1980

Cognitive Patterns as a Basis for the Classification of Learning Disabled Children: A Follow-up Study

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COGNITIVE PATTERNS AS A BASIS FOR THE CLASSIFICATION OF LEARNING DISABLED CHILDREN: A FOLLOW-UP STUDY

An Abstract of

A Thesis

In Partial Fullfillment

of the Requirements for the Degree

Specialist in Education

UNIVERSITY OF NORTHERN IOWA

by

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September 1980

ABSTRACT

The purpose of this study was to examine the educational implications of subdividing learning disabled children into cognitive ability groups according to a method proposed by Richman (1979b). A set of unstandardized discriminant function coefficients were used to weight Wechsler Intelligence Scale for Children (WISC) subtest scores. Richman proposed that three cognitive ability groups could then be derived from these coefficients: an Abstract Reasoning group, a Sequencing-memory group, and a General Language Disability group. Richman had developed this procedure through the investigation of a group of children who met a WISC criterion of Verbal Scale +15 $\leq$ Performance Scale $\geq$ 90.

To investigate this issue, a group of 176 children in public schools who had been identified as learning disabled and had received remediation in a learning disability resource room were selected. Also identified were two subgroups. The first (n = 50) met the WISC criterion used by Richman. The second (n = 108) met a criterion of an achievement score at least 15 standard score points below Full Scale IQ.

First, the unstandardized discriminant function coefficients were used to categorize the learning disabled samples into cognitive ability groups. Secondly, the relationship between cognitive ability classification and word recognition was evaluated by assessing frequency distributions of Wide Range Achievement Test (WRAT) Reading subtest scores to cognitive ability classifications. Third, factor

analysis of the WISC subtests for the three learning disabled groups was carried out and the factor structures for these groups compared to the factor structure of the Richman group.

For the three learning disabled groups categorization into the three cognitive ability subgroups was carried out. The percentage of children who fell into the Abstract Reasoning group for all three learning disability groups was less than for the Richman group and the percentage of children who fell into the General Language Disability group was greater than for the Richman group. Since the Abstract Reasoning group was the group for which the most educational implications were suggested and the General Language Disability group the group for which the least educational implications were suggested, the noted differences in frequencies would limit the use and effectiveness of this classification method with learning disabled groups.

The distribution of WRAT Reading scores among cognitive ability groups indicated that the Abstract Reasoning group tended to be the best readers. The Sequencing-memory group read less well and the General Language Disability group read the poorest. These findings were similar to those of the Richman group. However, the categorization method resulted in groupings across which WISC Full Scale IQs were found to be significantly different ($p < .05$). It would appear that this difference in Full Scale IQ would account for at least part of the relationship between reading disability and cognitive ability groups. Therefore, any inferences made between cognitive ability groups and reading ability would be inconclusive.

The factor structures obtained for the three learning disabled groups were not similar to the factor structure of the Richman group. Since the cognitive ability classifications suggested by Richman were based on the obtained factor structure of the group evaluated by Richman, categorization of learning disabled children who do not demonstrate a similar factor structure becomes suspect.

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This Study by: John Michael Carr

Entitled: Cognitive Patterns As A Basis For The Classification of Learning Disabled Children: A Follow-Up Study

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Specialist in Education

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ACKNOWLEDGEMENTS

I would like to express to the members of my thesis committee, Dr. Harley Erickson, Dr. Larry Kavich, Dr. Tom Little, and especially, to the chairman of my committee, Dr. Barry Wilson, for their time, helpful advice, and consultation in preparation of this thesis.

Alos, I would like to express my special appreciation to my grandmother, Agnes McInerney, whose support, encouragement and example made the accomplishment of this thesis possible.

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CHAPTER ONE

THE PROBLEM

Introduction

The field of learning disabilities has been a relatively recent and rapidly growing educational development. However, a confusion of terminology and seemingly conflicting ideas have pervaded the literature (Lerner, 1976). The many theoretical opinions regarding the cause of learning disability reflects, in part, the variety of professional disciplines involved (McWhirter, 1977). Some authors have argued that the learning disabled lag behind their peers developmentally (Gallagher, 1966). Others have emphasized a discrepancy between measured intelligence and scholastic achievement (Bateman, 1965). Johnson and Myklebust (1967) considered these children to have altered psychological processes. As several authors have pointed out, we do not yet have clear agreement on a precise definition of learning disabilities, and therefore, do not have a clear understanding of children who are learning disabled (Bryan & Bryan, 1978; Lerner, 1976).

This study will evaluate cognitive patterns of a learning disabled group to determine if a better understanding of differences in cognitive abilities as determined by cognitive patterns on the Wechsler Intelligence Scale for Children (WISC) subtests will provide insight into the identification and remediation of the learning disabled child.

Definitions of learning disabilities are further confounded by federal and state guidelines which serve primarily economic, administrative, and sociological functions, not the diverse theoretical perspectives necessary in either research or practice (Senf, 1977). For example, 23 different terms have been used in the 50 states to describe learning disabilities (McWhirter, 1977).

Despite these differences in terminology, theory, and definitions, a common characteristic has unified research in the field of learning disabilities. This unifying characteristic is the fact that there is a group of children of average intelligence or better who do not master basic academic skills for reasons that are not clearly understood. It has been the purpose of research in the learning disability field to investigate different possible causes of this observed behavior in order to develop a more exact classification of each child and allow for more appropriate remedial strategies to be devised.

Two general strategies have been used in psychological research to meet this purpose. The first attempted to distinguish the learning disabled child from the normal population. The intent of this effort has been to find a method to identify the common characteristics of the learning disabled child. It was felt this approach would allow for the development of group remediation strategies within the educational setting. However, it has become apparent that there are different kinds of learning disabilities, that is, different processing deficits for various learning disabled children.

This fact leads to the second approach which has attempted to differentiate causes within the learning disability group. The hope has been to find a method to differentiate the various disabilities within a group identified as learning disabled. It was felt this approach would allow for the development of remedial strategies more appropriate to the individual learning disabled child.

Differences in cognitive processing have been investigated in an effort to better understand the learning disabled student and to provide a definition that meets the need stated on page one. Much of this research has been conducted using standardized tests designed to measure cognitive processes. These tests have included instruments like the Primary Mental Abilities Test (PMA), the Wechsler Intelligence Scale for Children (WISC), the Illinois Test of Psycholinguistic Abilities (ITPA), and the Frostig Developmental Test of Visual Perception (Frostig). These standardized tests all have subtests intended to measure various aspects of cognitive and perceptual functioning. Researchers have attempted to use these tests to discover a characteristic pattern of subtest scores that would clearly differentiate the learning disabled child from the normal child and provide insight into the nature of the child's learning problem.

The WISC has been the most extensively used of these tests. Scores are obtained on each of 12 subtests and 3 additional scores are obtained: a Verbal Scale IQ derived from 6 subtests, a Performance Scale IQ derived from 6 subtests, and a Full Scale IQ based on all 12 subtests. Many researchers have administered the WISC to groups of learning disabled children, computed average scores for each subtest for the entire group, identified the subtests which were relatively high or low for the group, and then argued that these high and low scores constituted a characteristic cognitive profile of the learning disabled child. Implications for remediation were then typically suggested, although these suggestions have rarely been subjected to further trial or research.

In an early example of this type of study, Altus (1956) noted differences in WISC average subtest scores for a group of 25 severely disabled readers with WISC Full Scale intelligence quotients of 80 or greater. Studies of this type have tried to develop a subtest profile that is typical of the group. Altus observed that the mean Coding, Arithmetic, and Information subtest scores were relatively lower than the other mean subtest scores for the group and concluded this subtest profile was typical of the reading disabled child.

A different profile analysis of the reading disabled child which focused upon the comparison of WISC Verbal and Performance IQs was suggested by Belmont and Birch (1966). They evaluated WISC results of 150 reading disabled 9 and 10 year olds and 50 normal readers. First, they noted that while the mean Full Scale IQs of both groups were within the average range, the reading disabled group was significantly lower on all three IQ measures ($p < .001$). Second, 60% of the reading disabled group scored lower on the Verbal Scale than on the Performance Scale while 60% of the normal readers scored lower on the Performance Scale than on the Verbal Scale. The percentage of the reading disabled group who scored lower on the Verbal Scale than on the Performance Scale became more pronounced (64%), when only those children with Full Scale IQs between 90 and 109 were included. Finally, when the reading disabled group was divided into two groups based on the severity of the reading disability, the more severe group demonstrated a greater Verbal and Performance discrepancy than did the less disabled group. The authors concluded that these findings indicated a low Verbal and high Performance Scale profile (a LVHP profile) on the WISC was typical of the reading disabled child. The authors suggested this profile indicated that for reading disabled students of at least average intelligence the intellectual problem was one of language deficits rather than perceptual or manipulative deficits.

Unfortunately, early findings were inconsistent and in conflict with a number of later studies. Profile analysis has resulted in patterns which were often similar for the reading or learning disabled child, but have not been consistently the same. More importantly, the most commonly cited pattern of lower subtest group mean scores does not provide a profile that is typical of the individual reading or learning disabled child. This problem was evident in a study where Huelsman (1970) evaluated WISC subtest patterns of 101 under-achieving 4th grade readers. He also found average subtest scores of the group supported the often cited lower Coding, Arithmetic, and Information subtest pattern. While Altus had concluded that this group pattern was the typical profile for the reading disabled child, Huelsman found only 36% of the individual subjects differed significantly (3 points below their individual mean scaled score) in even one of the three subtests in the pattern. If these profiles were not representative of individuals, individual remediation recommended on the basis of these profiles becomes suspect.

Academic expectations based upon the LVHP profile also provided conflicting interpretations. For example, as Richman (1979a) had pointed out, reading expectations based solely on the lower Verbal IQ would provide lower expectations for reading since reading correlates highly with the Verbal IQ. However, reading expectations could be based on Performance IQ as an index of potential achievement and a high reading expectation would be indicated. Richman believed these early approaches to understanding the reading and learning disabled child were not successful because they were too simplistic in that they tried to determine a single cause. Richman argued that methods that would result in more homogeneous groups within the learning disabled population were needed if pattern analysis was to have predictive or remedial value.

