UNIVERSITY OF ALBERTA

THE WISC-III PATTERNS FOR READING AND MATH DISABLED STUDENTS

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 WISC-III Patterns for Reading and Math Disabled Students submitted by Robin D. Everall in partial fulfillment of the requirement for the degree of Master of Education in School Psychology.

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This thesis is dedicated first and foremost to my family who have endured through this challenging time. Their love, support and patience has not gone unnoticed or unappreciated. There have also been some special friends who have seen me through, who have been there to listen when a shoulder was badly needed, and who provided support and encouragement that gave me the resolve to continue despite my setbacks. For this I am truly grateful.

ABSTRACT

The present study was undertaken to investigate whether academic deficits severe enough to be labeled as learning disabilities resulted in divergent patterns of WISC-III IQ, subtest, and index scores. The history and implications of a learning disability diagnosis were discussed within the framework of previous research.

Subjects were 36 reading disabled and 32 math disabled students between the ages of 6 and 16 who were identified as learning disabled based upon discrepancy scores between their WISC-III Full Scale IQ and academic achievement level. The control group included 66 normally achieving children.

Descriptive statistics and correlations between intellectual ability and academic achievement scores were generated for each group. One-way ANOVA's were calculated to determine between group and within group differences on the WISC-III IQ, subtests and index scores.

Results obtained indicate that the Reading Disabled group differed from the other two groups on the percentage of subjects that produced a statistically significant Verbal/Performance discrepancy. Verbal scale subtest scores were depressed for the Reading Disabled group, whereas the Math Disability group produced a profile with equivalent Verbal and Performance IQ's, a pattern similar to that produced by the control group. Statistically significant group profile differences were not produced between the three groups.

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CHAPTER I

INTRODUCTION

The identification of children with learning difficulties is a controversial and complex issue of concern to parents, teachers, administrators, and school psychologists. The literature indicates that the male/female incidence ratio of learning disabled children is approximately 4:1 and estimates of prevalence range from 1.6% of the school population to 20% of all students (Fleischner, 1994; Moats & Lyon, 1993; Smith, 1991).

In the past decade, investigations into learning disabilities have emanated from a broad range of professional interests and expertise. Development of educational and learning theories, utility of assessment tools, and teaching or intervention strategies have characterized the research in the field. There has been, however, a lack of consensus regarding the definition and criteria to be used in identifying learning-disabled students. As a result, the literature includes confusing and often conflicting findings regarding identification, etiology, and treatment outcomes.

Intelligence testing is often an integral component in the identification of children with learning disabilities. The Wechsler Intelligence Scale for Children - Third Edition (WISC-III) is the most recent addition to the Wechsler intellectual ability tests and is intended for use with children from the ages of 6 years to 16 years. The purposes of the revision were to update the norms, make the test more engaging for the child, and modify the content to better measure a child's general intellectual ability (Wechsler, 1991). The new version is thought to provide more accurate estimates of a wide range of a child's abilities than did its predecessor. A revised factor structure has resulted in the introduction of a fourth factor-based index score identified as the Processing Speed Index.

As increasing numbers of children are being identified as having learning difficulties, it is imperative to understand the concept of learning disabilities (LD). Additional research will assist the process of accurately identifying, diagnosing, and providing useful treatment strategies for learning disabled students in the educational system. The wide range of disabilities within the LD population, however, makes it difficult to interpret research and develop a solid body of knowledge. Prior research on the WISC-R, the predecessor to the WISC-III, indicated that the test was unable to provide distinct LD profiles or discriminate accurately between different kinds of learning disabled children (Sattler, 1992). The current research will be evaluating the utility of the WISC-III in differentiating groups of learning disabled children.

Statement of the Problem

Undoubtedly it will be questioned whether or not the WISC-III should be used to identify children with learning disabilities. As the WISC-III included a sample of LD children in its wide norming sample it will likely be used extensively for assessing children with learning problems as well as assessment of exceptional and normal populations.

In the manual, Wechsler (1991) reports specific profile patterns for LD children including a higher Performance IQ than Verbal IQ, lower Full Scale IQ than non-LD children, and specific indices that showed weakness. He claims that the structure of the test provides a sound basis for profile analysis because it measures a wide range of abilities reliably and distinctly. However, because of its recent introduction into the assessment market, there is limited published research that evaluates the diagnostic usefulness of the WISC-III. Will the WISC-III produce distinct profiles for learning disabled subtypes? If so, the diagnostic usefulness of the test will be increased.

Extensive research has investigated whether consistent and identifiable patterns of performance can be identified for LD children generally (Kavale & Forness, 1984; Sattler, 1992; Smith, Smith, Matthews, & Kennedy, 1993). Research on WISC-III predecessors has been conducted to determine the validity of the verbal/performance differences as well as factor indices and subtest scatter of LD children. Results have been equivocal. With the introduction of the new revision of the WISC, many of the same questions that were investigated for the WISC-R will be re-investigated regarding LD children's performance.

The LD population is comprised of a heterogeneous group of individuals with varied disorders. LD children demonstrate difficulty in a variety of academic tasks. Indeed, within specific academic tasks, children may experience difficulties for multiple reasons. Therefore, no overall single profile can be identified that represents all LD children (McIntosh & Gridley, 1993; Sattler, 1992), or even LD children who demonstrate a deficit within a specific domain. Even if such a profile was identified, its diagnostic utility would be very limited, as different LD subgroups present with different cognitive and academic strengths and weaknesses. The ability to differentiate the subgroups from each other and from a control group through distinctive profiles would assist in the accurate identification, diagnosis, and remediation of LD children. As advancements are made in definition, classification, and diagnosis of learning disabilities, research findings will provide a stable context for comprehensive investigations of prevalence, developmental course and effective intervention strategies.

Purpose and Rationale of the Research

Research findings indicate that reading is the most common subject area affected by learning disability; mathematics and numerical computation are also prevalent, second only to disabilities in reading (Fleischner, 1994; Humphries & Bone, 1993; McLoughlin & Lewis, 1994; Sattler, 1992). It was on the basis of this research that group differences were evaluated based upon reading disability (RD) and math disability (MD) to determine whether academic deficits severe enough to be labelled as learning disabilities resulted in divergent patterns of performance on the WISC-III subtests, factor scores, and indices. The results may provide evidence of the utility of the WISC-III in a complete assessment battery for learning disabled students.

The current literature dealing with the characteristics of learning disabled children is inconclusive. To determine whether distinct cognitive patterns could be identified, the defining characteristics of two specific groups of LD students were examined and comparison of their WISC-III profiles was completed. The sample groups were comprised of subjects identified as learning disabled in reading (RD), and mathematics (MD). The study identified convergent and divergent patterns of performance on the intelligence test that allowed hypotheses to be generated concerning the cognitive strengths and weaknesses of the two groups. The results were compared to the performance of a control sample of normally achieving children.

Equivocal results in previous studies may have resulted from groups being identified on the basis of the presence of an unspecified learning disability. The knowledge acquired from grouping subjects on the basis of the specific academic deficiency may be useful to individuals who provide services to learning disabled children. Identifying cognitive processes of specific learning disability subtypes will surely enhance the understanding of the phenomenon of learning disabilities plus the development and implementation of remedial strategies.

As the WISC-III is a new test, there is limited research on the validity of the author's claims, particularly as they relate to learning disabled children. This study investigated whether the new edition provides useful diagnostic information for the assessment of these children. It also evaluated Wechsler's (1991) claim that the new edition is capable of assisting clinicians in identifying and discriminating between LD and non LD children. Since there is little available research to validate the effectiveness of the WISC-III in identifying learning disabilities and/or discriminating between different kinds of learning disabilities, this study also attempted to evaluate whether the WISC-III differentiated between LD and normal populations on the basis of the production of distinct and identifiable profiles.

Based upon the group profiles produced, how sensitive is the WISC-III to identifying differentiated groups of LD children? The factor profiles of the two identified LD and control groups were investigated for areas of convergence and divergence.

The results from this study add to a growing body of research determining whether there are consistent patterns that can be identified for subsets of learning disabled children. Careful scrutiny of the results may provide information as to the most useful aspects of the WISC-III battery in diagnosing possible learning disabilities.

Definition of Terms

In this study, the operational definition of learning disabilities as formulated by the Learning Disabilities Association of Canada (1986) was adhered to. In order to be diagnosed as learning disabled the child must demonstrate intellectual abilities, as measured by the WISC-III Full Scale IQ score, that are in the average to above average range. Discrepancy scores are utilized to determine whether an achievement-ability discrepancy of at least one standard deviation between the higher Full Scale IQ and lower academic achievement scores is evident in the child's performance. Deficits in several areas are considered as potential problem areas: communicating, reasoning, memory, reading, writing, spelling, or mathematics. The learning disability cannot be primarily due to visual, hearing, or motor handicaps. Mental retardation, emotional disturbance or environmental disadvantage may occur concurrently with the learning disability, but cannot be the cause of the disability. Because definitions of learning disabilities generally exclude children of low intelligence, those with IQ's below 85 were excluded from inclusion in this study.

An evaluation of WISC-III performance between the two LD samples in addition to a comparison to the performance of a control group was conducted. Control group membership was restricted to children whose Full Scale IQ was within the average range of 90 to 110. Their academic achievement level was determined to be within the normal and expected range, and therefore no significant discrepancies between FSIQ and academic achievement level were evident.

The Wide Range Achievement Test - Revised and Wechsler Individual Achievement Test were the measures used to determine the level of academic performance. Each of the subjects in all three groups was administered one of the two screening batteries. Children who demonstrated a significant discrepancy as defined in the above criterion in reading and any other academic subject with the exception of mathematics were assigned to the Reading Disabled (RD) group. Those who demonstrated a significant discrepancy in mathematics and any other academic area with the exception of reading were assigned to the Math Disabled (MD) group. WISC-III profiles of these two groups were compared to that of a control group comprised of children who met the criteria for inclusion in that sample.

Delimitations of the Study

It must be noted that the control group represents a clinical control sample as children were primarily referred to the Education Clinic by their parents or schools because of learning concerns. Therefore this group should be considered a non-random sample. As a result, the pool from which the control sample was chosen is not based upon a distribution of subjects who represent a normal proportional distribution and full spectrum of abilities that a randomly chosen population would. Consequently, the results of this study must be considered with caution as they will be applicable to LD children in comparison to a clinical control group only, and not the student population at large.

This study is primarily descriptive in nature and while it attempts to investigate some of the underlying concepts of cognitive processing in learning disabled children, no assessment batteries were administered to evaluate cognitive processing specific to learning disabled children. In addition, this study was not intended to investigate the underlying concepts of psychoeducational assessment or of the validity of the use of the WISC-III itself, but rather the focus was on the patterns of performance produced by learning disabled students.

Summary

With the significant number of students in the school population identified as being learning disabled, there have been numerous attempts to classify them in order to better serve their needs. Due to the heterogeneous nature of the group, however, this task has proven to be extremely difficult. Perhaps the identification of clear patterns could be made apparent if the individuals studied were first differentiated into groups reflecting specific learning disabilities.

This study evaluates group differences based on reading disability and math disability to determine whether academic deficits severe enough to be labelled as learning disabled are correlated with divergent patterns of performance on the WISC-III. Subtests, factor scores, and indices were compared and evaluated. Results were compared to the performance of a control group comprised of normally achieving children.

The criteria used in the learning disabled subject selection was adopted from the Learning Disability Association of Canada. Control group selection was limited to individuals having a Full Scale IQ ranging from 90 to 110 whose academic achievement was in the normal and expected range. All test data was drawn from files in the University of Alberta Education Clinic. Results were taken from testing done to investigate learning concerns and so should not be considered random. Academic achievement was measured by the Wide Range Achievement Test - Revised and Wechsler Individual Achievement Test. The purpose of this study was to determine whether the intelligence test and academic achievement criteria used to identify learning disabled children revealed distinct cognitive profiles between specifically identified LD and control groups on the WISC-III.

Chapter I has been a brief introduction to the discussion of learning disabilities and its importance. The purpose and rationale has been presented, followed by the definition of the learning disabilities being utilized in this research. Delimitations were then outlined.

Chapter II is a literature review which is presented in several sections. The history of the definitions and theoretical explanations of learning disabilities was briefly discussed. Characteristics of learning disabled children and the importance of identifying subtypes was then followed by reviews of the literature concerning reading disabled and mathematics disabled students. A brief review of the history and importance of intelligence testing is presented in the following section leading to the generation of the research questions and hypotheses that were investigated in this project.

Chapter III outlines the research design and procedure used in this thesis. It provides description of the subjects, the instruments utilized, the procedures for determining group membership, and the limitations of this study.

Chapter IV presents the results obtained from this research. To assist the reader, the results were divided into sections based upon group results. Descriptive results were presented first, followed by presentation of the differences identified within groups. Reading Disability group results are presented, followed by Mathematics Disability group results, then Control group results. Convergent and divergence domains between groups were then discussed as they related to the questions posed in Chapter II.

Chapter V is devoted to a discussion of the results, and focusses primarily on highlighting and addressing the objectives and hypotheses outlined in Chapter II. Comparisons between the results obtained in this research are made to results reported in previous learning disabilities research. A discussion of possible alternatives that explain the patterns that were identified within and between the groups follows. The chapter concludes with implications for teachers, counselors and school psychologists and recommendations for future research.

CHAPTER II

REVIEW OF THE LITERATURE

The ultimate goal of learning disability research is to understand how cognitive processes and patterns of LD children differ from those of children who have no learning disability (Torgesen, 1994). Once this can be determined, intervention and instructional implications will be more easily addressed. Based upon the finding that IQ range was not often restricted in samples of learning disabled children, Durrant (1994) recommended that IQ should be restricted in range in order to reduce heterogeneity and increase generalizability to school populations. It is also widely accepted that in order to satisfy the criteria of LD, children of low intelligence should be excluded from samples when investigating LD performance. As this has not always been done, results may have been compromised.

Definitions

The utilization of different definitions by different researchers has created problems within the field of learning disabilities. Identification of learning disabilities varies as a result of the definition's used to select subjects for inclusion and results in conflicting, controversial and discrepant results. In addition, no definition of learning disabilities has been spared from criticism aimed at vague constructs, lack of operational definitions, and exclusionary natures (Hooper & Willis, 1989). It has been difficult in the past to compare results between studies or domains of investigation because of this definitional issue.

Because definitional consensus is the foundation for research regardless of domain, numerous attempts have been made by a variety of committees and agencies over the years to formulate a definition of learning disability that is both valid and widely acceptable. Precise definitions are required to "provide solid rationales for generating theories, formulating hypotheses, classifying disorders, selecting subjects, and communicating with others" (Hammill, 1990, p. 74). A definition with precision allows for the investigation and understanding of the nature of learning disabilities. Therefore, until there is a general consensus among those researching the field, a variety of unrelated and often conflicting results may accrue.

The definition written by the National Joint Committee on Learning Disabilities in 1981 and amended in 1988, has resulted in a general consensus in the field (Hammill, 1990). The currently accepted definition includes several components required for the diagnosis of a learning disability. These in turn are based on a number of unstated assumptions regarding this handicapping condition. The NJCLD definition centers on the use of intelligence tests as a means of identifying intellectual ability. Identification is founded on the premise of underachievement, usually estimated by the discrepancy between academic achievement and intellectual ability as measured by an intelligence test. Based on this definition, if a large discrepancy is evident, the possibility of a learning disability exists. Although other handicapping conditions may also exist in the individual, they are not to be the cause of the learning disability, but may co-exist with it. Distinctions must be made as to the effect of the handicapping condition, and the conclusion reached that an inability to learn is not the result of the co-existing handicapping condition.

Of the children receiving special education services, about 48% are learning disabled, comprising the largest portion of the special education population and receiving the greatest amount of in-school assistance (Smith, 1991). Prevalence rates estimates range from 4% (Kavale & Forness, 1985) to 20% of the school population (Smith, 1991). The prevalence rates vary depending upon the definition and criteria utilized by various jurisdictions for individuals to qualify for special education services.

History of Learning Disabilities

Although there have been differing perspectives as to the etiology and nature of difficulty learning, the inability to achieve academically has been a recognized outcome.

Definitions have reflected the different conceptualizations of the inability to learn academic tasks in vogue at the time. They have covered the complete spectrum from medical to educational hypotheses (Kaufman, 1979).

Clinical descriptions of learning disabilities were being made at the turn of the century. Since the recognition of the disorders effects on children's learning, educators and scholars have attempted to understand its origins. For many years, etiology was considered primarily from a unitary deficit viewpoint, and a variety of deficit theories were developed. Patterning programs, psycholinguistic training programs, intersensory integration approaches and numerous other techniques were developed to address the perceived needs of learning disabled children (Kavale & Forness, 1985). Each theory or technique was thought to explain the development of learning disabilities in general, and usually a reading disability specifically, and provide remediation strategies that would overcome the disability.

Research by Strauss and Werner identified characteristics of brain injured children and the difficulties in learning that resulted from the brain injury. By 1947, Strauss and Lehtinen had established both biological and behavioral criteria for delineating brain damage in children that affected their capacity to learn. From the research into brain damage, investigations evolved to the area of examining atypical development resulting from clinically subtle but behaviorally significant damage to the brain (Kavale & Forness, 1985). Results lead researchers to believe that learning difficulties were possibly the result of injury to the Central Nervous System, even though the exact nature of the injury could not be specified (Smith, 1991).

Not all theories contended that learning disabilities are the result of structural brain damage. Proponents of Minimal Brain Dysfunction stated that deviation of function resulted from subtle deviations in brain structure (Hooper & Willis, 1989). They also contended that overall intellectual functioning was not affected. This conception of learning disabilities was critical of the perception that children with academic difficulties are brain damaged. The theory has been criticized by educators as being too medically oriented, and not addressing the assessment, educational, or remediation needs of the child.

Since the 1960's when Kirk coined the phrase 'learning disability', there have been ongoing attempts to produce the most appropriate theory and definition to facilitate LD children in acquiring the assistance they need to remediate underlying processing difficulties (Kavale & Forness, 1985; Smith, 1991). The focus has shifted from a medical perspective of etiology to an educational perspective of etiology and remediation. Explanations of etiology that have been proposed include developmental delay, poorly developed cognitive skills, extraneous factors such as depression or deprivation, and poor teaching or learning processes (Swanson & Ransby, 1994). Because manifestation of a learning problem usually occurs when the child enters school, the burden of intervention and remediation has been placed firmly on the educational domain. With the shift in focus, definitions and much of the resulting research moved away from etiological theories and toward the behavioral ramifications of the disorder. Emphasis was placed on the child's primary difficulty, the inability to learn adequately, that resulted in academic achievement deficits.

In 1969, legislation in the United States guaranteed appropriate educational services for all special needs children. Although there was no universally accepted definition of learning disabilities, it was increasingly accepted that, despite adequate intelligence and educational experience, LD students were unable to thrive in normal educational environments (Durrant, 1994; Sattler, 1992). In 1975, learning disabilities became a recognized handicapping condition and by definition mandated changes in the role of the school in the education of LD children in the United States (PL 94-142). Funding then became available to assist identified LD children in the classroom. Subsequently, researchers have produced a vast body of knowledge investigating many theoretical and practical aspects of learning disabilities as a handicapping condition.

No single theoretical perspective can explain the etiology, characteristics, and intervention strategies required for all cases of LD completely (Sattler, 1992; Smith, 1991). Research into learning disabilities is currently being conducted from a variety of perspectives and diverse disciplines include cognitive psychology, developmental psychology, educational psychology, and neuropsychology. Researchers observing children are affected by the theoretical perspective or academic orientation that they adhere to. While this diversity of approaches provides a wealth of information about LD children, it also produces information that is difficult to integrate into a comprehensive understanding of the disorder.

Despite differing theoretical viewpoints, researchers increasingly accept that a multiplicity of interacting characteristics produce a wide range of heterogeneous disorders (Hammill, Leigh, McNutt , & Larsen, 1988). There is a growing consensus that learning disabilities result from, and are affected by complex interactions between individual characteristics such as cognitive style, motivation, affective state, metacognitive awareness and neurological development. External variables such as family, curriculum requirements and teaching techniques are also thought to have varied effects on learning. As all models have merit and are likely not mutually exclusive, it is highly probable that the development and maintenance of learning disabilities result from multiple and interactive origins that occur within the context of the individual's life.

Research has focused on three main areas which originate from a variety of theoretical perspectives. These include etiology, outcome research and psychometric methods of identification and classification (Durrant, 1994). All have been investigated simultaneously with the results in each area influencing research in the others. Investigations into potential causes such as visual motor delays, delay in language development and language processing, attentional deficits, information processing patterns and cognitive processing have been major areas of interest since the 1960's although currently they are not being pursued as aggressively (Meltzer, 1994; Smith, 1991). The differing focuses have, however, led to understanding that learning disabilities are not a unitary disorder and that the causes and characteristics of LD differ between individuals.

In the past decade, outcome research has been prolific in the field of learning disabilities. The most extensively researched area focuses on evaluating intervention effects and assessing the effective intervention strategies such as metacognitive strategies and computer assisted instruction, utilized on the LD population (Durrant, 1994; Sandoval, 1993). Given the increasing emphasis on improvement of school implemented intervention strategies, investigations of academic achievement particularly in reading, spelling, and arithmetic, have remained constant (Bracken, 1988; Carlisle, 1994; Fleischner, 1994; Jordan, Levine, & Huttenlocker, 1994; Lewis, Hitch, & Walker, 1994; Mann, 1994; Stanovich, 1991). Affective and social components in the behavior of LD children as demonstrated by poorly developed social skills and emotional difficulties have also been investigated (Little, 1993).

Kavale and Forness (1985) criticize the field of learning disability research for its lack of theoretical foundation and for its adherence to generalizing rather than the production of abstract theories. This has been thought to result in vague rather than exact understandings of learning ability, learning potential, and learning deficiencies. Generalizing the findings of a huge body of research is thought to do little more than summarize what has been observed. However, research into this field is generally conducted through group research, often with parameters not clearly delineated, or based upon the accepted definition of the period, making consistent and reliable observations difficult to obtain. In fact, findings from individual studies are often conflicting, variable, and sometimes paradoxical (McLean-Thorne, 1994; Ogilvy, 1994).

