 reveals that there are significant positive correlations between the mean Binet IV Composite IQ and the four mean Area SAS's. Specifically, the highest correlation, .90 ($p < .001$), is between the Composite and Short-Term Memory SAS. The next highest correlation is between the Composite and the Verbal Reasoning SAS, .88 ($p < .001$). The correlations between the Composite, and the Abstract/Visual Reasoning and Quantitative Reasoning SAS's, were .72 ($p < .001$) and .79 ($p < .001$), respectively.

Therefore, hypothesis 14 is accepted.

Hypothesis 15

There will be significant positive correlations between the mean Binet IV Composite SAS, and the three mean factor scores.

TABLE 4.14

Correlations Between the Binet IV
Composite IQ and Factor Scores
(SBH Group Only)

	Verbal Comprehension	Nonverbal Reasoning/Visualization	Memory
Composite	.80	.85	.88

*All correlations are significant at the .001 level

Table 4.14 contains correlational data regarding the Binet IV Composite, Area, and factor scores. Table 4.14 reveals that there are significant positive correlations between the mean Binet IV Composite IQ and the three factor scores. Specifically, the highest correlation, .88 ($p < .001$), is between the Composite and Memory factor score. The next highest correlation is between the Composite and the Nonverbal Reasoning factor, .85 ($p < .001$). Finally, the correlation between the Composite, and the Verbal Comprehension factor score was .80 ($p < .001$).

Therefore, hypothesis 15 is accepted.

Summary

This chapter has dealt primarily with comparisons between the performance of the SBH group and the Binet IV standardization sample. The first section saw the acceptance of the hypothesis of a lower mean Composite IQ for the SBH group (88.0), versus the normative sample (99.8). In the second major section, the four Area scores were addressed, with hypotheses of lower Abstract/Visual Reasoning, Quantitative Reasoning, and Verbal Reasoning Area SAS's for the SBH group. In all three cases, the hypotheses were accepted. For the fourth Area score, Short-Term Memory the null hypothesis of no significant difference was adopted, as it was the opinion of this researcher that the research did not warrant a directional hypothesis. The result in this case was that the null hypothesis was rejected, as the Short-Term Memory Area score of the SBH group was found to be significantly lower than that of the standardization sample.

The third major section, addressed the three factor scores obtained from the Binet IV. For two of the three factor scores, Nonverbal Reasoning/Visualization and Verbal Comprehension, hypotheses regarding lower scores for the SBH group were generated, and accepted. For the third factor, Memory, the null hypothesis was adopted, and there was failure to reject this hypothesis. The SBH group's score did not differ significantly from that of the theoretical population mean, although it was lower.

The fourth major section focused upon the Binet IV subtest results. In this section, only one hypothesis was developed which stated that the SBH group's mean score on the Memory for Sentences subtest would not differ significantly from that of the standardization sample. Although the SBH group's mean score was lower, it did not differ significantly, and the hypothesis was accepted.

The SBH group's verbal/nonverbal discrepancies were investigated in the next major section, by comparing their performance on the Verbal Reasoning SAS versus Abstract/Visual Reasoning SAS, and the Verbal Comprehension versus Nonverbal Reasoning/Visualization factor scores. Again, given the available literature, null hypotheses were adopted to investigate both comparisons. In the former comparison, the null hypothesis was rejected, as the Verbal Reasoning Area score was significantly higher than the Abstract/Visual Reasoning SAS. In the latter comparison, there was failure to reject the null hypothesis, as no significant difference was found between the Verbal Comprehension and Nonverbal Reasoning/Visualization factors, although the Verbal Comprehension factor score was higher.

The final major section of results focussed upon correlational data, and introduced hypotheses regarding the SBH group's performance on the PPVT-R and Beery. Hypotheses of significant correlations between the Beery Standard Score and Binet IV Copying subtest, and between the PPVT-R and the Binet Vocabulary subtest, were accepted. Significant positive correlations were also hypothesized and found, between the Binet IV Composite IQ and four Area scores. This was also the case with respect to the Composite IQ and the three factor scores.

Case Studies

Two case studies will be presented to illustrate the performance of individual subjects on the Binet IV and supplementary tests. In the case of the male subject chosen, the Composite IQ was the closest, of the six male subjects, to the mean Composite (88.0) of the total SBH sample. The female subject was chosen, at random, from the six female subjects with Composite IQ's which were ± one standard error of measurement from the SBH sample's Composite (e.g. 85-91).

Case #1

The test data for this individual will be presented in a table format, followed by a brief summary of the salient features of the results.

Age:	10 years, 1 month
Grade:	4
Sex:	Female

Stanford-Binet Intelligence Scale: Fourth Edition

	Standard Age Score (SAS)
Verbal Reasoning Area	
Vocabulary	48
Comprehension	44
Absurdities	44
VERBAL REASONING SAS	**89**
Abstract/Visual Area	
Pattern Analysis	49
Copying	39
Matrices	52
ABSTRACT/VISUAL REASONING SAS	**92**

Quantitative Area	
Quantitative	40
Number Series	47
QUANTITATIVE REASONING SAS	**93**
Short-Term Memory Area	
Bead Memory	44
Memory for Sentences	43
Memory for Digits	46
Memory for Objects	44
SHORT-TERM MEMORY SAS	**85**
TOTAL COMPOSITE SCORE	**88**
Factor Scores	
Verbal Comprehension	89
Nonverbal Reasoning/Visualization	88
Memory	86