Recent research by Richman has not only pointed out problems associated with previous attempts to develop cognitive profiles for the learning disabled, but also has introduced a relatively new and sophisticated methodology into the search which he has suggested has significant educational implications.

Richman (1979b) was particularly concerned with developing a better understanding of children who obtained a Performance Scale score on the WISC of at least 90 and whose Verbal Scale score was at least 15 points below the Performance score. He believed this pattern indicated a language deficit which he called a specific verbal deficit. He felt the LVHP profile of this group was of limited value.

He determined that the factor analytic technique offered an alternative methodology that would help overcome some of the problems the profile analysis of groups had encountered. Richman identified a group of 81 children who met the verbal deficit criterion and carried out a factor analysis of the WISC subtest scaled scores for the group. The factor analytic procedure resulted in three factors. The first factor demonstrated strength in Similarities and Block Design and was interpreted as an abstract reasoning factor. The second factor demonstrated strength in Arithmetic and Picture Arrangement and was interpreted as a sequencing-memory factor. The third factor demonstrated strength only in Information and Richman determined any interpretation would, therefore, be speculative. Richman suggested that three cognitive ability groups could be determined from these factors. Two specific language disability groups were identified, one group with good abstract reasoning (Group 1) and a second group with good sequencing-memory skills (Group 2). A third group demonstrated deficits in both abstract reasoning and sequencing-memory and was identified as having a general language disability (Group 3).

Richman investigated the relationship of the three cognitive ability groups to word recognition ability as measured on the Wide Range Achievement Test Reading subtest. Results indicated that the distribution of reading scores among cognitive groups differed significantly from chance ($p < .001$). The Abstract Reasoning group tended to have higher WRAT scores than would be expected by chance, while the Sequencing-memory group did less well, and the General Language Disability group performed the poorest.

Richman applied another similar statistical procedure, a stepwise multiple discriminate analysis, and determined that this procedure grouped the subjects into virtually the same cognitive classification patterns as the factor analytic technique (78/81 were the same). He suggested the subtest weighting provided by the discriminate analysis technique could facilitate the evaluation of similar populations in terms of a relationship between cognitive patterns and reading. Richman suggested these general, but substantial implications from his findings: (a) an effective means of identifying specific cognitive ability groups from a global measure of intelligence within a verbal deficit population was demonstrated, and (b) the cognitive ability groups provided significant implications for educational remediation.

Statement of the Problem

The purpose of the present descriptive research was to determine the extent to which the findings of Richman, using a verbal deficit population, could be verified using different subgroups of learning disabled children. This research applied the classification procedure suggested by Richman to learning disabled children in public schools to determine if this technique could provide insight into the identification and remediation of the learning disabled child. To do this, the study was designed to answer the following questions:

1. Is the relative frequency of learning disabled children within each of the three cognitive ability categories for the three LD populations similar to the frequencies in Richman's verbal deficit population?

2. Do the frequencies of subjects (for all three LD populations) performing at various levels of word recognition, as measured by the WRAT, among the three cognitive ability classification groups, differ from "chance expectation", supporting the Richman finding of a relationship between cognitive ability classification and the reading ability of each child?

3. Does the WISC factor structure obtained by the subtest analysis of each learning disabled group support the Richman contention that for these children the obtained factor structure differs from that of a normal sample.

These questions would address the feasibility of this classification system being used in learning disabled populations.

Importance of the Study

If Richman's findings could be substantiated through replication within segments of the learning disabled population, the application of implied strategies could provide a needed tool in the identification and remediation of learning disabled children. These strategies could apply to the development of academic skills such as reading, math, spelling, and writing. For example, Richman suggested that a lower elementary child with reading problems who was higher in the Abstract Reasoning factor could be expected to initially learn to read better phonetically. Sight word and reading comprehension problems could be overcome as the identified abstract reasoning skills developed with age. With this group then, the best remedial strategy might be to use a phonetically-oriented, multisensory synthetic approach to early reading acquisition which minimizes the visual memory process involvement of sight words and simple comprehension. By using this approach, which minimizes the involvement of relatively weak areas of cognitive functioning, instead of a whole word or analytic technique which would more involve the weaker visual memory processes, the child would be provided a better chance of reading success as the child develops.

A child who was initially higher in the Sequencing-memory group would initially be expected to demonstrate better rote memory and sight-reading skills. Appropriate remedial attention could be given to overcome possible reading problems as the material becomes more abstract and involved with verbal reasoning. With this group the strategy might be to use a whole word or analytic technique to reading acquisition which stresses the visual memory processes and their concrete application (e.g., sight words, comprehension by linking words to pictures) early in the acquisition process. By minimizing and delaying heavy abstraction and verbal reasoning demands, which increase naturally with school achievement anyway, this approach likewise allows the child the opportunity for additional growth or maturation of less strong cognitive processes such that the child's chances for meeting those demands when they do appear will be greater. The essence of the strategy, then, lies in an appropriate match between early cognitive strengths/weaknesses and the early demands of various reading developmental reading approaches.

Limitations of the Study

One limiting factor is the diversity of the sample with respect to age. The population ranged in age from 6-5 to 16-2. Cognitive patterns of children could change developmentally. Since cognitive structures develop from concrete to more abstract levels over age, differences within more homogeneous age groups may result in different factor structures.

The present study used subtest data from both the WISC and the revised WISC and treated them as equivalent measures. While Sattler (1974) reported that over 72% of the items are essentially the same, the variation in instruments may influence results. The Information, Similarities, Arithmetic, Vocabulary, Comprehension, Picture Completion, and Picture Arrangement underwent major changes. Sattler agreed with Kaufman (1975) that despite these changes the WISC-R remains structurally and contextually the same as the WISC.

The size of the sample is also a limiting factor. While the total sample was 176, the study defined subgroups that were relatively small given the statistical procedure used. Cattell (1952) suggested a 4 to 1 rule of thumb when using factor analysis (e.g., 44 cases to 11 variables).

Definition of Terms

Cognitive Pattern

A clinical term used by various authors to describe variation in specific intellectual abilities of an individual.

Profile or Pattern Analysis

A method used by various authors to determine cognitive patterns consisting of a search for characteristic patterns in the trait profiles of an individual. The terms are used by various authors to make clinical interpretations of cognitive patterns by analysis of the variations in the 12 subtest scaled scores from the mean scale score on the WISC. Some authors have looked at intrachild variability comparing the subtest scores of a child to the mean scaled scores obtained by that child. Others have compared group means of the individual subtests to the average scaled score of the group in an attempt to determine typical cognitive patterns for a specific group of children (e.g., learning disabled).

Factor Analysis

A statistical method for interpreting scores and correlations of scores from a number of tests. The method attempts to simplify the description of data by reducing the number of variables or dimensions. All techniques of factor analysis begin with a complete table of intercorrelations among the tests and end with a factor matrix (Anastasi, 1976). This technique can be applied to WISC subtest patterns to allow for the clinical interpretation of factor loadings in terms of the psychological processes they have in common.

CHAPTER TWO

REVIEW OF THE LITERATURE

The appropriate identification and remediation of the learning disabled child's problems have been areas of concern in this rapidly growing field of learning disabilities. Some researchers have hypothesized that if differing cognitive patterns could be identified in special populations they could serve as a basis for identification and academic remediation (Myklebust, Bannochie & Killen, 1971; Senf, 1977). One method researchers have used to try to improve the understanding of cognitive patterns within the learning disabled has been to operationally define groups of children as learning disabled, evaluate cognitive processes for the group using tests designed to measure these various processes, and to compare the findings to those of normal populations. It was hoped that a causal understanding of the learning disabilities handicap could have been gained from the evaluation of these differences resulting in the development of more appropriate remedial strategies.

The articles included in this review have been categorized into the following groups: (a) research problems related to the development of causal theory, (b) subtest analysis and cognitive patterns, (c) critique of the cognitive pattern approach, and (d) the Richman argument.

Research Problems Related to the Development of Causal Theory

Research in the field of learning disabilities has been hampered by the lack of a commonly held causal definition. More importantly, the various definitions cited do not successfully define learning disabilities in terms of causal factors, but rather in terms of observed characteristics. Often researchers have selected samples of children who had been previously identified as, and had received remediation in, a learning disability resource room. However, placement as the sole criterion has proven to be of limited value in research since there seem to be a variety of underlying reasons for placement. Thus, more restrictive criteria have sometimes been used to try to alleviate this problem. One commonly used criterion has been a standard deviation discrepancy between an individually administered intelligence test and an individually administered achievement test (Iowa Department of Public Instruction, 1976). Another suggested criterion has been a 15 point Verbal IQ deficit compared to Performance IQ on the WISC and a Performance IQ greater than 89 (Belmont & Birch, 1966; Richman, 1979b).

Since the actual underlying causes for learning disabilities are uncertain, some researchers have operationally defined learning disabled subjects based on definitions that reflect their theoretical beliefs or simply on an unexplained discrepancy between estimated potential and achievement. Research has been carried out to test these various theories. It has been hoped that from identification of causes, tests could be developed that would measure these causal factors and remedial strategies could be suggested based on the results of these tests. The lack of an exact, universally defined and understood population has made research in this area difficult as noted by the fact that proposed theories have repeatedly been rejected when the suggested method of identification was subjected to replication or general practical application. Sometimes the theory itself has proved inadequate and sometimes the ability of tests to measure the constructions of the theory have proved inadequate.

For example, Frostig (1964) hypothesized that the causal factor behind learning disabilities was a weakness in visual perception. It was stated that a curriculum designed to develop memory for a sequence of geometric forms would train the child to overcome academic problems. The hypothesis was based upon correlational studies of reading and visual-motor abilities and the developmental theories of Piaget and Inhelder (Hammill, 1972). However, subsequent studies which attempted to substantiate the Frostig hypothesis were not supportive. Hammill cited 25 studies, 22 of which did not support the hypothesis. For example, Falik (1969) randomly divided 42 kindergarten children who were not in the top third of the Anton Brenner Developmental Test of School Readiness (Brenner) into two different kindergarten classes. One group received special visual-motor training, the other received the regular kindergarten curriculum. At the end of the school year no difference was reported between groups on the Brenner test. Also, there was no difference between groups when the Metropolitan Achievement Test was administered to 33 of the original sample (16 experimental, 17 control) in the middle of second grade.