The lack of a sound theoretical basis for the understanding of learning disabilities results in definitions being altered and adjusted partially on the basis of research findings (Torgesen, 1994). In addition, the prevailing political and social pressures being placed upon the education and legal systems to meet the educational needs of all children have a profound impact on how the disorder is viewed. Consequently, each developed definition of learning disabilities appears to have an element of generality to it that allows for a variety of interpretations; many are incompatible and conflicting.

Lack of homogeneity within LD classifications causes conflicting and confusing results in the field and is one of the major weaknesses in the research to date, as the heterogeneity of LD groups limits the utility and replicability of much of the current research (Durrant, 1994; Sattler, 1992; Snider & Tarver, 1989). Identification of LD children on the basis of poor academic achievement alone is inadequate as poor achievement may be a result of factors unrelated to the ability to learn (Sattler, 1992). The current definition accounts for differential behavioral outcomes. For example, communicating, reasoning, memory, reading, writing, spelling, or mathematics disability can be experienced singly or in conjunction with each other. The combinations of possible behavioral outcomes, pervasiveness of the disorder, and degree of the disorder, in conjunction with the cause, create tremendous range within the learning disability category.

<u>LD Characteristics</u>

Since learning disabilities are heterogeneous in nature, no two students with learning disabilities are exactly alike. This can create difficulty in identifying and remediating those with learning disabilities. The student may demonstrate only one or several of the behavioral characteristics associated with generalized learning disabilities. These may include significant difficulty in reading, arithmetic, spelling or writing in contrast to average or above average skills in other areas (Sattler, 1992; Smith, 1991); difficulty understanding or following a sequence of directions presented either orally or in written form (Kaufman, 1979; Sattler, 1992; Smith, 1991); inconsistent performance between verbal and written tasks (Lewis, Hitch, & Walker, 1994; Smith, 1991), frequent omission or addition of words when reading aloud (Smith, 1991); distractibility by visual or auditory stimuli commonly found in a regular classroom (Kaufman, 1979); and maintenance of negative perceptions regarding themselves and school, often reflected in frustration (Sattler, 1992; Smith, 1991).

Subtypes

Increasingly, research is focused on identifying subtypes that manifest similar behavioral outcome or academic difficulties. By identifying individuals who fall within closely defined parameters, the validity of the LD construct is enhanced. Identification of subtypes will rebut the critics who question the learning disability concept (Kavale & Forness, 1985; Ogilvy, 1994). Being able to identify clusters of children who present with the same cognitive processes and academic deficits will increase both our theoretical and practical knowledge of the construct (Hooper & Willis, 1989; Humphries & Bone, 1993a). As there is no single identifiable behavioral or cognitive factor that all researchers agree can be attributed to every individual who is categorized as learning disabled, smaller groups must be scrutinized to identify commonalities (Hooper & Willis, 1989).

There is a consensus among researchers that both math and reading can be identified as distinct subtypes of learning disabilities (Fleischner & Garnett, 1987; Lewis, Hitch, & Walker, 1994; Sattler, 1992; Smith, 1991; Stanovich, 1991). Silver and Tipps (1993) state that when researching cognitive abilities, using heterogeneous groups of learning disabled students may create the undesirable situation in which the strengths and weaknesses of the subgroups cancel each other out. Therefore, they recommend that criteria for subgroup membership be clearly operationalized.

The results of Lewis et al. (1994) are consistent with the hypothesis that learning disabilities not only can be subdivided, but that close examination indicates that math disabled children can be subdivided into groups based upon distinct mathematical deficits. Reading disability researchers have also consistently identified and classified children based upon the type of reading deficit they display (Stanovich, 1991). Neuropsychologists Semrud-Clikeman and Hynd (1994) suggest that children with arithmetic disabilities but without reading disabilities are a subset of children whose learning disabilities are due to different neurological pathways.

Reading Disability Research

Numerous and varied explanations of inability to learn to read have been posited in the literature. Explanations include: lack of phonetic representation in working memory (Mann, 1994); poor phonemic awareness (Stanovich, 1991); disruption in word-reading automaticity (Goldsmith-Phillips, 1994); inflexible strategy usage (Smith, 1991; Stanovich, 1991); brain structure anomalies (Semrud-Clikeman & Hynd, 1994); and inadequate decoding skills (Carlisle, 1994 ; Smith, 1991; Stanovich, 1991).

Children with reading disabilities may exhibit more specific characteristics than those mentioned above. Mann (1994) and Smith (1991) indicate that they may exhibit one or several of the following characteristics: limited sight vocabulary; few sounding out or decoding strategies; high frequency words are misread or high frequency words that must be sounded out each time they are encountered; difficulty using context to decipher non-familiar words; word by word reading at an extremely slow pace; difficulty in reading and following directions; an inability to grasp or identify the main idea of written material; difficulty in drawing conclusions and making inferences; and an inability to recall information in the sequence it was presented.

Neuropsychological accounts of reading disabilities attempt to place the cause of the reading problem within the brain structure of the child. As the left hemisphere is the mediator of language processing in most individuals, neuropsychologists hypothesize that there may be some anatomical or neurochemical abnormality within that hemisphere that results in poor reading skills.

Semrud-Clikeman and Hynd (1994) report that research based on results of Clikeman (1991) and Larsen (1990) indicates a relationship between brain structure anomalies and reading skill deficits. Results of neuropsychological assessments indicate an interaction of systems within the brain that contribute to the reading process. These systems appear to occur in deviant patterns more often in dyslexic children than those in control groups. Luria (cited in Semrud-Clikeman & Hynd, 1994) theorized that complex behaviors of reading and writing arise from the interaction of functional systems and that sensory input areas combine to allow higher level, dynamic processing of information. Research into brain structure and its interaction with learning abilities and/or learning styles may result in practitioners being able to develop and tailor programs that teach to children's strengths and help them learn compensatory tactics. "Particularly in situations in which the underachievement of children cannot be attributed to an overall depression of intellectual functioning, it is of great value to understand their relative capabilities in specific areas of cognitive functioning; this can lead directly to appropriate remedial efforts." (Snart, Das & Mensink, 1988).

A meta-analysis of 267 studies was conducted by Kavale in 1982 that investigated the relationship between auditory and visual perception with reading ability (cited in Kavale and Forness, 1985). The best predictor for reading achievement, with an accuracy rate of between 22% to 82%, proved to be sound blending. The magnitude and nature of the relationship of auditory and visual perception to reading indicated that both successfully increased the accuracy of predicting reading skills.

Some theorize that lower overall academic functioning relative to age peers results from deficits in reading ability that increase as the child progresses through school (Sattler, 1992). As reading disabled children are deprived of reading experiences through which other children acquire knowledge, their performance on tasks measuring acquired knowledge, verbal conceptualization, and sequencing decreases and the discrepancy between verbal subtest scores and performance subtest scores increases (Stanovich, 1991). The results are often noticeable cognitive and academic weaknesses that reflect generalized language and learning problems.

Language problems of a global nature are consistent with a uniformly depressed verbal profile. Mann (1994) argues that reading skill depends upon spoken language; therefore language problems and reading problems should be related. Short term memory is thought to be one of the major contributing factors to difficulty in both of these areas. To substantiate this claim, Mann cites research (Mann & Brady, 1988) that has shown poor readers to do poorly on the WISC-R Digit Span subtest, in conjunction with difficulty recalling strings of letters, syllables, and words in order.

Recent concepts have focused on attention, memory, and linguistic functions as the inherent causes of reading disabilities. Increasingly, a common theme is that reading disabilities involve complexity of processing that is yet to be determined unequivocally.

Math Disability Research

Mathematics difficulties are a pervasive problem among school children, but research investigating the acquisition of mathematics and computational skills has been limited in scope and number (Jordan, Levine, & Huttenlocher, 1994; Smith, 1991) because society has not valued mathematics skills as much as reading skills. However, as math reasoning ability resulting from an increasing demand for technological skills in our society becomes crucial, the amount of interest in and research about into children's math acquisition will likely increase.

Children with mathematics disabilities demonstrate characteristics that interfere with their ability to grasp numerical concepts and mathematics reasoning ability. These may include some or all of the following characteristics: difficulty performing basic arithmetic calculations (Smith, 1991); difficulty attending to operational signs (Jordan et al., 1994); frequent reversal of individual numbers or numbers in sequence (Fleischner, 1994; Jordan et al., 1994); inability to grasp basic mathematical concepts (Jordan et al., 1994; Smith, 1991); inability to generalize mathematical knowledge to other domains; and difficulty differentiating important from unimportant information in word problems (Smith, 1991).

Research has indicated that children with math disabilities have difficulty estimating answers and often guess an answer rather than attempting to solve the problem in a methodical manner.

Prevalence rates of math disabilities are estimated between 3.6% (Lewis et al., 1994) to 6% (Fleischner, 1987; Smith, 1991) of the school-aged population. Smith (1991) reports that the incidence of mathematical disabilities as identified by school identification differs between girls and boys at an estimated 2:1 ratio of girls to boys. Lewis et al. (1994), however, found that when assessing children who had not been school identified as learning disabled in math, there was a roughly equivalent number of boys to girls who fell within the specified criteria. The general consensus that recognizes that girls' mathematical competence decreases as they advance through school can be attributed more accurately to stereotyped beliefs in gender ability and the greater perceived value of math ability in boys (Fleischner, 1987; Lewis et al., 1994; Smith, 1991).

It has been hypothesized that proficient mathematical skills involve the integration of important cognitive, visual, motor, language, and attention processes (Smith, 1991). For example, well developed visual-spatial ability allows for the imaging of and rearrangement of objects in the mind; this facilitates the performance of mental calculations. Selective attention abilities allow the child to identify relevant elements of a problem and ignore extraneous details (Jordan et al., 1994). Short-term memory is required to keep all elements of the problem in a logical and sequential order in order to calculate a correct answer (Seigel, 1989).

Many factors have been hypothesized to result in difficulty in acquiring mathematics reasoning skills. These may include a lack of cognitive maturity manifesting itself in cognitive inflexibility that results in a limited ability to reason about several pieces of information at once (Smith, 1991); a deficit in language reasoning that limits ability to solve word problems (Fleischner, 1994; Jordan et al., 1994; Smith, 1991); a lack of metacognitive skills that allow the child to manipulate the tasks to fit individual styles of learning and processing information (Jordan et al., 1994; Sattler, 1992); and inadequate short-term memory for visually presented material (Seigel, 1989).

Of identified math disabled children, some exhibit a selective impairment of computational and conceptual abilities, while others demonstrate a math deficit in conjunction with a broader, more generalized deficit in all academic domains, particularly reading and spelling. Conversely, children with reading disabilities may do poorly in math problem solving because the demands of reading accurately while applying appropriate reasoning, using relevant information and ignoring extraneous information, is problematic. Attention is divided between attempting to read accurately and retaining pertinent information to correctly solve the math problem.

While some in the field postulate that language skills and reading ability are highly related to mathematical success because the symbols used are simply differently coded numeric language concepts (Smith, 1991), others dispute this claim (Lewis et al., 1994). Lewis et al. indicate that findings reveal arithmetic difficulties do not result from difficulties in reading, and that in fact, they were independent of reading skill for a subset of children.

Fleischner (1994) reports that in a study conduced with Garnett in 1987, intelligence was found to be independent of math ability within a group of learning disabled students and that neither the IQ score nor reading ability accurately predicted arithmetic performance. They report that performance scores and error analysis indicate that the major differences between math disabled and non-learning disabled students were the rate of learning math concepts, and the rate at which the children performed math tasks. Critical differences between the two groups are their visual-perceptual and visual-spatial abilities, which are believed to be significantly related to mathematical ability. In a review of current research, however, Fleischner (1994) indicates that some studies have shown general intelligence, verbal ability, and visual-spatial ability to be related to math achievement.

Controversy also surrounds the extent to which reading and math disabilities occur concurrently. Smith (1991) notes that reading and math disabilities tend to co-exist in learning disabled children, although the extent of each disability may vary. She bases this claim on the belief that information processing weaknesses such as spatial organization, alertness to visual detail, failure to shift psychological set and poor memory, affect all academic subjects. In addition, she hypothesizes that reading and math share the requirements of well developed cognitive skills, language ability, attention and memory for successful performance.

Neuropsychological investigations indicate that difficulties in visual-spatial perception evolve into non-verbal learning disabilities. Rourke (1990), focusing on intelligence test scores in conjunction with a battery of neuropsychological tests, has identified three groups of learning disabled children. Those who exhibit a high Performance/low Verbal IQ generally display deficits in reading and writing skills but no impairment in math. Those with roughly equivalent Verbal and Performance scores generally demonstrate equivalently low academic achievement scores in both reading and math. The children with high Verbal/low Performance IQ scores exhibit specific math disabilities. Further to this, Rourke has identified the right hemisphere of the brain as the location of impairment for math disabled children.

A number of clinical and experimental studies have investigated whether children with math disabilities alone display different underlying psychological problems than do children with math plus reading difficulties, or reading difficulties only. Neuropsychological results have shown that those with math disabilities alone performed normally on tests of auditory perception and verbal ability (Lewis et al., 1994), but poorly on tests of visual-spatial abilities (Fleischner, 1994; Lewis et al., 1994; Sattler, 1992). Children with combined reading and arithmetic difficulties performed below normal on visual-spatial skills but most poorly on verbal and auditory-perceptual skills (Lewis et al., 1994).Intelligence Tests

Psychometric data used in conjunction with clinical judgment is the principle criterion used for classification and identification purposes in determining learning disabilities (Wood, 1991). "IQ and achievement levels are probably the most difficult types of data to obtain, but they are also the most important defining characteristics of children with LD" (Durrant, 1994, p. 31). Because of the belief in this premise, research has focused on assessment tools and their utility in application to the LD population.

Conflicting results have been the result of measurement practices that do not rely on adequate tests and measures (Moats & Lyon, 1993) and lack of homogeneity of the sample (Moats & Lyon, 1993; Sattler, 1992; Wood, 1991). Therefore evaluating and administering technically adequate measurement instruments and tests is critical to an increased understanding of the cognitive components of learning disabilities. In order for psychometric instruments to provide clear diagnostic utility, they must meet the criteria of having adequate norms, reliability, and validity (Sattler, 1992).

The key to the usefulness of intelligence testing is to understand why children score the way they do, not merely to identify the level at which they can perform. Intelligence tests are used to predict ability to learn in school based upon the hypothesis that there is a close theoretical relationship between intelligence and learning ability (Kaufman, 1979).

Intellectual tests are central to the definition and identification of learning disabilities because they sample a wide range of skills and abilities. Arguments for the utility of intelligence tests are based upon the belief that identification of individual strengths and weaknesses should lead to effective intervention that will promote a child's academic competence (Clark & Jenson, 1993). The Wechsler tests have provided such an assessment tool since 1949 when the original edition of the WISC was introduced onto the market. It has since undergone two revisions, the WISC-R and WISC-III. Since the tests introduction, researchers have attempted to investigate the utility of identifying and classifying LD children utilizing the WISC tests.

While some researchers have questioned the use of IQ profiles in identifying LD children (Stanovich, 1991), the separate Verbal and Performance scales have made the Wechsler tests particularly attractive for attempting to identify a set of characteristics that might be useful for differential diagnosis (Kavale & Forness, 1984). In a meta-analysis of

LD research conducted by Durrant (1994) involving research conducted from 1988 to 1990, 85.8% of studies that reported IQ scores used the WISC-R or WAIS.

It has been hypothesized that LD children may demonstrate unique profiles on intellectual assessments. The inability to define consistent patterns describing LD children has plagued the field and an ongoing discussion and debate regarding whether characteristic IQ profiles for the learning disabled population exist continues (Snider & Tarver, 1989). Unique patterns of WISC-R performance have not been identified yet in the LD population and attempts to differentially diagnose LD children based upon significant differences with normal children have proven unsuccessful (Bloom, Topinka, Goulet, & Reese, 1986; Kavale & Forness, 1984).

Some research has suggested that LD children may differ from normal children with respect to verbal-performance discrepancies, patterns of subtest scatter, and profiles based on factor scores or theoretical models of cognitive abilities. Meta-analysis of WISC research (Durrant, 1994; Kavale & Forness, 1985) indicates considerable IQ overlap between the distributions of normal and learning disabled populations. In fact, the two populations were difficult to distinguish on the basis of Full Scale, Verbal or Performance IQ, or Verbal/Performance IQ discrepancies.

Despite this, researchers continue to explore the possibility of identifying typical profiles of LD children on major intelligence tests such as the WISC and WISC-R (Holcomb, Hardesty, Adams, & Ponder, 1987). Investigations of Verbal/Performance IQ differences on the WISC and WISC-R have proven equivocal (Holcomb, et al., 1987) in identifying a consistent profile that is exhibited by all LD children. A WISC-R pattern of low VIQ and high PIQ has been demonstrated in several studies (Humphries & Bone, 1993a; Smith, Smith, Matthews, & Kennedy, 1993). Many studies have found that LD groups show higher Performance IQ's relative to lower Verbal IQ more often than in normal groups indicating that LD children may tend to have higher Performance scores than

Verbal scores (Silver & Tipps, 1993). Other studies, however, have found no such pattern (Kavale & Forness, 1984).

Subtest variability within the LD population and between non-LD and LD children has been investigated in an attempt to gain insight into indicators that would improve the screening process for identifying learning disabilities. Large subtest variability, it was hypothesized, might indicate the need for closer examination of the possibility of learning disabilities. Results have been equivocal. LD children often demonstrate greater subtest variability than non-learning disabled children (Smith et al., 1993); however the considerable overlap between the two populations (Kaufman, 1979; Kavale & Forness, 1985; Smith et al., 1993) makes generalizations about patterns of subtest scatter untenable.

Kavale and Forness (1985) report a meta-analysis of 94 studies revealing that verbal subtest scores are suppressed relative to performance subtest scores for learning disabled children. As a group, LD children do most poorly on Digit Span (8.17), Arithmetic (8.69), Coding (8.77) and Mazes (8.93). Their best performances occurred on Picture Completion (10.70), Picture Arrangement (10.32), Object Assembly (10.28), Comprehension (10.13), and Block Design (10.11). Kavale and Forness report that LD groups actually exhibit less variability than normal groups on subtest scatter, which results in subtest profiles that are relatively flat and of little diagnostic value. None of the scores revealed any area of significant strength or weakness for the LD group and all scaled scores placed the LD group within the average range. Regroupings failed to demonstrate distinctive ability clusters that might be useful for clinical differentiation between LD and normal children. No recategorization, profile, pattern, or factor cluster emerged as a clinically significant indicator of LD. "In fact the average profile for LD does not reveal anything extraordinary and appears not unlike that found for the average normal child." (Kavale & Forness, 1985, p. 29).

Kaufman's (1979) factor analysis for each of the 6 to 16 age groups on the WISC-R yielded confirming evidence for the three factors included on the test including the Verbal

Comprehension Index (VCI), Perceptual Organization Index (POI), and Freedom from Distractibility Index (FDI). These factors were produced consistently, and considered sound evidence for the robustness and meaningfulness of the factors for children within the 6-16 age range (p. 22). Kaufman identified the first two factors as being in the cognitive domain, and the distractibility factor as being in the behavioral or affective domain.

Based upon Kaufman's results, the VCI and POI factors for all age groups indicate that the Verbal IQ and Performance IQ reflect a child's WISC-R performance on real and meaningful dimensions of mental ability. Based upon strong empirical evidence provided by factor analysis, the manual reports that Verbal and Performance abilities are treated as separately functioning, measurable entities on the WISC-III (Wechsler, 1991). Thus the discrepancy between these IQ's may well suggest important differences in the child's learning style and ability to handle different types of stimuli (Kaufman, 1979; Sattler, 1992).

Statistically significant Verbal/Performance splits are quite common in the normative populations (Kaufman, 1979; Sattler, 1992) and in fact are reported in the WISC-III manual (1991). Sattler (1992) provides age-based tables that indicate the amount of discrepancy between the Verbal and Performance IQ's required to reach statistical significance. Discrepancies may not reach actual clinical significance until they are of unusually large magnitude. Kaufman (1979) cautions that because Verbal/Performance splits are fairly common in the normal population, differences that are statistically significant in magnitude may not be sufficient enough to be meaningful practically.

Bloom, Topinka, Goulet, Reese, and Podruch (1986) state that 77% of an identified learning disabled group had Verbal IQ<Performance IQ patterns as compared to a more equal distribution of Verbal IQ>Performance IQ in the WISC-R normative sample. Thus, significant delay in the development of verbal-intellectual skills is identified as an outstanding characteristic of the learning disabled sample. They report that their result is comparable to Bannatyne's (1978) report that 60% to 80% of LD children had been found to have relative deficits in verbal areas. Bloom et al., conclude that verbal and language delays in learning disabled children appear to be developmental in nature, rather than secondary to emotional and family educational factors.

Humphries and Bone (1993b) report that for learning disabled children with the low Verbal/high Performance IQ pattern, the strongest correlation was produced between the Verbal IQ and the verbal subtest scores which were the strongest predictors of achievement. "The most provocative aspect of these findings is that the identification of an IQ-achievement and VIQ<PIQ discrepancy is not a guarantee that an accompanying unique pattern of cognitive functioning will be found that distinguishes children with LD and identifies relative strengths for them that are educationally relevant." (p. 188) They do conclude, however, that language problems of a global nature are consistent with a uniformly depressed verbal profile.

Kavale and Forness (1985) indicate that no recategorizations of WISC-R scores have revealed a significant difference between learning disabled and normal children. However, they do indicate that careful examination of cognitive processing styles may help to determine whether the cognitive styles of learning disabled children, or subtypes of learning disabled, differ from the cognitive styles of normal children. Contrary to these claims, upon examination of LD group profiles Clarizio and Bernard (1981) found that the Spatial (Block Design, Picture Completion, and Object Assembly)>Verbal (Similarities, Vocabulary, Comprehension)>Attention (Arithmetic, Coding) profile was characteristic of 35% of an LD sample on the WISC-R. The pattern demonstrates high scores on Spatial subtests, moderate scores on Verbal subtests, and lower scores on Attention subtests. Group profiles demonstrated that LD did exhibit a pattern similar to that reported in previous research (Kaufman, 1979).