Peabody Picture Vocabulary Test - Revised

Standard Score	101
Percentile	52
Age-Equivalent	10-2

Beery Developmental Test of Visual-Motor Integration

Standard Score	8
Percentile	32
Age-Equivalent	7-9

Case #1 involves a 10 year, 1 month old female who is in grade four. Her overall intellectual abilities, as reflected by the Binet IV Composite IQ score, fell within the low average range, at the 23rd percentile. Her verbal reasoning and comprehension abilities, as reflected by the corresponding Area and factor scores, were also in the low average range. Her nonverbal reasoning abilities, as reflected in her scores on the Abstract/Visual Reasoning

SAS, and Nonverbal Reasoning/Visualization factor score, were low average to average. Her highest Area score was obtained on the Quantitative Reasoning SAS, where her performance placed her within the average range when compared to other children her age. Her weakest area of intellectual ability appears to be her memory. Her scores on the Short-Term Memory Area, and Memory factor, were very similar and fell within the low average range. At the subtest level, her performance ranged from a low of 39 on Copying, to a high of 52 on Matrices, revealing that the Abstract/Visual Reasoning area has the greatest amount of variability of performance. Her subtest scores across the remaining three areas were much less variable.

This child's supplemental test results indicated that her receptive language skills, as measured by the PPVT-R, are near the centre of the average range. This finding is consistent with her performance on the Vocabulary subtest of the Binet IV. Her performance on the Beery placed her at the 32nd percentile, and is consistent with her score on the Copying subtest of the Binet IV.

Given the pattern of this child's results, it is likely that she struggles with school-related tasks, especially those involving memory and visual-motor tasks. She is likely to require special education assistance in various academic areas throughout her school career.

Case #2

As with the previous case study, the test data for this individual will be presented in a table format, followed by a brief summary of the salient features of the results.

Age: 9 years, 10 months

Grade: 3

Sex: Male

Stanford-Binet Intelligence Scale: Fourth Edition

	Standard Age Score (SAS)
Verbal Reasoning Area	
Vocabulary	47
Comprehension	43
Absurdities	45
VERBAL REASONING SAS	**89**
Abstract/Visual Area	
Pattern Analysis	51
Copying	35
ABSTRACT/VISUAL REASONING SAS	**84**
Quantitative Area	
Quantitative	43
QUANTITATIVE REASONING SAS	**86**
Short-Term Memory Area	
Bead Memory	34
Memory for Sentences	44
Memory for Digits	43
Memory for Objects	45
SHORT-TERM MEMORY SAS	**78**
TOTAL COMPOSITE SCORE	**81**

Factor Scores	
Verbal Comprehension	89
Nonverbal Reasoning/Visualization	76
Memory	85

Peabody Picture Vocabulary Test - Revised

Standard Score	111
Percentile	77
Age-Equivalent	11-1

Beery Developmental Test of Visual-Motor Integration

Standard Score	5
Percentile	9
Age-Equivalent	6-5

Case #2 involves a 9 year, 10 month old boy who is in grade three. This child's overall intellectual abilities, as reflected by his Binet IV Composite IQ score, fell within the low average range, at the 12th percentile, when compared to other children his age. His verbal reasoning and comprehension abilities, as reflected by his scores on the corresponding Area and factor scores, fell within the average range and represented his greatest strength intellectually. His Quantitative Reasoning SAS represented his next highest score, falling in the low average range. His Abstract/Visual Reasoning SAS was next highest, also in the low average range. This is in contrast to his much lower score on the Nonverbal Reasoning/Visualization (NR/V) factor - a score which placed him in the Slow Learner range. It is apparent that his very poor performance on the Bead Memory subtest had a detrimental effect upon his NR/V factor score. The Bead Memory score also brought down the Short-Term Memory SAS (Slow Learner), but did not influence the Memory factor score (Low Average) as this subtest is not involved in the calculation of this factor. The significant difference between this child's Verbal Comprehension and Nonverbal Reasoning/Visualization factor scores, in favor of the latter, is typical of the pattern reported in much the literature on the cognitive functioning of SBH children.

At the subtest level, this child's scores ranged from a lows of 34 (Bead Memory) and 35 (Copying), to a high of 51 (Pattern Analysis). In this respect, the marked variability within the Abstract/Visual Reasoning area which characterized the first case study is reflected again in this child's results.

With respect to the supplemental test scores, this child's receptive language skills, as reflected in his performance on the PPVT-R, appear to be above average, falling at the 77^{th} percentile. This score resulted in an age-equivalent of 11-1. His performance on the Vocabulary subtest of the Binet IV fell within the average range. The results of the Beery DTVMI placed this child at the 9^{th} percentile, indicating a weakness in the area of visual-motor integration. This result is consistent with this child's performance on the Copying subtest of the Binet IV.

The educational outlook for this child is rather similar to that of the first case study subject. Special education assistance will almost certainly be required for most if not all of this child's school career. Pencil and paper tasks are likely to cause a significant amount of difficulty, and alternative methods of expression will need to be pursued (e.g. oral reports, keyboarding, etc.). Receptive language represents an area of personal strength and should be utilized whenever possible by this child's teachers. Visual and verbal cues will be helpful in improving memory and reasoning ability.

Chapter 5

Discussion

With any new psychometric instrument, research is the key to establishing the utility of the instrument with both broad and specific populations. The present research represents an attempt to shed light on the utility of the Stanford-Binet Intelligence Scale : Fourth Edition (Binet IV), as a measure of the intellectual levels of hydrocephalic spina bifida (SBH) children. In addition, the intellectual functioning of SBH children is examined in detail, utilizing the Binet IV and supplementary test results.