In another study, Jacobs, Wirthlin, and Miller (1968) compared a group of subjects receiving the Frostig program in both kindergarten and first grade (n = 30), a group receiving the Frostig program in first grade only (n = 78), and a group receiving a standard curriculum (n = 67). An analysis of variance of the three groups on the Gates Reading Vocabulary and Comprehension subtests in second grade showed no significant differences among the groups. The authors concluded that the Frostig program had no particular advantage as far as future reading achievement was concerned.

Another test that was hoped to have academic implications in the field of learning disabilities was the Illinois Test of Psycholinguistic Ability (ITPA), developed by Kirk, McCarthy, and Kirk (1968). The authors attempted to consider mental functioning in three ways: (a) levels of organization, (b) channels of communication, and (c) psycholinguistic processes. Twelve subtests were developed that the authors felt measured the various components of mental functioning. It was hoped these 12 subtests would provide insight into the cognitive processing of the learning disabled group (Lerner, 1976). However, a review of references on the ITPA indicated there were only three main factors in the 12 subtests and the differences for certain individuals in separate subtests were most likely a consequence of measurement error (Carroll, 1972).

Guthrie and Seifert (1978) have pointed out that while subsequent replications have discredited these and other theories in the field of learning disabilities, it is important that the efforts are continued to better understand the causes of the discrepancy between achievement and estimated potential demonstrated by the learning disabled child. The authors proposed that it will be through the development and testing of theories that misconceptions regarding the learning disabled child can be eliminated and practical causal factors verified.

Subtest Analysis and Cognitive Patterns

A common method used to research possible variations in subgroups of children has been subtest analysis of test scores designed to measure various aspects of intelligence. This method has been used by researchers in education to study various subgroups including learning disabled, reading disabled, verbal deficit, and dyslexic. Although these subgroups have often been defined in different ways and the criteria for identification between studies have varied, all such groups have been composed of children of average or higher intelligence who have not mastered basic academic skills, ususally reading.

The study of cognitive patterns has relied almost exclusively on intelligence tests that have a number of subtests. It has been presumed that these subtests measure different cognitive processes. Thus, the Wechsler Intelligence Scale for Children (WISC) and the Wechsler Intelligence Scale for Children-Revised (WISC-R) have often been used in subtest analysis since the scales consist of 12 subtests, each considered to measure various aspects of intellectual ability. Each Wechsler subtest has been normed on a large standardization sample intended to be representative of children in the United States. Raw scores for each subtest have been converted to scaled scores with a mean of 10 and a standard deviation of 3. Thus, each subtest mean for a randomly selected group of American children would be expected to equal approximately 10. Various methods have been used to evaluate subtest patterns including profile analysis, cluster analysis, and factor analysis. Research using subtest analysis has been categorized according to these three methods.

Profile Analysis of Cognitive Patterns

Profile or pattern analysis has been the most commonly used method in the evaluation of cognitive patterns. This method usually involved operationally defining the group to be studied, obtaining a sample, administering the selected tests, finding the mean test scores for the group and determining the profile of strengths and weaknesses that is typical for the group. It has been thought that should the existence of stable, unique patterns for various subgroups be verified, classification into discrete categories might provide insight for better identification methods and development of remedial strategies based on the profile strengths and weaknesses.

Burks and Bruce (1955) identified 31 children as poor readers who were defined as one or more years below grade level on the Wide Range Achievement Test (WRAT) with WISC IQs of at least 90. WISC subtest patterns were identified on the basis of subtest deviation from the average scaled score. This group had average subtest scores that were significantly higher in Comprehension, Block Design, and Picture Arrangement; the group had average subtest scores that were significantly lower in Coding, Information, and Arithmetic. The exact criterion used for significance was not cited. The authors concluded that these high and low mean subtest scores suggested a profile of cognitive patterns that was typical of reading disabled children and was different from normal children. The authors noted the immediate availability of a structured stimulus in the higher score and the need for memory in the lower scores. It was hypothesized that poor readers, as a group, approach learning situations in a more concrete manner and were thus handicapped since the reading process inherently consists of abstractions requiring memory functions. Curriculum modifications to teach to these strengths were suggested.

Forty children attending a reading disability clinic were defined as reading disabled by Robeck (1960). Full Scale WISC IQ scores ranged from 85 to 136. Individual subtest scores were identified as significantly different if they varied from the individual average scaled score by more than the standard error of measurement of that subtest. The author then compared these significantly different subtest totals to chance expectation on the assumption that each subtest would be expected to vary significantly in equal numbers. The Digit Span, Arithmetic, Information, and Coding subtests were significantly lower ($p < .01$) for the reading disabled children supporting the early findings of Altus (1956) and Burks and Bruce (1955). The author suggested teachers of reading disabled students should adjust their teaching techniques to allow for this different pattern of intellectual functioning, but did not specifically cite how this should be accomplished.

A slightly different methodology was employed by Neville (1961) to evaluate subtest patterns of 35 reading disabled students. Children were termed disabled readers if they had a WISC Full Scale

IQ of 90 or greater and their reading achievement was at least two years below grade level as measured by the Florida Reading Scales. The students were then matched with a non-disabled reader on the basis of IQ, grade level, and sex. WISC mean subtest scaled score differences between the matched pair groups were compared by a correlated means *t*-test. The reading disability group was significantly lower ($p < .01$) in Information, Arithmetic, and Digit Span. The author suggested that results supported the use of a non-verbal approach using mostly kinesthetic and visual methods of instruction for reading disabled children. It was also suggested that in younger children specific activities could be performed to improve the weaker areas.

Kallos, Grabow, and Guarino (1961) analyzed the WISC profiles of 37 boys with Full Scale WISC IQs between 90 and 109 who were at least two years behind age/grade equivalent on the Durrell Analysis of Reading Difficulty. The authors reported mean subtest scores for the group were lower in Coding, Arithmetic, and Information and higher in Block Design. The authors concluded that a low Coding score when compared to other Performance tests of the individual in addition to a low Arithmetic or Information or a high Block Design score would tend to have diagnostic value for predicting a reading disability. This emphasis on the predictive utility of the Coding score was unique to this study. However, the authors did not state their criterion for determining when a subtest was viewed as significantly low.

A criterion of a WISC Full Scale IQ greater than 88 and a score on the Chicago Silent Reading Test and/or the Gates Advanced Primary

Test 6 months or more below the obtained mental age was used by Hirst (1960) to identify 30 disabled readers. WISC subtest scaled scores were compared to the individual's scaled mean score with a two point scaled difference determined significant. It was found that 38% scored below this criterion on Digit Span, 37% on Arithmetic, and 37% on Coding. This finding was suggested as another characteristic subtest pattern for the reading disabled. The author cited a need for studies to evaluate the implication of these findings in academic remediation. For example, it was suggested that Coding should be evaluated to see if it measures the rate of new learning or visual-motor ability. Pinpointing the exact weakness would allow for appropriate remedial strategies to be implemented.

Coleman and Rasof (1963) identified 126 subjects who were one or more years retarded in achievement in relation to their age and grade placement as reflected on the California Achievement Test (CAT) or Stanford Achievement Test (SAT). WISC Full Scale means ranged from 70 to 136. Subtest means were calculated and were compared to each other by a correlated means *t*-ratio. Significantly lower scores were reported on Information, Arithmetic, Vocabulary, Digit Span, and Coding and significantly higher scores were reported on Comprehension, Picture Completion, and Block Design. This pattern varied slightly from those previously noted with the addition of the low Vocabulary score. It was additionally noted by the authors that for this group the WISC Performance Scale was significantly higher than the Verbal Scale ($p < .001$) which had not been reported in previous studies. The authors suggested "the findings might help in dimensionalizing the intelligence variable in underachievement in delineating the role of strong and weak intellectual areas in planning treatment programs for the underachiever" (p. 150).

The common area of unexplained academic delay between the reading disabled population and the more recently identified learning disabled population provided the basis for the transition to research of cognitive patterns within the learning disabled population. It was anticipated that the investigation of cognitive patterns within the learning disabled population would provide insight that would aid in the understanding of the learning disability handicap.

In one study, Ackerman (1971) administered the WISC to 82 learning disabled children and 34 selected from the total sample of students. The learning disabled group obtained lower group means on Arithmetic, Digit Span, Information, and Similarities. However, the incidence of subtest scores for individuals where Arithmetic, Digit Span, Information, and Similarities were low did not differ between the two groups.

In summary, the methodology of early studies of variously defined learning disabled populations often used pattern analysis to evaluate cognitive patterns for the groups. It was anticipated that a better understanding of group patterns would provide clinical insight that would make identification easier and could be used in planning remedial strategies. The WISC was often used in this research since it is made up of subtests designed to measure various aspects of intelligence. Mean subtest scores for the group were determined and the pattern or profile of subtest mean scores was interpreted as typical of the strengths and weaknesses for that group. The most typical pattern cited for the reading and learning disabled groups of children was lower *WISC* subtest scores on Coding, Information, and Arithmetic compared to other subtests for the group.

Cluster Analysis

Bannatyne (1967) studied a group of children whose academic skills were lower than full scale intelligence would indicate. He used the term genetic dyslexia to describe this condition. Bannatyne developed a unique categorization by grouping subtests into three clusters of three subtests each. He assigned a name to each of the three based on the cognitive and perceptive processes he judged that they each had in common. The categories were defined as: (a) Spatial (Object Assembly, Block Design, and Picture Completion), (b) Conceptual (Comprehension, Similarities, and Vocabulary), and (c) Sequential (Digit Span, Arithmetic, and Coding). Bannatyne pointed out that it was implicit in the standardization of the *WISC* that a normal control group should demonstrate no difference between categories since all *WISC* subtests have a mean of 10 and a standard deviation of 3. He then selected a group of boys ages 8 to 11, with *WISC* Full Scale IQ scores between 85 and 115 who met the genetic dyslexia criteria. For this group 70% demonstrated a Spatial score greater than Conceptual. And 69%, in turn, demonstrated a Conceptual score greater than Sequential. Bannatyne suggested this Spatial > Conceptual > Sequential pattern was typical of the child with genetic dyslexia.

The pattern of three Performance subtest scaled scores (Spatial) greater than three Verbal subtest scaled scores (Conceptual) is supported by earlier findings of Belmont and Birch (1966) which noted that the WISC Performance Scale was generally greater than the Verbal Scale for disabled readers. Additionally, the three subtests Bannatyne labeled Sequential and found to have the lowest mean score in the pattern are identical to the distractibility factor found by Cohen (1959).