An analysis of individual subtests conducted by Clarizio and Bernard (1981) revealed that LD children scored lowest on Arithmetic, Coding, and Information. They scored highest on subtests of Picture Completion, Picture Arrangement, and Object

Assembly. Humphries and Bone (1993a) found that learning disabled children produced consistently weak performance on Object Assembly and Coding but they did not find significant ACID profiles in the LD group. Snider and Tarver (1989) report that Information and Arithmetic were the two lowest Verbal subtest scores in their identified LD group.

Because Verbal IQ has been shown to be a good predictor of academic achievement (Humphries & Bone, 1993; Kaufman, 1979; McLoughlin & Lewis, 1994; Post & Mitchell, 1993; Sattler, 1992; Snider & Tarver, 1989), a low Verbal IQ may indicate that the child lacks some of the verbal prerequisites for successful academic learning. If the higher Performance IQ is taken as an indication of their potential for learning, the child may unrealistically be expected to succeed (Kaufman, 1979). For this reason, there is a general consensus in the field that either the Full Scale IQ or the Verbal IQ should be utilized when comparisons are made with academic ability.

As new tests are introduced into the market, researchers explore their utility in aiding differential diagnosis and developing remedial hypotheses. The revision of the WISC-R to the WISC-III has provided updated norms while a significant portion (73%) of the test content remains the same (Wechsler, 1991). The revision has resulted in a test with excellent reliability and norms, that is regarded as a psychometrically sound instrument (Sattler, 1992). Kaufman describes the WISC-III as "a technically superior instrument" that is well constructed, has excellent standardization, and a comprehensive manual that includes both reliability and validity data (Kaufman, 1993, p. 353). Wechsler (1991) claims that the structure of this instrument measures a wide range of abilities reliably and distinctively and therefore should have a sound basis for profile analysis (Wechsler, 1991).

The WISC-III has received generally good reviews (Kaufman, 1993; Little, 1992; Sattler, 1992). Factor analysis has provided solid empirical support for the interpretation of the Verbal and Performance IQ's as separate entities in the WISC-III as they were on the earlier editions. However, there is some question as to the validity of the reported factor structure (Sattler, 1992). The structure was altered to four factors with the intention of increasing the ability to identify meaningful psychological dimensions. The Verbal Comprehension Index is based upon the same subtests as it was for the WISC-R, as is the Perceptual Organization Index. The structure of the Freedom from Distractibility Index (FDI) has been changed from Arithmetic, Digit Span, and Coding to Arithmetic and Digit Span only. The difference in the WISC-III factor structure does require caution, however, in comparing its results to WISC-R results (Sattler, 1992).

The fourth factor, identified as the Processing Speed Index (PSI), is derived from the addition of a new subtest identified as Symbol Search to the Coding subtest. This factor may prove useful in assessing the visual discrimination and visual processing of nonverbal information (Kaufman, 1993; Post & Mitchell, 1993; Sattler, 1992). The manual reports that the new Processing Speed Factor is reasonably stable (.84), correlates moderately with measures of intelligence and achievement (generally in the .30 to .50 range), and joins distractibility as an area of weakness for learning disabled children (Wechsler, 1991).

In the new version, Coding is a regular subtest and Symbol Search is supplementary. The manual (Wechsler, 1991) claims that Symbol Search measures visual-spatial processing speed and seems to involve some measure of planning ability, whereas Coding measures psychomotor speed. It is also reported that Symbol Search emerged as a distinct weakness for a group of 65 children with learning disabilities. While this subtest contributes to the fourth factor, its only other role is to "substitute for Coding in the determination of IQ scores" (Wechsler, 1991, p. 70). Kaufman (1993) states that a major weaknesses in the revised edition may be the increased emphasis on speed in general, the new subtest and new factor specifically.

The new version has been criticized for placing too much emphasis on speeded responses and bonus points accrued as a result of correct speedy responses (Kaufman, 1993; Sattler, 1992). Relying upon speed may penalize children who are capable of answering correctly but who require processing time to arrive at a correct answer. Kaufman

(1993) reports that both the FDI and PSI have emerged as distinct weaknesses for LD children. The focus on speeded responses on these indices may cause difficulty for LD children and not provide an accurate profile of their abilities.

As previously mentioned, research evaluating the effectiveness of the Wechsler IQ's, indices, and subtest profiles to identify LD children is equivocal. Wechsler (1991) claims that research has indicated that LD children often demonstrate a significant difference between their Verbal IQ and Performance IQ as well as depressed Freedom from Distractibility and Processing Speed scores. Kavale and Forness (1984) in their meta-analysis of studies involving the WISC-R however, report that research failed to detect any significant pattern differences between LD and non-LD children between the Index scores, although it was claimed that FDI would be low for learning disabled students. As a result, further research will be needed in order to validate the claims of the WISC-III's diagnostic usefulness with the learning disabled population.

Despite the separate and independent roots of various theories used to judge intelligence, it is agreed that there is a reasonable amount of overlap between each of the measures and the results indicated through the use of intelligence tests. The commonalities between separate theories substantiate the value of intelligence tests and the potential practical meaningfulness of the scores they produce. The differences between theories reinforce the necessity of interpreting IQ's in the context of other tests or behavior-related information before reaching conclusions about an individual's overall mental functioning.

Achievement scores

Durrant's (1994) meta-analysis of learning disability research revealed that 96% of the learning disability studies reported achievement scores in the form of reading scores, either word recognition or reading comprehension or both. Forty percent of the studies reported math achievement and 14% reported spelling achievement.

The Wide Range Achievement Test - Revised (WRAT-R) is used as a basic screening device to identify possible strengths and weaknesses in basic school subjects. It is one of the most commonly used norm-referenced individually administered achievement batteries utilized to measure relative areas of academic competency (Chittooan, D'Amato, Lassiter, & Dean, 1993; Durrant, 1994; Fleischner, 1994). One advantage of this particular assessment device is that it allows the examiner to observe how the student attempts to complete the computational problems presented. Studies have indicated that WISC-R Verbal intelligence scores tend to accurately predict performance on WRAT-R achievement test (Chittooan et al., 1993).

Criticism of the WRAT-R has focused on the fact that relatively few items are presented for the student to complete. Within the arithmetic component, for example, the number of items measuring any computational process or skill is limited (Fleischner, 1994). To measure reading ability, only word recognition is included. Lewis et al. (1994) support the use of the WRAT-R however, by claiming, "Word-recognition performance is as powerful a discriminator of normal or impaired reading as is overall performance on a composite range of reading measures, including reading aloud, word discrimination, and word knowledge." (p. 286) Despite the limited number of questions and tasks evaluated, the WRAT-R continues to be utilized because it has been determined that the test provides different information than the WISC-R, and seems to assess skills that are primarily acquired and utilized in an academic setting (Chittooan, D'Amato, Lassiter, & Dean, 1993).

Typical correlations between aptitude and achievement are generally in the .50 - .60 range overall, with values of about .70 usually obtained in elementary school. Correlations of this magnitude are considered to be both statistically and practically significant at this level. The WISC-III manual (p. 207) cites correlations between VIQ, PIQ and FSIQ with WRAT-R Reading to be .62, .29 and .53 respectively. Correlations between VIQ, PIQ and FSIQ with WRAT-R Arithmetic are reportedly .61, .40 and .58 respectively. These correlations are based upon large samples and have been averaged across ages.

The Wechsler Individual Achievement Test was published in 1992 and designed to accompany the Wechsler tests of intellectual performance (McLoughlin & Lewis, 1994). Although it is comprised of eight subtests, it can be utilized as a screening device by the administration of three subtests, Reading, Mathematics, and Spelling. The WIAT manual reports that correlations with the WISC-III range from r = .45 between PIQ and Reading to r = .66 between VIQ and Reading. The reported correlations between Mathematics Reasoning and Ability range from r = 66 with PIQ to r= .84 with FSIQ.

In a study comparing the performance of slow learners (SL), identified by a below 85 FSIQ and equivalent academic achievement levels to learning disabled students, Humphries and Bone (1993) examined the correlations of the WISC-R subtest scores and performance on the WRAT-R. They found none of the higher performance subtest scores produced by the LD children correlated significantly with their reading, spelling, or arithmetic achievement scores on the WRAT-R. A high Performance IQ did not compensate for a low Verbal IQ on academic tasks. Although significant correlations were produced between the Verbal IQ and Reading (r = .56), and Spelling (r = .63), no significant correlation was produced with Arithmetic (r = .35). They also found that the Information subtest correlated with Reading (r = .55) and Spelling (r = .6); that Digit Span correlated with Spelling (r = .38) and Arithmetic (r = .37); and that the WISC-R Arithmetic subtest correlated with the WRAT-R Arithmetic (r = .38) subtest.

In comparison, Mayes and Vance (1992) report correlations produced by a group of 38 learning disabled students between the WISC-R and WRAT-R that exhibit less relationship between the intelligence and achievement tests. The Arithmetic subtest correlated with Full Scale IQ (r = .46) with Verbal IQ (r = .29) and Performance IQ (r = .52). The Reading subtest correlated with Full Scale IQ (r = .26) with Verbal IQ (r = .26) and Performance IQ (r = .19).

The ability to discriminate between learning disabled and non-learning disabled students and how to identify LD children has been a major issue in the last few years.

Classification systems are similar to conceptual definitions in that they are not necessarily tied to measurement. As a result, controversy arises over the classification of LD over numerous problems, such as inability to differentiate between low-achieving students and LD students, that arise during the identification process (Humphries & Bone, 1993; Wood, 1991). Psychometric data is the principle criterion used for classification and identification of LD.

To be identified as learning disabled by the current definition of learning disabilities being utilized in Alberta, a child must demonstrate an ability-achievement discrepancy of significant proportions. Discrepancy models for identifying LD are based on the assumption that intelligence tests measure potential, that intelligence and achievement are independent, and that the presence of the LD will not affect the child's performance on the intelligence test (Ogilvy, 1994). Also, a fundamental assumption is made that the degree of discrepancy between academic achievement and IQ is meaningful in some way.

Discussion and debate over the best choice of discrepancy methods for use in determining a significant difference between ability and achievement has been based on conflicting research findings. Although several methods of calculating the discrepancy are available, the standard score method and regression procedure appear to be the most reliable (Clarizio & Phillips, 1989; Wood, 1991). While the regression method appears to produce more conservative distinctions in identifying learning disabled children, the standard score method is more often utilized (Fleischner, 1994, Humphries & Bone, 1993; Kaufman, 1979).

The advantage of the standard score discrepancy model is that the degree of discrepancy can be easily calculated without the necessity of utilizing a formula or table. Standard scores account for mental ability, grade placement, and measurement error during the calculations. They are criticized, however, for overlooking the regression between ability and achievement (Clarizio & Phillips, 1989; Wood, 1991) in the evaluation of children who are at the extremes of the normal distribution.

The operational definition of a significant discrepancy between tests has been offered by Sattler (1992), who suggested that if two tests produce scores that deviate by an amount equal to or more than one standard deviation, the difference is significant. The criterion of one standard deviation seems adequate in most cases, especially when tests are highly reliable and have small standard errors of measurement (Bracken, 1988). To increase the precision, age-based discrepancy requirements rather than grade-based discrepancies (McLoughlin & Lewis, 1994) have been calculated by Sattler to account for a variation in measurement error and reliability at the various ages.

One of the major criticisms of IQ testing is that the IQ may be affected by the same learning difficulties that cause academic difficulty or underachievement, resulting in scores that may be biased against the child and not reflective of the child's learning potential (Kaufman, 1979). The extent to which researchers adhere to this belief will affect the method they use to identify an IQ/achievement discrepancy, how large a discrepancy is required to be both statistically and practically significant, and the variables that constitute the most effective formula for determining a learning disability.

Although there has been extensive research into the performance of learning disabled children on the Wechsler intelligence tests, the introduction of the new edition requires that learning disabled children's performance on the intelligence test be re-evaluated to determine whether new information can be obtained by utilizing the most recent revision. Consequently, the following questions and hypotheses arise and will be examined in the current study.

Research Questions

The present study was based upon investigating whether the WISC-III provided diagnostic utility in identifying and classifying subtypes of learning disabled students and whether a distinction could be made between LD subtype profiles.

1. Does the WISC-III produce distinct profiles for learning disability subtypes? Is there a difference between the profiles produced by reading disabled children in

contrast to those produced by mathematics disabled children? If differences in performance are identified, what are the convergent and divergent patterns of group performance? Do the two groups differ on intellectual and/or diagnostic dimensions in the profiles that they produce?

2. How does the WISC-III profile discriminate between LD and non LD children? Do the two groups differ in their intellectual or diagnostic levels relative to a control group of non-learning disabled children?

Hypothesis 1 - The Reading Disability and Math Disability groups will be distinguishable by the WISC-III profile differences and subtest scatter profiles that were produced. The RD group is expected to exhibit generalized depression on Verbal subtests relative to the Performance subtests. The MD group is expected to demonstrate depressed Arithmetic subtest scores only, relative to other subtest scores.

Hypothesis 2 - Group differences that emerge between the two LD groups and the control group are expected to satisfy the criteria for clinical significance. The WISC-III group profiles produced are expected to assist in the discrimination between learning disabled and non-learning disabled individuals in that they are clearly distinguishable in the patterns of profiles produced.

Hypothesis 3 - It is hypothesized that the Freedom from Distractibility Index and Processing Speed Index scores will be lower for the MD group than for the RD group, as distractibility and processing speed are believed to be more strongly related to math achievement than reading achievement. The correlations between the Arithmetic achievement score and the FDI and PSI are also expected to be high. The RD and control groups are expected to produce similar FDI and PSI scores.

It is hoped that the results from this study will add to a growing body of research intended to evaluate how learning disabled children perform on the WISC-III. As advancements are made in definition, classification and diagnosis of learning disabilities, research findings may provide a stable context within which comprehensive investigations of prevalence, developmental course and response to interventions can be examined.

CHAPTER III

METHOD AND DESIGN

Subjects

The subjects for the study were children between the ages of 6 and 16 who had been referred by their parents or schools to the Education Clinic at the University of Alberta for complete psychoeducational assessments. Three hundred and thirty-six children comprised the pool. Each child had been administered the 13 subtests of the WISC-III in addition to one or more academic achievement tests and visual-motor perceptual tests. Test protocols and reports were examined to determine whether each child met the designated criteria. From this non-random sample, the performance of 36 children who met the criteria for a Reading Disability (RD) group and 32 who met the criteria for a Mathematics Disability (MD) group were examined and compared to a group of 66 non-disabled children of average IQ.

The average age of the total sample from which the groups were drawn was 10 years and 4 months with an average of grade five. The total clinical sample was comprised of 239 male and 99 female subjects. Children whose referrals resulted from primary medical or emotional difficulties were then excluded from the sample selection. In addition, children identified as Attention Deficit Disorder and taking medication for the disorder, or who were referred for further testing to investigate the possibility of Attention Deficit Disorder as a result of the psychoeducational assessment were eliminated from the pool.

Although the ages of children in the total sample ranged from ages 6 to 16, no 6 or 16 year olds were identified for group membership in either of the two disability groups, and no 16 year olds were identified for control group membership.The RD group was comprised of 26 male and ten female subjects whose average age was 9 years, 10 months. Subjects ranged from ages 7 to 15. The MD group was composed of 27 male and five female subjects whose average age was 10 years. Subjects ranged in age from ages 7 to 15.

The control group was composed of 47 males and 19 females whose average age was 10 years, 3 months. Ages ranged from 6 to 15 in the control group. One-way ANOVA's calculated to determine age ($F = .424$, $p = .655$) and gender ($F = 1.05$, $p = .351$) differences indicated no significant differences between groups.

Referrals for subjects included in the study had been made primarily because of parental concerns about their child's learning, general parental interest, or school/ classroom placement concerns. Those children who met the requirements for RD group membership had been referred primarily as a result of parental concerns ($n = 25$) or general parental interest ($n = 8$). Those who met the criteria for MD group membership had been referred on the basis of parental concerns ($n = 21$) or general parental interest ($n = 9$). Referrals for control subjects included parental concerns ($n = 38$), general parental interest ($n = 21$), and school placement issues ($n = 4$). All children included in the sample were English speaking including one subject in each of the Reading and Math Disability groups and two subjects in the control group who were bilingual.

Prior to each assessment the parent or guardian of the child signed a consent form provided by the Education Clinic, allowing test data to be used for research purposes by university students. To fulfill the requirements and standard procedure for the University of Alberta, an ethics proposal was submitted to the Department of Educational Psychology for approval. To address the requirements of the Ethics Committee review, confidentiality was assured and maintained by not recording any personal information that identified individual subjects. Demographic information and test scores were the only information extracted from the clinic files.

Instrumentation

The Wechsler Intelligence Scale for Children - Third Edition, introduced into the market in 1991, is the latest revision of the Wechsler scales of intelligence for children. The revision was completed to renorm the standardization sample and to update the content of the test (Wechsler, 1991). It is comprised of 13 subtests, one of which is a new supplementary subtest identified as Symbol Search. Unlike the predecessors that produced three factor scores, Wechsler (1991) claims that the WISC-III can be separated into four factor indices, Verbal Comprehension, Perceptual Organization, Freedom from Distractibility, and Processing Speed.

The WISC-III has impressive reliability (Sattler, 1992) reporting average internal consistency reliability coefficients of .96 for Full Scale IQ, .95 for the Verbal IQ and .91 for the Performance IQ. Average internal consistency reliabilities for the subtests range from .69 for Object Assembly to .87 for Vocabulary and Block Design. Average test-retest reliabilities are reported to be .94 for Full Scale IQ, .94 for Verbal IQ and .87 for Performance IQ. Average test-retest reliabilities for the subtests range from .57 for Mazes to .89 for Vocabulary (Sattler, 1992). The manual suggests that the test has adequate concurrent and construct validity.

The WIAT is an achievement battery comprised of eight subtests that are designed to assess a variety of academic skills, each in a different curriculum domain. Both individual subtest and composite scores can be generated. Three of the subtests (Basic Reading, Mathematics Reasoning, and Spelling) may be used as a quick screening instrument. It is normed on children ranging from ages 5 years to 19 years encompassing kindergarten to grade 12. The norming sample included a group of learning disabled children. Total composite score reliability ranges from .94 to .98 depending upon age, and subtest reliabilities are all above .80. Test-retest reliability averages for all ages range from .83 to .92 for the subtests and .90 to .97 for the composite scores.

The WIAT contains two subtests that measure mathematical ability. Mathematics Reasoning is a subtest that assesses numerical operations within a problem solving context. The numerical operation subtest requires computation of basic arithmetic in addition to fractions, ratios, percentiles, etc., presented in the traditional paper and pencil format. The two reading subtests included in the total battery are Basic Reading, which is a single word mediated task, and Passage Comprehension, a task that assesses the ability to make inferences, understand sequences of events, and answer questions based upon the silent reading of a passage of text.

Because the WIAT is normed in the same manner as the Wechsler intelligence tests, it allows for reliable comparison of intellectual ability and achievement levels. Correlations between Reading Comprehension and ability range from .47 to .74 with Verbal IQ at ages 9 and 15, from .30 to.50 with Performance IQ at ages 9 and 11, and from .44 to .66 with Full Scale IQ at ages 9 and 11. Math Reasoning and ability correlations are reported to range from .69 to.82 with Verbal IQ at ages 7 and 16, from .41 to .66 with Performance IQ at ages 15 and 16, and from .64 to .84 with Full Scale IQ at ages 7 and 16. (Manual, 1992). The authors claim that the WIAT has been found to provide an "excellent degree" of accuracy in identifying LD children based on an ability/achievement discrepancy in one or more areas (p. 161).

The WRAT-R is an achievement screening battery that consists of three subtests that can be administered independently or together. It is normed on groups ranging from ages 5 years 0 months to adulthood with two separate forms, each targeted for specific age ranges. The WRAT-R, Level 1, is specifically designed and intended for children between the ages of 5 years 0 months to 11 years 11 months. The WRAT-R, Level 2, is designed and intended for use with children from ages 12 years 0 months to adults age 74. Internal consistency indices for both forms of each of the subtests are: Reading $r = .99$, Spelling $r = .99$, Arithmetic $r = .98$. Test-retest reliability coefficients (Reading $r = .94$, Spelling $r = .95$, Arithmetic $r = .92$) for both forms indicate high test-retest reliability (Jastak & Wilkinson, 1984).

While the WIAT Numerical Operations subtest more closely resembles the format of the WRAT-R Arithmetic subtest in that both contain computation problems presented in the traditional paper and pencil format, the Numerical Operations subtest is not included in the quick screening battery. The decision-making of academic achievement level will likely be based upon the screening scores and the total battery will not be administered to the majority of students. Therefore, Mathematics Reasoning was chosen to compare to the WRAT-R Arithmetic achievement score because of a higher likelihood that it would be administered to students at large and decisions regarding mathematics ability would be based upon this subtest score. The same rationale was employed in the decision to include the word identification subtest, Basic Reading, rather than the Passage Comprehension subtest, as it is likely that Basic Reading will be more commonly utilized in decision-making processes.

Tables are provided in the manuals for each of the WRAT-R, WIAT and WISC-III batteries that convert raw scores to standard scores with a mean of 100 and a standard deviation of 15, allowing for comparison of standard scores on the achievement data with ability scores. Age equivalent scales rather than grade equivalent scales were used to generate the standard scores.

Procedures

Required as standard procedure at the University of Alberta is a written submission of the purpose, rationale, and method of any proposed study to an Ethics Committee prior to the study being undertaken. A written proposal and description of the study was submitted to the Committee Chairman on April 19, 1994, delineating the parameters of the study and the manner in which confidentiality would be maintained. Approval to proceed was obtained on May 16, 1994.