Restatement of Study Objectives

In Chapter One, the general framework for this research was stated and outlined. Two major objectives were stated which comprised the basis of this study's orientation and focus.

In Chapter Two, the condition known as spina bifida was discussed in detail, with additional emphasis on the associated symptom of hydrocephalus. The current research on the intellectual functioning of SBH children was presented. In addition, the Binet IV was introduced and discussed. The limited research on the Binet IV was reviewed, and 15 hypotheses were developed based on this and the spina bifida research.

Chapter Three focused upon the design and procedures of this study, and in chapter Four the results of the data analysis conducted on this study's sample of SBH children were presented.

The focus of this Fifth and final chapter is to discuss the results from this study, as well as their implications for the use of the Binet IV with SBH children, and for future research. The discussion is organized in a similar fashion to the presentation of results in the previous chapter, which involved moving from the global (Composite) to the specific (subtests).

Binet IV Composite Score

The results of the present research confirm the most prominent finding in the research with respect to the intellectual functioning of SBH children - overall intellectual functioning which is significantly lower than that of the non-handicapped population. Specifically in the present research, the mean Composite IQ of the SBH group (mean = 88.0, SD = 11.4) was significantly lower ($z = -3.60$, $p < .05$) than the mean of the standardization sample, for the same age range (mean = 99.8, SD = 15.7). The mean Composite IQ reported in this research is very similar to those found in much of the literature. For example, in Anderson (1976), a sample of children with spina bifida obtained a mean WISC Full Scale IQ of 88. Similarly, Soare and Riamondi (1977) reported an overall IQ on the Stanford-Binet : Form L-M of 88, for a sample of children with myelomeningocele and hydrocephalus. Two studies reported WISC Full Scale scores for samples of children with spina bifida and arrested hydrocephalus - 86 by Badell-Ribera et al (1966), and 87 by Keller et al (1979). In Dennis et al (1981), a sample of hydrocephalic children obtained a 90.8 Wechsler Full Scale IQ. In an article by Sand et al (1974) a full scale IQ score of 87.7 was reported for a sample of children with myelomeningocele and hydrocephalus - no reference was made to the type of instrument used to measure the stated IQ, although it seems likely that the WISC or WISC-R was used. Finally, Badell-Ribera et al (1966) reported a mean WISC Full Scale IQ of 87 for their sample of children with spina bifida and arrested hydrocephalus.

Other researchers have reported overall scores which were much lower than that of the present sample of SBH children. For example, in Hurley et al (1983), a group of children with spina bifida and hydrocephalus obtained a mean Wechsler Full Scale of 77.6 (WISC-R or WAIS). Tew and Laurence (1975) reported a WPPSI Full Scale of 70 for a group of children with spina bifida and shunted hydrocephalus. In Keller et al (1979) a group described as having spina bifida and hydrocephalus obtained a mean WISC Full Scale score of 76.

The majority of the studies cited involved the use of various forms of the Wechsler scales. Parsons (1969) and Soare and Riamondi (1977), were the only studies which utilized the Stanford-Binet : Form L-M, and they reported overall IQ scores of 91 and 88, respectively.

While the preponderance of the research surveyed is consistent with the findings of the present research, there is evidence of differing results. There are at least two likely contributors to this phenomenon. First, the previously mentioned difference in the test instruments utilized. Despite high correlations between the Binet IV and the Wechsler scales, a certain amount of variability is bound to enter the equation when test scores are compared. Second, and more prominently, is the differential classification of subgroups within the various studies. The lack of a standard classification, especially with respect to the type and severity of hydrocephalus and spina bifida lesions, makes comparisons from study to study more tenuous. Despite these difficulties, the evidence supporting the findings of the present research regarding the overall intellectual ability of SBH children are supported by the majority of the findings in the literature.

While the results of the present research indicate that the Binet IV is reflecting the findings in the research regarding the overall intellectual functioning of SBH children, it is important to reiterate, that the overall intellectual functioning of *individual* SBH children may not reveal the general and specific deficits as reported in the literature and in this present research. As noted earlier by Korabek and Cuvo (1981), the SBH population is characterized by a high degree of variability of intellectual functioning.

Binet IV Area and Factor Scores

Performance on the four Area scores (Verbal Reasoning, Abstract/Visual Reasoning, Quantitative Reasoning, and Short-Term Memory), and three factor scores (Verbal Comprehension, Nonverbal Reasoning/Visualization, and Memory) was also investigated. The SBH group results were compared to those of the

Binet IV standardization sample obtained from the Technical Manual. In addition, for certain results, namely verbal-performance discrepancies, only the SBH groups results were utilized. As will be discussed later in this chapter, a key issue in addressing performance on the Area and factor scores will be the configuration of subtests used in determining these scores.

Verbal Ability.

In comparing the SBH groups verbal abilities with those of non-SBH children, the research is clear in indicating significantly below average verbal IQ scores for children with arrested or shunted hydrocephalus (Table 2.5). The results of the present research confirm this finding. As reported in Chapter 4, the Verbal Reasoning (VR) mean score for the SBH group was 92.9 which was significantly lower ($z = -2.13$, $p < .05$), than that of the standardization sample (mean = 99.9). Similarly, the SBH group's mean Verbal Comprehension (VC) score of 90.4 was significantly lower ($z = -2.88$, $p < .05$), than the theoretical mean (100.0). As Anderson (1977) has noted, the verbal abilities of SBH children often appear to be their greatest area of strength. The current results are most similar to those in the literature which are reported for those children described as having spina bifida with "arrested" hydrocephalus, or as having spina bifida (with no mention of associated hydrocephaly). In particular, Tew and Laurence (1975) reported a verbal IQ of 87.5 for their sample of children with spina bifida and arrested hydrocephalus. In

Badell-Ribera (1966) and in Keller et al (1979), scores of 94 and 90, respectively, were noted for children with the same diagnosis as those in the Tew and Laurence study.