Bannatyne (1974) and Rugel (1974) suggested this same pattern was typical of the learning disabled child. This pattern has become one of the most extensively investigated patterns in the learning disabled population. Bannatyne (1971) suggested these categorized scores could be used as "a practical diagnostic tool" (p. 273) when working with a learning disabled population.

Smith, Coleman, Dokecki, and Davis (1977) examined the WISC-R subtest pattern of 208 learning disabled students in a large metropolitan school system. The sample ranged in ages from 6-3 to 12-1. Categorization of the students by the Bannatyne groupings resulted in 43% of the children demonstrating the Spatial > Conceptual > Sequential pattern. Smith et al. cited this finding as 17% over chance occurrence and suggested the results supported the Bannatyne findings. They concluded that the predictive utility of this pattern could be most useful.

In conclusion, Bannatyne developed a unique pattern of WISC subtest clusters which he believed could be a practical diagnostic tool in the evaluation of learning disabilities. The three clusters were each composed of three tests which Bannatyne believed measured similar aspects of intelligence. He concluded that a Spatial >

Conceptual > Sequential pattern was typical of the learning disabled populations.

The Factor Analytic Technique

Factor analytic methods have been used as an alternative methodology to study cognitive patterns in the learning disabled population. This methodology has a long history in the area of intelligence testing. The correlational technique developed by Spearman and refined by Thurstone (1935) into the factor analytic technique has become a widely accepted statistical procedure in the analysis of intelligence. The factor analytic technique has been extensively applied to the Wechsler scales in an attempt to reduce the variables into statistically similar groups. It has been anticipated these factors could then be identified through common psychological processes that would have implications in the identification and remediation of learning problems. Early researchers applied the factor analytic technique to the Wechsler scales to try to determine if there were different cognitive patterns among clinical subpopulations in mental hospitals. For example, factor analytic studies by Cohen (1952) of adult psychoneurotic, schizophrenic, and brain-damaged groups were used to help understand psychological functions which underlie performance on intelligence tests.

Cohen (1959) presented the classic factor-analytic study of the WISC on the original standardization samples of children at age levels 7-6, 10-6, and 13-6. Five correlated factors were found consistently in the three age groups which Cohen believed could be identified as: Verbal Comprehension I and II, Perceptual Organization, Freedom from Distractibility and a quasi-specific factor with a second order general factor, G, accounting for one-half of the true variance.

Silverstein's (1969) factor analysis of the WISC indicated two distinct factors which highly supported the Verbal and Performance scales as developed by Wechsler (1949) and suggested the need to study predictive utility as the necessary next crucial step. Kaufman's (1979) extensive review of the factor analysis of the WISC-R also yielded one consistent and recurrent finding: "the emergence of robust Verbal Comprehension and Perceptual Organization factors" (p. 6).

It has been the hope of researchers that distinctive or different factors from those found in a normal population could be identified within the learning disabled population that would demonstrate predictive or remedial use. Myklebust, Bannochie, and Killen (1971) suggested the cognitive structure of the learning disabled child differed from normals in the organization of the intellect. Wallbrown, Wherry, Blaha, and Counts (1974) investigated this hypothesis through a factor-analytic study of 70 reading disabled students of at least average intelligence. The factor structure obtained for this group was compared to the factor structure obtained on a normal population. They concluded that learning disabled subjects demonstrated less ability to integrate and were factorially more complex. These conclusions supported the Myklebust et al. (1971) hypothesis and suggested that the results of factor-analytic research with normals cannot be expected to describe the test performance of a learning disabled student.

In summary, factor-analytic methods have a long history in the area of intelligence testing. Recently, this method has been applied to WISC subtests of learning disabled groups to see if the resulting factors would provide insight into possible differences in cognitive patterns for this group. Differences in factor structures from normal groups were found and various authors suggested these differences should be used in planning educational strategies.

Critique of the Cognitive Pattern Approach

While the research related to cognitive patterns has had a long history in the educational field with many advances reported, there have been methodological problems that should be noted. Guthrie and Seifert (1978) have pointed out that the reliability of a complete subtest profile analysis was lower than the individual subtest reliability. Since the cognitive pattern approach involves a comparison of WISC subtest differences, it is important that the differences be great enough that the same pattern could be expected upon retest. Hopkins and Michael (1961), pointed out that to use the WISC for an individual pattern analysis, even if the pattern was based upon a group pattern, the effective sample size was 1 and subtest differences between 2.9 and 5.3 were necessary for significance at the $p < .05$ level.

Studies which have used group means to establish patterns in the learning disabled population have often identified similar patterns, but the patterns have not consistently identified individual learning disabled children. For example, Huelsman (1970) identified 101 fourth graders as underachievers on the basis of WISC and Gates Reading Survey Test scores that indicated a mental age at least 1 year 5 months greater than reading age. None of the 101 underachievers was significantly low (3 points or more below subject's own mean weighted subtest score) on the Information and the Arithmetic, and the Coding WISC subtests, a pattern often cited as the "intellectual pattern" of the reading disabled reader. Additionally, only 23 of the 101 (22%) disabled readers had a Performance IQ higher than Verbal IQ by 15 or more points. Huelsman concluded that while groups of disabled readers tend to show high Performance IQ and low scores in Information, Arithmetic, and Coding on the WISC, individual disabled readers generally demonstrated no items of the pattern and seldom demonstrated the complete pattern. He questioned the practical value of the earlier findings of cognitive patterns among the reading disabled and cautioned that a study of pattern differences should be directed toward defining the predictive or remedial significances of those differences.

The study cited by Smith et al. (1977) demonstrated this same methodological problem. The authors reported the Bannatyne pattern groupings as 17% over chance and concluded that the predictive utility of this pattern could be most useful in the identification of learning disabled children. However, the pattern, if routinely applied, would fail to identify over one-half (57%) of those who had been previously identified and would apparently wrongly identify 26% of the normal population as learning disabled. These results indicate that careful interpretation and replication of studies relating to apparent cognitive patterns are needed.

Factor analysis has been used much the same way as pattern analysis in the investigation of cognitive patterns. It has been hoped by some researchers that a more sophisticated statistical procedure would overcome some of the methodological problems of pattern or profile analysis (Richman, 1979b; Wallbrown, Blaha, & Vance, 1980). However, two of the methodological problems cited above appear to have remained. First, the collection of group data is interpreted and applied to individuals. Studies have not been conducted to evaluate the validity of this procedure. Secondly, the interpretation of the meaning of the factors through psychological insight is called for in the factor analytic procedure. Correct interpretation of the factor loadings would be required if they were to have remedial value.

The Richman Argument

A more detailed review of the Richman (1979b) argument is presented since the present study followed the same procedures as the Richman study using a different learning disabled population. Richman identified a group of children who obtained Performance IQ scores on the WISC of at least 90 and whose Verbal IQ scores were at least 15 points lower than the Performance IQ. He labeled this discrepancy a specific verbal deficit and indicated this LVHP profile alone did not provide enough information to adequately base academic expectations or remedial strategies. Also, he hypothesized that factors obtained by factor analysis of WISC subtest scores for a group of verbal deficit children would provide additional information upon which academic expectations and remedial strategies could be based.

Richman evaluated 81 children who met the specific verbal deficit criterion. A factor analysis of the WISC subtests was carried out using Varimax rotated factor matrices. Richman evaluated the resulting factors in terms of demonstrated psychological processes as suggested by Anastasi (1976). The factor analytic procedure resulted in three factors. The first factor demonstrated strength in Similarities and Block Design and was interpreted as an abstract reasoning factor. The second factor demonstrated strength in Arithmetic and Picture Arrangement and was interpreted as a sequencing-memory factor. The third factor demonstrated strength only in Information and Richman determined any interpretation would, therefore, be speculative. Richman suggested three cognitive ability groups could be determined from these factors. Two specific language disability groups were identified, one group with good abstract reasoning (Group 1) and a second group with good sequencing-memory skills (Group 2). A third group demonstrated deficits in both abstract reasoning and sequencing-memory and was identified as having a general language disability (Group 3).

Richman applied another similar statistical procedure, a stepwise multiple discriminate analysis, and determined that this procedure grouped the subjects into virtually the same cognitive classification patterns as the factor analytic technique (78/81 were the same). Richman determined through the chi-square statistical procedure that these identified cognitive groups demonstrated a strong relationship to the Reading subtest on the Wide Range Achievement Test (WRAT) ($p < .001$). A comparison of the cognitive classification to the distribution of WRAT scores indicated a higher frequency of Abstract

Reasoning subjects within the higher WRAT score range than would be expected by chance, with the Sequencing-memory group doing less well, and the General Language Disability group scoring the poorest on the WRAT Reading subtest. It was suggested that the subtest weighting provided by the discriminate analysis technique could facilitate the evaluation of similar populations in terms of a relationship between cognitive patterns and reading. Richman felt that if these findings were supported by further research, recategorization for specific groups would have significant educational implications.

Summary

The appropriate identification and remediation of the learning disabled child have been areas of concern in this rapidly growing field of learning disabilities. The lack of a causal understanding of the discrepancy exhibited by the learning disabled child between estimated academic potential and actual achievement has been extensively investigated. One area researched in this effort has been the investigation of cognitive patterns for the learning disabled child. A common method used to research possible variations in cognitive patterns in subgroups of children has been profile or pattern analysis of test scores designed to measure various aspects of intelligence.

Many studies have pointed out similar mean group subtest patterns on the WISC for reading or learning disabled children. Lower subtest mean scores on Coding, Information, and Arithmetic subtests have often been cited. Other researchers have reported a deficiency in verbal skills compared to performance skills based on a LVHP profile on the WISC as typical of the learning disabled child. A more complex categorization for the learning disabled child was suggested by Bannatyne. He noted a pattern which he categorized as Spatial > Conceptual > Sequential on the WISC was typical of the learning disabled child. While all of these group patterns for learning disabled children did provide insight into overall group differences in cognitive patterns, they did not successfully differentiate individuals who were learning disabled from the general population.