The data was collected from the files of children who had been administered complete psychoeducational assessments in the previous two years at the Education Clinic. As part of the assessment, each child was individually administered the 13 subtests of the WISC-III, an achievement test including the assessment of reading, arithmetic, and spelling, and a visual-motor perceptual test. All tests were administered and scored according to standard procedure by supervised graduate students. Three classes of graduate students enrolled in a graduate level assessment course, Educational Psychology 545 in the 1992/93 winter term, 1993 summer session, and 1993/94 winter session at the University of Alberta were involved in the administration of the tests. The students had been trained, and were supervised, by chartered psychologists in the administration, scoring, and interpretation of all tests used in the assessment batteries.

The test results were recorded from within each subject's confidential file in the clinic. Data included the child's sex, age at time of testing, community size, school, grade, retention history if any, special placement if any, and complaints of learning difficulties. As it is not clinic policy to record information regarding race or ethnicity, data on these variables was not available. Children were assigned group membership, either Reading Disability, Mathematics Disability or control, based upon their WISC-III and academic achievement scores.

Definition of Terms

In this study, the operational definition of learning disabilities as formulated by the Learning Disabilities Association of Canada (1986) was adhered to. Subject selection for membership in a learning disabled group were based on the following criteria:

1. The child demonstrates intellectual abilities in the average to above average range, as measured by the WISC-III Full Scale IQ score.
2. The child demonstrates an achievement-ability discrepancy of at least one standard deviation which is obtained by comparison of the higher Full Scale IQ with a lower academic achievement score at the time of the assessment.
3. There is a deficit in one of the following areas: memory, reading, writing, spelling, or mathematics.
4. The learning disability is not primarily due to visual, hearing, or motor handicaps; mental retardation, emotional disturbance or environmental

disadvantage, although a learning disability may occur concurrently with any of these conditions.

The learning disability definition rests on the assumptions that a child demonstrates the capacity to learn, has normal sensory functioning in conjunction with adequate educational opportunity to learn, and lacks severe emotional disturbance. Before each child was identified as having a learning disability, the listed conditions were met and other conditions ruled out as possible causes for low academic achievement.

Because of the nature of the sample and the fact that deficits in reading or mathematics were the main areas of interest in the current study, they were the only two academic areas upon which group membership was assigned. As definitions of learning disabilities generally exclude those with a low intelligence, children whose IQ's were below 85 were excluded from the study.

To meet the defined requirements, all learning disabled subjects demonstrated average or above average FSIQ's within the range of 85 to 125. Discrepancies of more than 1 standard deviation (15 points at a minimum) between the higher FSIQ and lower achievement standardized scores was required for LD group membership. The Wide Range Achievement Test - Revised, Levels 1 and 2, (Jastak & Wilkinson, 1984) and the Wechsler Individual Achievement Test (reference, 1992) were the two academic achievement tests used to determine individual academic achievement level. Those children not administered both Reading and Arithmetic subtests on the WRAT-R or both the Reading and Mathematics subtests on the WIAT, were excluded from group assignment even though they may have met all other criterion for inclusion. Those children whose poor academic performance resulted from behavioral problems, i.e., Conduct Disorder, were also excluded from the sample.

Two diagnostic groups, Reading Disability (RD), and Mathematics Disability (MD), were identified. Those exhibiting a 15-point or more discrepancy between FSIQ and a reading subtest were placed in the RD group. Those exhibiting a 15-point or more discrepancy between FSIQ and mathematics subtest were placed in the MD group. Twenty-four subjects exhibited significant (15 points or more) ability/achievement discrepancies in both reading and mathematics, but no statistically significant difference between the two scores. Each subject was subsequently placed in the group in which they demonstrated the largest discrepancy between ability and achievement. Two subjects produced equally discrepant scores in both reading and math. One was randomly assigned to the Reading Disability group; the other was assigned to the Math Disability group. The RD group contained 36 subjects while the MD group was composed of 32 subjects.

A group of 66 normally achieving children who had been administered either the WRAT-R or WIAT achievement tests and whose FSIQ fell within the 90 to 110 range were assigned to control group membership. Paired sample *t*-tests demonstrated that no significant discrepancy between intellectual ability and academic performance scores were evident in this sample of subjects.

Test report information was recorded for each student and computational analyses were performed using the SPSS-X program. SPSS-X is a computer program developed specifically for analyzing data from social science research (Norusis, 1990). Descriptive statistics were generated to ascertain group characteristics. T-tests for paired samples were calculated to investigate whether significant differences existed between reading and mathematics achievement scores within each group. Verbal/Performance IQ discrepancies were calculated individually based upon age. Correlations between achievement scores and WISC-III IQ scores and WISC-III factor scores were then calculated to describe the strength of the relationship between variables. One-way ANOVA's were calculated to determine the similarities and differences on the Full Scale IQ, Verbal IQ and Performance IQ factor scores between the three groups. Tukey's Honestly Significant Difference was the post-hoc test utilized to determine where the differences lay between groups.

Limitations of the Study

The sample from which the subjects were chosen was obtained through the University of Alberta, Education Clinic. The majority of referrals to the Clinic result from learning and school related concerns on the part of parents who made the referrals. It is unlikely that this sample is comprised of a normal distribution of students with a complete range of abilities and academic achievement levels. Therefore, it should be considered a clinical sample, and not representative of the school population at large. Consequently, the results of this study may primarily apply to a clinical sample of school-aged children.

Conversely, the subjects included in the learning disabled groups were not taken from learning disabled classrooms, special classrooms, or special schools for the learning disabled, but rather were children in regular classroom settings who were experiencing difficulty learning. Therefore the conclusions of this study may not apply to children who experience the most severe kinds of learning disabilities.

Group results were generated and utilized for all analyses and calculations. Therefore the results cannot be generalized to individuals, b... rather apply to group profiles only. This is particularly true as learning disabled children represent such a heterogeneous group that conclusions about individuals cannot be made from group findings. One characteristic cannot be assumed to be applicable to all or even a majority of LD children.

Specific information regarding race and SES were generally unaccounted for in the demographic information as it is not clinic policy to gather this information on referred children. However, reflecting the ethnic composition of the City of Edmonton and surrounding communities, the subjects in this study come from a predominantly white, middle class population. As a result, the research results may be limited in their generalizability to children of diverse racial, SES or ethnic backgrounds. Because it is a non-random sample, the generalizability of the results may be limited to clinic settings only.

There are limitations to the use of an intellectual ability/academic achievement discrepancy analysis. A severe discrepancy does not constitute a diagnosis of learning disability, it only established that the primary symptom of learning disability exists (The Psychological Corporation, 1992). In addition, a severe discrepancy is inherently limited in assessing young children's academic achievement level. Young children have limited formal educational experiences, and as the reviewed literature demonstrated, children need to be exposed to a variety of learning experiences and educational contexts before the identification of learning disability is usually applied. Caution should therefore be exercised when evaluating the results.

CHAPTER IV

RESULTS

Reading Disability Group

WISC-III Results: IQ and Index Scores

Table 1 summarizes the means and standard deviations of the WISC-III IQ and index scores for the Reading Disabled group. Consistent with previous research, (Sattler, 1992) and in the WISC-III manual (Wechsler, 1991), examination of the group means indicates that the RD group performed lower on the Verbal IQ scale than on the Performance IQ scale, exhibiting an 8-point differential between the mean Verbal and Performance IQ scores. The FSIQ fell within the normal range and demonstrates more homogeneity between the subjects than either the Verbal or Performance IQ scores. The Verbal IQ was 4 points lower than the FSIQ, and 8 points lower than the Performance IQ score. Both the VIQ and PIQ scores represent more heterogeneous groups as the ranges were larger by 11 and 12 points than the FSIQ range. The ranges are reflected by the slightly larger standard deviations than that of the FSIQ.

Table 1

WISC-III IQ and Factor Score Means and Standard Deviations for RD Group

WISC-III Factor	Mean	S.D.
Full Scale IQ	105.19	10.50
Verbal IQ	101.31	12.69
Performance IQ	109.31	12.37
Verbal Comprehension Index	101.28	13.25
Perceptual Organization Index	111.56	11.34
Freedom From Distractibility Index	97.28	11.84
Processing Speed Index	100.56	14.40

Individual cases were examined to determine the number of subjects that demonstrated a statistically significant Verbal/Performance IQ discrepancy based upon age (Sattler, 1992, p. 1168). Eighteen of the RD children had a low Verbal IQ/high Performance IQ discrepancy. Two subjects had a 12 IQ point differential that was significant at .05. Four subjects had a 14 to 17 IQ point differential, significant at the .01 level. Twelve subjects had a 18 to 38 IQ point differential that was significant at .001. These subjects represented 50% of the total RD sample. Five subjects had significantly high Verbal IQ/low Performance IQ discrepancies. One child had a 16-point discrepancy, significant at the .01 level, and four children had 12 to 24 IQ point discrepancies, significant at the .001 level. This group comprised 13.8% of the total group. Of the 36 children in the Reading Disability group, 63.8% exhibited significant V/P splits. The manual reported (Wechsler, 1991, p. 262) that the normative sample resulted in a total of 24.3% who produced V/P splits larger than 15 points. Of the RD group members, 58.3% obtained discrepancies larger than this. (See Appendix A)

The WISC-III Index scores represent heterogeneity of performance for those in the Reading Group. Reflecting a higher PIQ score, the highest of the indices was Perceptual Organization which was 10.3 points higher than the next index score and had the most restricted range. There is a 14.28 point difference between the Perceptual Organization Index and lowest factor score obtained on Freedom from Distractibility. The Processing Speed Index and Verbal Comprehension Index were within .5 points of each other, exhibiting roughly equivalent performance on these two indices for this group. The range for the Processing Speed Index, reflected by a higher standard deviation, did indicate more heterogeneity in that it was relatively larger than any other index score range.

Wechsler (1991) reported in the WISC-III manual that a group of Reading-Disordered children produced a mean profile that demonstrated a descending level of performance from Perceptual Organization (104.7) to Verbal Comprehension (100.4) to Processing Speed (95.4) to Freedom from Distractibility (93.2). Unlike those results, in which both Freedom from Distractibility and Processing Speed Index scores were depressed relative to other Index scores, the subjects in this study produced a profile on which Freedom from Distractibility Index was the only depressed mean score relative to the others.

Subtest Scores

Table 2 summarizes the means and standard deviations of the RD, MD, and control groups WISC-III subtest scaled scores.

Table 2

RD, MD and Control Group Means and Standard Deviations for WISC-III Subtests

Subtest	RD Mean	SD	MD Mean	SD	Control Mean	SD
Information	9.33	2.76	10.34	2.96	9.93	2.46
Similarities	10.27	3.24	11.63	3.24	9.89	2.46
Arithmetic	10.11	2.69	9.13	2.69	9.41	2.21
Vocabulary	9.69	2.85	11.31	3.39	9.70	2.46
Comprehension	11.42	3.26	11.50	3.03	9.80	2.68
Digit Span	8.53	2.77	9.91	2.49	9.46	2.73
Picture Completion	12.61	2.48	12.13	2.85	10.98	2.32
Coding	9.47	3.86	8.56	3.37	8.45	3.29
Picture Arrangement	12.22	3.15	11.88	3.34	10.53	2.73
Block Design	11.39	3.23	10.19	3.51	9.89	2.87
Object Assembly	11.03	2.27	10.78	2.67	9.30	2.14
Symbol Search	10.28	2.92	9.47	3.10	9.26	2.68
Mazes	10.74	3.01	10.78	4.13	10.47	3.55

Figure 1 presents the profile of subtest scores produced by the RD group. The lowest mean was produced on the Digit Span subtest , which although not included in determining the Verbal IQ, is considered a verbal subtest. Of the six Verbal subtests, five of them, Digit Span, Information, Vocabulary, Arithmetic, and Similarities, were included in the six subtests with the lowest means. The one Performance subtest included in the lowest six was the Coding subtest, which had the third lowest scaled score mean overall. Four

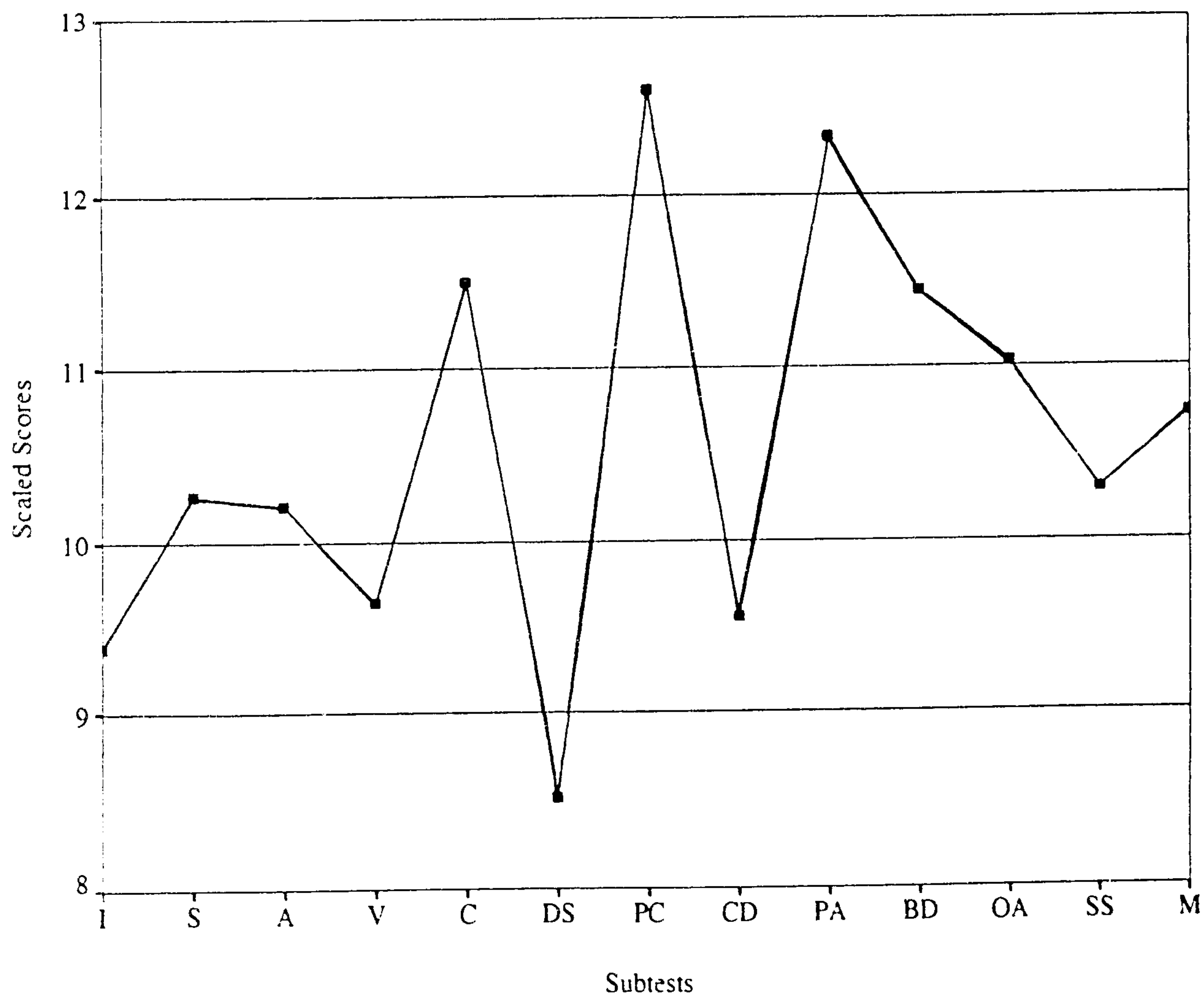

Figure 1. RD Group WISC-III Mean Subtest Scores

subtests, Digit Span, Information, Coding, and Vocabulary all had mean scaled scores of below 10. The Performance subtests that resulted in the highest mean scaled scores were Picture Completion and Picture Arrangement which both had means of over 12, and Block Design and Object Assembly which had means of over 11. Comprehension was the single Verbal subtest that fell within the top subtest means with the third highest scaled score mean. The standard deviations for all subtests were within the normal and expected range (Wechsler, 1991) of 2.27 (Object Assembly) to 3.86 (Coding).

One-way ANOVA's were calculated to determine whether there were any significant differences within the RD group performance on the individual subtests. The results indicate that there were significant differences between the Similarities and Comprehension subtests ($F = 2.6579$, $p = .0270$), and between the Vocabulary and Comprehension subtests ($F = 2.9898$, $p = .0155$). In both instances the Comprehension means were significantly higher. Significant differences were also obtained between the Similarities and Digit Span subtests ($F = 2.358$, $p = .0399$), and between Similarities and Vocabulary ($F = 5.5913$, $p = .0003$) with the mean of Similarities being the higher of the two.

Academic Achievement

As reported in the Method section, all subjects were administered either the WIAT or WRAT-R achievement test in order to evaluate individual academic achievement level in reading (word identification) and mathematics (computation and problem solving).

Table 3 reports the RD group standard score group means, standard deviations and sample size administered for each of the WIAT and WRAT-R subtests. A significant difference was obtained between the WIAT reading and math subtests ($t = 5.53$, $df = 13$, $p < .0001$) with the reading being depressed by 17.29 points, roughly one standard deviation difference. A significant difference ($t = 5.50$, $df = 18$, $p< .0001$) between the reading and arithmetic subtests was produced by children administered the WRAT-R who exhibited a

12.05 point differential between a higher arithmetic and lower reading scores. As hypothesized, children with reading disabilities scored lower on the reading subtest than on the mathematics subtest.

Table 3

Academic Achievement Subtest Means and S.D. for RD Group

Academic Achievement Subtest	Mean	S.D.	Sample n's
WIAT Reading	86.93	9.59	14
WIAT Mathematics	104.21	14.50	14
WRAT-R Reading	74.95	11.73	22
WRAT-R Arithmetic	86.53	11.36	22

The RD group academic achievement scores indicate that on both achievement tests, subjects score lower on the reading (word identification) subtest than on the mathematics subtest. Those administered the WRAT-R reading demonstrated a wider range of scores than those administered the WIAT reading subtest. The standard deviations for both reading subtests were within the expected range, 9.59 on the WIAT reading subtest which reflects its more restricted range and 11.73 on the WRAT-R reading subtest which reflects a wider range.

The reading subtests do not appear to be equivalent in that there was a 12-point discrepancy between the mean of the WRAT-R and WIAT subtests. The difference may reflect that the two subtests are measuring different things, the content differs markedly between the two subtests, or one discriminates more finely than the other. Any of these conditions would be expected to result in mean differences; therefore it would be expected that they would produce non-equivalent numbers. In addition, a smaller group of subjects was administered the WIAT, resulting in a 40% difference in group sizes which may account for the discrepancy in the two subtest means.

The WIAT mathematics and WRAT-R arithmetic subtests scores demonstrate a significant difference, 17.68 points, in subtest means. As mentioned in the method section, the WRAT-R measures computation skills while the WIAT mathematics subtest measures computational skills presented within a problem solving framework. As a result, a large discrepancy between the means may be explained by the differences in content, presentation and format of the two subtests. There is a 9 point difference between the subtest ranges, therefore the mathematics subtests standard deviations do not differ as substantially as the reading subtest standard deviations. The children with reading disabilities, as a group, demonstrated below average achievement scores, with reading being lower than mathematics.

Correlations

Correlations calculated between WISC-III scores and academic achievement scores produced different results depending upon the achievement test utilized to determine academic competence. Caution must be exercised when interpreting the results as the sample sizes for both the Reading Disability group and Math Disability group were small, particularly as the WIAT subtest correlations are concerned. The difference in sample sizes between those administered the WIAT subtests (RD group, n = 14, MD group, n = 6) and those administered the WRAT-R subtests (RD group, n = 22, MD group, n = 26), in addition to the small sample sizes, particularly for the WIAT subtests, may have a profound affect on the results. The results must therefore be viewed with caution as the correlations may have been inflated by the small sample.

Results were compared to those reported for a group of learning disabled children in the WISC-III manual (1991, p. 207). The results reported by Wechsler were obtained on group of LD children in which the type of learning disability was not specified, and the group was comprised of both LD and ADHD children.

Correlations reported by age in the WIAT manual (1992, p. 366-375) between reading and WISC-III FSIQ range from .44 at age 9 to .66 at ages 11 and 12; with VIQ range from .47 to .74 at ages 9 and 15; and with PIQ from .3 to .5 at ages 9 and 11. Mathematics correlations with FSIQ range from .64 to .84 at ages 7 and 16; with VIQ range from .57 to .82 at ages 11 and 16; and with PIQ range from .49 to .66 at ages 14 and 16.

Table 4 summarizes the correlations obtained between academic achievement scores and IQ scores for the RD group. FSIQ correlations with all achievement subtests were significant at the .01 level. The WIAT Math, WRAT-R Reading and WRAT-R Arithmetic subtests produced equivalent correlations in the .6 to .7 range.

Table 4

Correlations between WISC-III and RD Achievement Scores

	WIAT RDG	WIAT MATH	WRAT RDG	WRAT MATH
FSIQ	.936***	.620**	.679***	.615***
VIQ	.795***	.549*	.505*	.491**
PIQ	.514	.287	.570**	.506**
VCI	.750**	.471	.450	.401
POI	.419	.246	.506**	.440*
FDI	.809***	.697**	.408*	.357
PSI	.449	.406	.636***	.484*

WIAT n = 14,
WRAT-R n = 22

* p = .05
** p = .01
*** p = .001

Correlations between VIQ and all academic subtests were significant at the .05 level. The strength of the relationship was equivalent for the WIAT Math, WRAT-R Reading and WRAT-R Arithmetic subtests ranging from .54 to .49. The strongest correlations were produced between VIQ and the WIAT Reading subtest, and the weakest correlations with WRAT-R Arithmetic subtest.

While the correlations obtained between PIQ and the WRAT-R subtests were significant at the .01 level, those obtained between PIQ and the WIAT subtests were not significant. As previously discussed, the small number of subjects administered the WIAT may have contributed to this finding. The WISC-III manual reports correlations in the .3 to .4 range between PIQ and WRAT-R Reading and PIQ with WRAT-R Arithmetic, this group produced a higher correlations (r =.57 and r =.50 respectively). While PIQ had the weakest relationship to reading on both achievement tests, the magnitude of the relationship found in the current study was much larger than that reported by Wechsler.

