

THE USE OF KAUFMAN'S FACTOR ANALYSIS OF THE  
WISC-R IN DISTINGUISHING ABLE AND DISABLED  
READERS AT THREE GRADE LEVELS

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## CHAPTER I

### INTRODUCTION

#### Presentation of the Problem

For decades investigators have sought to identify the separate causes of reading disability. The search for a single cause is very complicated and, in most cases, many causal factors are found in various combinations. The most common factors contributing to reading disability include constitutional and physical factors, emotional factors, cultural factors, and educational factors. These factors rarely act independently and, for the most part, the interrelationships among these factors are far greater in complexity than are any of the factors taken individually. Thus, one usually sees the interplay of both obvious and subtle forces as reading disability unfolds. The continued search for causes of reading disability is needed, not only to throw new light on a complex problem, but to assess the relevance of existing information.

Much of the difficulty with research in the area of causation may stem from the fact that those who have attempted to contribute to this research have used an inductive approach, reasoning from the individual case to the group. People have worked with reading disabled students and then, in their desire to help them, have sat back and speculated about the problem. In so doing they have looked for analogies from the

brain injured, the mentally retarded, the deaf, and the cerebral palsied. The results of such attempts to explain reading disability have been generally unproductive because of the approach used (Ross, 1976). A more promising approach may be the deductive method which uncovers empirically based principles that hold true for the group. One reasons from these general principles to the particular case. To uncover general principles which characterize disabled readers, one must study the learning processes of the specific group about which one is concerned.

Shortly after the development of the Wechsler Intelligence Scale for Children in 1949, investigators sought to determine whether disabled readers perform in a typical way. The WISC was particularly amenable to such investigation because of its twelve-subtest, Verbal and Performance Scale construction. The WISC quickly became the instrument of choice for many clinicians in assessing the intellectual organization and the separate abilities assumed to be basic to the reading process. By studying the unique subtest patterns demonstrated by poor readers on the WISC, reading specialists have sought a better understanding of the reading process, of mental functioning during reading, and an efficient therapy for disabled readers. Many studies emphasize the difference between Verbal and Performance IQ's as predictive of reading disability, but the more popular method has been to study subtest patterns.

The interpretation of subtest patterns demonstrated by disabled readers has been criticized on several points. First, the studies often involve a comparison of single subtests of not very high reliability without attention to the statistical significance of the differences between scores. In other words, the importance attributed



by many clinicians to differences between subtest scores may often be no more than chance variation. Secondly, many of the subtest patterns are based on clinical populations where the reasons for referral are often something other than reading disability (Spache, 1976). Lastly, although consistent performance patterns have evolved from subtest pattern studies, there has been little attention directed to the developmental nature of these patterns. In other words, disabled readers have been treated as if they were a class. One is led to believe that disabled readers perform poorly on a group of subtests across all chronological age ranges. For these reasons, then, pattern analysis alone does not identify the student as a disabled reader.

A more recent and more promising approach to the study of the significance of low subtest scores, and the focal point of the present study, has come with the various factor-analytic studies of the Wechsler Intelligence Scale for Children (Maxwell, 1959; Cohen, 1959; Bannatyne, 1971). The results of these factor-analytic studies clearly indicate groups of intercorrelated subtests which can be interpreted into remedial prescriptions. Furthermore, an approach to decisions regarding remedial treatment, as well as to further exploration of the student's school and family history, can be definitely based on factor-analytic findings (Spache, 1976). Kaufman's (1975) factor analysis of the Wechsler Intelligence Scale for Children-Revised (WISC-R) resulted in three factors, apart from general intelligence, which Cohen had earlier termed Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility. Not only did Kaufman identify three "meaningful" WISC-R factors, but he also examined developmental trends in the WISC-R factor structure from age to age and interpreted the results of the

analysis in terms of their practical clinical significance. In Kaufman's study, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility emerged as meaningful factors at all eleven age levels between  $6\frac{1}{2}$  and  $16\frac{1}{2}$ .

Kaufman's Factor A, Verbal Comprehension, combined the WISC-R subtests of Vocabulary, Comprehension, Similarities, and Information. Together these subtests appear to reflect that aspect of verbally retained knowledge impressed by formal education, and they reflect the application of judgment to situations following some implicit manipulation. According to Kaufman (1975), the consistency of the Verbal Comprehension factor from age to age was remarkable.

Factor B, Perceptual Organization, contains the WISC-R subtests of Block Design, Object Assembly, Picture Arrangement, Picture Completion, and Mazes. Like Factor A, Perceptual Organization demonstrated remarkable consistency across the  $6\frac{1}{2}$  to  $16\frac{1}{2}$  year range. The subtests included in Factor B are all non-verbal and require the interpretation and/or organization of visually perceived materials against a time limit.

Factor C, Freedom from Distractibility, includes the WISC-R subtests Digit Span, Coding and Arithmetic and is characterized by the same consistency across the age ranges that was true for Factors A and B. While this factor is defined as Freedom from Distractibility, Kaufman cautions that interpretation of the meaning of Factor C presents a thorny problem. Earlier investigators who had obtained a factor similar to Factor C interpreted it as a memory score. Even Cohen (1959), who originally defined it as a memory score, later claimed that it "is primarily a Freedom from Distractibility factor; its interpretation as a memory factor is in error." There are several reasons for interpreting Factor C as a Freedom from Distractibility measure rather than one of

memory. Short-term memory and arithmetic skills are particularly vulnerable to a student's distractibility and lack of concentration and sustained attention. Furthermore, when medication is used with children having these problems, there is typically a marked reduction in their distractibility and a subsequent improvement in their memory and arithmetic performance. This supports both Cohen's and Kaufman's contention that Factor C is a distractibility factor and not a memory factor. Drugs do not produce learning; they only make learning more possible. Therefore, successful performance with either memory tasks or arithmetic requires as a precondition, Freedom from Distractibility.

According to Kaufman, the structure of the WISC-R and its subsequent factorial recategorization has been shown to be stable across statistical techniques as well as across the entire age range for which the test is intended. Each of the three factors obtained by Kaufman indicate an overwhelming consistency across the  $6\frac{1}{2}$  to  $16\frac{1}{2}$  age range, and each factor may be interpreted as meaningful and clinically useful.

Given that Kaufman's three factors, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility are meaningful, clinically useful, and represent a relevant approach regarding decisions for remedial treatment, it follows that several prevalent hypotheses for explaining reading disability can be examined. By recategorizing the twelve WISC-R subtests, and by studying the performance of disabled readers on the resulting factors at different levels of maturation, several cogent challenges to the research preceding the present study can be made.

Support for investigating the factor performance of disabled readers at differing levels of maturity is found in research suggesting

that language deficiencies, particularly the lack of an extensive language base, may be directly related to the adolescent disabled reader's lack of growth beyond the elementary grades (Ray, 1976). Other research investigating the language skills of adolescent disabled readers and younger normally-achieving readers performing at the same level indicate a strong relationship between reading and language skills beyond the elementary grades (Tooker, 1977). Additionally, Tooker suggests that developmental variations may account for both the magnitude and importance of the relationship between reading performance and specific language abilities at different stages of maturation and reading levels. Consequently, one would not expect children at different levels of maturation to perform similarly on the three Kaufman factors. If, as Ray and Tooker suggest, developmental variations account for the differences between able and disabled readers in language and reading, then the performance of the two groups on Factor A, Verbal Comprehension, should not be the same across the grades.

Additional support for studying the factor performance of disabled readers at different levels of maturation is obtained by examining two prevalent explanations for reading failure in primary-age children: perceptual-deficit and verbal functioning. Both approaches hold that mastery of their respective skills is a fundamental prerequisite to achievement in reading and other school subjects. Proponents of both approaches argue that achievement in reading and/or other school subjects may be improved with concentrated training programs usually aimed at the primary-aged child. The general premise of each approach, perceptual-deficit and verbal functioning, is that each is heavily correlated with reading failure and subsequently contributes heavily to, or causes, the disability.

Perceptual skills are viewed by many teachers and administrators as so crucial to reading that many school districts screen their primary-age students with tests that include many perceptual-motor items. Yet, Roswell and Natchez (1977), noted that there is little or no evidence in favor of the notion that visual-perceptual disability is a significant correlate, much less a cause, of reading disability. In examining prevalent explanations for reading failure in the primary grades, Vellutino (1977) criticizes perceptual-deficit hypotheses, arguing that, "Given the redundant use of a limited number of symbols in recurring combinations, the visual demands in reading are ultimately minimal, and poor and average readers at various stages of development should not differ on measures of visual processing." It appears that any improvement in perception which is a result of training is its own reward; activities should never be recommended in the hope that improvement will generalize to reading or other activities (Hammill, 1975). Factor B, Perceptual Organization, then, if administered to children of differing levels of reading and maturation, should be a sensitive indicator of the efficacy of perceptual-deficit hypotheses with primary-age disabled readers.