Factor analysis of WISC subtests for groups of learning disabled children has been more recently investigated to determine if this procedure could overcome some of the methodological problems encountered in profile analysis. If psychological interpretation could be given to the factors, each child could then be categorized according to demonstrated factor strengths from which educational implications could be made. Richman suggested the factor analytic technique could be used to determine the factor structure for this group. This factor structure could then provide insight into possible differences in cognitive patterns within this group that could be used in planning educational strategies. Research in this area has been limited and further research is needed to determine the value of this approach.

CHAPTER THREE

METHODS AND PROCEDURES

The purpose of the present descriptive research was to determine the extent to which the findings of Richman, using a verbal deficit population, could be verified using different subgroups of learning disabled children. This research applies the classification procedure suggested by Richman to learning disabled children in public schools to determine if this techinque could provide insight into the identification and remediation of the learning disabled child.

Subjects

The subjects were 176 learning disabled students from the northeast Iowa school districts of Oelwein, West Dubuque, and Decorah. The largest community in these districts has a population of 7,735 and the area is highly agricultural. The districts have a minority population of .3% or less. There were 127 males and 49 females in the sample, ranging in age from approximately 6 to 16. Subjects were selected on the basis of enrollment as a learning disabled student and available WISC and achievement scores.

The subjects were further categorized by three commonly used criteria into three learning disabled groups: (a) receiving remediation in a learning disabilities classroom (LD1), since this has been the most commonly used criteria in learning disabilities research, (b) WISC Performance IQ 15 points or greater than Verbal IQ and the Performance IQ greater than or equal to 90 (LD2), which closely matched the Richman criteria, and (c) WISC Full Scale IQ greater than 84 with an individual administered achievement test standard score (e.g., Wide Range Achievement Test [WRAT]) at least one standard deviation below the IQ score (LD3), which met learning disability guidelines provided by the State of Iowa Department of Public Instruction (1976). The LD2 and LD3 criteria were used to meet the stated need for more homogeneous samples in learning disability research (Senf, 1977). All 176 subjects met the LD1 criteria, 50 subjects met the LD2 criteria, and 108 subjects met the LD3 criteria. There were 28 subjects common to all three LD groups.

Instruments

Wechsler Intelligence Scale for Children (WISC)

Intelligence test scores were collected from school records from tests which had been administered at the time of evaluation for possible program placement. A Verbal, Performance, and Full Scale intelligence quotient were obtained as well as eleven scaled scores: Information, Comprehension, Arithmetic, Similarities, Vocabulary, Digit Span, Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Coding. The WISC manual (Wechsler, 1949) reported reliability coefficients of .92 to .95 for the Full Scale, .88 to .96 for the Verbal Scale, and .89 to .91 for the Performance Scale. The reliabilities for the subtests range from a low of .62 for the Coding subtest at the 12.5 age level to a high of .92 for the Vocabulary subtest at the 16.5 age level. Sattler (1974) reported that the large overlap of the WISC-R with the WISC (e.g., 72% of the items are essentially the same in both tests and the Coding subtest remains the same) suggested that the validity of the WISC-R will be similar to that of the WISC.

Wide Range Achievement Test (WRAT)

Achievement scores were collected from school records from tests which had been administered at the time of evaluation for possible program placement. The grade equivalents were converted to standard scores based on the normative table in the WRAT Manual (Jastak & Jastak, 1965).

The WRAT Manual reported split-half reliability of the WRAT on a sample of 200 subjects to be between .90 and .95. Thorndike (1972) reported validity to actual academic grade placement is limited, but the test demonstrated value in a research setting as an estimate of general level of ability.

Methodology

The WISC/WISC-R subtests of the subjects were used to categorize the subjects based on the unstandardized discriminant function coefficients determined by Richman. The coefficients, which provide subtest weightings, are presented in Table 1. Two sets of discriminant function coefficients were used by Richman to identify three cognitive pattern groups.

Examples are provided in Tables 2, 3, and 4 to demonstrate the procedure involved in determining cognitive ability groups using the Unstandardized Discriminant Function Coefficients. Function 1 served to separate the Abstract Reasoning group from the other two groups, and Function 2 discriminated between the Sequencing-memory group and the General Language Disability group. To use these func-

Table 1

Discriminant Function Coefficients Based on WISC Subtests as Determined by Richman (1979)

Subtest	Unstandardized Discriminant Function Coefficients	
	Function 1	Function 2
	Abstract Reasoning	Sequencing-memory
Comprehension	.0139	-.2424
Arithmetic	-.0828	.2290
Similarities	.1889	.2319
Vocabulary	-.0034	.1348
Picture Arrangement	.0650	.1926
Block Design	.1985	-.0319
Coding	-.0917	.2369
(Constant)	-3.0300	-7.3776

Note. From "Patterns of Intellectual Ability in Children with Verbal Deficits" by L. C. Richman and S. D. Lindgren, Unpublished paper presented Iowa School Psychology Association, Des Moines, Iowa, 1979.

tions, (a) each child's scaled score for each WISC/WISC-R subtest was multiplied by the corresponding unstandardized coefficient (C1 and C2); (b) after computing the sum of the products, the appropriate constant was added and the final value examined.

An example of a profile for a child that would be classified into the Abstract Reasoning group is presented in Table 2. First,

Table 2

Computational Example for Subjects

Assigned to Abstract Reasoning Group

	WISC Subtests							
	Comp	Arit	Sim	Voc	PA	BD	Cod	Sum
Scaled Scores (SS)	11	8	11	10	11	12	8	
Coefficient 1 (C1)	.01[b]	-.08	.19	.003	.06	.20	.09	
C1 x SS	.15	.66	2.08	-.03	.72	238	-.73	.88[a]

[a]Final value for Function 1 after constant value of -3.03 is added to sum of C1 x SS.

[b]Decimals rounded off in table to 2 decimals.

the child's WISC scores are multipled by the C1 weight, totaled and the constant added to the score to determine the value for Function 1. Since the final value for Function 1 is positive, the child is classified into the Abstract Reasoning group. An example of a profile for a child that would be classified into the Sequencing-memory group is presented in Table 3. Function 1 is determined in the same manner as above. Since the value for Function 1 is negative, the same pro-

Table 3

Computational Example for Subjects Assigned to Sequencing-memory Group

	WISC Subtests							
	Comp	Arit	Sim	Voc	PA	BD	Cod	Sum
Scaled Score (SS)	8	11	8	11	12	8	13	
Coefficient 1 (C1)	.01	-.08	.19	.00	.06	.20	-.09	
C1 x SS	.11	-.91	1.51	-.04	.78	1.59	-1.19	-1.18[a]
Coefficient 2 (C2)	-.24	.23	.23	.13	.19	-.03	.24	
C2 x SS	-1.94[c]	2.52	1.86	1.40	2.31	-.26	3.08	1.67[b]

[a]Final value for Function 1 after constant -3.03 is added to the sum of C1 x SS.

[b]Final value for Function 2 after constant -7.38 is added to the sum of C2 x SS.

[c]Decimals rounded off in Table 3 to 2 decimals.

cedure is carried out using C2. Since the value of Function 2 is positive, this child would be placed in the Sequencing-memory group. An example of a profile of a child that would be classified into the General Language Disability group is presented in Table 4. Function 1 and Function 2 are determined in the same manner as above. Since the value of both Functions is negative, the child would be placed in the General Language Disability group.

The subjects for each cognitive ability classification were also grouped into reading levels defined on the basis of 15 point deviations from the mean of 100 on the WRAT as suggested by Richman. The relationship between cognitive ability classification and reading

Table 4

Computational Example for Subjects

Assigned to General Language Disability Group

	WISC Subtest							
	Comp	Arit	Sim	Voc	PA	BD	Cod	Sum
Scaled Scores (SS)	12	9	8	11	10	10	11	
Coefficient 1 (C1)	.01	-.08	.19	.00	.06	.20	-.09	
C1 x SS	.17	-.73	1.51	-.04	.65	1.98	-1.01	-.32[a]
Coefficient 2 (C2)	-.24[c]	.23	.23	.13	.19	-.03	.24	
C2 x SS	-2.91	2.06	1.86	1.48	1.93	-.32	2.61	-.67[b]

[a]Final value for Function 1 after constant -3.03 is added to the sum of C1 x SS.

[b]Final value for Function 2 after constant -7.38 is added to the sum of C2 x SS.

[c]Decimals rounded off in Table 4 to 2 decimals.

levels was then tested for significance using chi-square. If a relationship between cognitive ability classification and reading level was noted, the frequency of classification to pattern would be examined to determine the nature of this relationship.

Factor analysis was used to obtain a factor structure for each learning sample using the same Statistical Package for Social Sciences Factor Program (Nie, Hull, Jenkins, Steinbrenner, & Brent, 1975) as Richman to compare factor structures between groups. The factor structures were compared through psychological insight into subtest groupings as suggested by Anastasi (1976).

CHAPTER FOUR

RESULTS AND DISCUSSION

Comparisons among the three learning disabled groups of children in this study and the Richman verbal deficit group of children are reported in this chapter. Comparisons are made concerning: (a) the relative frequency of placement of subjects into one of the three cognitive groups (Abstract Reasoning, Sequencing-memory, and General Language Disability) using the unstandardized discriminant function coefficients suggested by Richman, (b) the relationship within each of the groups between cognitive ability classification and word recognition ability, and (c) factor structure of each of the groups. The implications of these comparisons are also discussed in this chapter.

Relative Frequencies of Cognitive Ability Classification Between Groups

The classification of the children in the Richman study (n = 81) by cognitive ability group resulted in the placement of 30% into the Abstract Reasoning group, 23% into the Sequencing-memory group, and 47% into the General Language Disability group. In the present study, classification by cognitive ability group was carried out for each of the three learning disabled groups. Classification of the LD1 group (n = 176) resulted in the placement of 12% into the Abstract Reasoning group, 26% into the Sequencing-memory group, and 62% into the General Language Disability group. Classification of the LD2 group (n = 50) resulted in the placement of 10% into the Abstract Reasoning group, 34% into the Sequencing-memory group, and 56% into the General Language Disability group. Classification of the LD3 group (n = 108) resulted in the placement of 18% into the Abstract Reasoning group, 29% into the Sequencing-memory group, and 53% into the General Language Disability group. These percentages indicated that the use of the unstandardized discriminant function coefficients suggested by Richman for cognitive ability classification resulted in 12 to 20% fewer learning disabled students falling into the Abstract Reasoning group than for Richman's verbal deficit children and 6 to 15% more learning disabled children falling into the General Language Disability group than for Richman's verbal deficit children. A comparison of the Sequencing-memory group with the present Sequencing-memory group yielded similar results.