Wechsler's (1991) reported correlations produced by a group of learning disabled children between both the WRAT-R Reading and Arithmetic subtest scores with the WISC-III IQ scores differ from the results obtained with this sample of children with reading disabilities. The manual reports the correlations obtained between WRAT-R Reading with FSIQ, VIQ and PIQ to be .53, .62, and .29 respectively (p. 207). The findings from the RD group produced results that were inconsistent with those reported by Wechsler. While the magnitude of the relationship was not substantially different for either the FSIQ with reading or the VIQ with reading from that reported in the manual, the pattern of strongest to weakest correlations was different. The strongest correlation was produced between FSIQ and the academic subtests, and the weakest correlation was produced between VIQ and the academic subtests, whereas Wechsler reports the strongest relationship to be between VIQ and reading and weakest between PIQ and reading.

The manual reports correlations obtained between WRAT-R Arithmetic with FSIQ, VIQ, and PIQ to be .58, .61, and .40 respectively. The present findings indicate a reverse pattern in the RD group from that reported by Wechsler. RD subjects produced a stronger correlation between FSIQ and arithmetic than that obtained between VIQ or PIQ and arithmetic on both the WIAT and the WRAT-R arithmetic subtests.

Sattler (1992) reports that correlations between intelligence test scores and reading ability generally fall within the range of .45 to .65 for reading disabled children. While the WRAT-R reading subtest produced a correlation close to this magnitude in the current study, the WIAT reading subtest produced a substantially higher correlation.

Mathematics Disability Group

WISC-III Results: IQ and Index Scores

Table 5 summarizes the means and standard deviations of the WISC-III IQ and index scores for the Math Disabled group. The FSIQ was in the normal range, and equivalent to that obtained by the Reading Disabled group. The range indicates that performance between subjects within the Math Disability group is fairly homogeneous. In contrast to the Reading Disabled group, the MD group exhibited no Verbal/Performance differences. An examination of the ranges, however, indicates that in comparison to the FSIQ, the Verbal IQ and Performance IQ score ranges were larger than that of the FSIQ, representing more heterogeneous performance. The standard deviations for the three IQ scores were well within the normal and expected range reported in the manual (Wechsler, 1991).

Table 5

WISC-III IQ and Factor Score Means and Standard Deviations for MD Group

WISC -III Factor	Mean	S.D.
Full Scale	105.47	12.43
Verbal IQ	104.78	12.98
Performance IQ	105.50	12.15
Verbal Comprehension Index	107.28	14.17
Perceptual Organization Index	108.63	12.38
Freedom from Distractibility Index	98.25	10.45
Processing Speed Index	95.91	15.12

Individual scores were examined to determine whether statistically significant Verbal/Performance IQ splits could be identified. Seven subjects produced low Verbal IQ/high Performance IQ splits. Two were significant at the .05 level, three at the .01 level, and two at the .001 level. The smallest significant split was 10 points, obtained by a 15 year old, and the largest was 21 points, obtained by a 9 year old. The low Verbal/ high Performance profile was obtained by 21.87% of the total group. The same number and percentage of subjects obtained a high Verbal/ low Performance IQ discrepancy. Four subjects produced significant differences at the .05 level, one at the .01 level, and two at the .001 level. The smallest discrepancy in this group was 11 points and the largest was 24 points, both obtained by 8 year olds. In the MD group, a total of 43.75% produced significant V/P splits. The WISC-III manual reported (p. 262) that 44.5% of the normative population obtained Verbal/Performance IQ differences of 10 points or more.

In a pattern similar to that of the RD group, the MD group exhibited a 12.72 point mean differential between the highest and lowest index scores, obtained on the Perceptual Organization Index and Processing Speed Index, respectively. While both Freedom from Distractibility and Processing Speed indices were depressed relative to the other index and IQ scores, FDI was 2.34 points higher than the PSI score. The restricted range of the FDI, reflected by the standard deviation, indicates homogeneous performance between the subjects while the PSI range indicates more heterogeneous performance within the group. Verbal Comprehension Index and Perceptual Organization Index mean scores were both elevated relative to the other index and IQ scale scores. This finding is similar to that reported for learning disabled children generally in the WISC-III manual (Wechsler, 1991). Wechsler reported that learning-disabled children produced Perceptual Organization Index>Verbal Comprehension Index>Processing Speed Index>Freedom from Distractibility Index profiles. The standard deviation of the VCI was larger than that of the POI, reflecting a wider range of performance between MD group subjects.

Subtest Scores

Figure 2 presents the profile of subtest scores produced by the MD group. As summarized on Table 2, the MD group produced their lowest subtest scaled score mean on the Coding subtest. Of the four lowest subtests with scaled score means of below 10, two load onto the Verbal IQ (Arithmetic and Digit Span). These two subtests when added together comprise the third factor, the Freedom from Distractibility Index score. The other two lowest scoring subtests, Coding and Symbol Search, load onto the Performance IQ and when added together comprise the new fourth factor, the Processing Speed Index score. The five subtests on which this group produced scaled score means of over 11 included three Verbal IQ subtests, Similarities, Comprehension, and Vocabulary, and two Performance IQ subtests, Picture Arrangement and Picture Completion. All of these subtests include a strong verbal component in that all require verbal mediation for successful completion. Standard deviations on the Mazes subtests was larger than expected or reported in the WISC-III manual (Wechsler, 1991). On all other subtests, standard deviations within the expected and normal range were obtained ranging from 2.49 (Digit Span) to 3.39 (Vocabulary).

One-way ANOVA's were calculated to determine whether significant differences between subtest mean scaled scores had been produced. Significant differences between Coding and Picture Completion mean scaled scores ($F = 3.1406$, $p = .0147$), Coding and Symbol Search ($F = 3.8966$, $p = .0041$), and Block Design and Symbol Search ($F = 3.130$, $p = .0219$) were identified.

Academic Achievement

As reported in the Method section, all subjects were administered either the WIAT or WRAT-R achievement test in order to evaluate individual academic achievement level in reading (word identification) and mathematics (computation and problem solving).

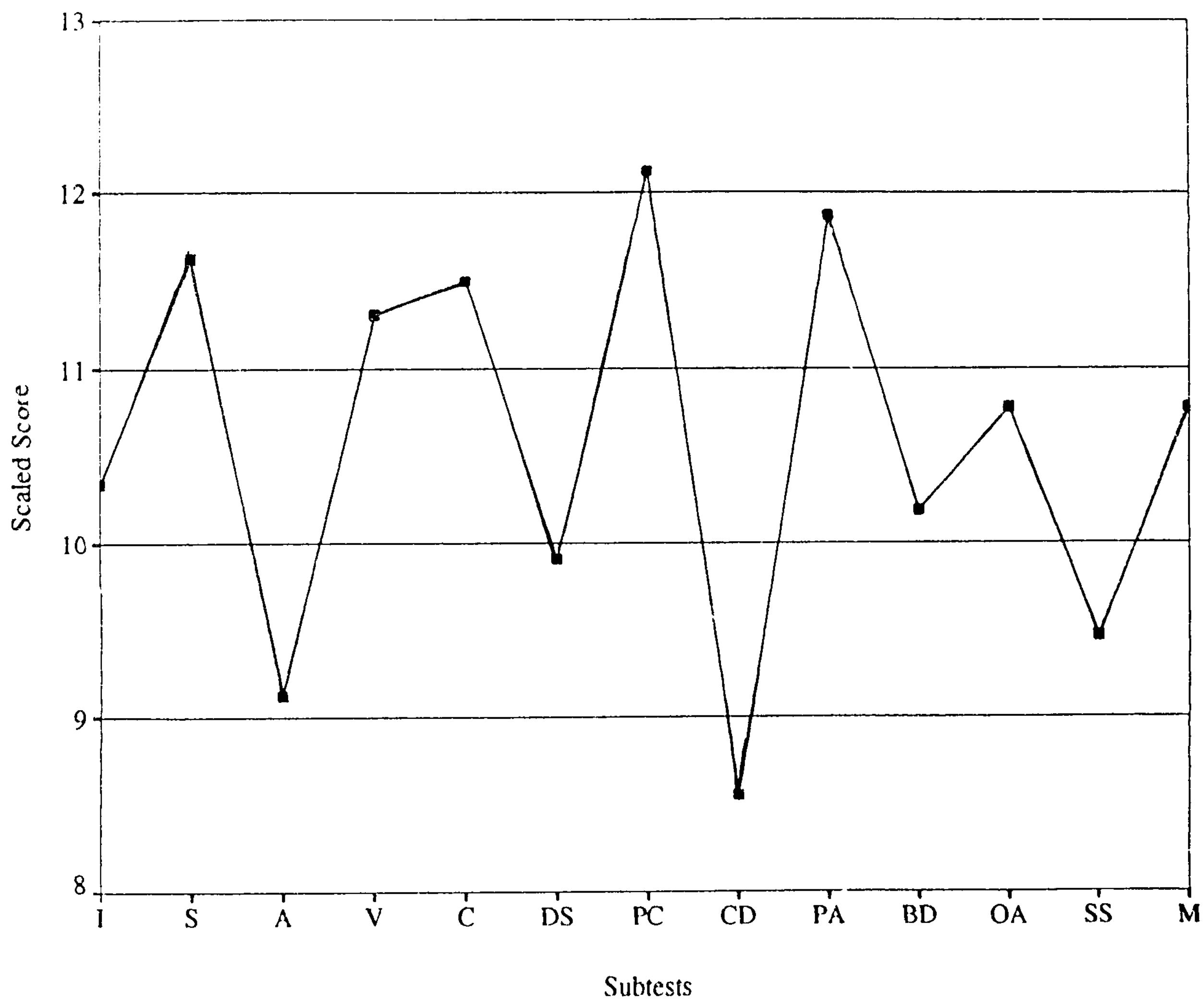

Figure 2. MD Group WISC-III Mean Subtest Scores

Achievement data produced by the MD group is reported in Table 6. No significant difference was produced between the WIAT reading and mathematics subtest although the group means indicated that performance on the math subtest was 14.0 points lower (roughly one standard deviation) than performance on the reading subtest. The result may have been affected by the small number of subjects in the group (n = 6) who were administered the WIAT. Despite the lack of statistical significance, a 14 point discrepancy between academic subtests may be of practical significance. There was a significant difference between the WRAT-R arithmetic and reading subtests (t = -4.80, df = 25, p = .0001) with arithmetic being the lower. Subtest means indicate that performance on the mathematics subtest was 14.23 points lower than performance on the reading subtest. As hypothesized, children with mathematics disabilities scored lower on their mathematics subtest score when compared to the reading subtest score. Both achievement tests produced similar discrepancies between the reading and mathematics subtest scores.

Table 6

Academic Achievement Subtest Means and S.D. for MD Group

Academic Achievement Subtest	Mean	S.D.	Sample n's
WIAT Reading	102.00	15.52	6
WIAT Mathematics	88.00	7.46	6
WRAT-R Reading	95.04	15.20	26
WRAT-R Arithmetic	80.81	12.82	26

Correlations

Correlations between MD achievement scores and WISC-III IQ and factor scores are presented on Table 7. As previously noted, the small sample size administered the WIAT subtests (n = 6) had a substantial influence on the results.

A substantial correlation was produced between the FSIQ and the WIAT Reading subtest which was significant at the .05 level. Both the WRAT-R Reading and Arithmetic subtests were significant at the .001 level. As was evident for the RD group, the FSIQ when correlated with the WIAT Reading produced a substantial correlation at the .8 level, but when correlated with the Math subtest produced a more conservative correlation at .58. Wechsler (1991) reported correlations between FSIQ and Reading to be .53, and between FSIQ and Arithmetic to be .58. When compared to those reported in the manual (p. 207), correlations between the FSIQ and WRAT-R Reading and Arithmetic were higher than would be expected (r = .64 and r = .79, respectively). While the WIAT subtest correlations indicated that reading was more strongly related to FSIQ, the WRAT-R correlations produced the opposite results. The Arithmetic subtest was more strongly correlated to FSIQ than the Reading subtest.

Table 7

Correlations between WISC-III and MD Achievement Scores

	WIAT RDG	WIAT MATH	WRAT RDG	WRAT MATH
FSIQ	.828*	.587	.644***	.790***
VIQ	.754	.641	.743***	.828***
PIQ	.803*	.445	.297	.496**
VCI	.709	.532	.727***	.741***
POI	.850*	.413	.360	.490**
FDI	-.0272	.209	.586**	.600***
PSI	-.107	.170	.226	.382*

WIAT n = 6,
WRAT-R n = 26
* p = .05,
** p = .01,
*** p = .001

Verbal IQ correlations with the WIAT subtests were not significant, although strong correlations were produced for both subtests. Conversely, the WRAT-R Reading and Arithmetic subtests both correlated with VIQ at the .001 level. The same pattern of results was produced for the VIQ correlations as had been produced for FSIQ correlations. WIAT Reading was more strongly associated with VIQ than WIAT Math, and WRAT-R Arithmetic was more strongly correlated than WRAT-R Reading.

Examination of the Performance IQ with achievement subtest correlations indicated that the WRAT-R Arithmetic was moderately associated with PIQ ($r = .49$) and was significantly correlated at the .01 level. The WRAT-R Reading produced a weaker correlation ($r = .29$) and was not significantly correlated. While the relationship between WIAT Reading and PIQ was significant at the .05 level, the WIAT Math and PIQ were not significantly correlated. Again, opposite patterns were produced between the achievement batteries, in that Reading was more highly correlated than Math on the WIAT, and Arithmetic was more highly correlated than Reading on the WRAT-R battery.

The WIAT reading results indicate that while VCI and POI are strongly related to reading achievement, FDI and PSI are virtually unrelated. The WIAT mathematics subtest produces similar results in that the relationship between it and VCI and POI are stronger than the relationships with FDI and PSI. The WIAT Mathematics correlations confirm those reported by Wechsler; however, these results must be viewed with caution as the WIAT was administered to a small group ($n = 6$).

The overall pattern for the MD group indicates that the WRAT-R Reading correlated higher with VIQ than FSIQ or PIQ ($r = .74$, $r = .64$, $r = .29$, respectively) and that the relationship was elevated when compared to that reported in the WISC-III manual. WRAT-R Arithmetic correlations produced similar results with VIQ being more strongly correlated than FSIQ or PIQ ($r = .82$, $r = .79$, and $r = .49$, respectively). The manual reported these correlations to be .61 for VIQ, .58 for FSIQ and .40 for PIQ.

Control Group

WISC-III Results: IQ and Index Scores

Table 8 shows the means and standard deviations of the WISC-III IQ and index scores for the Control group. Equivalent mean scores were obtained for the Verbal, Performance and Full Scale IQ scores with a .88-point difference between the three scores. Examination of the standard deviations indicates that, in a pattern similar to that of both LD groups, the FSIQ represented more homogeneity of performance than the other two IQ scores. In fact, the FSIQ standard deviation was far more restricted than that of either the VIQ or PIQ. Reflecting a restriction of group membership to those subjects whose IQ's fell within the 90 to 110 range, FSIQ, VIQ, and PIQ were all depressed relative to IQ scores on either of the LD groups in which group membership was not as severely restricted.

Table 8

WISC-III IQ and Factor Score Means and Standard Deviations for Control Group

WISC -III Factor	Mean	S.D.
Full Scale	98.36	5.67
Verbal IQ	98.29	9.41
Performance IQ	99.17	8.16
Verbal Comprehension index	98.77	9.65
Perceptual Organization Index	101.53	9.70
Freedom from Distractibility Index	98.12	10.61
Processing Speed Index	94.42	12.43

Verbal/Performance IQ discrepancies were identified within the group and statistical significance was determined based upon age provided by Sattler (1992, p. 1168). Fifteen subjects obtained low Verbal/ high Performance IQ discrepancies. Three produced 12 IQ point discrepancies that were significant at the .05 level. Four demonstrated 16-point differences what were significant at the .01 level and eight demonstrated 20 to 26 IQ point differences that were significant at the .001 level. This represented 22.72% of the control group membership. Ten subjects obtained significantly high Verbal/ low Performance IQ differences. Two subjects produced 12 IQ point differences that were significant at the .05 level, three produced 15 and 16 point differences, significant at the .01 level, and five produced 20 to 45 IQ point differences that were significant at the .001 level. This group comprised 15.1% of the control group. In total, 37.87% of the control group members produced V/P split profiles which is comparable to that reported in the WISC-III manual (p. 262) which found that 35.8% of the normative sample produced discrepancies of 12 IQ points or more.

The group produced a mean spread of 7.11 points between the highest and lowest index scores, Perceptual Organization and Processing Speed respectively. Similar to the pattern of the MD group, the Control group Processing Speed Index was the lowest index score and was depressed relative to the performance on the other indices. Subjects exhibited the most heterogeneous performance on the PSI. The mean scores for the Verbal Comprehension Index, Perceptual Organization Index, and Freedom from Distractibility Index were roughly equivalent as only a 3.4 point differential resulted between them. In addition, the standard deviations were roughly equivalent. The pattern of Index scores for the control group exhibited more range than that reported for the control group in the WISC-III manual (Wechsler, 1991).

Comparisons of the results from the control group utilized in this study were compared to control group results obtained for aged 10 and 11 year olds in the manual. This age group was chosen for comparison because age 10 was the average age of group membership in the present study. When compared to the results reported in the Manual (1991, p. 171), the control group in the current study scored within .17 IQ point on the Performance IQ (manual control mean = 99.0 vs. 99.17), 1.24 IQ points on the FSIQ (manual control mean = 99.6 vs. 98.36), and 2.01 IQ points on the Verbal IQ (manual control mean = 100.3 vs. 98.29).

Index scores were also comparable between the two control groups ranging from 1.52 IQ points on the Perceptual Organization Index (manual control group = 100.1 vs. 101.53) to 4.38 IQ points on the Processing Speed Index (manual control group = 98.8 vs. 94.42). Both Verbal Comprehension and Freedom from Distractibility Indexes fell within 2 to 2.5 IQ points of those reported in the manual.

Subtest Scores

Figure 3 presents the subtest profile produced by the control group. As summarized in Table 2, the Control group produced their lowest scaled score means on the Coding subtest with a score of below 9. Including Coding, the five subtests with the lowest means were Symbol Search, Object Assembly, Arithmetic, and Digit Span. As previously mentioned, Coding, and Symbol Search added together produce the Processing Speed Index, and Arithmetic and Digit Span comprise the Freedom from Distractibility Index. These four subtests were within the lowest scoring of the five subtests. The highest scaled scores with means of over 10, were produced on the Picture Completion, Picture Arrangement, and Mazes subtests. No pattern of primarily Verbal or Performance subtests comprising the high or low range was evident, but rather, subtests from both of these scales were interspersed throughout the profile. The standard deviations were all within the normal and expected range as reported by Wechsler (1991) with the lowest being 2.14 (Object Assembly) and the highest being 3.55 (Mazes).

As summarized on Table 9, when compared to the means and standard deviations reported in the Manual (1991) for 10 and 11 year olds, the means and standard deviations of the control group for this study are very similar. The subtest scaled score means produced by the control group for this study range from .01 difference on Block Design to .85 scaled score point difference on Coding.

One-way ANOVA's were calculated to determine whether significant differences between subtest mean scaled scores had been produced. Significant differences between

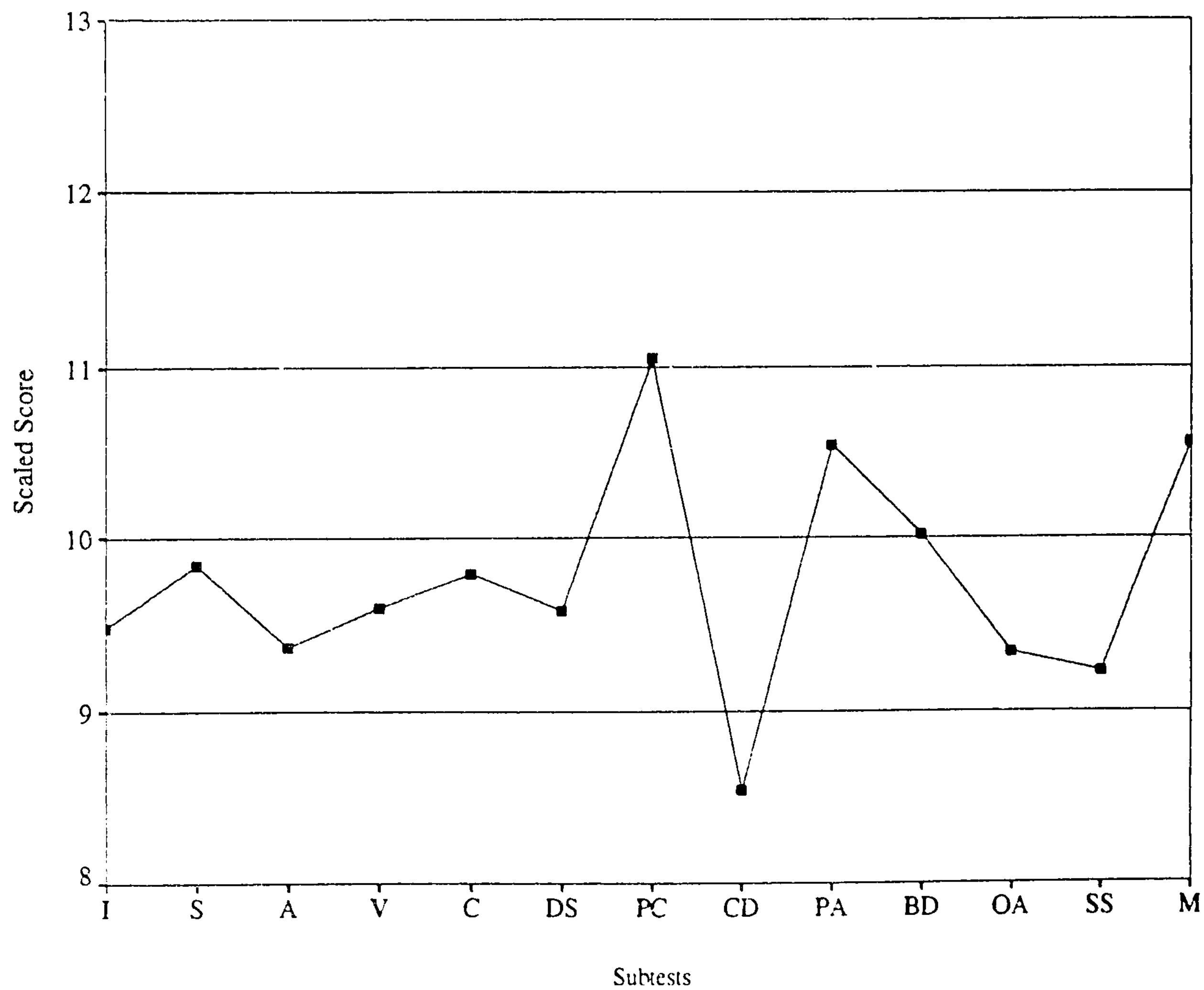

Figure 3. Control Group WISC-III Mean Subtest Scores

Picture Completion and Object Assembly mean scaled scores (F = 2.5816, p = .0177), and between Similarities and Digit Span (F = 2.364, p = .0146) were identified.