Children with "shunted hydrocephalus", typically implying a more advanced form of the condition, were reported as having lower verbal scores than those found in the present study. In Tew and Laurence (1979), and Keller et al (1979), scores of 78.1 and 81.0, respectively, were noted.

In sum, the findings support the literature with respect to lower than average verbal abilities when SBH children are compared to non-handicapped populations. Additionally, the presence of more serious forms of hydrocephalus is associated with even poorer verbal skills.

Nonverbal Ability.

The research presented earlier is unanimous in finding of deficits in fine-motor, visual-motor, and visual-perceptual skills in SBH children. The findings in the present study indicated that the Abstract/Visual Reasoning Area score, and the Nonverbal Reasoning/Visualization factor score, of the SBH sample were significantly lower than those of the Binet IV standardization sample and theoretical population means, respectively. Miller and Sethi (1971) reported visual/perceptual deficits in hydrocephalic children as measured by the Bender Visual Motor Gestalt Test and the Frostig Developmental Test of Visual Perception (Frostig). Sand et al (1973) showed similar deficits in performance on the

Frostig. Turner (1986) reported poorer upper limb function in hydrocephalic versus non-hydrocephalic myelomeningocele children. The results of these and the current study are consistent with the type of motor difficulties expected in children with the Arnold-Chiari malformation. This malformation implicates the cerebellum which is involved in motor control. The combination of poorer motor control and perceptual deficits has a most significant negative effect upon the performance of SBH children on non-verbal tasks such as those involved in the Binet IV's Abstract/Visual Reasoning Area and Nonverbal Reasoning/Visualization factor scores. In sum, the current results support those in the literature with respect to the absolute (normative) and relative weakness of SBH children in the area of non-verbal skills. The SBH group's weakest Area and factor scores were those reflecting these non-verbal abilities.

Verbal-Performance Discrepancy.

The Verbal Reasoning SAS (VR) and Verbal Comprehension factor (VC) scores reflect a subject's ability to process, and reason with, language. The literature reviewed for this study was inconclusive regarding the verbal reasoning abilities of SBH children in comparison to their nonverbal abilities (as reflected by their Abstract/Visual Reasoning SAS (A/VR) and their Nonverbal Reasoning factor (NR/V) scores). Some research (Badell-Ribera, et al, 1966; Tew & Laurence, 1975, Mayers, 1976), indicated that the verbal abilities of SBH children, as reflected in

WISC or WISC-R Verbal IQ scores, were significantly stronger than their non-verbal abilities. Other research (Keller et al, 1979; Tew, 1973), did not support this claim, suggesting that SBH children's verbal abilities did not differ significantly from their nonverbal abilities. Current findings using the new revision of the Wechsler Primary and Preschool Scale of Intelligence - Revised (Wechsler, 1989), add support to the research suggesting non-significant differences between verbal and non-verbal abilities in the SBH population (D. V. Erickson, personal communication, September, 1991).

The results of the present research were consistent with the literature in that they support no clear statement regarding significantly stronger verbal than non-verbal abilities. In this study, the SBH group's Verbal Reasoning SAS was significantly higher than their Abstract/Visual Reasoning SAS. This significant difference was not found when the Verbal Comprehension and Nonverbal Reasoning/Visualization factors were compared, although the Verbal Comprehension score was higher.

These diverse results can be clarified somewhat upon examination of the differing subtest configurations of the Area and factor scores involved. For example, the Verbal Reasoning SAS is calculated (for ages five to eleven) using scores from the following subtests: Vocabulary, Comprehension, and Absurdities. This differs from the configuration of the Verbal Comprehension factor score only for children aged two to seven, in which the Memory for Sentences subtest is added. In terms of measurements of verbal reasoning ability, the Area and factor scores mentioned differ only to a small extent in their makeup.

By contrast, the configurations of the Abstract/Visual Reasoning Area and Nonverbal Reasoning/Visualization factor scores are quite different for the age group being considered. The A/VR Area score is comprised of the Pattern Analysis, Copying, and Matrices subtests. The NR/V factor score is calculated from performance on the Pattern Analysis, Copying, Bead Memory, and Quantitative subtests. The differing composition of the NR/V factor score, and the variable performance of the subjects on the subtests involved, may have accounted for the lack of a significant difference between this score and the Verbal Comprehension factor score.

<u>Quantitative Reasoning</u>.

In the area of numerical reasoning ability, the present sample was predicted to perform poorer than their non-handicapped counterparts, as reflected in the Binet IV Quantitative Reasoning Area score. This was the case, as the SBH group's score of 92.2 was significantly lower than that of the standardization sample. Schaffer et al (1985) reported the performance of myelomeningocele children on the Wide Range Achievement Test (WRAT). The sample in that study performed significantly below the published norms in the area of mathematics. Agness and McLone (1987) also utilized the WRAT, and the KeyMath Diagnostic Arithmetic Test. They reported math disabilities in their myelomeningocele sample of second to ninth graders to be far more common than reading or spelling disabilities. The results of the present study are consistent with the limited literature on the numerical reasoning ability of SBH children.

Memory.