Relationship Between Cognitive Ability Classification and Reading Ability

As indicated in Table 5, Richman had found WRAT Reading scores to differ significantly by cognitive ability group, $X^2(6) = 67.48$, $p < .001$. Since the chi-square statistic was used to assess differences in groups in reading, further examination of the relative frequencies is required to determine the nature of this difference. In the Richman study, 75% of the Abstract Reasoning group scored above the mean of 100 on the WRAT Reading subtest. Children categorized into the Sequencing-memory group scored less well with 21% scoring above the mean. However, an additional 58% of the Sequencing-memory

Table 5

Distribution of WRAT Reading Standard

Scores by Cognitive Ability Group

According to Richman (1979)

Cognitive Ability Group	WRAT Reading Scores			
	≤ 69	70-84	85-99	100-114
Abstract Reasoning (N = 24)	0	2	4	18
Sequencing-memory (N = 19)	1	3	11	4
General Language Disability (N = 38)	10	24	4	0

Note. From "Patterns of Intellectual Ability in Children with Verbal Deficits" by L. C. Richman and S. D. Lindgren, Unpublished paper presented Iowa School Psychology Association, Des Moines, Iowa, 1979

Note. The relationship between cognitive ability group and WRAT Reading Standard Scores was significant, X^2 (6) = 67.48, $p < .001$.

group scored within one standard deviation (15 points) of the mean. None of the General Language Disability group scored above the mean and only 14% scored within one standard deviation of the mean.

The same analysis procedure was used for each of the three learning disability groups identified in the present study. For the LD1 group, the WRAT Reading subtest score frequencies significantly differed from chance across cognitive ability groups, X^2 (8) = 26.44, $p < .001$ as presented in Table 6. Thirty-two percent of the Abstract Reasoning group scored above the mean and an additional 41% scored within a standard deviation of the mean. Thirteen percent of the Sequencing-memory group scored above the mean and an additional 62% scored within a standard deviation of the mean. Only 6% of the General Language Disability group scored above the mean and an additional 40% scored within a standard deviation of the mean. These frequency distributions were consistent with the Richman findings in that the Abstract Reasoning group had the highest percentage of scores above the mean and the General Language Disability group had the lowest percentage of scores above the mean. However, the percentage of children scoring 85 or above was slightly higher for the Sequencing-memory group than for the Abstract Reasoning group.

For the LD2 group no significant differences were apparent among cognitive ability groups on WRAT Reading subtest scores, X^2 (6) = 7.05, $p < .32$ as presented in Table 7. An examination of the relative frequencies indicates that while all of the children in the Abstract Reasoning group scored above or within a standard deviation of the mean, the relatively small number of children in that group,

Table 6

Distribution of WRAT Reading Standard

Score by Cognitive Ability Group

for all Subjects (LD1)

Cognitive Ability Group	WRAT Reading Scores				
	≤ 69	70-85	85-99	100-114	≤ 115
Abstract Reasoning (N = 22)	0	6	9	5	2
Sequencing-memory (N = 45)	2	9	28	6	0
General Language Disability (N = 109)	7	51	44	6	1

Note. Subjects receiving remediation in a learning disabilities classroom.

Note. The relationship between ability group and WRAT Reading Standard Scores was significant, X^2 (8) = 26.44, $p < .001$.

Table 7

Distribution of WRAT Reading Standard

Scores by Cognitive Ability Group

for Subjects Meeting IQ Criteria (LD2)

Cognitive Ability Group	WRAT Reading Scores			
	≤ 69	70-84	85-99	100-114
Abstract Reasoning (N = 5)	0	0	4	1
Sequencing-memory (N = 17)	1	7	8	1
General Language Disability (N = 28)	2	15	10	1

Note. Subjects *WISC* Verbal Scale +15 ≤ Performance Scale ≥ 90.

Note. The relationship between ability group and *WRAT* Reading Standard Scores was not significant, X^2 (6) = 7.03, $p < .32$.

together with the similarity of frequency distributions between the Sequencing-memory and General Language Disability groups, accounted for this finding.

For the LD3 group WRAT Reading subtest score frequencies differed significantly from "chance" across cognitive ability groups, X^2 (8) = 35.00, $p < .001$ as presented in Table 8. An examination of the relative frequencies resulted in findings similar to the Richman and the LD1 groups. Thirty percent of the Abstract Reasoning group scored above the mean and an additional 40% scored within a standard deviation of the mean. For the Sequencing-memory group 10% scored above the mean and an additional 68% scored within a standard deviation of the mean. None of the General Language Disability group scored above the mean and only 33% scored within a standard deviation of the mean. The percentage of children scoring 85 or above was slightly higher for the Sequencing-memory group than for the Abstract Reasoning group.

For all three LD groups, the Abstract Reasoning group had the highest percentage of scores above the mean and the General Language Disability group had the highest percentage of scores more than one standard deviation below the mean. For the LD1 and LD3 groups, the groups in which WRAT Reading subtest scores differed significantly by cognitive ability groups, the percentage of children scoring 85 or above was slightly higher for the Sequencing-memory group than for the Abstract Reasoning group.

Factor Structures of Groups

WISC varimax rotated factor matrices for the verbal deficit group evaluated by Richman are presented in Table 9. Factor 1 had

Table 8

Distribution of WRAT Reading Standard

Scores by Cognitive Ability Group

for Subjects Meeting DPI Guidelines (LD3)

Cognitive Ability Group	WRAT Reading Scores				
	≤ 69	70-84	85-99	100-114	≤ 115
Abstract Reasoning (N = 20)	0	6	8	4	2
Sequencing-memory (N = 31)	2	5	21	3	0
General Disability Language (N = 57)	7	31	19	0	0

Note. Subjects WRAT subtest score +15 ≤ WISC Full Scale IQ ≥ 85.

Note. The relationship between ability group and WRAT Reading Standard Scores was significant, X^2 (8) = 35.00, $p < .0001$.

Table 9

WISC Factor Analysis

As Determined by Richman (1979)

Variable	Factor 1	Factor 2	Factor 3
WISC Subtests			
Information	31	19	62*
Comprehension	-07	-40	07
Arithmetic	-61	46*	07
Similarities	82*	31	00
Vocabulary	01	08	-23
Picture Completion	09	22	22
Picture Arrangement	-17	64*	05
Block Design	85*	-08	06
Coding	-60	02	-07

Note. From "Patterns of Intellectual Ability in Children with Verbal Deficits" by L. C. Richman and S. D. Lindgren, Unpublished paper presented Iowa School Psychology Association, Des Moines, Iowa, 1979.

Note. Decimals are omitted.

*Factor loadings > 35.

factor loadings greater than .35 for Similarities and Block Design. Richman determined that this factor represented abstract reasoning abilities. Factor 2 had factor loadings greater than .35 for Picture Arrangement and Arithmetic. Richman determined this factor represented sequencing-memory abilities. Factor 3 had a factor loading greater than .35 on Information. Richman determined that this factor was not readily interpretable since only one subtest had a factor loading greater than .35.

The same varimax rotated factor procedure was used to evaluate the three learning disabled groups of the present study. The results for the LD1 group are presented in Table 10. Factor 1 had factor loadings greater than .35 for Information, Similarities, Arithmetic, Vocabulary, and Comprehension. Factor 1 could be described as a verbal factor since it loaded heavily on all the Verbal Scale subtests (except the supplemental Digit Span subtest). Factor 2 had factor loadings greater than .35 for Picture Completion, Picture Arrangement, Block Design, and Coding. Factor 2 could be described as a performance factor since these subtests make up the Performance Scale of the WISC. Factor 3 had factor loadings greater than .35 for Digit Span, Arithmetic, and Block Design. The subtest that loaded greater than .35 on Factor 3 requires attention to task and could be described as an attending factor.

The results for the LD3 group are presented in Table 11. The factor structure for this group was similar to the LD1 group. Factor 1 had factor loadings greater than .35 on the same five Verbal Scale subtests and Block Design and could also be described as a verbal

Table 10

WISC/WISC-R Factor Analysis for

all Subjects (LD1)

Variable	Factor 1	Factor 2	Factor 3
WISC Subtests			
Information	81*	00	16
Similarities	70*	12	00
Arithmetic	50*	11	53*
Vocabulary	84*	11	01
Comprehension	73*	02	09
Digit Span	01	08	85*
Picture Completion	14	61*	12
Picture Arrangement	16	47*	17
Block Design	15	63*	39*
Object Assembly	-12	76*	00
Coding	00	54*	25

Note. Decimals are omitted.

*Factor loadings $\geq$ 35.

Table 11

WISC/WISC-R Factor Analysis for

Subjects Meeting DPI Guidelines (LD3)

Variable	Factor 1	Factor 2
WISC Subtests		
Information	83*	02
Similarities	69*	09
Arithmetic	56*	40*
Vocabulary	84*	-05
Comprehension	81*	04
Digit Span	30	28
Picture Completion	05	58*
Picture Arrangement	17	48*
Block Design	35*	64*
Object Assembly	-08	68*
Coding	-08	62*

Note. Decimals are omitted.

*Factor loadings $\geq$ 35.

factor. Factor 2 had factor loadings greater than .35 on the same five Performance Scale subtests and Arithmetic and could also be described as a performance factor.

Factor analysis of the LD2 group, the group most closely resembling the Richman group resulted in four factors as presented in Table 12. The factor loadings greater than .35 for subtests in each of the four factors did not seem to have common processes within each factor that would allow them to be described in terms of common psychological processes.

Discussion

The purpose of this study was to determine if the categorization of learning disabled children by the cognitive ability classification method suggested by Richman would differentiate between cognitive styles of learning disabled children. It was hoped this information could be used to more accurately identify the learning disabled child and provide information that would be useful in planning more appropriate educational strategies.

To evaluate the degree to which this classification method meets this purpose, three questions need to be addressed:

1. Are the numbers of learning disabled children who fall into the groups for which special remedial procedures are suggested (the Abstract Reasoning and Sequencing-memory groups) sufficient enough to warrant the procedure?