Table 9

Comparison of WISC-III Control group with Current Study Control Group

Subtest/Scale	Manual Control		Current Control		Difference Score
	Mean	SD	Mean	SD	IQ points
Information	10.1	2.9	9.53	2.46	.57
Similarities	10.3	2.9	9.89	2.46	.40
Arithmetic	9.6	2.6	9.41	2.21	.19
Vocabulary	9.9	3.2	9.70	2.46	.20
Comprehension	10.1	3.1	9.80	2.68	.30
Digit Span	10.1	2.8	9.46	2.73	.64
Picture Completion	10.2	2.8	10.98	2.32	.78
Coding B	9.3	3.1	8.45	3.29	.85
Picture Arrangement	9.8	2.9	10.53	2.73	.73
Block Design	9.9	3.1	9.89	2.87	.01
Object Assembly	9.6	3.0	9.30	2.14	.30
Symbol Search B	9.8	3.0	9.26	2.68	.54
Mazes	9.9	3.5	10.47	3.55	.57
Verbal IQ	100.3	13.7	98.29	9.41	2.01
Performance IQ	99.0	13.1	99.17	8.16	0.17
Full Scale IQ	99.6	13.1	98.36	5.67	1.24
Verbal Comp. Index	101.0	14.2	98.77	9.65	2.23
Percept. Org. Index	100.1	12.9	101.53	9.70	1.52
Freedom-Distract. Index	100.3	12.5	98.12	10.61	2.18
Processing Speed Index	98.8	13.9	94.42	12.43	4.38

Academic Achievement

As reported in the Method section, all subjects were administered either the WIAT or WRAT-R achievement test in order to evaluate individual academic achievement level in reading (word identification) and mathematics (computation and problem solving). Table 10 reports the Control group standard score group means, standard deviations and sample size administered for each of the WIAT and WRAT-R subtests.

Performance on all the academic subtests produced means and standard deviations within the average and expected range. No significant differences were found between the WIAT reading and mathematics subtests. Analysis of performance on the WRAT-R demonstrated that there was a significant difference ($t = -2.37$, $df = 39$, $p = .023$) between the performance on the reading subtest and arithmetic subtest. Achievement in arithmetic was consistently below that of reading. This finding was contrary to the hypothesis that children in the control group would demonstrate equivalent achievement levels in both reading and mathematics.

Table 10

Academic Achievement Subtest Means and S.D. for Control Group

Academic Achievement Subtest	Mean	S.D.	Sample n's
WIAT Reading	100.53	12.36	24
WIAT Mathematics	99.46	10.62	24
WRAT-R Reading	99.49	11.41	42
WRAT-R Arithmetic	95.27	9.35	42

Correlations

While the control group had a substantially larger sample, correlation results must be interpreted cautiously as the control group had a restricted IQ range as a condition of group membership.

Correlations between the IQ and Index scores and academic achievement subtests are reported for the control group in Table 11. While demonstrating relative strength, the correlations between the subtests and FSIQ, VIQ and PIQ are substantially weaker than those produced by the RD and MD groups, which would be expected given the small sample sizes of the two disability groups, and the restriction of range in the control group.

Performance between the FSIQ and all four academic subtests is moderately related. The significance levels produced differ by achievement test administered. The WRAT-R is significantly related to FSIQ at the .001 level, while the WIAT is significantly related to FSIQ at the .05 level. The WRAT-R Arithmetic subtest produced the strongest relationship and the WIAT Math produced the weakest relationship with FSIQ.

The relationship's between VIQ and the achievement subtests are stronger than those produced with FSIQ, with the exception of the WRAT-R Arithmetic subtest. Moderate relationships were produced with both WIAT subtests which were significant at the .01 level. The WRAT-R Reading subtest produced a moderate correlation at the .001 significance level. The WRAT-R Arithmetic with VIQ relationship was weaker, although significant at the .05 level.

Reflecting the correlations produced with VIQ, the VCI correlations with both WIAT Reading and WRAT-R Reading were moderate and significant at the .01 level. While the WIAT Math was also moderately related, i was significant at the .05 level. The WRAT-R Arithmetic relationship was weak and not significant.

Correlations produced between PIQ and achievement subtests were weak, and none reached levels of significance. Both WIAT subtests produced weak negative correlations. No relationships which were produced between POI and the achievement subtests were significant and all were weak. The same pattern was evident between the PSI and all subtests.

Table 11

Correlations between WISC-III and Achievement Scores for Control group

	WIAT RDG	WIAT MATH	WRAT RDG	WRAT MATH
FSIQ	.419*	.393*	.431***	.482**
VIQ	.562**	.526**	.496***	.363*
PIQ	-.217	-.225	-.007	.144
VCI	.557**	.451*	.439**	.218
POI	-.122	-.070	.022	.027
FDI	.122	.426*	.653***	.531***
PSI	-.195	-.194	-.082	.239

WIAT n = 24,
WRAT-R n = 42
* p = .05,
** p = .01,
*** p = .001

WRAT-R Reading and Arithmetic subtests both produced moderat, and highly significant at the .001 level, correlations with the FDI. The relationship with WIAT Math was also moderate and significant at the .05 level. A weak and non-significant relationship was produced with the WIAT Reading subtest.

Tests of Homogeneity of Variance

The Levene Test for homogeneity of variance was calculated because of the difference in group sizes and differing IQ ranges utilized between groups, to determine whether one-way ANOVA's would be an appropriate statistical analysis. One-way ANOVA's were then calculated to determine mean group differences (see Appendix B). The Tukey Honestly Significant Difference was chosen as the post hoc comparison because it allows for all pai wise comparisons of means and is less susceptible to differing group sizes than other post hoc evaluations. However, the results of these analyses must be considered with caution for the following reasons. Both the RD and MD groups were negatively skewed samples which violates one of the assumptions of the ANOVA. This was not the case for the control group that produced a more even distribution of scores.

Results of the Levene Test of homogeneity of variances indicated that there were statistically significa t differences between the standard deviation of the control group when compared to the math and reading groups on the FSIQ (p = .0001), VIQ (p =.038), and PIQ (p = .018) scores. Such differences were expected because of the IQ restriction for control group membership that was not utilized for LD group membership. While the control group was restricted to a 20 point IQ spread, the two LD groups had 40 point IQ spreads. No significant differences were produced on the Index or subtest scores however.

One-way ANOVA results indicate that as would be expected, significant differences between group means were produced for the Full Scale IQ, Verbal IQ, and Performance IQ. Significant differences were produced on the FSIQ between both the RD and MD groups from the control group (F = 9.903, p = .0001). A significant difference was produced on the VIQ between groups (F = .3665, p = .028). Tukey HSD analysis indicated that there was a difference between the MD and control groups, but not between the RD and control or MD and RD groups. Comparisons of the PIQ between groups resulted in significant differences (F = 11.852, p = .0001) between the MD group and control and the RD group and control, but not between the RD and MD groups.

ANOVA's were calculated on the subtest and index scores to determine which subtests were contributing to the differences discussed above. Again, the results must also be viewed with caution because of the skewed nature of the RD and MD groups. The standard deviations of the subtests, however, were all within the normal and expected range as indicated by Wechsler (1991).

Examination of the Index score ANOVA's demonstrated that significant differences were produced on two of the Index scores. The Verbal Comprehension Index result indicated a significant difference (F = 5.555, p = .004) was produced between the MD group and control group, but no differences were evident between the RD group and the others. A significant difference was produced between both the RD and MD groups with the control group on the Perceptual Organization Index (F = 11.29, p = .00001). There were no differences produced on either the Freedom from Distractibility or Processing Speed Indices.

Both the RD and MD groups propduced mean scores that were significantly higher than the control group on the Comprehension subtest (F = 5.333, p = .005). Mean scores differed significantly between the MD group and control group on the Similarities subtest (F = 3.950, p = .021), and on the Vocabulary subtest (F = 4.037, p = .019) but no differences were evident between the RD and MD groups on either subtest. Therefore, the Similarities, Vocabulary, and Comprehension subtests are the main contributing factors that result in a significant difference between the MD and control groups on the Verbal IQ.

Several subtests accounted for the significant differences in group means on the PIQ. Both RD and MD group means differed significantly on the Object Assembly subtest (F = 8.202, p = .0004) from the control group mean. The RD group mean significantly differed from the control group mean on the Picture Completion (F = 5.564, p = .004), and on Picture Arrangement (F = 4.471, p = .013) subtests.

Question 1

Does the WISC-III produce distinct profiles for learning disability subtypes? Is there a difference between the profiles produced by reading disabled children in contrast to those produced by mathematics disabled children?

RD Group

The RD group was characterized by FSIQ scores within the average range (105.19), despite the liberal IQ criterion for group membership that ranged from 85 to 125. Non-verbal abilities were close to the high average range while the verbal comprehension abilities of the group were depressed relative to their problem solving abilities. Examination of the Index scores indicates that they performed within the average and expected range as a group, with the exception of the Perceptual Organization Index score which was in the high average range.

Figure 4 presents the IQ and index score profiles produced by the RD group. The group obtained their lowest mean subtest scores on Digit Span (8.53), Information (9.33), Coding (9.47) and Vocabulary (9.69). The highest subtest scores were obtained on Block Design (11.39), Comprehension (11.42), Picture Arrangement (12.22), and Picture Completion (12.61).

There was a limited range in the variability between the subtests. All standard deviations were within the expected range of 3 points (Wechsler, 1991) with the exception of Coding on which the subjects demonstrated more diversity in performance. The majority of subtests had SD's of between 2.77 and 3.26. Those subtests with the least variability and therefore the smallest standard deviations were Object Assembly (2.27), Picture Completion (2.48), and Arithmetic (2.69). The Comprehension (SD = 3.26), Similarities (3.24), and Block Design (3.23) subtests produced large, but equivalent standard deviations. Reflecting a scaled score range from 2 to 18, the most variability was produced on the Coding (SD = 3.86) subtest. The result indicates that some children produced significantly lower scores on the Coding subtest than on the other subtest scores. As Coding was one of the lowest score subtests it could be claimed, based on the low mean and large standard deviation, that as a group the RD children appear to score lower than expected and exhibit a wide range of performance on the Coding subtest.

MD Group

Examination of the MD group profile indicates that the Full Scale IQ, Verbal IQ and Performance IQ were all within the normal and expected range. As discussed previously, the IQ level was not elevated despite the liberal IQ parameters for group membership. The Perceptual Organization Index (108.63) and Verbal Comprehension Index (107.28) were high relative to the groups performance on both the Freedom from Distractibility Index (98.25) and the Processing Speed Index (95.91). While the FDI and PSI scores are within the average range, they are depressed relative to the other indices. Figure 5 presents the profile produced for IQ and index scores.

The MD group profile demonstrated that the lowest mean scaled scores were obtained on the Coding (8.56), Arithmetic (9.13), Symbol Search (9.47), and Digit Span (9.91). The scaled scores on the Arithmetic subtest ranged from 5 to 13, whereas the scaled score points on the other subtests ranged from 4 to 18 on Coding, 4 to 16 on Symbol Search, and 5 to 16 on Digit Span. The highest mean scaled scores were obtained on Vocabulary (11.31), Comprehension (11.50), Similarities (11.63), Picture Arrangement (11.88), and Picture Completion (12.13) subtests. The scaled score ranges for these subtests varied from 3 to 18 on Picture Arrangement to 8 to 19 on Picture Completion. Although Picture Arrangement and Picture Completion load onto Performance IQ, they both require verbal mediation for successful completion, therefore all of the subtests upon which the MD children did well as a group involve a strong verbal component.

Reflecting the limited range of scaled score points, the subtests with the smallest variability were Digit Span (2.49), Object Assembly (2.67), and Arithmetic (2.69). Performance on Digit Span and Arithmetic scores was fairly consistent between group subjects in that the mean scores on these subtests are not only depressed relative to the scaled scores of the other subtests, but there was less variability between subjects' performance on them than on the majority of other subtests. The subtests on which the largest variability was produced were Mazes (4.13), Block Design (3.51), Vocabulary

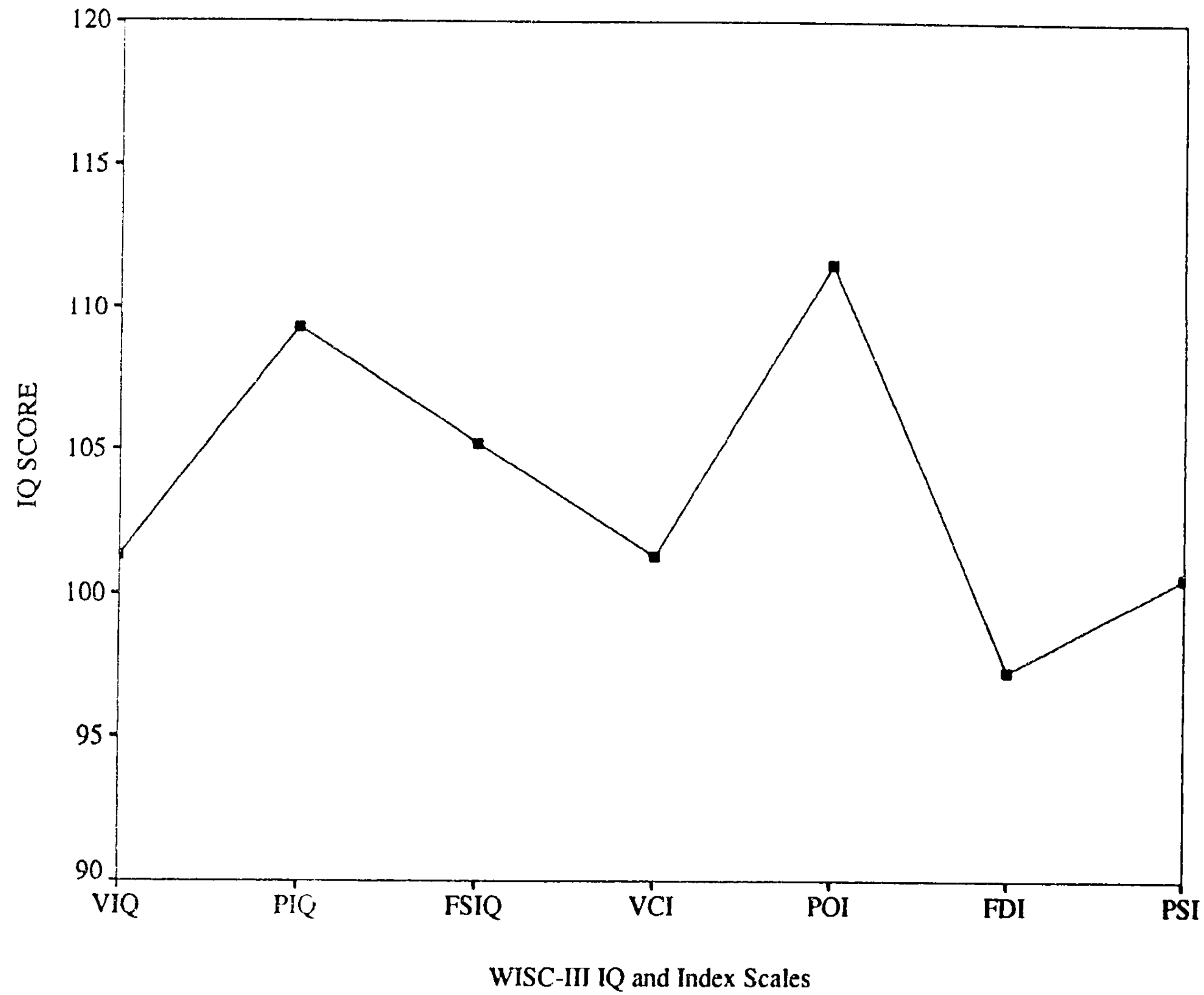

Figure 4. RD Group WISC-III Profile

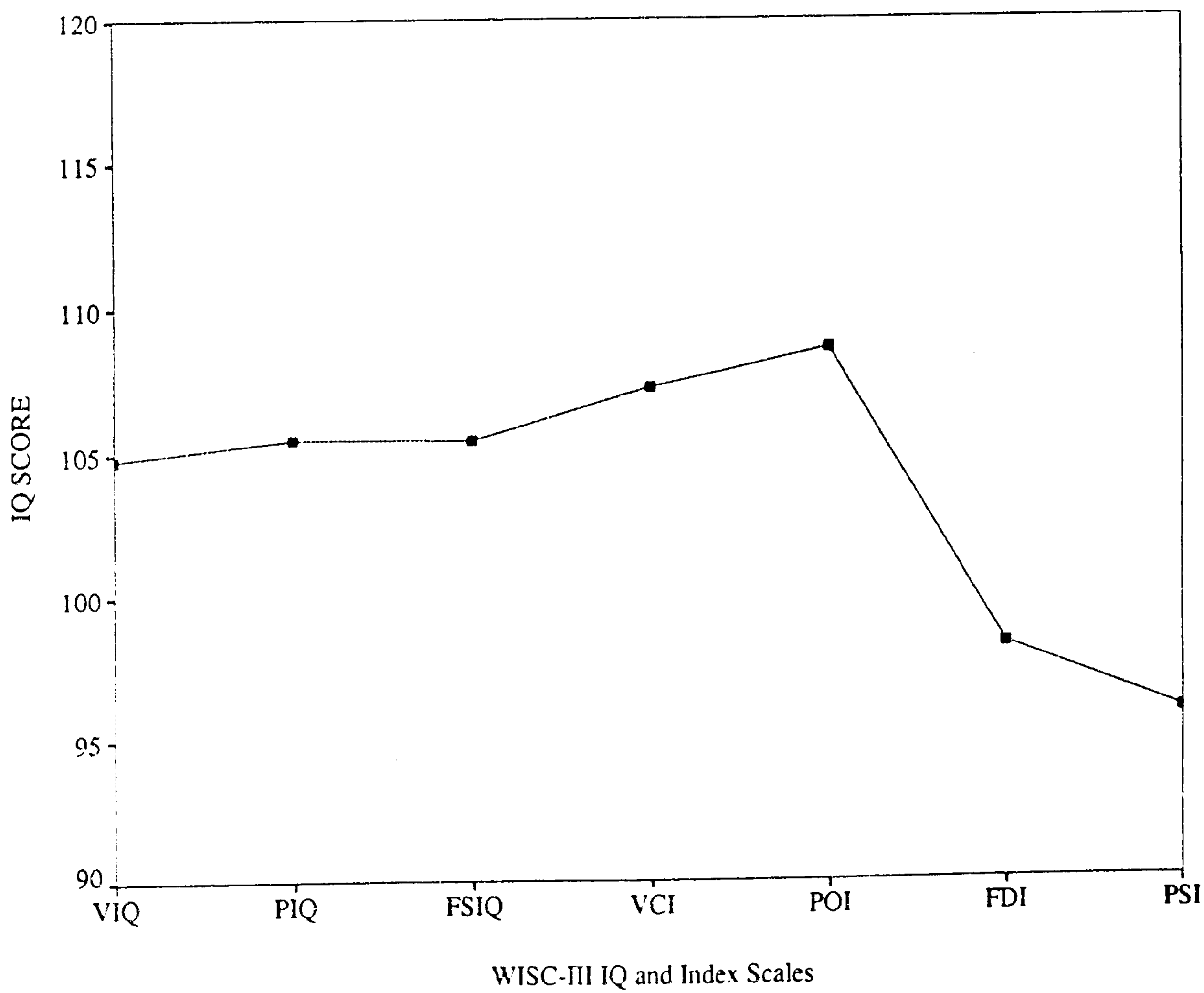

Figure 5. MD Group WISC-III Profile

(3.39), and Picture Arrangement (3.34). The variability evident on the Mazes subtest indicates that there was less consistent performance between subjects. Some children did well relative to their performance on other subtests while others did poorly relative to performance on their other subtests.

RD and MD Comparisons

Group profiles that were distinctly and significantly different from each other were not produced by the subjects in the two groups, although different profiles did result from the analyses. Performance was within the average range on all subtests, and there was considerable overlap between groups in all areas of the WISC-III.

All IQ, index, and subtest means were within the normal and expected range for both the RD and MD groups. There were differences in the patterns of scores produced, however. The Reading disabled group produced a group profile that demonstrated lower scores on several of the subtests that load onto the Verbal IQ component of the test. Their means were one and a half points below the Math Disability group mean profile on the Similarities (RD = 10.28, MD = 11.63), Vocabulary (RD = 9.69, MD = 11.31), and Digit Span (RD = 8.53, MD = 9.91) subtests, and half a point below the MD group on the Information subtest (RD = 9.93, MD = 10.34). The only VIQ subtest on which the MD group had a lower mean was on the Arithmetic subtest, as would be expected. The Comprehension subtest mean scores were equivalent (RD = 11.42, MD = 11.50).