Both Loban (1963) and Strickland (1962) have shown that within the normal range, there is no significant relationship between oral language and reading achievement in the primary grades. However, a relationship emerges between oral language and reading achievement in grades four through six. The overwhelming majority of children enter the first grade with enough language competency to perform all the tasks they are asked to do. This includes learning to read on the elementary levels. In short, primary-age students generate almost all types of

sentence structures and these are generally more complex than the ones used in textbooks in the primary grades. Natchez (1977) enthusiastically advised and supervised oral language skills training in the early primary grades, such that children could pass with flying colors all tests of oral language at age expectation. She concluded, however, that

. . . by March of first grade it was clear that success was not just around the corner; sadder but wiser we learned that training a child to be ready did not change the child's brain such that the next step in language acquisition 'came naturally' (p. 40).

If this is true for training the linguistic antecedents or correlates best documented to be relevant to reading disability, then one may draw his own conclusions as to the rationale for training the weakly correlated perceptual handicaps. If Strickland's argument is valid, then Factor A, Verbal Comprehension, should be a sensitive indicator of verbal functioning if administered to children of differing maturational and reading levels. Or, as both Strickland and Vellutino advise, perhaps we should search elsewhere for our causes of reading disability with primary-age children, say Factor C, Freedom from Distractibility.

#### Purpose of the Study

The specific purpose of this study was to statistically distinguish between the two types of reader, able and disabled, at three levels of development: grade two, grade four, and grade six. Three discriminating variables, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility were selected as characteristics on which the groups were expected to differ. A second purpose of this study was to determine the importance of each of the Kaufman factors in

distinguishing between the two reader types at each of the three grade levels.

#### Statement of the Problem

To many the Wechsler Intelligence Scale for Children-Revised has become the instrument of choice in studying intellectual organization in children. The reorganization of the WISC-R, which emerged from various attempts to factor-analyze and identify its structure, affords a marked improvement to test interpretation over pattern and single subtest analysis. Unfortunately, the use of single subtest analysis has not diminished in popularity.

The present study was designed to establish the relationship of the three Kaufman factors (Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility) to reader type, able and disabled, at each of three grade levels. The major criticism of research being conducted in this area is its lack of focus on developmental changes in WISC subtest performance and, more specifically, in performance on the Kaufman factors. Present research clearly indicates that disabled readers obtain their lowest scores on the WISC-R subtests which comprise Kaufman's Factor C, Freedom from Distractibility. No specification is made, however, of whether this score pattern is common to all disabled readers regardless of grade level or whether it is age related. A child who develops slowly in Freedom from Distractibility will be handicapped in learning to read regardless of methodological placement. Are the three Kaufman factors representative of abilities which impede or facilitate the developmental reading process at

different stages of maturation? Do they represent abilities which are differentially unique to reader type?

The present study sought responses to these questions of interest and continued the research with disabled readers and the WISC-R. Through subtest recategorization, this study offers an alternative method of defining and measuring student performance on the Wechsler Intelligence Scale for Children-Revised.

#### Definition of Terms

##### Disabled Reader

For the purposes of this study a disabled reader refers to an individual who, according to Wilson (1976), is .5 of a year or more below reading expectancy at grade two, .8 of a year or more below reading expectancy at grade four, and 1.2 years or more below reading expectancy at grade six. A disabled reader, furthermore, has an estimated intellectual potential within the average range.

##### Reading Expectancy

Reading expectancy is the student's predicted level of attainment based on years of school attendance and intellectual level. For the purpose of this study, reading expectancy was determined by the Bond and Tinker (1957) formula:  $RE = \text{Years in School} \times IQ/100 + 1$ . (1 is given as a constant since a child is assigned a grade equivalent of 1.0 on entry to school).



### Development Reader (Able Reader)

A developmental reader refers to an individual who is achieving normally in skill acquisition in reading in regards to age and grade placement. For the purposes of this study an able reader is one who is no more than .4 of a year below reading expectancy at grade two, no more than .7 of a year below reading expectancy at grade four, and no more than 1.1 of a year below reading expectancy at grade six. An able, or developmental reader, is a student whose estimated intellectual potential falls within the average range.

### Hypotheses

The objective of the present study was to determine if the three Kaufman factors could statistically distinguish between the two types of reader, able and disabled, at three levels of development: grade two, grade four, and grade six; to determine the accuracy with which a factor, or linear combination of factors, can predict reader type at grades two, four and six, and to determine the relative importance of the factors in predicting reader type at grades two, four and six.

The following null hypotheses were advanced:

Null Hypothesis I: There are no significant differences at grade two between the means of able and disabled readers on (1) Verbal Comprehension, (2) Perceptual Organization, and (3) Freedom from Distractibility.

Null Hypothesis II: There are no significant differences at grade four between the means of able and

disabled readers on (1) Verbal Comprehension, (2) Perceptual Organization, and (3) Freedom from Distractibility.

Null Hypothesis III: There are no significant differences at grade six between the means of able and disabled readers on (1) Verbal Comprehension, (2) Perceptual Organization, and (3) Freedom from Distractibility.

Null Hypothesis IV: The discriminant function prediction equation is no more accurate in predicting group membership at grade two than would be possible by chance alone.

Null Hypothesis V: The discriminant function prediction equation is no more accurate in predicting group membership at grade four than would be possible by chance alone.

Null Hypothesis VI: The discriminant function prediction equation is no more accurate in predicting group membership at grade six than would be possible by chance alone.

#### Assumptions and Limitations

It was assumed in the present study that while the three Kaufman factors, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility are certainly not all inclusive of the causal sources of reading disability, they are representative of other variables which have been used to describe this problem.

Group membership, or reader type, was a function of both the formula used for determining an expectancy score and the definition of reading disability used in this study. Other formulas or other definitions may yield different results.

This study focused on disabled readers and able readers in grades two, four, and six. The findings of this study should not be generalized beyond the three grade levels from which the samples were drawn.

## CHAPTER II

### REVIEW OF RELATED LITERATURE

#### Introduction

Historically, the poor reader has been of much interest to educators. Every teacher has a number of children who are not achieving in this subject to the extent that their mental abilities would indicate. The Wechsler Intelligence Scale for Children-Revised (WISC-R) has become the instrument of choice, among most clinicians, in assessing the intellectual functioning of disabled readers. This is so, in part, because the WISC-R is composed of twelve subtests contained within a Verbal and Performance scale. Differences in subtest performance of an individual are referred to as test scatter, and attempts to determine whether there is any similarity among the scattergrams of disabled readers have been numerous. A careful review of the literature concerned with WISC subtest pattern analysis indicates that, from the very beginning, these studies developed independent of each other. Few of the studies attempted to rectify design errors of preceding investigations; more often than not, problems in design were perpetuated from one study to another. For twenty years following the development of the WISC in 1949, investigators sought to determine the differences between unitary scores of the WISC profiles of disabled readers. Part one of this chapter summarizes these norm-referenced, quantitative

interpretation studies and relates them to the purposes of the present study. Part two presents the rationale and summary results of two factor analyses of the WISC and WISC-R.

### Historical Overview of Subtest Pattern

#### Analysis

Very shortly after publication of the WISC in 1949, investigations regarding the nature of subtest scatter of disabled readers appeared. There has been a reasonable degree of agreement among the studies despite vast differences in methodology and treatment. Graham (1952) used 96 profiles of unsuccessful readers drawn from the files of the Psychological Service Center for Children at the University of Denver. In Graham's study the unsuccessful reader was defined as a child between the ages of 8-0 and 16-11 who had fallen twenty-five percent or more below the mean grade level on the Wide Range Achievement Test. While Graham's study is usually cited as the first investigation of subtest analysis, his investigation was intending to demonstrate that the profile of a typical adolescent psychopath was very similar to that of an adolescent experiencing reading difficulty. Arithmetic, Digit Span, Information, and Vocabulary averaged below the mean. The first weakness of subtest analysis designs relating to reading disability is encountered in this study as the sample was drawn from a clinic setting where the true nature of pathology or reading disability was not known. Additionally, age-specific performance was not identified. There is an inherent weakness in the instrument chosen to define disability as well. At any rate, young criminals and psychopaths and poor readers

tend to bear a strong resemblance as far as their WISC profiles are concerned.

In a doctoral study done at the University of Virginia, Flanary (1953) used the Wechsler-Bellevue Scale with ninety disabled readers and twenty normal readers between the ages of twelve and sixteen to determine subtest patterns. He found the subtests Information, Comprehension, Digit Span, Arithmetic, Similarities, Vocabulary, Picture Arrangement and Digit Symbol to be the subtests which most clearly differentiate between retarded and normal readers. Flanary stated,

This may be interpreted to mean that the retarded reader has poor memory function, poor conceptual (abstract) thinking ability, short attention span, weak powers of concentration, meager vocabulary, poor planning ability and show slow psychomotor speed (p. 1045).

One is inclined to be critical of Flanary's study. With the inclusion of only two more subtests, the disabled reader would be low on every subtest included in this battery. Such a profile is synonymous with lowered ability. However Flanary's sample included disabled readers between the ages of twelve and sixteen years only. His is the first and only study reviewed which is restricted to this older age range, and one evidences the emergence of three new significant subtests which are unique to retarded readers: Similarities, Comprehension, and Vocabulary. These three subtests comprise the verbal comprehension factor used in the present investigation. Flanary had unknowingly demonstrated the presence of developmental trends with the various subtests, the focal point of the present study. Had Flanary gone beyond his data in analyzing his results, he could have inferred that the extent to which a set of subtests predicts to reading retardation is a function of age and possibly reading level.