The SBH sample's memory abilities were reflected in their performance on the Short-Term Memory Area score, and the Memory factor score. As was the case in considering the verbal-nonverbal discrepancy in SBH children's performance on intellectual measures, the research on the memory abilities of this population was also inconclusive. As a result, null hypotheses were adopted. Again, as was the case regarding verbal-nonverbal discrepancies, there was differing results when the memory Area and factor scores were considered. Specifically, the Short-Term Memory Area score (89.5) was significantly lower than that of the standardization sample. However, this was not the case with the Memory factor score (94.4), which, although lower, did not differ significantly from the theoretical population mean.

Once again, in considering this discrepancy between the Area and factor scores, the configuration of subtests involved is crucial. The Short-Term Memory Area score is comprised of the Bead Memory, Memory for Sentences, Memory for Digits, and Memory for Objects subtests. By contrast, the Memory factor score combines performance on the latter three subtests mentioned, in different combinations for different ages (see Table 2.6), but does not utilize the Bead Memory score for any age group. In the case of the present sample, the Bead Memory subtest represented one of the weakest subtest scores (43.3), second only to the Copying subtest (41.5). Thus, the configuration of subtests plays a major role in understanding the discrepancy between the memory Area and factor scores.

The literature dealing with the memory abilities of SBH children will be discussed in the next section which addresses the subtest results.

Binet IV Subtest Scores

The only subtest on which a hypothesis was based, Memory for Sentences, requires the ability to remember verbal connective material. As noted in Chapter 4, the performance of the SBH children on this subtest did not differ significantly from that of the standardization sample.

The results of the present study are consistent with the research reported by Parsons (1969), and Cull and Wyke (1984), in the area of memory. Their research indicated that the memory of SBH children did not differ significantly from non-hydrocephalic and non-handicapped children, when the material to be remembered was meaningful connected material. The Memory for Sentences subtest requires the memorization of this type of material. The implication, as noted by Cull & Wyke, is clear - whenever possible, provide contextual cues for SBH children when memorization is required. That is, utilizing stories and other verbal frameworks to enhance their memory capabilities is likely to be a more effective strategy.

However, performance on the Memory for Sentences subtest is not restricted to immediate recall. Attention and concentration, listening comprehension, and auditory processing are also involved with successful performance on this subtest.

In addition, a significant result of the current research, is the lack of significant differences between the performance of the SBH group and the Binet IV standardization sample on three of the four subtests in the Short-Term Memory Area. The SBH group's scores on these subtests were as follows: Memory for Sentences (46.5), Memory for Digits (46.6), Memory for Objects (48.9). Although no hypotheses were developed regarding the Memory for Digits subtest, the results of the present study appear to be inconsistent with the findings in the literature (Cull & Wyke, 1984; Parsons, 1969), which report a difficulty for SBH children in recalling non-meaningful material such as strings of unrelated numbers or letters. The sample in this study did equally well with both meaningful and non-meaningful information.

The only subtest in the Short-Term Memory Area on which the SBH group's performance was significantly lower than that of the Binet IV standardization sample, was the Bead Memory subtest, where the mean score was 43.3. However, this subtest is distinctive from the other subtests in the memory Area for a few reasons. First, it involves a strong perceptual component, both in terms of form perception and discrimination. Second, it involves spatial relations. Finally, it requires a degree of eye-hand coordination to place the beads on the stick. As has been revealed in the present study, as well as the reported literature, SBH children show deficits in all three of these areas. Thus, the SBH group's poorer performance on this subtest versus the remaining subtests in the memory Area, is reasonable.

Correlational Data

The Composite IQ of the SBH group was correlated with the four Area scores and three factor scores. The highest correlations were between the Composite score, and the Short-Term Memory Area (90) score, and Memory factor (88) score. The lowest Area and factor score correlations were with the Abstract/Visual Reasoning (72) and Verbal Comprehension (80), respectively. All correlations were significant at the .001 level, and suggest no concerns regarding the relationship of the Composite score to the Area and factor scores. Generally, however, the correlations between the Composite and the factor scores were stronger (range 80-85), than were those with the Area scores (range 72-90).

The results of the Beery (standard score) were correlated with various subtests on Binet IV. The hypothesized significant positive correlation with the Copying subtest was realized (.42). In addition, a significant correlation was observed between the Beery and the Bead Memory subtest. This appears to be a confirmation of the visual-motor component involved in the Bead Memory subtest. A somewhat surprising result was the lack of a significant correlation with the Pattern Analysis subtest. It is possible that the more abstract nature of this visual reasoning task, versus the more concrete Copying and Bead Memory tasks, led to this result.

The second supplementary measure utilized in this study was the PPVT-R. The standard score for this measure was correlated with the Vocabulary, Comprehension, and Absurdities subtests of the Binet IV. A strong correlation (.62 at the .001 level) was observed with the Vocabulary subtest, indicating a relationship between this expressive language task and the PPVT-R's receptive language task. A less strong, but still significant correlation (.49) was noted with the Comprehension subtest, while the correlation with the Absurdities subtest failed to reach significance (.20). It would seem that while receptive language is strongly related to expressive language and social reasoning in the verbal mode, it may not be related to social reasoning in the visual and abstract modalities.