The results of the Performance subtests demonstrate a different pattern from those of the Verbal subtests. Whereas the Reading Disability group produced lower means on the Verbal subtests, the Math Disability group produced lower means on the Performance subtests. The group means indicate that the MD group scored lower on all the performance subtests than the RD group did, with the exception of the Mazes subtest on which the two groups produced equivalent means. The largest differences were on the Block Design subtest (RD = 11.39, MD = 10.19), Symbol Search (RD = 10.28, MD = 9.47), and

Coding (RD = 9.47, MD = 8.56). Small differences were found between the two groups on the means of Picture Completion (RD = 12.61, MD = 12.13), Picture Arrangement (RD = 12.22, MD = 11.88), and Object Assembly (RD = 11.03, MD = 10.78).

Correlations calculated between FSIQ and the achievement subtests are comparable for both the RD and MD groups. In both groups the WIAT Reading correlates substantially, and is the highest correlation produced. WRAT-R Reading correlations are comparable at .67 for the RD group and .64 for the MD group. The correlations produced on the WIAT Math subtest also demonstrate relationships of similar strength. The WRAT-R Arithmetic is the only subtest upon which the correlations produced by the MD group were stronger than that produced by the RD group.

The correlations between the subtests and VIQ for the MD group were stronger than the correlations that resulted from RD group performance. Whereas the WRAT-R Arithmetic was correlated at .49 for the RD group, it was .82 for the MD group. The WIAT Math correlation for the MD group was .64 as opposed to the RD group correlation of .54. WRAT-R Reading also resulted in a higher correlation in the MD gr (r = .74) as opposed to the RD group (r = .50). The WIAT Reading was the only subtest upon which the RD group correlation was higher with VIQ than the MD group.

Substantial differences were obtained between the RD and MD groups on correlations between PIQ and academic subtests. Whereas the WIAT Reading correlation was moderate for the RD group, it was highly correlated for the MD group. Conversely, the WIAT Math was shown to have a low correlation for the RD group, but moderate for the MD group. The WRAT-R Reading had a moderate correlation for the RD group, but low for the MD group. The one subtest that produced similar results for both groups was the WRAT-R Arithmetic.

While the individual subtest results between the RD and MD groups may not indicate statistical differences, the differences may have practically significant implications in that the RD children as a group appear to demonstrate lower scores on several of the

Verbal subtests which may indicate a generalized deficit whereas the MD children appear to demonstrate a specific deficit in arithmetic only. These findings are consistent with those reported by Lewis, Hitch and Walker (1994) who also found a generalized deficit for RD children as opposed to a specific deficit of MD children. Children with reading disabilities may produce profiles that show lower VIQ subtest scores because of their reading difficulties that affect their ability to use language and to obtain knowledge.

These results support Hypothesis 1 presented in Chapter II that stated the expectation of the current study was to find that the verbal subtests scores of the Reading Disabled group would be depressed relative to Math Disabled group that would produce specific deficits in arithmetic and related subtests rather than generalized deficits in all verbal areas. The expectation that the Freedom from Distractibility and Processing Speed Index scores would be lower for the Math Disability group versus the Reading Disability group outlined in Hypothesis 3 in Chapter II, was not substantiated. Although the pattern of the Index scores produced by the two groups was different, there was no significant difference between groups on the two Index scores themselves.

Question 2

Does the WISC-III profile discriminate between LD and non LD children? How do the two groups differ in their intellectual and diagnostic levels relative to a control group of non-learning disabled children?

As previously reported, the control group was restricted to subjects whose FSIQ fell within the 90 to 110 range, and therefore the group produced average FSIQ scores. There were relatively few differences among the subtest scores for this group. Achievement subtest scores were commensurate with intellectual abilities.

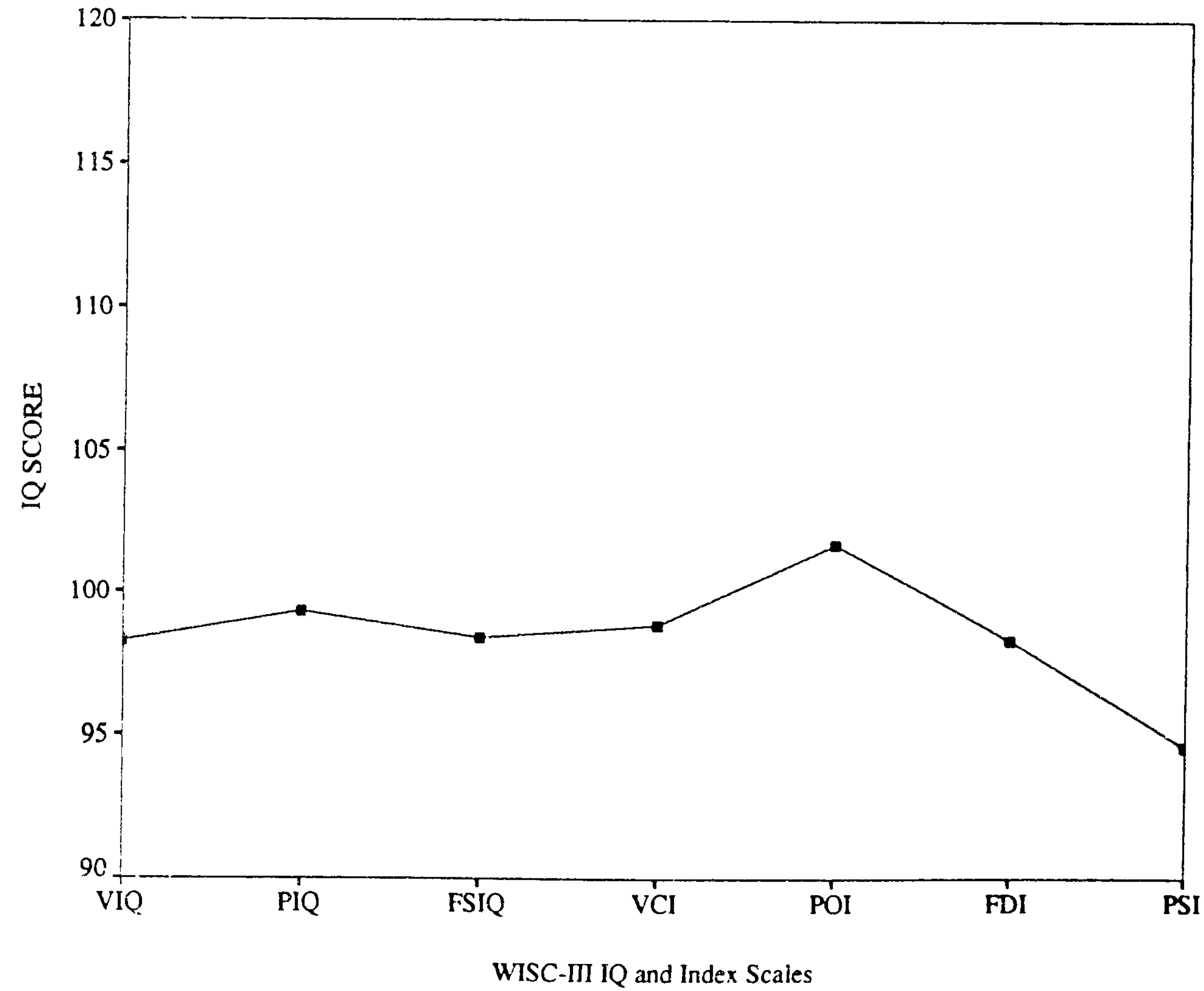

Figure 6.Control Group WISC-III Profile

The control group profile of IQ and index scores is presented in Figure 6. Lowest subtest scaled scores were obtained on Coding (8.45), Symbol Search (9.26), and Object Assembly (9.30). Subtest scaled scores ranged from 3 to 18 on Coding, 4 to 15 on Symbol Search, and 2 to 13 on Object Assembly. Highest subtest scaled scores were obtained on Mazes (10.47), Picture Arrangement (10.53), and Picture Completion (10.98). Subtest scaled scores ranged from 3 to 19 on Mazes to 5 to 19 on Picture Arrangement, and 5 to 16 on Picture Completion.

Reflecting on the ranges of the scaled scores, the subtests with the smallest standard deviations were Object Assembly (2.14), Arithmetic (2.21), and Picture Completion (2.32). With two exceptions, the standard deviations of the subtests fell within 2 to 3 scaled score points. The two exceptions with standard deviations above 3 scaled score points were Mazes (3.55) and Coding (3.29).

As compared to the control group, the LD groups produced slightly higher average WISC-III Full Scale IQs. All groups displayed average FSIQ, VIQ and PIQ's. A PIQ>FSIQ>VIQ pattern of performance was obtained by each group, although the magnitude of the discrepancy between the mean scores differed. All indices for the three groups were within the average range. The Control and MD groups both produced POI>VCI>FDI>PSI patterns on the WISC-III index scores. The RD group, on the other hand, produced a POI>VCI>PSI>FDI pattern in which the positions of PSI and FDI were reversed. The Picture Completion and Picture Arrangement subtests had the highest scaled score means for all three groups. Both the MD group and Control group produced their lowest scaled score means on the Coding subtests, and both groups produced similar ranges of subtest means and standard deviations. The RD group produced a profile on which the Verbal subtests comprised the lower scaled score means and the Performance subtests comprised the higher scaled score means.

In summary, the LD subjects performed at a lower level than did control group subjects in reading and arithmetic subtests on the Wechsler Individual Achievement Test and Wide Range Achievement Test - Revised. Discrepancies on the achievement subtests were in the anticipated direction for both the RD and MD groups; depressed reading scores were obtained for the RD group as compared to the math scores, and depressed math scores were obtained for the MD group as compared to reading scores. Academic achievement scores obtained by the control group indicate that there was no difference in performance between reading and mathematics for those subjects who were administered the WIAT, but that there was a consistent pattern of lower arithmetic scores relative to reading scores for the subjects administered the WRAT-R. Such a finding may be a reflection of the population that was assessed at the clinic.

The results obtained did not support Hypothesis 2, presented in Chapter II, that outlined the expectation that group differences between the LD groups and control group would be generated that would allow for discrimination between learning disabled and non-learning disabled children. No clinically significant differences were produced on the Full Scale IQ, Verbal IQ, Performance IQ, Index scores or subtest scores between the three groups.

Correlations between IQ and Index Scores

The relationship between WISC-III IQ and Index scores were examined. The intercorrelations with each IQ and factor based scale for each of the LD group's and the control group are presented in Tables 12 to 14. Wechsler (1991) cautions that some correlations are inflated because the two correlated scales have subtests in common (i.e., Performance and Full Scale). The correlations between the Index scores however, do not present this difficulty.

The results for all three groups demonstrate similar findings to those reported in the WISC-III manual (pp. 270-279). As expected, the Verbal Comprehension Index and Verbal IQ scores correlate more highly with each other than with the Performance IQ or index scores. Conversely, Perceptual Organization, and Performance IQ scores correlate more highly with each other than with the Verbal IQ or index scores.

As reported in the manual (1991) and expected, all three groups produced strong relationships between FSIQ and VIQ, FSIQ and VCI, VIQ and VCI, and PIQ and POI. On several measures, the RD and MD groups produced strong relationships while the control group produced moderate to weak relationships. These included FSIQ with PIQ, FSIQ with POI, FSIQ with PSI and PIQ with PSI. The RD group was differentiated from the MD and control groups by the correlations produced between FSIQ with FDI, VIQ with VCI, and PSI with FDI. In these cases, the RD group correlations were stronger than those produced by either of the other two groups. The MD group was differentiated from both the RD or control groups by producing moderate correlations between PIQ with VIQ, POI with VIQ, PIQ with VCI, POI with VCI, and PSI with VCI. The correlations produced by the RD and control groups were weak.

This finding indicates that for this sample the FDI factor score provides discrimination between reading disabled and non-reading disabled children as a group. The PSI correlations also appear to discriminate between the learning disabled groups and the control group.

In summary, while the correlations produced by all three groups are similar to those reported in the WISC-III manual, the groups do differ on the patterns of relationships that they produce. The RD group appeared to produce stronger correlations on the FDI than the other two groups and the MD group produced stronger correlations with the PIQ and POI relationships. The PSI correlations with the other Index and IQ scores were stronger for both the RD and MD groups than the control.

Table 12

Intercorrelations between WISC-III FSIQ and Index Scores for RD group

	VIQ	PIQ	VCI	POI	FDI	PSI
FSIQ	.804	.724	.769	.697	.726	.533
VIQ		.173	.971	.204	.732	.222
PIQ			.148	.918	.352	.627
VCI				.186	.615	.170
POI					.389	.335
FDI						.301

Table 13

Intercorrelations between WISC-III FSIQ and Index Scores for MD group

	VIQ	PIQ	VCI	POI	FDI	PSI
FSIQ	.907	.833	.843	.815	.491	.506
VIQ		.530	.959	.548	.478	.351
PIQ			.446	.922	.390	.591
VCI				.445	.322	.373
POI					.465	.279
FDI						.073

Table 14

Intercorrelations between WISC-III FSIQ and Index Scores for Control group

	VIQ	PIQ	VCI	POI	FDI	PSI
FSIQ	.720	.426	.710	.416	.408	.106
VIQ		-.314	.966	-.231	.459	-.158
PIQ			-.289	.876	-.018	.347
VCI				-.206	.294	-.168
POI					.006	-.080
FDI						-.071

<u>Summary</u>

In summary, the Reading Disability group differed from the Math Disability group and Control group by the percentage of subjects that demonstrated a statistically significant Verbal/Performance discrepancy. The Reading Disability group also showed a lower Verbal, higher Performance IQ profile when compared to the other groups that produced equivalent scores. Subtest scores were depressed on the Verbal scales for the Reading Disability group, but on subtests related to mathematical ability only for the Math Disability group. The correlations between the WISC-III and academic achievement scores were elevated for both groups, but the results need to be viewed with caution because of the small sample sizes.

Statistically significant group profile differences were not produced between the two learning disabled groups or between the learning disabled groups and the control group. The Reading Disability group demonstrated generalized deficits whereas the Math Disability group demonstrated specific deficits on the WISC-III.

CHAPTER V

DISCUSSION

The research currently being discussed provides implications for a variety of individuals who work with special needs children. This chapter will discuss the following: comparison of the results with previous studies investigating the identification of learning disabled students from their WISC-III profiles, discussion of possible causes that led to the results, practical implications for school psychologists, counselors, and educators, and suggestions for future research.

Comparison of Current Findings to Previous Research

There are few currently published studies on the validity of the WISC-III or factor score patterns for learning disabled children. As a result, the performance of LD children in this study will be compared to results obtained in WISC-R research.

Verbal Performance Splits

As found by Durrant (1994) and Kavale and Forness (1985), the Full Scale, Verbal and Performance IQ's of the Reading Disabled and Math Disabled groups were not distinguishable from each other or from those of the control sample.

The examination of Verbal/Performance IQ discrepancies, however, indicates that the two LD groups in the present study produced divergent results. Of the Reading Group, 50% of the subjects demonstrated a low Verbal IQ, high Performance I[illegible]lly significant discrepancy, and 13.8% demonstrated a high Verbal IQ, low Performance IQ discrepancy, for a total of 63.8% of the subjects. These results are consistent with the finding of Bloom et al. (1986) and Bannatyne (as cited in Bloom et al., 1986) who found Verbal/Performance discrepancies of between 60% to 80% in their LD subject samples. The Verbal/Performance profile of the Reading Disabled group is also consistent with those cited by Humphries and Bone, (1993a), Rourke et al., (1990), and Smith et al., (1993). Conversely, the profiles produced by the Math Disability group did not exhibit a large proportion of subjects who demonstrated a Verbal/Performance discrepancy in either direction. While Rourke (1990) indicated that math disabled children tend to exhibit a high Verbal IQ, low Performance IQ pattern, the subjects in the current sample produced equivalent Verbal and Performance IQs, a pattern inconsistent with Rourke's findings. It would therefore appear that for this sample, verbal and non-verbal skills are developed to an equivalent level.

Index Score Patterns

In the manual, Wechsler (1991) reported a pattern of Perceptual Organization Index > Verbal Comprehension Index > Processing Speed Index > Freedom from Distractibility Index for a group of learning disabled children. The Reading Disabled group in this study produced the same pattern of index scales, although the magnitude of the difference between the scales was different than reported by Wechsler. There was a discrepancy between the POI which was in the high range, the VCI and PSI which were in the average range and the FDI which was in the low average range. The Math Disability group produced a divergent pattern in which both the POI and VCI were in the average range, the FDI and PSI were in the low average range. The positions of the FDI and PSI were alternated. In addition, the Perceptual Organization Index and Verbal Comprehension Index scores were very similar, and there was a large difference between them and the FDI and PSI average scores. The findings of this study are consistent with those reported by Kaufman (1993) and Saklofske et al.(1994) although the sample utilized by Saklofske et al. also produced a low Verbal Comprehension Index score.

Patterns produced by the two groups indicate both similarities and distinct differences in subtest performance. Comprehension was the one Verbal subtest upon which performance by both groups was very similar and Picture Completion and Picture

Arrangement were the two Performance subtests upon which each of the groups produced their highest results, a pattern consistent with that reported by Sattler (1992).

Subtest Score Patterns

Wechsler (1991) does not differentiate between reading and mathematics disabilities in his discussion of profiles produced by children with learning disabilities. He does however, include a separate LD sample comprised of reading disabled children solely, but does not clearly specify the subtest means for this group. There is no description as to how the children were selected or identified. With no differentiation between subtypes, the manual (1991) reports that LD children produce their lowest scores on the Coding and Digit Span subtests. In this sample, while Coding was a relatively weak, Digit Span was more strongly identified as a weakness in the Reading Disabled group. In the Math Disability group, Coding was the lowest subtest score and was closely followed by the Arithmetic and Symbol Search subtests.

The subtest profile produced by the Reading Disabled group conforms to the profile Kavale and Forness (1985) obtained in their meta-analysis of WISC-R subtest performance by learning disabled children. The five highest subtests, Picture Completion, Picture Arrangement, Block Design, Comprehension, and Object Assembly, and three lowest score subtests Digit Span, Arithmetic, and Coding are the same as identified in the meta-analysis. This may lead to the conclusion that although the format of administration and content of the subtests has been altered, essentially the WISC-R and WISC-III produce the same results with reading disabled children.

The MD group produced less similar results to those reported in Kavale and Forness' study, however. Of the highest mean subtests, only three, Picture Completion, Picture Arrangement, and Comprehension, were the same as the meta-analysis indicated. Given that research into learning disabilities has historically focused primarily on reading disabilities with little emphasis on those who demonstrate math disabilities alone, the influence of mathematics disabilities may have been minimal in previously identified learning disabled samples. Profile differences may have been averaged out by the larger proportion of reading disabled students in the samples studied. Consequently, the general findings in the LD literature meta-analysis do not appear to reflect the performance of this group of mathematics disabled students, but they do reflect the performance of reading disabled students.

In comparison to Saklofske et al.'s (1994) results on WISC-III subtests, the Reading Disabled group differs from the Attention Deficit Disorder sample profile but the Math Disability group profile differs little with respect to the lowest mean subtests. Saklofske et al. report that the identified sample produced their best results on perceptual organization tasks. This appeared to be the pattern with the Math Disabled students as well although to a lesser extent in this sample.

Although Kavale and Forness (1985) found that learning disabled children produced flatter subtest scatter profiles than normal children, the results of this study indicated that both Reading Disabled and Math Disabled groups produced profiles showing considerable scatter between subtest and index profiles. The two learning disabled groups produced more variability on their subtest and index profiles indicating definite strengths and weaknesses in performance in contrast to the profile of the control group which was relatively flat. Given the restriction in IQ range for control membership, a flat profile is understandable and expected.

Generally consistent with the results reported by Humphries and Bone (1993a), Mann (1994), and Snider and Tarver (1989), the Reading Disability group demonstrated weaknesses in Digit Span, Coding, Information and Vocabulary, all of which involve memory. Digit Span is thought to measure short term memory and attention to non-meaningful verbal stimuli in addition to flexibility of cognitive processing. The other three subtests showed relative weakness in areas thought to measure both long term or short term memory and ability to express general knowledge. Strengths were identifiable on subtests that appear to measure non-verbal, rather than verbal, stimuli.

As with the Reading Disability group, the Math Disability group showed strengths in Picture Completion, Picture Arrangement, and Comprehension. The group also demonstrated strengths in Similarities and Vocabulary, the subtests generally thought to measure level of abstract thinking and the ability to form concepts in a verbal form. Weaknesses produced by the Math Disability group include Coding, Arithmetic, and Symbol Search, subtests which are thought to indicate concentration, attention, and short term memory. Performance on these subtests is also thought to be influenced by level of anxiety.

The overall findings of the WISC-III profiles are consistent with those reported by Sattler (1992) who found a generalized deficit for RD children as opposed to a specific deficit of MD children.

General Discussion

The purpose of this study was to determine whether the intelligence test and academic achievement criteria used to identify learning disabled children revealed distinct cognitive profiles between specifically identified LD and control groups on the WISC III. Discussion of the cognitive processing and differences between the two disability groups will be presented within the framework of the research questions and hypotheses posed in Chapter II.

Question 1

Does the WISC-III produce distinct profiles for learning disability subtypes? Is there a difference between the profiles produced by reading disabled children in contrast to those produced by mathematics disabled children? If differences in performance are identified, what are the convergent and divergent patterns of group performance? Do the two groups differ on intellectual and diagnostic dimensions in the profiles that they produce?

While the WISC-III does appear to produce distinct individual subtest profiles between the RD and MD groups, they are not differences that can be considered statistically significant. The differences, however, may have practical implications in diagnosing and programming for the needs of learning disabled children.