An hypothesis was advanced by Burks and Bruce (1955) that the poor reader may be weak in those subtests of intelligence tests which resemble vital characteristics inherent in written language. Burks recommends curriculum modification if a consistent pattern of abilities for poor readers can be found. The subjects of this study included eleven readers who were pretested with the Wide Range Achievement Test and the WISC. They ranged in grade level from third to eighth grade. While Burks and Bruce located a pattern common to poor readers, the authors defined the pattern in terms of Goldstein and Scheerer's (1941) concepts of concrete and abstract cognitive styles. A concrete attitude is defined as a person dealing with his environment directly without reflection, conceptualizing and symbolizing. An abstract attitude is demonstrated by a person when he mentally leaves the immediate stimuli and, with the use of symbols, forms concepts and generalizations about an experience. Poor readers in Burk's study scored high on Block Design, Comprehension and Picture Arrangement which, he maintains, calls for less abstract behavior than is needed for the other subtests of the scale. These three subtests are less abstract because the stimuli remain immediately available. On the other hand, Arithmetic, Coding and Information, the three lowest subtests among the disabled readers, rely on memory functions for a stimulus which is not immediately available and call for abstract behavior. Poor readers, consequently, approach learning situations in a more concrete manner than do normal readers and do poorly because reading involves abstractions strongly depending upon memory. While Burks' sample size was small, making generalizations tenuous, defining the subtest patterns according to concrete and abstract is interesting.

Altus (1956) sought to locate a distinctive subtest pattern among 25 disabled readers. The poor readers, ranging between third and eighth grade, scored lowest on Arithmetic, Coding, and Information which is consistent with both Graham and Burks' findings. The consistency of the findings suggests a typical profile for disabled readers although the number of cases was small. The investigation mixed Wechsler-Bellevue I and Wechsler-Bellevue II tests in with the WISC and failed to indicate the statistical significance of his comparisons.

Sheldon and Garton (1959), whose purpose it was to check and supplement the study of Altus made three years earlier, used eleven children with known reading handicaps in an experimental group and a second sample of children matched on the variables of age and sex as a control group. Their study differed from that of Altus in two respects: 1) the addition of control groups, and 2) the use of deviation scores rather than average scaled score. Nevertheless, Sheldon and Garton substantiated Altus' original research indicating Arithmetic, Digit Span and Coding as the lowest subtests among the subtests of disabled readers.

Spache (1957) also noted Arithmetic, Coding and Digit Span the lowest subtests among the subtest performance of disabled readers. Spache was actually more concerned with the difference between the Verbal and Performance scale. Marked differences appeared between the Verbal and Performance scores with two-thirds of Spache's retarded readers distinctly inferior on the Verbal scale. He proposes that if the differences reflect native ability to deal with non-verbal tasks, the language inferiority may act as a predisposing factor in reading disability. On the other hand, the greater development of non-



verbal abilities may represent the disabled reader's compensatory efforts to find recognition in another field of effort. According to Spache, there is evidence in his study that children who do poorly in reading offer resistance to reading. This is evidenced in their subtest scatter in that poor readers show better social than formal learning. Having failed in a linguistic area, cites Spache, the poor reader tries to achieve success and recognition first by developing a superficial, verbalistic social adjustment and secondly, by increasing their efforts in non-linguistic areas. Underneath the facade of social conformity is a core of resentment of failure expressed in resistance to the academic demands of parents and school. This is an interesting and highly speculative interpretation of subtest scatter which possesses some intuitive bases. It opposes the typical search for an elusive underlying cognitive basis for reading disability and seeks, instead, to interpret scatter cognitively and affectively. Huelsman (1970) suggests that Spache's study may well have been the first to indicate subclassifications of reading disability based on verbal-performance differences. It appears, also, that Spache considers language inferiority critical in explaining reading disability. While one cannot deny the importance of language in school learning, it is the position of this study that language ability, verbal comprehension in particular, may be afforded too much credit in explaining reading disability in the early years. Research cited earlier (Strickland, 1962) suggests that, within the normal range, there is no significant relationship between oral language and reading achievement in the primary grades.

By the end of the 1950's research had clearly established that retarded readers, on the average, score poorly on the subtests Arithmetic,

Coding, and Digit Span. These same students, on the other hand, tend to earn higher scores on Block Design and Object Assembly. With the exception of Spache (1957) and Burks and Bruce (1955), the characteristic pattern demonstrated by disabled readers was established with unimaginative clarity. Subtest pattern research in the sixties evidenced more imaginative research efforts. Hirst (1960), for example, used a two dimensional chart combining deviation from the national mean for the subtest (10) on one dimension and from the child's own mean on the other dimension. Secondly, Hirst investigated the subtest differences between the severely and mildly retarded readers. Unfortunately for Hirst, her additional efforts were not particularly productive. She contributed little new knowledge. Only the subtest Object Assembly was differentially sensitive to the performance of mildly and severely retarded readers. The severely retarded reader scored much higher on this subtest than the mildly retarded reader. Generally, the pattern was the same as reported in earlier studies: high Picture Completion and Picture Arrangement and possibly Block Design and Object Assembly, and low Digit Span, Coding and Arithmetic. Hirst notes that since the two-dimensional approach provides a dual reference for judging the extent of deviation on subtest scores, greater confidence can be attributed to the nature and significance of the subtest pattern.

Trying to overcome the tendency toward small sample size evidenced in many of the earlier studies, Neville (1961) compared the subtest patterns of the WISC of male retarded readers with male normal readers. Thirty-five matched pairs of male readers were studied. When these two groups were analyzed, Information, Arithmetic and Digit Span were low, and Block Design and Picture Arrangement were high. Like Spache,

Neville notes that the low scores appear to be related to school tasks and high scores to non-formal learning tasks clearly removed from verbal skill. Neville was the first investigator to at least recognize a factor analysis of the WISC. He used Cohen's 1959 five-factor analysis to attach definitions to low subtest patterns, but he does not include any part of the factor analysis in his investigation. Neville notes, additionally, that poor readers are weak in some areas of the WISC because of their poor reading and not because they are inherently less endowed in some areas. Furthermore, Neville advocates non-verbal approaches with these children, utilizing mostly kinesthetic and visual methods of instruction. However, non-verbal, kinesthetic approaches are useful not because of their inherent value as a reading methodology, but because they are particularly successful in controlling attention and distractibility.

The question of whether the intellectual functioning of mildly retarded readers and severely retarded readers would be significantly different was first raised in a study by Sawyer (1965) who reasoned that a difference would exist even though the group was limited to those whose full-scale IQ was between 90 and 119. A statistical comparison of the Wechsler subtests using Fisher's Discriminant Function indicated that, for the total group, the first four variables in descending order of influence were Arithmetic, Digit Span, Comprehension, and Vocabulary. When only boys were considered, the order of influence, as determined by the size of the discriminant function coefficient, was Digit Span, Arithmetic, Vocabulary, Picture Completion, Object Assembly and Comprehension. Sawyer's was one of the few studies to consider a difference in the ability of the subtests of the Wechsler

to discriminate between types of readers when various age levels are involved. When one group was classified by age, the ability of the subtests to discriminate declined in effectiveness as chronological age increased. Digit Span, for example, is consistently associated with severely disabled readers at the younger age levels, but more closely related to the mildly retarded at the older age levels. Unfortunately Sawyer did not pursue this relationship or try to explain it. The relationship that Sawyer found, but failed to capitalize on, lies at the heart of the present investigation. Subtests do lose their ability to discriminate; the important point is that they are replaced by another, more important subtest at different grade levels. Sawyer notes that her study has two implications for education. The severely retarded reader can be identified as being different from the mildly disabled reader. Additionally, the ability of the WISC to discriminate at the younger ages makes it useful for early identification of children who may be severely disabled readers potentially. However, the lower chronological age limit of Sawyer's sample was age eight, an age which, for most disabled readers, would be beyond the age where early identification is appropriate. She is correct in assuming that the progress made by the severely disabled, as they grow chronologically, indicates that as a group they do not improve appreciably in skill development in spite of their capacity to learn. She is correct, additionally, in stating that a different kind of learning situation is needed for these students. What is needed is a test which would accurately discriminate between able and disabled readers at the lower age ranges.

Kallos, Grabow and Gaurino (1961), while confirming a consistency in patterns of disabled readers, raised a further question as to

whether disabled readers evidence differing subtest patterns within high, average, and low IQ ranges. Paterra (1963) considered subtest pattern differences along both age and IQ dimensions. Her results indicate that retarded readers within the average and superior ranges have above average verbal reasoning ability, verbal comprehension, and the ability to differentiate essential from non-essential details. Disabled readers with higher verbal IQs show greater variability than those with higher performance IQ. Paterra's study points toward changes with age and toward verbal-performance IQ differences as a means of sub-classification, a point made by Spache. The particular subtest patterns demonstrated by disabled readers with differing levels of intelligence was also studied by Bush and Mattson (1973). Bright and gifted under-achievers were compared with bright and gifted achievers. A comparison was also made of normal-level underachievers with normal-level readers. The normal-level achievers and underachievers were found to show significant differences on the following subtests: Information, Digit Span, and Arithmetic. The bright and gifted achievers and under-achievers were found to show significant differences on the Arithmetic and Digit Span subtests. The study was in accordance with other studies which showed erratic and significant deviations in the subtest scores of Information, Arithmetic, and Digit Span. Both the normal-level readers and underachievers in this study demonstrated the same direction in the deviation of their scores, which was an overall lowered score on all subtests. Bush and Mattson (1973) noted that intellectual differences appear to account for the lowered scores rather than primary weaknesses among the underachieving groups on the subtests. In short, intellectual differences were used to describe the

variation among subtest scores and achieving and disabled readers in this study.