2. What is the nature of the relationship between cognitive ability classification and demonstrated reading ability (e.g., does

Table 12

WISC/WISC-R Factor Analysis for

Subjects Meeting IQ Criteria (LD2)

Variable	Factor 1	Factor 2	Factor 3	Factor 4
WISC Subtests				
Information	51*	28	26	29
Similarities	65*	47*	-05	-10
Arithmetic	87*	05	12	16
Vocabulary	-36	58*	53*	37*
Comprehension	22	28	64*	37*
Digit Span	10	-05	-05	82*
Picture Completion	05	76*	23	18
Picture Arrangement	10	08	05	53*
Block Design	59*	-16	49*	28
Object Assembly	12	-05	79*	26
Coding	22	73	-17	13

Note. Decimals are omitted.

*Factor loadings $\geq$ 35.

the Abstract Reasoning group read the best because of abstract reasoning ability or might there be other reasons)?

3. Are the factor structures of the learning disabled groups supportive of the abstract reasoning and sequencing-memory classification method suggested by Richman?

In the three learning disabled samples evaluated, the frequency distributions by cognitive ability group resulted in only 10 to 18% of the children falling into the Abstract Reasoning group and 53 to 62% falling into the General Language Disability group. The relatively low percentage of learning disabled children identified in the Abstract Reasoning group was important since this is the group for which Richman indicated that the cognitive ability grouping offered the most potential for remediation. Furthermore, the high percentage of children who fell into the General Language Disability group should also be noted, since the cognitive ability grouping method offered no remedial suggestions for these children. However, even if the percentages of learning disabled children who could be helped through the cognitive ability classification system was small, it would be useful if the classifications are accurate.

Since the learning disability field is an educational area where more adequate programs are needed, it is important to verify the relationship between cognitive ability group and reading ability. The distribution of WRAT Reading scores among cognitive ability groups seemed to support the Richman contention that the Abstract Reasoning children could be expected to be the best readers as a group. It is important to note that this relationship was determined on the basis of group scores and not scores of each individual. Therefore, the cognitive ability grouping is subject to the same problems with interpretation and generalization that the group profile was. However, the categorization method could still prove useful if the general relationship between cognitive ability and reading style is demonstrated. Richman proposed that the relationship between cognitive ability group and reading ability was an indication of differences in reading styles between the cognitive ability groups. It was important to evaluate the groups to see if there could be explanations for this relationship other than the one suggested by Richman.

Independent means *t*-tests were carried out to evaluate differences in *WISC* Full Scale IQ scores among cognitive ability groups and are presented in Table 13. For the LD1 group the mean Full Scale IQ for the Abstract Reasoning group was significantly higher than the mean Full Scale IQ of the Sequencing-memory group, $t\ (65) = 3.40$, $p < .01$. The mean Full Scale IQ for the Sequencing-memory group was, in turn, significantly higher than the mean IQ of the General Language Disability group, $t\ (152) = 8.81$, $p < .01$. Similar differences in Full Scale IQ among cognitive ability groups were noted for the LD2 and LD3 groups.

It would appear that these differences in Full Scale IQ between cognitive ability groups would account at least in part for the relationship between cognitive ability and reading ability. This expected relationship between *WISC* Full Scale IQ and reading ability limits

Table 13

WISC Full Scale (FS), Verbal Scale (VS), and Performance Scale (PS) IQ with Means and Standard Deviations Tabulated by Cognitive Ability Group and Learning Disability Group

Cognitive Ability Group	WISC Scale	LD1 (N = 176) X̄	LD1 SD	LD2 (N = 50) X̄	LD2 SD	LD3 (N = 108) X̄	LD3 SD
Abstract Reasoning	FS	110.36**	6.9	109.60*	9.5	111.20*	6.7
	VS	108.64	2.4	110.20	8.8	109.85	12.4
	PS	110.46	9.7	118.40	8.6	110.75	10.1
		(n = 22)		(n = 5)		(n = 20)	
Sequencing-memory	FS	103.38**	8.1	101.47*	6.7	106.19*	7.4
	VS	98.13	10.3	90.29	6.3	100.94	10.3
	PS	108.96	9.3	114.47	7.2	111.16	9.4
		(n = 45)		(n = 17)		(n = 31)	
General Language Disability	FS	91.57**	7.6	91.43**	6.9	93.93**	6.8
	VS	89.35	10.1	80.14	6.4	91.63	8.2
	PS	96.30	10.2	105.68	7.9	98.07	9.2
		(n = 109)		(n = 28)		(n = 57)	
LD Total	FS	96.95	10.4	96.66	9.4	100.65	10.1
	VS	94.00	12.4	85.60	9.4	97.68	11.9
	PS	101.31	11.8	109.94	9.1	104.18	11.4
		(n = 176)		(n = 50)		(n = 108)	

*Notes a significant difference ($p < .05$) between Full Scale IQ's of Cognitive Ability Groups for that Learning Disability Group.

**Notes a significant difference ($p < .01$) between Full Scale IQ's of Cognitive Ability Groups for that Learning Disability Group.

any interpretation that could be given to the relationship of the cognitive ability groups themselves to reading ability.

In conclusion, it is important to discuss the factor structures themselves. The cognitive ability grouping categorization was based on what Richman indicated was unique, interpretable factors for a specific verbal deficit population. Similar factor structures for the learning disabled groups would support the use of the Richman categorization method in learning disabled groups. It could then be argued that the basic premise differentiating between cognitive styles based on unique factor structures for special populations offered methods of identification and classification that through refinement could still prove helpful. However, the factor structures for the LD1 and LD3 groups in the present study closely resembled the factor structures Cohen (1959) and Kaufman (1975) had obtained in a normal population. The factor structure for the LD2 group, the group most closely matching the verbal deficit group, was unique, but was not similar to the verbal deficit group. Richman based the cognitive ability groupings on the unique factor structure of the verbal deficit group. Since the factor structures for the three learning disability groups investigated here were not similar to the factor structure of the Richman verbal deficit group, it would seem that the cognitive ability classifications of the Richman verbal deficit group do not generalize to learning disabled groups.

It would appear that for the aforementioned reasons that the use of the unstandardized discriminant function coefficients based on a verbal deficit group should not be used to classify learning disabled children into cognitive ability groups. Furthermore, it appears that for these learning disabled groups Full Scale IQ alone would be as good an indicator of reading ability as the additional procedure of cognitive ability grouping.

CHAPTER FIVE

SUMMARY

The rapidly growing field of learning disabilities has been an area where research has been diverse and the generalization of findings difficult due to a confusion of terminology and a diversity of ideas as to its cause. Learning disability is the term used to describe children who are of at least average intelligence and who do not achieve at the level indicated by this intellectual potential for reasons that are unclear. While physical, social, and emotional factors have generally been ruled out as primary causes by definition, the actual causes have not been determined.

A variety of theories have been suggested and many have been tested and implemented with limited success. In psychology most research has dealt with perceptual and cognitive processing of the learning disabled child. Early research efforts into these areas focused on the use of the WISC subtest patterns based on mean WISC subtest scores for the group and suggested the resulting mean subtest pattern as the typical cognitive pattern for the group.

Burks and Bruce (1955) and Altus (1956) each evaluated subtest patterns for groups of reading disabled children and concluded that a WISC subtest pattern of lower scores on the Information, Arithmetic, and Coding subtests was typical of the reading disabled child. Many later studies using similar reading and learning disabled populations reported similar group patterns on WISC subtests. However, Huelsman

(1970) pointed out that while many of these group patterns were similar, the pattern was not typical of many of the individuals within the group. He suggested the need to better understand differences among individuals within these populations if the findings were to have value in identification or in planning remedial strategies.

Richman has evaluated a group of children which he described as having a verbal deficit based on a WISC Verbal Score at least 15 points below the Performance Scale. He indicated that this criterion alone was insufficient as a basis for any academic remediation. Through factor analysis of WISC subtests of children who met this verbal deficit criterion, Richman concluded that a unique factor structure existed for this group. He determined the first factor represented abstract reasoning skills and the second factor represented sequencing-memory skills, and that these factors allowed the children to be subgrouped according to factor strength. A child who scored well on the subtests that loaded heavily on the first factor would be placed in an Abstract Reasoning group. A child who scored well on the subtests that loaded heavily on the second factor would be placed in the Sequencing-memory group. A child who did not score well on either of the factor groupings would be placed in a General Language Disability group. Richman believed that more appropriate educational strategies could be made based on the factor strength each child demonstrated. He suggested that if this method of categorization would apply to less restrictive populations it could be of value in the school setting.

It was the purpose of the present study to investigate the value of subgrouping learning disabled children into cognitive ability groups using the method proposed by Richman. To investigate this issue, a group of 176 children in public schools who had been identified as learning disabled and received remediation in a learning disability classroom were selected. The total group of 176 children was evaluated. Also identified and evaluated was a subgroup of 50 children who met a verbal deficit criterion of a WISC Verbal Scale at least 15 points less than the Performance Scale. A second subgroup of 108 children was also identified and evaluated, who met an additional Iowa Department of Public Instruction criterion of a WRAT subtest score at least 15 points below the WISC Full Scale score.

First, the unstandardized discriminant function coefficients were used to categorize the learning disabled samples into cognitive ability groups. Secondly, the relationship between cognitive ability classification and word recognition was assessed by evaluating the frequency distributions of WRAT Reading subtest scores across cognitive ability classifications. Third, factor anlaysis of the WISC subtests for the three learning disabled groups was carried out and the factor structures for these groups compared to the factor structure of the verbal deficit sample investigated by Richman.

The learning disabled samples were categorized into the three cognitive ability subgroups using the procedure suggested by Richman. For all three learning disability groups, categorization into the three cognitive ability subgroups using the unstandardized discriminant function suggested by Richman was possible. However, the percentage of children who fell within the Abstract Reasoning group for all three learning disability groups was less than for the Richman sample, while the percentage of children who fell into the General Language Disability group was greater than for the Richman sample. Since the Abstract Reasoning group was the group for which the most educational implications were suggested and the General Language Disability group was the group for which the least educational implications were suggested, the noted differences in frequencies would limit the use and effectiveness of the classification method in learning disabled groups.