Although the Full Scale IQ scores are the same for the two groups, when looking specifically at the Verbal Comprehension Index, thought to be a purer reflection of verbal abilities than the Verbal IQ, the Math Disabilities group scored almost half a standard deviation higher than did the Reading Disabilities group. Therefore, although the IQ range is the same for both groups, the RD group shows poorer Verbal abilities than does the MD group which appears to indicate generalized language deficits whereas the MD demonstrated specific deficits. In terms of the Perceptual Organization Index, however, the pattern is the opposite in that the RD children demonstrate better performance on nonverbal reasoning tasks, particularly those that involve logical, sequential processing and verbal subtalk.

The Reading Disabled group produced a large Verbal/Performance discrepancy, as was hypothesized. The RD children as a group appear to demonstrate lower scores on several of the Verbal subtests which may indicate a generalized deficit in language processing and conceptualization whereas the MD children appear to demonstrate a specific deficit in arithmetic skills and short term memory. The RD profile was distinguished by poorly developed conceptualization skills as reflected by low scores in the Information, Vocabulary, Digit Span and Coding subtests. Children with reading disabilities may produce profiles that show lower VIQ subtest scores because of their reading difficulties that affect their ability to use language and to obtain knowledge. In addition, their avoidance of reading, or tendency to read inaccurately so that the information being obtained is distorted, separates these children because of the quality of their reading experiences. Children without reading disabilities are able to comprehend and assimilate new information more easily than their reading disabled peers, which allows for a whole domain of acquiring information denied the reading disabled.

Some reading disabled children may have visual-spatial difficulties that include visual sequential memory deficits, visual discrimination and spatial organizational problems that hinder their ability to learn to read automatically. These may occur in conjunction with, or separately from, auditory-linguistic deficits that reduce their ability to utilize auditory sequential memory, or reduces the capacity of their auditory memory. Those children who experience difficulty in both language related and visual-spatial areas may be at a distinct disadvantage in learning how to read.

There is also a possibility that Reading Disabled children focus so much attention on the task of attempting to read accurately, that they overload their working memory and do not have enough capacity left to comprehend what they are reading. They are unable to divide their attention between the decoding skills required for reading and the concept formation skills required to comprehend the meaning of the text. Automatization of decoding may not have occurred to a sufficient degree to allow for fluid reading. Unless required to read aloud, it may appear to an observer that the child is decoding properly and should be comprehending the material he is reading. This may be a critically inaccurate assumption if the child is dedicating so much energy toward the decoding of individual words that he is unable to comprehend the actual meaning of the passage at hand.

As discussed in the literature review, and demonstrated to a limited extent in this study, many reading disabled students may also demonstrate deficiencies in mathematics. One explanation may be that word problems rely heavily on language reasoning to identify the essential components of the problem, in addition to understanding the types of calculations that are required to successfully complete mathematical tasks. Cognitive flexibility is required to reason about several pieces of information at once, which may be difficult for both reading disabled and math disabled students. It is possible that reading disabled children are less mature in the development of their cognitive flexibility, which affects both reading and mathematical skills.

Because reading disabled students appear unable to associate and integrate different language skills and concepts, they appear to require methods of instruction that present information in a logical, sequential, progressive manner. When this type of instruction is not provided, the frustration that they experience may further interfere with their ability to learn. As their frustration level builds, it creates further interference with their verbal processing abilities and their attention is then divided between the emotional experience of feeling frustrated and the challenge of the difficult task that they are attempting to complete.

Another possible explanation may be that reading disabled children have little ability to utilize strategies appropriately, to change psychological set when the task requirements are altered, or to realize that the strategy that they are attempting to use is ineffective or inappropriate. Reading disabled children may not be aware of the utility or effectiveness of different strategies or where such strategies may be implemented effectively. Understanding that a variety of strategies can result in successful completion of the task may be lacking in these children. Their success is limited by their inability to develop new and effective strategies when the one they are using is ineffective.

When Index profiles were observed, it became apparent that the Reading Disability group profile was characterized by a high Perceptual Organization Index, and considerably lower Verbal Comprehension, Processing Speed, and Freedom from Distractibility Index scores. The Perceptual Organization Index, in the high average range, may reflect well developed intellectual abilities in areas that require non-verbal reasoning, visual-spatial abilities, visual organization and sequencing skills. Comparatively, the other skills mentioned fall within the average range, and appear to reflect less developed skills in the areas of verbal comprehension, complex processes involving attention, concentration, and problem-solving strategies in addition to the ability to respond speedily and accurately. The Index scores may provide more information about the Reading Disabled child's abilities than the Full Scale IQ does. The high Perceptual Organization Index inflates the Full Scale IQ score which might inflate the perception of their abilities in all areas. This may be particularly true in regard to school-related tasks.

The Math Disability group produced an Index profile distinctly different from the Reading Disabled group. For the Math Disability group, both the Verbal Comprehension Index and the Perceptual Organization Index, which are thought to be pure measures of verbal and performance intellectual ability, were consistently high. This indicates that their intellectual abilities are equally developed in both domains and that difficulty in performance in mathematics may be attributable to other factors.

Compared to the Verbal Comprehension and Perceptual Organization Index scores, the Freedom from Distractibility and Processing Speed Index scores were both dramatically lower. These low scores could indicate that problems in mathematics are a result of factors such as distractibility, anxiety level, lack of concentration, poor short term memory for both visual and auditory information, inability to sequentially process effectively, poorly developed simultaneous processing abilities and inability to perform effectively under time constraints.

The Math Disability group had notably higher scores in Information, Similarities, and Vocabulary than the Reading Disability group did, a finding which leads to the hypothesis that the language conceptualization ability of the Math Disability group is more highly developed than it is in the Reading Disability group. When the profile produced is carefully scrutinized, it appears that the Math Disability group has well developed abilities in areas requiring conceptual thinking, flexibility of thought processing, and attention to important and relevant environmental detail. This leads to the hypothesis that they are able to assimilate environmental information and adapt their thinking processes to accommodate what they learn

The math disability in these children became apparent when their scores on Arithmetic, Coding, and Digit Span subtests were examined. The lowest scores were noted for Coding and Arithmetic, which are thought to measure concentration and distractibility, anxiety and/or disinterest in school-like tasks. In addition, Symbol Search and Digit Span scores were relatively low for these students. Taken together, these subtests measure specific arithmetic skills and short term visual and auditory memory. Scores could have been adversely affected as well by anxiety, as well as by poor short term memory and lack of speed and accuracy.

Of particular note was the Math Disabled group score on the Object Assembly subtest. It is thought that Object Assembly involves simultaneous processing and visual spatial processes, the same cognitive processes as are hypothesized to be involved in arithmetic computation and problem solving. This finding appears to substantiate the results of this research which indicate that the conceptual abilities to do math are not lacking in these students, but that the basic arithmetic skills themselves may be weak. This subtest awards a significant number of bonus points for completing the task correctly and quickly.

Those children who demonstrate weak simultaneous processing or visual spatial processing difficulties may be adversely affected by an inability to grasp mathematical concepts and complete arithmetic tasks. Conversely, these children may not lack basic processing ability, but might require more time to understand and practice mathematical concepts, and complete assigned tasks. Poor performance on timed subtests such as Coding and Symbol Search could reflect time restraints more than lack of ability. Another possible explanation for low scores in these areas may be that these children proceed through the tasks slowly due to a possible concern for accuracy and desire to complete the questions correctly.

In general terms it appears that the Reading Disability group has difficulty with conceptualization and with analysis and synthesis of information. It also would appear that the group has difficulty with retrieval of information from both long term and short term memory. Problems in school involving language tasks might reflect their difficulty with tasks involving storage and retrieval of information, ability to integrate information from a variety of sources, and to assign meaning to relevant information.

Based upon the results of this study, although there were differences between the Reading Disability and Math Disability group profiles, the differences are not generalizable to individual subjects, but can only be applied to group profiles. In addition, when evaluating the profile of an individual child, the differences that would be evident are not large or distinct enough to allow for specific identification of reading or mathematics disability because the variability within each group profiles was usually larger than the variability between group profiles, therefore distinct patterns were not consistently produced. The ranges produced on the subtests overlapped to such an extent, that only group comparisons based on mean scaled scores can be made. Caution must therefore be exercised when considering individual cases.

Question 2.

How does the WISC-III profile discriminate between LD and non LD children? Do the two groups differ in their intellectual and diagnostic levels relative to a control group of non-learning disabled children?

The Index profiles produced by the Control group appeared to be relatively flat. There was little difference between the Verbal, Performance and Full Scale IQ scores and the differences between the Verbal Comprehension, Perceptual Organization, Freedom from Distractibility and Processing Speed Index scores were not pronounced.

Compared to the Index score discrepancies produced by the Reading Disability group, the control group profile was flatter and demonstrated little variation between Index scores. The differences were not statistically significant between the two groups. The Math Disability group Index score profile was strikingly similar to that of the control group except for the magnitude of the difference between the Verbal Comprehension and Perceptual Organization Indices and the Freedom from Distractibility and Processing Speed Indices.

The result of the analysis indicates that the WISC-III profiles produced do not differentiate between the Control and learning disabled groups to a significant degree. An interesting finding in this study, however, is that the profiles produced by the Math Disabled group appeared to be more closely aligned to the performance of the Control group than the Reading Disability group profile. The subtest profile produced by the Control group was also relatively flat compared to both the Reading and Math Disability groups.

The implications of these results may indicate that children in the Reading Disabled group are demonstrating generalized language and learning deficits, whereas children in the Math Disabled group are demonstrating more balanced intellectual development with the exception of short term memory and arithmetic skills. While group profiles were obtained, these cannot be generalized to individuals within the groups as there was considerable overlap on test scores between the groups, and the differences in profiles were not distinct enough to be able to identify an individual based upon a specific profile.

Implications for School Psychologists, Counselors and Educators

When children are referred to a school psychologist for a psychoeducational assessment, that person must endeavor to determine the specific areas of weakness in academic tasks. A crucial part of this investigation is to understand the circular nature of learning disabilities and to consider the impact of the ecological and contextual factors that contribute to the learning disability.

The psychologist must be able to recognize that learning disabilities can be a result of a unique interaction of processes rather than one specific type of processing deficiency. Ability to identify specific subtypes through distinctive profiles may assist in the accurate identification and diagnosis of learning disabled children. If LD subtypes can be identified, a variety of instructional techniques and strategies can then be developed and recommended to match the learning difficulty with the most effective remedial strategy. It is essential, therefore to have investigated LD subtypes from a variety of perspectives and classifications.

School counselors who work to interpret psychological reports to both parents and teachers must be able to clearly express the unique nature and difficulties that result from the learning disability in question. They should also assist the child by making teachers and administrators aware of the underlying conceptual or skill related problems that the child is experiencing. They must be able to distinguish and communicate to others involved in the educational processes of the child, appropriate and inappropriate intervention strategies for a specific child based on a specific disability.

It would be advantageous to both students and educators if teachers have the training and expertise to identify and incorporate specific instructional techniques that may be a pre-requisite to effective learning for learning disabled individuals. It cannot be assumed that because they are capable in a skill such as decoding, that they comprehend other skills such as extracting the meaning from phrases, sentences or paragraphs. Concrete and logically sequential instructional techniques in all aspects of learning a language must be utilized for these children to learn and understand language thoroughly and completely. Failing to provide such instruction may result in a learning environment that is ineffective and frustrating to all those concerned with assisting the child to learn.

Because their auditory as well as their visual skills may be weak, it may be necessary for reading disabled children to be encouraged to express themselves verbally and practice their verbal skills at every possible opportunity. These children may demonstrate a cognitive style that processes language-related information more slowly than average children. Therefore, in a classroom setting, they may require additional time to think and process information before responding.

Children who demonstrate low Processing Speed Index's and who process information slowly may require more time for instruction and completion of tasks in the classroom. These children may also benefit from longer instructional sessions, although a variety of techniques and cross-modal presentations of information may be required to overcome the child's distractibility, reinforced by peer pairing in the classroom.

As mathematics is a discipline that requires sufficient practice to develop mastery, children with math disabilities may require more repetitions of instruction, need more time to practice and more drill to develop the required skills, in addition to receiving direct and explicit instruction to understand the rule-governed nature of mathematics. Drill and practice should be encouraged until the child has overlearned pertinent skills, which allows the child to achieve success before moving onto the next level of mathematical task.

Implications for Future Research

Through the process of completing the current research, many questions have been generated that are deserving of investigation. In a clinical setting, questions related to the production of a WISC-III ACID profile, low scores on the Arithmetic, Coding, Information and Digit Span subtests, could be investigated in differentiated learning disability groups. In addition, differentiating specific disabilities within the Reading Disability group and the Math Disability group may be helpful in expanding our understanding of the underlying cognitive deficits that are exhibited within each subtype.

An additional direction may be in the examination of metacognitive structures and strategies utilized by learning disabled children to more completely understand how metacognitive usage influences successful task completion and how the metacognitive strategies of learning disabled children differ from non-learning disabled children. Motivation and anxiety level also affect academic performance which may be particularly relevant to children experiencing difficulty in mastering academic tasks. The preceding directions in research could be approached either by examination of groups or of individual case studies.

The factor structure of the WISC-III needs extensive research to determine its ..nical value. Until independent research is conducted, the interpretive value of the

Freedom from Distractibility Index and Processing Speed Index will remain equivocal. Validity studies to determine whether other average groups of children produce equivalent IQ, Index and subtest results as those reported in the manual also need to be conducted. In addition, as this study used a clinical control sample, future research may benefit from the use of a control group more representative of the normal population.

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APPENDIX A
WISC-III VERBAL/PERFORMANCE SPLITS

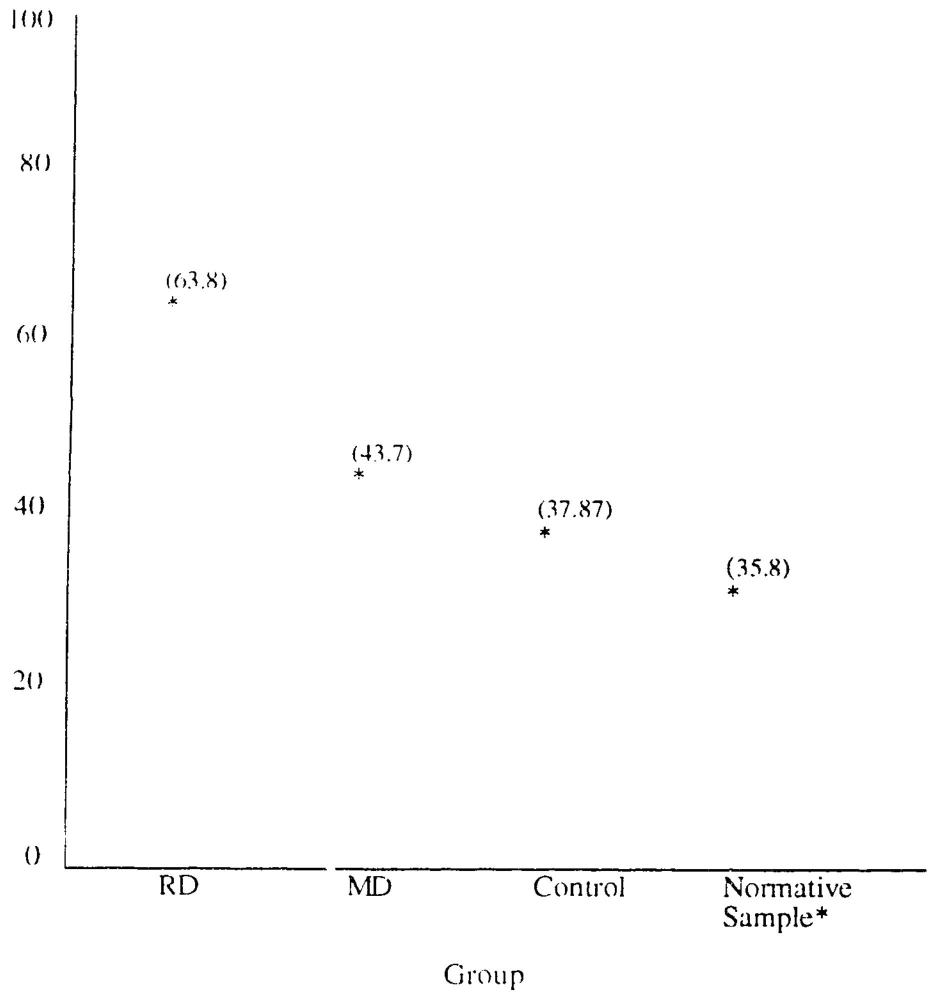

Figure 1. Group Percentage with Significant Verbal/Performance IQ Splits

* reported in Wechsler, 1991, p. 262.

APPENDIX B

WISC-III ANOVA's

Table 1b

One-way Analysis of Variance
Full Scale I.Q.

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	1623.6569	811.8285	9.9032	.0001
Within Groups	131	10738.8804	81.9762		
Total	133	12362.5373			

Table 2b

One-way Analysis of Variance
Verbal I.Q.

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	929.8770	464.9385	3.6654	.0283
Within Groups	131	16616.6379	126.8446		
Total	133	17546.5149			

Table 3b

One-way Analysis of Variance
Performance I.Q.

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	2579.4333	1289.7166	11.8523	.0000
Within Groups	131	14254.8056	108.81653		
Total	133				

Table 4b

One-way Analysis of Variance
Verbal Comprehension Index

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	1562.1510	781.0755	5.5551	.0048
Within Groups	131	18419.2819	140.6052		
Total	133	19981.4328			

Table 5b

One-way Analysis of Variance
Perceptual Organization Index

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	2649.2687	1324.6344	11.2908	.0000
Within Groups	131	15368.8283	117.3193		
Total	133	18018.0970			

Table 6b

One-way Analysis of Variance
Freedom From Distractibility Index

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	21.0105	10.5053	.0881	.9157
Within Groups	131	15498.2376	119.2172		
Total	133	15519.2481			

Table 7b

One-way Analysis of Variance
Processing Speed Index

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	879.5103	439.7551	2.3555	.0989
Within Groups	131	24083.2170	186.6916		
Total	133	24962.7273			

Table 8b

One-way Analysis of Variance
Similarities Subtest

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	65.4456	32.7228	3.9509	.0216
Within Groups	131	1084.9798	8.2823		
Total	133	1150.4254			

Table 9b

One-way Analysis of Variance
Vocabulary Subtest

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	63.6437	31.8219	4.0376	.0199
Within Groups	131	1032.4533	7.8813		
Total	133	1096.0970			

Table 10b

One-way Analysis of Variance
Comprehension Subtest

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	91.6166	45.8083	5.3332	.0059
Within Groups	131	1125.1894	8.5892		
Total	133	1216.8060			

Table 11b

One-way Analysis of Variance
Picture Completion Subtest

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	69.4148	34.7074	5.5648	.0048
Within Groups	131	817.0404	6.2369		
Total	133	886.4552			

Table 12b

One-way Analysis of Variance
Picture Arrangement Subtest

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	80.2936	40.1468	4.4715	.0132
Within Groups	131	1176.1616	8.9783		
Total	133	1256.4552			

Table 13b

One-way Analysis of Variance
Object Assembly Subtest

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	2	87.7092	43.8546	8.2026	.0004
Within Groups	131	700.3804	5.3464		
Total	133	788.0896			

Table 14b

RD Group One-way Analysis of Variance
Between Full Scale IQ and Verbal IQ

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	21	4909.8889	233.8042	4.4978	.0029
Within Groups	14	727.7500	51.9821		
Total	35	5637.6389			

Table 15b

RD Group One-way Analysis of Variance
Between Full Scale IQ and Performance IQ

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	21	4451.9722	211.9987	3.2844	.01321
Within Groups	14	903.6667	64.5476		
Total	35	5355.6389			

Table 16b

RD Group One-way Analysis of Variance
Between Full Scale IQ and Perceptual Organization Index

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	21	3718.0222	177.0487	3.1581	.0156
Within Groups	14	784.8667	56.0619		
Total	35	4502.8889			

Table 17b

RD Group One-way Analysis of Variance
Between Full Scale IQ and Freedom From Distractibility Index

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	21	3760.7556	179.0836	2.1907	.0676
Within Groups	14	1144.4667	81.7476		
Total	35	4905.2222			

Table 18b

RD Group One-way Analysis of Variance
Between Similarities and Comprehension

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	9	164.6681	18.2965	2.6579	.0270
Within Groups	24	165.2143	6.8839		
Total	33	329.8824			

Table 19b

RD Group One-way Analysis of Variance
Between Vocabulary and Comprehension

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	9	112.3039	12.4782	2.9898	.0155
Within Groups	24	100.1667	4.1736		
Total	33	212.4076			

Table 20b

RD Group One-way Analysis of Variance
Between Similarities and Digit Span

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	11	131.3857	11.9442	2.3581	.0399
Within Groups	23	116.5000	5.0652		
Total	34	247.8857			

Table 21b

RD Group One-way Analysis of Variance
Between Vocabulary and Similarities

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	11	201.0048	18.2732	5.5913	.0003
Within Groups	23	75.1667	3.2681		
Total	34	276.1714			

Table 22b

MD Group One-way Analysis of Variance
Between Coding and Picture Completion

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	9	200.4382	22.2709	3.1406	.0147
Within Groups	21	148.9167	7.0913		
Total	30	349.3548			

Table 23b

MD Group One-way Analysis of Variance
Between Block Design and Symbol Search

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	11	240.9250	21.9023	3.1300	.0129
Within Groups	20	139.9500	6.9975		
Total	31	380.8750			

Table 24b

MD Group One-way Analysis of Variance
Between Coding and Symbol Search

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	11	239.9250	21.8114	3.8966	.0041
Within Groups	20	111.9500	5.5975		
Total	31	351.8750			

Table 25b

Control Group One-way Analysis of Variance
Between Similarities and Digit Span

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	13	141.0605	10.8508	2.3641	.0146
Within Groups	51	234.0779	4.5898		
Total	64	375.1385			

Table 26b

Control Group One-way Analysis of Variance
Between Object Assembly and Picture Completion

Source	D.F.	Sum of Squares	Mean Squares	F Ratio	F Prob.
Between Groups	8	79.2400	9.9050	2.5816	.0177
Within Groups	57	218.6994	3.8368		
Total	65	297.9394			