Subtest pattern analysis, as it relates to disabled readers and social class and adjustment, has been studied by McLean (1964), and Reid and Schoer (1966). Claiming that mental age, chronological age, socio-economic level, educational experience and emotional adjustment must be considered before drawing conclusions regarding WISC subtest scatter, McLean (1964) studied well-adjusted disabled readers, well-adjusted non-disabled readers, poorly-adjusted readers and poorly-adjusted non-disabled readers. His data indicate that disabled readers were significantly lower in Verbal IQ than Performance IQ, and that among the four groups there were no significant differences in Comprehension, Similarities, Picture Arrangement, Block Design and Object Assembly. McLean found higher scores in Picture Completion among the disabled groups; he indicated, in addition, that poorly adjusted readers have greater extremes. Reid and Schoer (1966) found that social class had a non-significant effect on the subtest pattern. It is generally assumed that the lower class child is at a somewhat greater disadvantage on certain types of test items than on others. No such interaction was evident on Reid's study.

The established pattern does not appear to be affected when disabled readers are identified by underachievement as opposed to identification according to some number of months below grade level. Coleman and Rasoff (1963) investigated the subtest patterns of 126 disabled readers and twenty overachievers. Underachievers were low in tasks involving school-type learning, concentration and memory (Information, Arithmetic, Vocabulary, Digit Span and Coding) and high on

subtests loaded with Perceptual Organization and informal learning (Comprehension, Picture Completion and Block Design). The typical subtest pattern, according to Coleman and Rasoff, was not affected by level of intelligence or degree of underachievement. Overachievers who were having academic difficulty (high Information and Vocabulary, but low Coding) showed some opposing tendencies in subtest patterns and a high degree of scatter.

Concern for a functional analysis of performance prompted Keogh (1973) to investigate patterns of WISC performance of children with serious school learning and adjustment problems. Although Keogh's study does not use able and disabled readers directly, hers is one of the few studies to use a factor approach in studying the WISC performance of children having learning problems. Although single summarizing or unitary scores provide a basis for categorization and/or placement, according to Keogh, reliance on quantitative interpretation does not direct remedial or treatment strategies for individual children. Using Cohen's (1959) WISC factor analysis which supposedly tapped three relatively independent functions, Keogh proposed that individual differences in styles of intellectual performance could be determined. Learning disordered, hyperactive, and mentally retarded boys were studied. Keogh determined that learning disabled subjects were adequate in Verbal Comprehension and Perceptual Organization abilities, their lowest scores coming on the Attention-Concentration items (Freedom from Distractibility). The learning disabled and hyperactive groups did not reflect differential scores in the Verbal or Performance scale. Yet, there were significant differences in subtest category skills. Keogh's process analysis is very close to the present

investigation. But again, while she demonstrated that learning disabled students score poorly on Freedom from Distractibility tasks, her sample covered an age range of four years; thus, the age-grade specificity question in regards to WISC factor performance is still unanswered.

The practice and efficacy of using the WISC as an indicator of the strengths and weaknesses of children with disabilities was questioned by several investigators. In an extensive study, relevant to the present investigation, Ackerman, Peters and Dykman (1971) attempted a precise analysis of the assets and liabilities of specific learning disability children (CLD) with the ultimate goal of developing diagnostic subcategories and tailoring specific programs of remediation for children with these assessed deficits. Relative to Wechsler's WISC standardization population, the CLD children were appreciably lower on the verbal scale than were the controls. However, an adequate Verbal IQ on the WISC does not assure success in school. Some 63 percent of the CLD children had Verbal IQs of 100 or higher; 27 percent scored 110 or higher on the Verbal scale. Ackerman (1971) found that the brighter the child the less apt he was to have a reading disability. No consistent differences in WISC profiles were attributable to neurological activity groupings; nor were there any characteristic WISC patterns which identified children with learning disabilities in the general school population. Some had a fifteen-point or greater difference between their Verbal and Performance IQ's. So did some academically adequate controls. Some showed greater scatter on their subtest scaled scores; so did some academically adequate controls. Ackerman (1971) concludes,



The concept of underachievement is based on the rather tenuous assumption that IQ tests (principally the WISC) measure true learning potential. Two of the largest public school systems (Los Angeles and New York City) have actually banned the use of IQ tests. Perhaps, as Wechsler argued, the action was misdirected. Perhaps not. What is needed is a highly reliable instrument (or battery of tests) for measuring scholastic aptitudes in young children along a variety of dimensions. Then educators should attempt to design a number of elementary school curriculums to allow proper placement of children with differing aptitudes (p. 47).

Huelsman (1970) reviewed over twenty studies, covering a twenty year period, which dealt with subtest patterns of disabled readers. He concluded that low Information, Arithmetic and Coding patterns do appear to characterize groups of disabled readers. However, Huelsman suggests that interpretation of low and high WISC subtest scores probably should not be restricted to the Information, Arithmetic, and Coding subtests. In fact, interpretation probably should not be restricted to underachievers, inasmuch as achievers appear to have about the same incidence of high and low subtest scores. According to Huelsman, sample differences probably account for some of the differences in conclusions among the studies reviewed. He adds, in conclusion, that research should now turn toward discovering what the differences among subtests mean rather than toward more pattern identification.

#### Factor Analytic Studies Involving the

#### WISC and WISC-R

In order to systematically investigate the intellectual domain as sampled by the Wechsler scales, several investigators factor analyzed the WISC standardization data at various age levels (Maxwell, 1959; Cohen, 1959; Bannatyne, 1971). With the exception of Bannatyne's

factor analysis of the WISC, these studies did not appear as opposition to subtest pattern analysis, but rather, as attempts to provide some insight into the process of intellectual maturation via the comparative analysis of the factorial structures at different age levels. The logical implications of the resulting factor scores are such as to suggest that these scores, since they follow definable functional unities in children, should be of greater use than either the relatively unreliable and ambiguous single subtest scores on the one hand, or the more or less a priori Verbal and Performance IQs on the other (Cohen, 1959). Cohen adds that the factor scores of a subject can be compared among themselves much as subtest scores are. The effect of such comparison is to partial out the all-pervading influence of G, resulting in differences which can be attributed to what is specific to the primary factors involved.

The labels which define a particular factor are, for the most part, tentative and hypothetical. The particular set of factors which one chooses to use is determined primarily by one's own understanding of what the component subtests measure, or by additional empirical methods. For example, Bannatyne uses "sequencing" to label the factor which includes Arithmetic, Coding and Digit Span. Cohen had originally termed this factor a memory factor, and Kaufman (1974) has named this same factor, Freedom from Distractibility.

Kaufman's factor analysis of the WISC-R was selected for use in this study for two reasons: 1) Kaufman's definition of the Factor which includes Arithmetic, Digit Span and Coding as a Freedom from Distractibility factor is both logically and theoretically correct. Support for this definition was offered in Chapter I; 2) The WISC, upon

which the other factor analytic studies are based, was replaced in 1974 by the WISC-R. The WISC-R represents a complete renorming and revision of the 1949 WISC.

Kaufman (1974) explored the factor structure of the WISC-R for the eleven age groups comprising the standardization sample. Essentially, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility factors emerged at all eleven age levels. These factors, furthermore, may be considered meaningful and clinically useful. Overall, Verbal Comprehension resembles Wechsler's Verbal Scale so closely that it easily could have been named "Verbal." Kaufman used Verbal Comprehension because it describes the theoretical ability underlying the factor in terms of both content (Verbal) and mental process (Comprehension). The label Perceptual Organization was assigned for the same reason. The Freedom from Distractibility factor was so named, by both Cohen and Kaufman, because it reflects concentration, selective attention and distractibility. According to Kaufman, the structure of the WISC-R is both consistent with, and a decided improvement over, the structure of its highly successful predecessor, the WISC.

#### Summary

It is apparent from the review of the literature that low scores on the WISC subtests Arithmetic, Coding, and Digit Span appear to characterize groups of disabled readers. Additionally, disabled readers appear to achieve their highest scores on the subtests Picture Completion, Picture Arrangement, Block Design, and Object Assembly. Mixed results are evidenced on the subtests Vocabulary, Similarities and Comprehension. The consistency of these patterns for disabled readers is

remarkable over the twenty-five year history of WISC subtest pattern research with disabled readers. What must ultimately be implied, however, is that the studies reviewed may very well be inconclusive because they have treated disabled readers as if they were a class and have not subclassified them by age or by grade. The subtest patterns obtained in the majority of studies were based on a single group of disabled readers whose chronological ages ranged from eight to sixteen years. A logical interpretation of the results, when using such a broad range of school-aged children, is that second grade disabled readers and eighth grade disabled readers may be characterized by the same deficiencies in cognitive performance. The potential for misdirected remedial and treatment strategies based on such an interpretation is great.