Richman had determined that for the verbal deficit children the Abstract Reasoning group tended to be the best readers. The Sequencing-memory group read less well and the General Language Disability group had the lowest reading ability. The distribution of WRAT Reading scores among the cognitive ability groups for the three learning disabled groups was similar to the distribution of Richman's deficit group. However, the use of the coefficients suggested by Richman to classify learning disabled children into cognitive ability subgroups resulted in groupings on which the WISC Full Scale IQ score for the Abstract Reasoning group was approximately six points higher than that of the Sequencing-memory group. And, the Full Scale IQ of the Sequencing-memory group was, in turn, 11 points higher than that of the General Language Disability group. These differences in Full Scale IQ among cognitive ability groups were found to be significantly different using independent means *t*-tests ($p < .05$). Differences in

Full Scale IQ were not as great in the verbal deficit sample evaluated by Richman and he concluded the influence of IQ on the findings was minimal. However, the difference in IQ among cognitive ability groups in the present study would seem to have influenced the relationship between cognitive grouping and reading level. It appears that for these learning disabled groups Full Scale IQ alone would be as good an indicator of reading ability as the additional procedure of cognitive ability groupings.

Richman indicated that the factor structure obtained from factor analysis of the WISC subtests in the verbal deficit group supported the hypothesis of a unique factor structure in children with a verbal deficit. The first factor loaded on Similarities and Block Design subtests which Richman determined to be an Abstract Reasoning factor. The second factor loaded on Picture Arrangement and Arithmetic which Richman determined to be a Sequencing-memory factor. The factor structures obtained for the total learning disabled group and the IQ achievement score discrepancy subgroup in the present study were similar to those found in the standardization samples of the WISC and WISC-R by Cohen and Kaufman. For these learning disabled groups, it would appear that a unique factor structure is not present and the generalization of the factor structure of a verbal deficit sample to less restrictively defined learning-disabled populations is unwarranted. The factor structure for the low Verbal, high Performance Scale on the WISC, the group most similar to the Richman verbal deficit sample, was unique. However, the four resulting factors were not similar to the three factors of the Richman sample and did not seem to be interpretable in terms of cognitive process.

In conclusion, it would appear that while the learning disability groups could be categorized into three cognitive ability groups using the unstandardized discriminant function coefficients the value of this categorization cannot be determined, due to the differences in Full Scale IQ which resulted from the classification procedure. Therefore, it would appear that for these learning disabled groups: (a) academic expectations could be more easily determined by use of Full Scale IQ, and (b) the factor analysis of the WISC subtest scores for these groups did not result in a unique factor structure upon which cognitive ability classification could be based. These findings suggest that the general application of the Richman procedure to learning disabled children is unwarranted.

REFERENCES

Ackerman, P., Peters, J., & Dykman, R. Children with specific learning disabilities: WISC profiles. Journal of Learning Disabilities, 1971, 4, 150-166.

Altus, G. A WISC profile for retarded readers. Journal of Consulting Psychology, 1956, 20, 155-156.

Anastasi, A. Psychological testing (4th ed.). New York: Macmillan, 1976.

Bannatyne, A. The etiology of dyslexia and the color phonics system. In Selected papers of the 3rd annual international conference on learning disabilities of children and youth. Tulsa, 1967.

Bannatyne, A. Language, reading, and learning disabilities. Springfiled, Ill.: Charles C. Thomas, 1971.

Bannatyne, A. Diagnosis: A note on recategorization of the WISC scaled scores. Journal of Learning Disabilities, 1974, 7, 272-273.

Bateman, B. An educator's view of a diagnostic approach to learning disorders. In J. Hellmuth (ed.), Learning disorders (Vol. 1). Seattle: Special Child Publications, 1965.

Belmont, L., & Birch, H. The intellectual profile of retarded readers. Perceptual and Motor Skills, 1966, 46, 486-493.

Bryan, T., & Bryan, J. Understanding learning disabilities. Pt. Washington, N. Y.: Alfred, 1975.

Burks, H., & Bruce, P. The characteristics of poor and good readers as disclosed by the Wechsler Intelligence Scale for Children. Journal of Educational Psychology, 1955, 46, 486-493.

Carroll, J. Review of Illinois test of psycholinguistic abilities (rev. ed.). In O. Buros (ed.), Seventh Mental Measurements Yearbook (Vol. 1). Highland Park, N. J.: Gryphon Press, 1972.

Cattell, R. Factor analysis; an introduction and manual for the psychologist and social scientist. New York: Harper, 1952.

Cohen, J. Factors underlying Wechsler-Bellevue performance of three neuro-psychiatric groups. Journal of Abnormal and Social Psychology, 1952, 47, 359-375.

Cohen, J. The factorial structure of the WISC at ages 7-6, 10-6, and 13-6. Journal of Consulting Psychology, 1959, 23, 285-299.

Coleman, J., & Rasof, B. Intellectual factors in learning disorders. Perceptual and Motor Skills, 1963, 16, 139-152.

Falik, L. The effects of special perceptual motor training in kindergarten on second grade reading. Journal of Learning Disabilities, 1969, 2, 395-402.

Frostig, M. Developmental test of visual perception: Administration and scoring manual. Palo Alto, Calif.: Consulting Psychologists Press, 1964.

Gallager, J. Children with developmental imbalances: a psycho-educational definition. In W. Cruickshank (ed.)., The teacher of brain-injured children: a discussion of the bases of competency. Syracuse, N. Y.: Syracuse University Press, 1966.

Guthrie, J., & Seifert, M. Education for children with learning disabilities. In H. Myklebust (ed.)., Progress in learning disabilities (Vol. 4). New York: Grune & Stratton, 1978.

Hammill, D. Training visual perceptual processes. Journal of Learning Disabilities, 1972, 5, 552-559.

Hirst, L. Usefulness of a two-way analysis of WISC subtests in the diagnosis of remedial reading problems. Journal of Experimental Education, 1960, 29, 153-160.

Hopkins, K., & Michael, W. The diagnostic use of WISC subtest patterns. California Journal of Educational Research, 1961, 11-12, 116-117; 130.

Huelsman, C. B. The WISC subtest syndrome for disabled readers. Perceptual and Motor Skills, 1970, 30, 535-550.

Iowa Department of Public Instruction. Iowa's recommended operational criteria for identification of students with learning disabilities. Des Moines, Ia.: Department of Public Instruction, 1976.

Jacobs, J., Wirthlin, L., & Miller, C. A follow-up evaluation of the Frostig visual perceptual training program. Educational Leadership Research Supplement, 1968, 4, 169-175.

Jastak, J. F., & Jastak, S. R. The wide range achievement test: manual of instructions. Wilmington, Del.: Guidance, 1965.

Johnson, D., & Myklebust, H. Learning disabilities: educational principles and practices. New York: Grune & Stratton, 1967.

Kallos, G., Grabow, J., & Guarino, E. WISC profiles of disabled readers. Personnel and Guidance Journal, 1961, 39, 476-478.

Kaufman, A. S. Factor analysis of the WISC-R at 11 age levels between 6½ and 16½ years. Journal of Consulting and Clinical Psychology, 1975, 43, 135-147.

Kaufman, A. S. WISC-R research: implications for interpretation. School Psychology Digest, 1979, 8, 5-27.

Kirk, S., McCarthy, J., & Kirk, W. Illinois test of psycholinguistic abilities: examiner's manual. University of Illinois Press, 1968.

Lerner, J. Children with learning disabilities: theories, diagnosis, and teaching strategies. Boston: Houghton Mifflin, 1976.

McWhirter, J. The learning disabled child: a school and family concern. Champaign, Ill.: Research Press Co., 1977.

Myklebust, H. R., Bannochie, M. N., & Killen, J. R. Learning disabilities and cognitive processes. In H. R. Myklebust (ed.), Progress in Learning Disabilities (Vol. 2). New York: Grune & Stratton, 1971.

Neville, D. A comparison of the WISC patterns of male retarded and non-retarded readers. Journal of Educational Research, 1961, 54, 195-197.

Nie, H., Hull, C., Jenkins, J., Steinbrenner, K., & Bent, D. Statistical package for the social sciences (2nd ed.). New York: McGraw-Hill Book Co., Inc., 1975.

Richman, L. Language variables related to reading ability of children with verbal deficits. Psychology in the Schools, 1979, 16, 299-305. (a)

Richman, L. Patterns of intellectual ability in children with verbal deficits. Unpublished paper presented Iowa School Psychology Association, Des Moines, Iowa, 1979. (b)

Robeck, M. Subtest patterning of problem readers on the WISC. California Journal of Educational Research, 1960, 11, 110-115.

Rugel, R. P. WISC subtest scores of disabled readers: A review with respect to Bannatyne's recategorization. Journal of Learning Disabilities, 1974, 7, 48-55.

Sattler, J. M. Assessment of children's intelligence (Revised reprint). Philadelphia: W. B. Saunders, 1974.

Senf, G. A perspective on the definition of LD. Journal of Learning Disabilities, 1977, 19, 537-539.

Silverstein, A. An alternative factor analytic solution for Wechsler's intelligence scales. Educational and Psychological Measurement, 1969, 29, 763-767.

Smith, M. D., Coleman, J. M., Dokecki, P. R., & Davis, E. E. Recategorized WISC-R scores of learning disabled children. Journal of Learning Disabilities, 1977, 19, 437-443.

Thorndike, R. Wide Range Achievement Test, revised edition. In O. Buros (ed.)., Seventh Mental Measurement Yearbook (Vol. 1). Highland Park, N. J.: Gryphon Press, 1972.

Thurstone, L. The vectors of mind; multiple-factor analysis for the isolation of primary traits. Chicago: The University of Chicago Press, 1935.

Wallbrown, F., Blaha, J., & Vance, B. A reply to Miller's concerns about WISC-R profile analysis. Journal of Learning Disabilities, 1980, 13, 340-345.

Wallbrown, F. H., Wherry, R. J., Blaha, J., & Counts, D. H. An empirical test of Myklebust's cognitive structures hypothesis for 70 reading-disabled children. Journal of Consulting and Clinical Psychology, 1974, 42, 211-218.

Wechsler, D. Manual for Wechsler Intelligence Scale for Children. New York: Psychological Corporation, 1949.

Wechsler, D. Manual for Wechsler Intelligence Scale for Children - Revised. New York: Psychological Corporation, 1974.