Administration and Interpretation

An important issue in discussing results of any intellectual assessment, is the framework in which the interpretation will take place. A key emphasis of the assessment practicum at the University of Alberta was the importance of interpretation of test results according to factors born out by research, rather than, or at least in addition to, the framework suggested by the test developers. Interpretation of the Binet IV is no exception. However, while Sattler (1988) recommends the use of the three factor scores, rather than the four Area scores, in the interpretation of the Binet IV, recent research (Spelliscy, 1991) suggests that the Area scores have more validity and utility than was first considered. Addressing the issue of a model adopting the 'g' factor and four Area scores Spelliscy notes:

> The provisional acceptance of the 4-1 model has many advantages. Foremost is its basic adherence to two levels of the SBIV theoretical framework. Secondly, this model is loyal to practical SBIV test construction and interpretation designs. Thirdly, this model is able to avoid the complexities of multi-level interpretations that, at this stage, may be ethically risky given their lack of empirical support. A final advantage of this model is its support across all three age groups [3-6, 7-11, 12-23]. Separate models for each age group are cumbersome and particularly problematic when defining age related cut-off points. The provisional acceptance of the SBIV four cognitive areas is restricted by both practical and ethical considerations ... Practical considerations are important in choosing to tentatively accept the 4-1 model ... Less interpretative weight should be given to Area Scores that are defined by a single subtest. This is particularly problematic for the Quantitative Reasoning Area. At the 3 to 6 year level only one quantitative subtest is available. Care should be exercised in utilizing Area Scores that are based on subtests known to load outside their designated area. This is especially problematic when it is the only subtest defining that area ... All references to specific subtests should be treated as hypotheses unless empirical evidence exists to substantiate any proposed relationships. (p. 227)

The results of the present research speak to the importance of the framework for the interpretation of test scores. As an example, when considering the memory factor and Area scores, it is apparent that if the data are viewed in terms of an Area score interpretation, one conclusion is reached - that there is a significant difference between the memory abilities of the SBH group and the Binet IV standardization sample. Conversely, if the results are considered in terms of the memory factor (which involves a different configuration of subtests, depending upon the age of the subject), there is no longer a significant difference between the SBH group and the Binet IV standardization sample. In sum, the configuration of Area and factor scores is crucial in interpreting the results of the present study, and in considering the results of any individual's Binet IV performance.

In terms of general administration issues, the Binet IV test materials themselves had a high interest level with the SBH children, likely due to the colorful pictures and numerous manipulatives. As a result, the Binet IV appears to have good face validity with this population of special need children. The easel format of the test booklets is easy to work with, and the large age range (2-23) gives the clinician much latitude in terms of clients who can be tested with the Binet IV. The weight of the Binet IV kit will be a concern for some clinicians.

Meloff (1987) reports the results of a questionnaire by Janzen, Boersma and Krausher (1987) responded to by 68% of student clinicians attending the Fall/Winter session of the Educational Psychology assessment course at the University of Alberta. Table 5.1 presents Meloff's summary.

Summary of Binet IV Clinician Questionnaire
Janzen et al (1987)
(adapted from Meloff, 1987)

	Percentage of Responses
Four Major Strengths of the Binet IV	
1. Better sampling of the memory area	72
2. Wide age range (2-18 years)	68
3. Obtaining four Area Scores plus Composite	63
4. Ease of testing format	59
Four Major Weaknesses of the Binet IV	
1. Lengthy administration time	68
2. Difficulty in scoring some tests	63
3. American items	50
4. Inadequate SEM and confidence intervals	27
Client Response to the Binet IV	
1. Enjoyment of pictorial format	54
2. Moderate enjoyment	50
3. Much enjoyment	40
4. Held attention well	36
5. Found the test lengthy	31

Table 5.1 (cont'd)

Summary of Binet IV Clinician Questionnaire
Janzen et al (1987)
(adapted from Meloff, 1987)

	Percentage of Responses
Age Range Most Suitable for Binet IV Administration	
1. 6-12	77
2. 13-18	22
3. 2-5	9
Difficulties Encountered During Administration	
1. Backing up after choosing entry level	63
2. Marking the Copying test	59
3. Finding the appropriate pages in books	36
Difficulties Encountered While Interpreting	
1. Interpreting if significant differences exist between Area Scores	45
2. Knowing what the subtests are measuring	36
3. Interpretation of subtest patterns	31
Choice of Binet IV over other Individual IQ Tests	
1. In order to examine the memory area in more detail	86
2. Being a "power test" with all tests untimed except Pattern Analysis	68
3. Use with young children (2-5 years)	54

Table 5.1 (cont'd)

Summary of Binet IV Clinician Questionnaire
Janzen et al (1987)
(adapted from Meloff, 1987)

Comparison of Binet IV with the WISC-R	Percentage of Responses
1. Ease of Administration	
Binet IV	18
WISC-R	59
Equal	18
2. Ease of Interpretation	
Binet IV	36
WISC-R	59
Equal	18
3. Test that gives more information	
Binet IV	45
WISC-R	13
Equal	27

Future Research Considerations

The research reviewed for this study, and the results herein, lead to the following suggestions for further research:

1. There is a need for a greater emphasis on current research with SBH children, and a relatively new subgroup within the SBH population, adolescents. Research is needed which continues to examine the specific cognitive skills of these individuals. Research of this nature has been cited in Erickson (1990).

2. Long-term research is also needed. Longitudinal research with this population is possible now more than it ever has been in the past, due to improved intervention and medical management. Opportunities are now available to the researcher wishing to follow individuals over an extended period of time. Issues such as the predictive validity of the Binet IV with the SBH population, and the patterns of general and specific intellectual functioning over time are examples of issues in need of attention.

3. Research is needed into the relationship between these children's school achievement and self-esteem. Some research with non-handicapped populations suggests a strong positive correlation between academic achievement and self-esteem. Implications for counselling enormous, especially since these children must deal with the potential negative feedback from peers as a result of their physical handicaps.