Interpretation of the results evidenced in the literature review is complicated further by the fact that a majority of the subtest patterns were based on clinical populations rather than on true samples of the entire population. Additionally, definitions of what actually constitutes a disability in reading vary from study to study. Generalization of results from studies that define disability as some number of months below grade level and studies that define disability as a function of potential is a difficult procedure.

Table I summarizes the subtest pattern behavior of disabled readers evidenced in the literature review. The twelve WISC-R subtests have been recategorized according to Kaufman's Factor A, B, and C. Functional differences in performance of disabled readers on the Kaufman factors are clearly illustrated in the table. The contents of Table I (L, H, X, and O) indicate whether, for a given study, the group of disabled readers studied scored high on the subtest, low on the subtest,

TABLE I  
 APPLICATION OF KAUFMAN'S FACTOR ANALYSIS  
 OF THE WISC TO PUBLISHED RESEARCH

	Graham (1952)	Flanary (1953)	Burks (1955)	Altus (1956)	Richardson (1956)	Spache (1957)	Sheldon (1959)	Hirst (1960)	Dockrell (1961)	Kallos (1961)	Neville (1961)	Coleman (1963)	Paterra (1963)	McDonald (1964)	Robeck (1964)	McLeod (1965)	Sawyer (1965)	Corwin (1967)	DeBruler (1968)	Lyle & Gozen (1969)	Huelsman (1970)	Ackerman (1971)	Keogh (1972)	Bush (1973)	
<b>A. Verbal Comprehension</b>																									
Information	L	L	L	L	L	X	L	X	L	L	L	L	X	L	L	L	L	O	L	L	L	X	O	L	
Similarities	H	L	X	X	X	X	O	X	X	O	X	O	X	X	H	H	H	O	X	X	X	H	O	X	
Vocabulary	L	L	X	X	L	X	L	X	L	O	X	L	L	X	H	L	L	O	L	X	X	X	O	L	
Comprehension	H	L	H	X	X	X	L	X	X	O	X	H	H	X	H	H	L	H	X	H	X	X	O	X	
<b>B. Perceptual Organization</b>																									
Picture Completion	H	X	H	H	H	H	O	H	H	O	X	H	H	H	H	H	H	O	H	X	X	X	O	X	
Picture Arrangement	H	L	H	X	H	H	O	H	H	O	H	O	X	H	X	L	H	O	X	H	X	X	O	H	
Block Design	H	X	H	X	X	X	O	X	H	H	H	H	X	H	H	H	H	O	X	H	X	X	O	X	
Object Assembly	H	X	X	X	H	H	O	X	X	O	X	O	X	H	X	H	X	O	X	X	H	X	O	X	
Mazes	O	X	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	O	X	X	O	O
<b>C. Freedom from Distractibility</b>																									
Arithmetic	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	O	L	L	L	L	L	
Digit Span	L	L	L	X	X	X	O	L	X	O	L	L	X	L	L	L	L	O	O	O	L	O	L	L	
Coding	L	L	L	L	L	L	L	L	L	L	X	L	X	L	L	L	L	L	L	L	O	L	L	O	

L = Low  
 H = High  
 X = No Difference  
 O = Not Given

whether there was no difference in relation to the other subtests, or whether the results of a given subtest were reported. The comparisons represent intra-profile differences and not comparisons with able readers.

Table II indicates many of the design weaknesses evidenced in the studies cited in the literature review. Huelsman (1970) suggests that research be directed toward discovering the possible significance of low subtest scores rather than toward pattern identification. The present study, by recategorizing the WISC-R subtests and subgrouping disabled readers by grade, intends to discover the possible significance of low subtest scores and increase the usefulness of the WISC-R in the psycho-educational evaluation.

TABLE II

CRITERIA FOR JUDGING RESEARCH ON THE WISC SUBTEST  
PERFORMANCE OF RETARDED READERS

	Graham (1952)	Flanary (1953)	Burks & Bruce (1955)	Altus (1956)	Sheldon (1959)	Spache (1957)	Dockrell (1960)	Hirst (1960)	Kallos (1961)	Neville (1961)	Pattera (1963)	Sawyer (1965)	McDonald (1964)	McLeod (1965)	Reid (1966)
Sample Size	*96	110	42	25	11	100	34	30	37	70	33	180	60	293	87
Age Specificity	No	Yes	No	No	No	No	No	No	No	No	No	Yes	Yes	No	No
Criterion Test	WRAT	NA	WRAT	NA	NA	NA	Grey Oral	Chicago Silent	Durrell Word Analysis	Florida Reading Scales	NA	NA	NA	NA	NA
Normals	No	Yes	Yes	No	Yes	No	No	No	No	Yes	No	No	No	Yes	No
Grade Specificity	No	No	No	No	No	No	No	No	No	No	No	No	No	No	No
Clinic Sample	X	NA				X	X	X	X	X		X		X	
School Sample		NA	X	X	X						X				X

\*Included WISC and Wechsler Bellevue

## CHAPTER III

### DESIGN AND METHODOLOGY

#### Introduction

Literature cited in the preceding chapters has established the need and basis for the investigation of developmental trends on the three Kaufman factors with able and disabled readers. This chapter describes the research methodology employed in the present study, including a description of the subjects, procedures, and statistical analysis.

#### Subjects and Procedures

The investigation was conducted during the spring semester of 1978. The subjects for this study were drawn from four elementary schools in three different counties in north-central Oklahoma. The schools were chosen for reasons of proximity to Stillwater, Oklahoma. Demographic records indicate that approximately three percent of the population sampled is Black, approximately five percent is Native American and the other extraction, and the remaining ninety-two percent is caucasian. In all, 466 elementary school pupils, from the four schools included in the study, were screened with the Lorge-Thorndike Non-Verbal Intelligence Test and the Gates-MacGinitie Reading Comprehension Tests. From this number, samples were drawn which consisted of 60 pupils at each of the three different grade levels: a group of



thirty disabled readers at second, fourth, and sixth grade, and a group of thirty able readers at second, fourth, and sixth grade. In all, 180 elementary students were used in this investigation. Able readers who met the selection criterion were randomly drawn for the sample according to grade level. Disabled readers who met the selective criteria were included in the study, as they were identified, until the cutoff of 30 per grade was obtained. The number of disabled readers was such that all who met the criteria were used.

The following criteria were met by all students included as subjects for the sample population of this study.

1. All students fell within the average age range for grade placement at mid-year as determined by the State of Oklahoma. Pupils who had repeated a grade or who, for some reason or another, were older than the average for a particular grade were not included in the study.
2. All students were currently functioning within the range of average or above intelligence on a standardized test of non-verbal intelligence. Only those students with deviation IQ scores of 85 or above on the non-verbal form of the Lorge-Thorndike Intelligence Test were included in the study.
3. All students were informally observed as being free of gross mental, physical, or emotional handicaps which might interfere with the learning process.
4. All students were from a monolingual language background. Only those students whose primary home language was English were included in the study so as not to confound reading

disability with other disabling conditions. The study included one Black child at grade two, and one Native American at grade four. All others were white, middle-class children.

5. Teacher judgment was sought regarding the classification of each of the 180 pupils in the study. If teacher judgment differed in regards to a student's group assignment, the student was replaced in the sample. A total of four pupils were replaced.
6. Using a standardized test of silent reading ability, reading achievement of all students was determined to be within the following defined ranges for group inclusion: able readers were defined as reading at or above their expectancy level as determined by the Bond and Tinker formula. Disabled readers were defined as reading .5 of a year or more below expectancy at grade two, .8 of a year or more below expectancy at grade four, and 1.2 years or more below expectancy at grade six (Wilson, 1976). Expectancy for each pupil was determined by the Bond and Tinker (1957) formula:

$$\text{Years in School} \times \text{IQ}/100 + 1$$

7. Parental permission was obtained for the testing.
8. All students completed all tests included in the battery.

#### Testing Procedures

The following tests were administered in this sequence by qualified, trained examiners, to the sample population between the dates of February 20, 1978, and April 22, 1978:

1. Lorge-Thorndike Intelligence Tests, Nonverbal Series, levels 2 and 3, Irving Lorge and Robert L. Thorndike, 1957.
2. Gates-MacGinnitie Reading Test, Primary B, and Survey D, Arthur I. Gates and Walter H. MacGinnitie, 1972 (1965).
3. Wechsler Intelligence Scale for Children-Revised, Verbal and Performance Scales, 12 subtests, David Wechsler, 1974.

All group tests were administered to the students during the regular school day at an hour determined by the school's administrator. For the individually administered test, the Wechsler Intelligence Scale for Children-Revised, the children were removed from the classroom. These tests were administered in rooms relatively free from distractions by trained, qualified examiners. The students were informed of the nature and purpose of the testing and assured of the confidentiality of their scores. Strict adherence to standardized directions and procedure was followed.

#### Test Instruments

##### Lorge-Thorndike Intelligence Tests

##### Nonverbal Series, Level 2 and 3

This test was used as both a screening instrument for the sample selection and as a source for determining reading expectancy. The nonverbal series yields an estimate of scholastic aptitude independent of the ability to read. The nonverbal series is entirely pictorial, diagrammatic, or numerical.

The test was normed on a stratified sample of communities throughout the nation consisting of over 136,000 children. The concurrent validity of the nonverbal battery with other group intelligence tests is reported to be .84.

#### Gates-MacGinnitie Reading Tests

##### Primary B and Survey D Levels

The Gates-MacGinnitie is a standardized group test which measures three aspects of silent reading ability: comprehension, speed and accuracy, and vocabulary. The comprehension test was selected as a criterion measure of the student's ability to read and understand complete prose passages. It was used to identify the reading level of the students used in the study by comparing their reading level with expectancy. The comprehension test contains twenty-one passages of increasing difficulty in which 52 response spaces have been provided. For each blank the student must choose one of five answers provided to best complete the meaning of the whole passage.

The validity of this test is based on the content of the typical school curriculum. The authors cite a study by Davis (1968) which reports concurrent validity coefficients for the correlation of Survey D with four other standardized reading tests. The median coefficient was .80 for the comprehension test.

The Gates-MacGinnitie Reading Tests were standardized on a nationwide sample of approximately 40,000 students in 37 communities. Each student who participated in the standardization first took one form of the reading test designed for his own grade and then either another form of the same test or one form of the test designed for the grade

above or below his own. In this way an extensive grade norm subsample of two-thirds of the standardization sample was established.

Wechsler Intelligence Scale for  
Children-Revised (WISC-R)

The WISC-R is a much respected individual intelligence test designed for ages 6-0 to 16-11 years. It consists of twelve subtests which are combined into two sub-scales to yield three measures of intelligence: verbal, performance, and full-scale. The WISC-R is a revision and complete restandardization of the 1949 WISC. The standardization sample, based on the 1970 census, included a stratified sample of over 2,200 cases throughout the nation.

The total WISC-R battery (12 subtests) was administered individually to all 180 public school sample children in the order presented by the manual of directions.

Information. This subtest is basically a measure to determine how much general information the subject has abstracted from his surrounding environment. The student responds orally to questions, factual in nature, read to him by the examiner.

Similarities. This subtest is composed of 17 pairs of words which require the identification of likeness between objects, substances, facts or ideas. The subtest measures remote memory, concept formation and the ability to see associational relationships. It also assesses logical and abstract thinking and the individual's ability to verbalize generalizations.

Vocabulary. The vocabulary subtest of the WISC-R consists of 32 words, to be defined, arranged in order of increasing difficulty. It measures the individual's oral language vocabulary and word knowledge acquired from experience and education. It also reflects one's ability to understand and use the language.

Arithmetic. This subtest is designed to measure the child's ability to utilize abstract concepts of number and numerical operations by having one compute simple mathematical problems without pencil and paper.

Comprehension. This subtest presents seventeen questions which involve common sense, reasoning and moral judgment. It measures the individual's ability to utilize practical knowledge and judgment in social situations and reflects his knowledge of conventional standards of behavior.

Digit Span. This subtest requires the student to repeat a series of digits stated by the examiner. It is designed to measure one's immediate or sequential auditory memory.

Picture Completion. This test is designed to measure the individual's ability to separate essential from non-essential characteristics of visually presented material. The child is presented a picture and asked what part is missing.

Picture Arrangement. Picture Arrangement requires the child to rearrange an increasing number of picture-story cards to make a sensible story. The test is designed to measure one's ability to

sequentially arrange pictures of social events. The synthesis of parts into an intelligible whole is involved in this test.

Block Design. This test is designed to measure the perception, analysis, synthesis and reproduction of abstract designs. The subject is presented with a stimulus of card designs and is required to match a block design to the card design.

Object Assembly. This subtest presents four familiar but increasingly difficult puzzle items for the subject to assemble. It measures one's ability with simple assembly tasks and one's ability to synthesize parts into recognizable wholes.

Coding. Coding is a symbol-copying task which measures visual-motor dexterity and associative learning as well as speed and accuracy in making these associations.

Mazes. This subtest is designed to measure the child's use of planning and foresight in addition to visual-motor coordination and speed and accuracy by presenting the child with increasingly complex mazes to solve.

#### Kaufman's Three Factors of the WISC-R

Each of the twelve subtests of the WISC-R are used in determining Kaufman's three factors. The raw scores for each subtest are converted to a scaled score which ranges in value from one to twenty. A scaled score of ten on the WISC-R represents an average score. A factor score is determined by summing the scaled scores for each subtest comprising

a particular factor and then dividing by the number of subtests. For each of the 180 pupils in this study, a single factor score was obtained by the following procedure:

Verbal Comprehension: For each pupil in this study, the single factor score for Factor A, Verbal Comprehension, was obtained by summing the scaled scores for Information, Similarities, Vocabulary, and Comprehension and dividing this sum by four.

Perceptual Organization: For each pupil in this study, the single factor score for Factor B, Perceptual Organization, was obtained by summing the scaled scores for Picture Completion, Picture Arrangement, Block Design, Object Assembly, and Mazes and dividing this sum by five.

Freedom from Distractibility: For each pupil in this study, the single factor score for Factor C, Freedom from Distractibility, was obtained by summing the scaled scores for Arithmetic, Coding and Digit Span and dividing this sum by three.

#### Statistical Analysis

Each of the statistical analyses which follows utilized the Statistical Package for the Social Sciences computer programs (SPSS). Analyses were conducted at the Oklahoma State University Computer Center on an IBM System 370/158 computer.

Independent samples t-tests were conducted to test the difference between the means of able and disabled readers on Verbal Comprehension, Perceptual Organization, Freedom from Distractibility, Lorge-Thorndike IQ, and WISC-R Full Scale IQ. The following formula was applied to



determine whether significant differences exist between able readers and disabled readers on these variables.

$$t = \frac{\bar{X}_1 - \bar{X}_2}{\sqrt{\frac{n_1 s_1^2 + n_2 s_2^2}{n_1 + n_2 - 2} \left( \frac{1}{n_1} + \frac{1}{n_2} \right)}}$$

Two-group discriminant function analysis was used to determine whether or not group membership could be predicted on the basis of the three Kaufman factors. The objective of discriminant function analysis is to weight and linearly combine the discriminating variables which leads to a single dimension upon which able and disabled readers differ at each of the three grade levels. The discriminant function is of the form

$$D_i = d_{i1}Z_1 + d_{i2}Z_2 + \dots + d_{ip}Z_p \quad (i = 1, \dots, k-1)$$

where  $k$  is the number of groups for the discriminant analysis,  $D_i$  is the score on discriminant function  $i$ , the  $d$ 's are weighting coefficients, and the  $Z$ 's are the standardized values of the  $p$  discriminating variables used in the analysis.

A stepwise selection method was utilized where independent variables are selected for entry into the analysis on the basis of their discriminating power. A multivariate statistic, Wilks' lambda (Overall and Klett, 1972), was used as the selection criterion for the stepwise procedure. Wilks' lambda may be conceived of as the ratio of the within groups error variance to the total variance. Lambda can be evaluated for significance using the chi-square statistic for  $(k - 1)p$

degrees of freedom, where  $k$  is the number of groups and  $p$  is the number of variables. The variable which maximizes the overall multivariate  $F$  ratio for the test of differences between the group centroids also minimizes Wilks' lambda, a measure of group discrimination. The variable initially selected is then paired with each of the other available variables one at a time and the selection criterion is computed. Additionally, the stepwise procedure does not include variables in the analysis which do not provide improvement in discrimination between the groups.

## CHAPTER IV

### STATISTICAL ANALYSIS

#### Introduction

This investigation was concerned with the possibility of inferring an individual's reader type from multivariate data. The scores for differences between actual achievement and expected achievement were dichotomized into able and disabled reader types; the predictor variables included the Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility factors derived from the twelve subtests of the Wechsler Intelligence Scale for Children-Revised (Kaufman, 1975). This chapter contains a detailed account of the statistical treatment of the data, the analysis of the results, and the extent to which the various hypotheses were supported. The chapter is divided into two major sections: the first section contains the descriptive statistics of the preliminary analysis; the second section discusses several post-hoc analyses which were applied to the data after the research questions of the main study had been answered, and an explanation of the discriminant equation and classification coefficients.

#### The Main Study

##### Preliminary Analysis

Before discriminant functions are generated for a set of variables

it must first be determined if the two reader types do differ significantly on the three predictor variables used in this investigation. This is essentially a test of the equality of the group means of able and disabled readers on each of several independent variables and, in the two group cases, is typically measured by the t-test statistic. The independent samples t-test was used to test the equality of the group means. T-tests were conducted between the mean scores of Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility for the two reader types at grades two, four, and six. If these variables do not differentiate between able and disabled readers at grades two, four, and six, the construction of discriminant functions is not worthwhile. The composite results of these tests are reported in Table III. The null hypotheses of concern and the results bearing on the null hypotheses are presented below.

Null Hypothesis I: There are no significant differences at grade two between the means of able and disabled readers on (1) Verbal Comprehension, (2) Perceptual Organization and, (3) Freedom from Distractibility.