4. There is a definite lack of research into the specific academic functioning of these children, with comprehensive measures such as the Woodcock-Johnson Psychoeducational Battery -Revised. Research of this nature would prove invaluable in guiding academic interventions to accommodate for the specific academic weaknesses of individual SBH children.

5. Research into the effectiveness of various educational interventions/remediation techniques on skill deficit areas in needed.

6. Neuropsychological studies of the functioning of SBH children may lead to more effective interventions, as well as a greater understanding of the particular neurological structures and functions implicated in the SBH condition. Hurley (1983) provides an excellent example of the utility of neuropsychological instruments when he explains the low score of spina bifida subjects on the finger tapping test (left hand) of the Halstead-Reitan Neuropsychological Battery:

> If the difficulty with visual perceptual tasks shown by spina bifida subjects signals some right cerebral hemisphere dysfunction, then impairment of left hand fine motor speed on a task like finger tapping is explicable in terms of neurological organization. (p. 117)

Clearly, the potential usefulness of neuropsychological assessment with this population is great.

7. A related area of research would involve the use of the Test of Visual Perceptual Skills (non-motor) (Gardner, 1988), to investigate the differential impact of perceptual versus motor deficits on tasks involving both of these components. As noted earlier in this study, SBH children typically do poorly on tasks involving visual-motor skills. Hurley (1983), speaking of the relatively strong scores of SBH children on the tactual performance test of the Halstead-Reitan battery, notes:

> The good performance of the spina bifida - hydrocephalic subjects may indicate that their impairment on complex perceptual motor tasks is due more to visual perceptual and visual organization problems than motor difficulties, *per se*, since the tactual performance test is done blindfolded. (p. 117)

8. There appeared to be a particular dearth of literature regarding the memory function of SBH children. Continued research using such measures as the Binet IV, Wechsler Memory Scales, Visual Aural Digit Span Test, and others may lead to a greater understanding of the strengths and weaknesses of SBH children in this area.

9. Research into the use of academic screening devices such as the newly published Canada Quick Individual Educational Test (Canada QUIET) (Wormeli & Carter, 1991) with the SBH population is also needed.

10. Research is needed into the effectiveness of the Binet IV with specific age groups, such as adolescents, adults, and pre-school children.

Educational Implications

The Binet IV will be useful in identifying the intellectual strengths and weaknesses of SBH children, which can guide the type of programming which will maximize an individual child's opportunity for success in learning. However, the Binet IV is only one of many measurement tools which should be utilized, and it can serve to guide the clinician as to appropriate follow-up assessments. The greatest challenge, and most important role, for the clinician, is to make the results of a Binet IV assessment pragmatic and meaningful for the educators and parents of these children. Numbers, in and of themselves, are useless. The skilled examiner and clinician will use all available information (i.e. standardized and non-standardized test data, self/parent/teacher-reports, observational data, etc.), and integrate this myriad of data into a meaningful whole.

It is the responsibility of educators to be aware of the particular strengths and weaknesses of SBH children so that appropriate goals and objectives can be formulated and successfully met for these children. It is the responsibility of the educational psychologist to effectively utilize the Binet IV and similar measures to this end, and to educate and inform educators and parents of each child's educational strengths and needs.

Summary

In summary, the major research questions guiding the present research were two-fold, and related: (1) to investigate whether or not the Binet IV results from the present SBH sample reflected findings in the literature regarding the intellectual functioning of SBH children; and, in doing so, (2) examine the utility of the Binet IV as a means of identifying the intellectual functioning, and specific strengths and weaknesses of SBH children.

With respect to the study's objectives: In sum, the Binet IV appears to have considerable utility. For the present sample, it has revealed the pattern of overall and specific intellectual functioning of SBH children as found in the existing literature. In doing so it has confirmed it's utility as an effective instrument in identifying an individual SBH child's unique pattern of intellectual strength and weakness. The Binet IV is an effective tool, however, the proper and meaningful use of this tool depends on the individual clinician or researcher. This is where the true utility of this instrument will be revealed.

In conclusion, there exists at the present time a paucity of research data on the Binet IV (Meloff, 1987). This is especially true regarding its use with the spina bifida population. Although this is not surprising given the recency of the introduction of the Binet IV to the field, there is clearly a need for more research on the Binet IV to supplement the data found in the existing literature and in the Binet IV's Technical Manual. It is hoped that the proposed research will represent a meaningful and useful contribution to the growing research of an instrument which may be destined to become "standard equipment" in the assessment arsenal of researchers and practitioners. Above all, it is hoped that this research will provide practical assistance to those working with children with spina bifida. In this regard, the present author agrees wholeheartedly with Keller et al (1979):

> Through better understanding of the cognitive, perceptual and motor and emotional make-up of the spina bifida child, more appropriate remedial learning procedures may improve their function and ability to cope with an increasingly complex world in which they find themselves. (p. 1)

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Appendix A

Parent Letter Requesting Participation in Research

Appendix A

Dear __________ :

Currently I am in the process of completing requirements for a Master's degree through the University of Alberta. The completion of a thesis is a major part of this endeavor. From December 1986 to April 1987 I was employed at the Glenrose as a research assistant to Dr. David Erickson in the Department of Psychology. Through this involvement I was exposed to a very special patient population, children and adolescents with spina bifida. I have since decided that spina bifida would be the focus of my thesis research.