Null Hypothesis II: There are no significant differences at grade four between the means of able and disabled readers on (1) Verbal Comprehension, (2) Perceptual Organization and, (3) Freedom from Distractibility.

Null Hypothesis III: There are no significant differences at grade six between the means of able and disabled readers on (1) Verbal Comprehension, (2) Perceptual Organization and, (3) Freedom from Distractibility.

TABLE III  
 COMPOSITE T-TEST RESULTS FOR READER TYPE AND PREDICTOR  
 VARIABLES AT GRADES TWO, FOUR AND SIX

V	Type	$\bar{X}$	Grade 2 sd	t	$\bar{X}$	Grade 4 sd	t	$\bar{X}$	Grade 6 sd	t
LIQ	A	107.533	11.563	2.18*	114.466	9.558	3.84**	111.833	8.797	3.64**
	D	100.400	7.722		104.166	11.151		103.400	9.133	
GRS	A	28.366	3.200	19.71**	39.733	4.234	16.47**	46.400	3.081	10.69**
	D	11.333	3.487		18.733	5.552		28.566	8.601	
VC	A	11.300	2.132	3.61**	11.675	1.980	4.56**	11.433	2.092	4.45**
	D	9.667	1.296		9.575	1.565		9.283	1.601	
PO	A	11.440	1.528	3.13*	11.386	1.235	2.58*	11.466	1.281	2.98*
	D	10.200	1.537		10.435	1.550		10.373	1.546	
FD	A	10.455	1.664	4.14**	10.477	1.243	3.66**	10.755	1.904	4.01**
	D	8.622	1.768		8.944	1.928		8.966	1.530	

\* p < .01  
 \*\* p < .001  
 df = 58

As Table III indicates, the two-tailed probability of obtaining, by chance,  $t$ -values equal to or greater than those reported is .01 and .001 in all cases. The three Kaufman factors, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility, do discriminate between able and disabled readers at grades two, four, and six. The null hypotheses of concern, that there are no differences between the group means across variables at grades two, four, and six, are not supported. Additionally, inspection of the direction of the differences in group means on each of the three Kaufman factors indicate that disabled readers tend to score lower on each of the three Kaufman factors at each grade level than do able readers. Able readers score higher on each of the three factors at each grade level. As Table III indicates, the difference between the LIQ (Lorge-Thorndike IQ) means for able and disabled readers was greater than would be expected by chance.

An initial assumption of this investigation, however, was that able and disabled readers, as defined in Chapter I, do not differ in intelligence. The intent was to determine reader type from a student's difference score; i.e., the difference between a student's actual reading achievement score, as measured by the Gates-MacGinnitie Reading Test, and that same student's expected achievement score as determined by the Bond and Tinker formula described in Chapter III. Essentially, this difference represented reading (over and underachievement) with the influence of IQ, as measured by a non-verbal instrument, removed. On this basis, it was assumed that two students might have vastly different intelligence quotients, say 120 and 85, and yet be assigned to the same group. Reader type (group membership), then, was assumed to

be dependent upon difference scores and was not expected to be related to intelligence. The failure of the data to confirm this assumption leads one to question the validity of the Bond and Tinker formula for predicting achievement scores when applied to the groups of students used in this study.

The validity (quality) of the Bond and Tinker formula is determined by how well it predicts reading; i.e., the validity of the Bond and Tinker formula is represented as  $(r_{GM.BTex})$ , where GM is the Gates-MacGinnitie reading score and BTex is the Bond and Tinker expectancy score. Given that the Bond and Tinker formula is a linear function of LIQ, the data necessary to test this validity was available in the present study. In the population the Bond and Tinker formula cannot be expected to predict reading achievement, as measured by the Gates-MacGinnitie, with any greater accuracy than the LIQ can predict the Gates-MacGinnitie score. In fact, the Bond and Tinker formula should not be expected to predict (i.e., account for the Gates-MacGinnitie variance) in the present sample of students any better than would a simple linear regression of Gates-MacGinnitie on LIQ determined on one sample when applied to another sample. How well a simple linear regression determined on one sample will predict, when applied to another sample, may be estimated by use of the Wherry shrinkage formula (Lord and Novick, 1968).

Table IV presents, for each grade level, a set of correlation coefficients which indicate the relationship between the Gates-MacGinnitie raw score (GRS) and Bond and Tinker expectancy, between Gates-MacGinnitie raw score and Lorge-Thorndike IQ (LIQ), WISC-R Full Scale IQ and difference scores, and the shrinkage, or estimated

correlation, between LIQ and Gates-MacGinnitie reading score. The validity of the Bond and Tinker formula for use in producing difference scores was tested by examining the difference between the expectancy and Gates-MacGinnitie correlations and the Wherry estimated correlations. Since these were of nearly equal magnitude, it was concluded that the Bond and Tinker formula was as valid for predicting reading scores (expectancies) as least-squares linear regressions on a sample of 60 would have been. It is interesting to note, additionally, that WISC-R full scale scores correlate with the difference scores.

As the coefficients in Table IV indicate, the Bond and Tinker reading expectancy formula does as well in determining the difference scores of the subjects in this investigation as a prediction equation would do when applied to another group. This is evidenced by the similarity between the estimated  $r$  and the  $r$  for LIQ and GRS. Theoretically, when the Bond and Tinker formula is used with another group of students, one cannot have complete confidence that it will work successfully in determining difference scores; it will be less accurate. This shrinkage is due to the fact that the new group of students is not identical to the students used in this study. Table IV clearly indicates that the difference formula works for people other than those in this study. The direction of the differences evidenced at grades two and four between expectancy and GRS, and LIQ and GRS, is unusual because, theoretically, it is impossible for expectancy (which is a function of IQ) to be greater than the population value based on IQ alone. Rounding errors can partially explain these differences as can restriction of the range when using the Bond and Tinker formula. The expectancy



formula is most successful in predicting a grade score when used with students whose intelligence quotients fall within the range of 90 to 110.

TABLE IV  
RESULTS OF CORRELATION BETWEEN ACTUAL READING  
SCORE AND LIQ, EXPECTANCY AND ACTUAL READING  
SCORE AND FULL SCALE IQ AND DIFFERENCE  
SCORE

Grade	Expectancy and GRS	LIQ and GRS	FSIQ and Diff. Score	Shrinkage, Estimated r
2	.39	.37	.53	.35
4	.58	.57	.55	.56
6	.51	.60	.58	.59

Essentially, the Bond and Tinker formula is good for determining difference scores when the Lorge-Thorndike Non-Verbal IQ Test is used. However, it is not perfect as evidenced by the correlation of .53, .55, and .58 between Full Scale IQ and the expectancy or difference score. The correlation coefficients in column four of Table IV indicate that the Kaufman factors and/or Full Scale IQ carry more information about reading achievement than does Lorge-Thorndike Non-Verbal Intelligence. There is more, yet unidentified, information contained in Full Scale intelligence which this study seeks to define.

## The Two-Group Discriminant

### Function Analysis

A central question in this study was: Do the three Kaufman factors discriminate between the two groups of students: able readers and disabled readers? T-tests of the equality of the means of the groups on the three Kaufman factors led to rejection of the hypotheses of no difference at a high level of statistical significance. The question now arises as to which of these variables is the most sensitive and best able to differentiate between the two types of readers. With what degree of accuracy can group membership be predicted? Does the importance or contributory power of a variable change from grade to grade? The null hypotheses of concern and the results bearing on the hypotheses are presented below.

Null Hypothesis IV:                   The discriminant function prediction equation is no more accurate in predicting group membership at grade two than would be possible by chance alone.

Null Hypothesis V:                   The discriminant function prediction equation is no more accurate in predicting group membership at grade four than would be possible by chance alone.

Null Hypothesis VI:                  The discriminant function prediction equation is no more accurate in predicting group membership at grade six than would be possible by chance alone.

Three separate, within-grade, two-group discriminant function analyses were performed to determine whether or not group membership

could be predicted on the basis of the three Kaufman factors. The objective of discriminant analysis is to weight and linearly combine the discriminating variables to produce a single dimension upon which the two reader types differ. In other words, at each grade level, we want to discriminate between the two groups in the sense of being able to tell them apart. At each grade level, two, four, and six, variables were selected for inclusion into the discriminant function by a stepwise selection procedure which selects variables on the basis of their discriminating power. Essentially, the stepwise process begins by choosing the single variable which has the highest value on the selection criterion. Wilks' lambda (Overall and Klett, 1972) was used as the stepwise selection criterion in this study.

Table V presents the results of the stepwise selection procedure for grades two, four, and six. Reported in the table are Wilks' lambda, an inverse measure of the discriminating power in the original variables which has not yet been removed by the discriminant function--the larger lambda is, the less information remaining; chi-square which provides the test of significance of the discriminant function, and Rao's V, a generalized measure of distance between the group centroids. In the stepwise procedure, the variable selected, from those variables not yet included in the discriminant function, is the one which contributes the largest increase in Rao's V when added to the previous variables.