This leads me to the reason for my correspondence with you. With the support and guidance of Dr. Erickson it is my desire to investigate the usefulness of a new intellectual assessment scale with children with spina bifida. This measure, the Stanford-Binet Intelligence Scale: Fourth Edition (Binet IV), could prove to be very useful in identifying the particular strengths and weaknesses of the child with spina bifida, thus allowing for the most beneficial and individualized educational and remedial programs to be developed. In order to investigate the utility of the Binet IV for such a purpose, my research would involve administering the Binet IV to a group of 25 children with spina bifida and hydrocephalus, then comparing those results to findings in the literature. I would ask you to consider allowing your child to be assessed as part of this research.

Should you decide to allow your child to participate in this study, it would involve a single assessment session lasting from two to three hours. The assessment session would take place at the Glenrose Rehabilitation Hospital, or in your child's school, on a day and at a time convenient to you and your child.

I will be contacting you by phone very shortly to confirm that you have received this letter and to discuss with you the possibility of your child's involvement in this research. Please remember that if you agree to allow your child to be involved, at any time you or your child may ask to withdraw from this research study and there will be no questions asked.

If you have any questions regarding the purpose of this research or the nature of your child's involvement (should you choose to involve him), please do not hesitate to contact me through the University of Alberta Education Clinic at 432-3746. Also, please feel free to contact Dr. Erickson at the Glenrose (471-2262) as he has been, and will continue to be, very involved in this research project. Thank-you for your consideration.

Sincerely,

Gregory Erickson, B.A.
Student Clinician
University of Alberta
Education Clinic

Appendix B

Distribution of Sample by Demographic Characteristics

TABLE 1

Distribution of Sample by Age

AGE	N	PERCENT
5-0 to 5-11	2	8.7
6-0 to 6-11	3	13.0
7-0 to 7-11	2	8.7
8-0 to 8-11	4	17.4
9-0 to 9-11	6	26.1
10-0 to 10-11	5	21.7
11-0 to 11-11	1	4.4
Mean Age = 8.6 yrs.	Total = 23	Total = 100.0

TABLE 2

Distribution of Sample by Gender

SEX	N	PERCENT	MEAN AGE
Male	6	26.1	8.2
Female	17	73.9	8.8
TOTAL	23	100.0	8.6

Appendix C

Correlational Data

TABLE 3

Intercorrelations Between Binet IV Factor Scores, and Subtest Scores for the SBH Group

	Voc	Cpr	Abs	Ptn	Cpy	Mat	Qnt	NSr	BdM	MSt	MDg	MOb
Verbal Reasoning	72	73	57	29 (.09)	32 (.07)	47 (.17)	47	-13 (.37)	43	63	43	65
NonVerbal Reasoning	53	54	44	51	54	19 (.36)	71	-26 (.25)	89	19 (.20)	70	47
Memory	75	79	43	47	07 (.40)	72	67	-21 (.31)	34 (.10)	66	73	76

*decimal points have been omitted from this correlation table
**all correlations are significant at the .05 level or higher except where noted.

TABLE 4

Correlations Between Beery & PPVT-R Standard Scores and Binet IV Composite, Area, and Factor Scores

	CMP	VR	A/V	QR	STM	Verbal Comp	NVerb. Reas.	Memory
PPVT-R Std. Score	55	55	42	28 (.10)	53	66	27 (.10)	55
BEERY Std. Score	61	51	60	46	50	52	62	49

*decimal points have been omitted from this correlation table
**all correlations are significant at the .05 level or higher except where noted.

TABLE 5

Intercorrelations Between Binet IV Composite IQ, Area Scores, and Factor Scores for the SBH Group

	VR	A/V	QR	STM	Verbal Comp.	NVerbal Reason.	Memory
COMP	88	72	79	90	80	85	88
VR		44	66	74	86	64	77
A/V			39	61	45	68	55
QR				56	51	71	75
STM					77	76	89
Verbal						55	76
NVerbal							56

*Decimal points have been omitted from this correlation matrix
**Correlations of .61 and above are significant at the .001 level; correlations between .51 and .56 are significant at the .01 level, correlations between .39 and .45 are significant at the .05 level.

Table 6

Intercorrelations Between Binet IV Composite, Area, and Subtest Scores for the SBH Group

	VR	A/V	QR	STM	Voc	Cpr	Abs	Ptn	Cpy	Mat	Qnt	NSr	BdM	MSt	MDg	MOb
Cmp	88	72	79	90	75	76	56	47	40	61	73	-15	67	50	76	77
VR		44	66	74	85	80	71	28	32	47	61	-17	48	54	45	61
A/V			39	61	35	44	26	69	45	74	36	-12	53	28	66	41
QR				56	56	57	43	33	11	45	96	-23	43	09	70	87
STM					67	68	42	32	44	65	49	-06	74	65	78	74
Voc						63	41	36	13	60	50	-09	40	49	52	49
Cpr							26	32	17	33	57	-11	38	55	44	70
Abs								-01	44	49	38	-20	35	25	11	19
Ptn									-03	43	31	-32	30	06	69	23
Cpy										21	15	-64	51	22	13	05
Mat											23	-27	-24	53	54	49
Qnt												-55	39	03	66	78
NSr													18	21	-37	08
BdM														21	52	28
MSt															09	19
MDg																68

* Decimal points have been omitted from this correlation matrix
* Correlations of .61 and above are significant at the .001 level, correlations between .48 and .61 are sig. at the .01 level,correlations between .35 and .48 are sig. at the .05 level...

WITH THE FOLLOWING EXCEPTIONS:

	(.05)	(.01)	(.001)	
Matrices (Mat)	.74	.88	---	n=9
Memory for Digits (MDg)	.38	.52	.66	n=18
Memory for Objects (MOb)	---	.61	.77	n=14
Number Series (NSr)	one sig. corr. of -.64 (.03 level)			n=6