#### Grade Two

The results of the stepwise selection procedure shown in Table V indicate that only two of the original three variables were selected for inclusion into the discriminant function for grade two. Freedom

TABLE V  
 DISCRIMINATING POWER OF DISCRIMINANT FUNCTIONS  
 BY GRADE: WILKS' LAMBDA, CHI-SQUARE,  
 RAO'S V

Grade	Variable	Wilks'	Chi Square <sup>1</sup>	Rao's V	Sig. of Change in Rao's V
2	FD	.77209		17.10713	.000
	VC	.71010	19.516*	23.66910	.010
4	VC	.73626		20.77678	.000
	PO	.69636	20.625*	25.27933	.034
6	VC	.74599		19.79036	.000
	PO	.69328		25.65118	.015
	FD	.65903	23.550*	29.97287	.038

\*  $p < .001$

<sup>1</sup> Chi-squares reported are those used to test significance of the two or three variable discriminant function.

from Distractibility was selected first as the variable having the most information contributing to group differences at grade two. The addition of the information possessed by Verbal Comprehension adds significantly to the discriminant function at the .01 level of probability. The two factors, Freedom from Distractibility and Verbal Comprehension, produced a significant degree of separation between the groups. After the discriminant function for grade two had been derived, Wilks' lambda was .71010. Lambda was transformed into a chi-square statistic for a test of statistical significance. The obtained  $X^2 = 19.516$ ,  $df = 2$ , was significant at the .01 level of probability. Additionally, it can be seen that the information carried by Perceptual Organization was not enough to contribute to further discrimination between the able and

disabled readers at grade two. Its inclusion into the equation would not have been useful. Although it was determined earlier that Perceptual Organization differentiated significantly between the groups, given the variables already selected in the stepwise procedure, Perceptual Organization did not contribute significantly to group separation.

#### Grade Four

At grade four, Verbal Comprehension was selected as the variable containing the information most useful for group separation. After inclusion of Verbal Comprehension, information regarding one's Freedom from Distractibility contributed to the function at a .034 level of significance. After the function had been determined for grade four, Wilks lambda was .69636. The obtained chi-square = 20.625,  $df = 2$ , and a probability level less than .001. The information possessed by Perceptual Organization would not have generated any additional discriminatory power to the function at grade four given the discriminating power of the variables already selected.

#### Grade Six

All three eligible variables were selected for inclusion into the discriminant function at grade six. Verbal Comprehension was selected as containing the information most useful for group separation, with Freedom from Distractibility contributing at a .015 level of significance and Perceptual Organization contributing at a .038 significance level. The Wilks' lambda of .65903 corresponds to a chi-square of 23.550,  $df = 3$ , and a probability level of less than .001.

The hypotheses of concern predicted that the discriminant function equation would be no more accurate in predicting group membership than would be expected by chance. Support for accepting these hypotheses was not obtained.

The present study created two groups of equal number at each of three grade levels. Classification probabilities for the cases in the study were assumed to be equal. With a dichotomous criterion variable, then, chance could predict group membership accurately 50 percent of the time. The results reported in Table V lend support to the power and significance of the discriminant function. Further support for the rejection of hypotheses set II is indicated in Table VI which reports the accuracy of the discriminant function in classifying students of known group membership. As Table VI indicates, the discriminant functions calculated for grades two, four, and six can correctly classify and assign group membership with accuracy ranging from 73.33% at grades two and six, to 75% at grade four. The classification routine correctly identifies from 73% to 75% of the cases in this study as members of the group to which they actually belong. This is substantially better than the 50 percent accuracy that would be expected by chance.

Further information regarding group differences can be derived from study of the group centroids. A group centroid represents the mean of all the discriminant scores for a particular group (reader type) at each grade level. Group centroids are reported in Table VII by grade and reader type. The group centroids presented in Table VII serve an important function in discriminant analysis. While various rules of classification have been proposed, the notion of "distance" comes into play in most of them; that is, an individual is assigned to

TABLE VI

CLASSIFICATION RESULTS BY READER TYPE FOR  
GRADES TWO, FOUR, AND SIX

Grade	Type	Actual Group	N of Cases	Predicted Group		Percent of Grouped Cases Correctly Classified
				Able Reader	Disabled Reader	
2	Able	A	30	20 66.7%	10 33.3%	73.33%
	Disabled	D	30	6 20.0%	24 80.0%	
4	Able	A	30	23 76.7%	7 23.3%	75.00%
	Disabled	D	30	8 26.7%	22 73.3%	
6	Able	A	30	20 66.7%	10 33.3%	73.33%
	Disabled	D	30	6 20.0%	24 80.0%	

that group whose centroid is closest to the data-point representing him. "Closeness" is usually measured by a probabilistic notion of "distance."

TABLE VII  
CENTROIDS OF GROUPS IN REDUCED  
DISCRIMINANT SPACE

Grade	Group	Centroid
2	Able	.53381
	Disabled	-.53379
4	Able	.54633
	Disabled	-.54631
6	Able	.57877
	Disabled	-.57873

The centroid score .55381 represents the mean discriminant score of all second grade able readers in the sample; the centroid score -.53379 represents the mean discriminant score of all second grade disabled readers in the sample. The group centroid is the most typical location of a case from that group in the discriminant function space. A comparison of the group centroids on a particular function indicates how far apart the groups are along that dimension. Given that zero represents the grand mean of all the classified cases for a particular grade level, analysis of Table VII indicates that able readers and disabled readers have clearly been separated by the discriminant function.



The results of the stepwise variable selection procedure which produced a set of variables for inclusion into the discriminant function at each grade level have already been reported. The standardized and unstandardized discriminant coefficients are reported in Table VIII. Analysis of Table VIII provides the answer to a third research question which is central to this study: Do the variables which have been found to discriminate between able and disabled readers do so consistently across the grades?

TABLE VIII  
STANDARDIZED AND UNSTANDARDIZED COEFFICIENTS  
FOR DISCRIMINANT FUNCTIONS AT GRADE TWO,  
FOUR, AND SIX

Grade	Variable	Standardized Coefficients	Unstandardized Coefficients
2	FD	.67005	.34591
	VC	.51067	.26537
4	VC	.71754	.34802
	FD	.42111	.23596
6	VC	.54626	.25416
	FD	.39691	.20509
	PO	.33767	.22334

At each grade level, the standardized discriminant function coefficient ( $d$ ) represents the relative contribution of the associated variable to that function. At grade two, Freedom from Distractibility ( $d=.67005$ ) is nearly one-third greater in importance than is Verbal

Comprehension ( $d=.51067$ ) in distinguishing between able and disabled readers. At grade four, Verbal Comprehension ( $d=.71754$ ) is nearly twice as important as Freedom from Distractibility ( $d=.42111$ ). At grade six, Verbal Comprehension ( $d=.54626$ ) is clearly more important in differentiating between able and disabled readers than either Freedom from Distractibility ( $d=.39691$ ) or Perceptual Organization ( $d=.33767$ ). Additionally, the three variables do not contribute similarly across the grades. The contribution that each variable makes to the discriminant function is different at each grade level. Table VIII indicates that knowledge of one's Freedom from Distractibility is relatively important in distinguishing between able and disabled readers at grade two. Freedom from Distractibility diminishes in importance relative to Verbal Comprehension by grade four and even more so by grade six. Perceptual Organization contributes no information to the discriminant function until grade six and then its importance is less than that of the other variables. Verbal Comprehension, on the other hand, is the major contributor to the discriminant function beginning at grade four.

The standardized discriminant coefficients reported in Table VIII, in addition to representing the relative contribution of a variable to the function, are used with discriminating variables that are coded in standard form. The unstandardized coefficients listed in Table VIII are multiplied by the raw values of the associated variables to arrive at a discriminant score. After adding a constant to adjust to the grand mean, a score is obtained. The shape of the distribution of scores derived from standardized and unstandardized coefficients is identical. Unstandardized coefficients do not report the relative importance of the variables. Listed below are the unstandardized

discriminant function equations for grades two, four, and six. The appropriate variable and its associated coefficient is reported in Table VIII. The discriminant functions for each grade level are of the following form.

$$\text{Grade 2: } D = .34591\text{FD} + .26537\text{VC} - 6.08153$$

$$\text{Grade 4: } D = .23596\text{FD} + .34802\text{VC} - 5.98909$$

$$\text{Grade 6: } D = .20509\text{FD} + .25416\text{VC} + .22334\text{PO} - 7.09393$$

### Post-hoc Analysis

The questions central to this study have been answered. Several relevant characteristics were found which maximally differentiate between able and disabled readers. Coefficients were computed which indicated the relative importance of the variable in discriminating between the two groups. Additionally, it was determined that the discriminating power of a variable changes from grade to grade. In short, by assigning appropriate weighting coefficients, several variable scores can be transformed to a single value which has maximum potential for distinguishing between members of the two groups. The desired discriminant function is thus of the form

$$y = a_1x_1 + a_2x_2 + \dots + a_px_p + c$$

where  $a_1, a_2, \dots, a_p$  are the weighting coefficients to be applied to the  $p$  original scores for each individual, and  $c$  is the constant to be added to adjust for the grand mean. The discriminant coefficients used in the main study were calculated from and used to classify cases of known group membership. This theoretical discriminant equation is not applicable for prediction when the group membership of an individual is

not known. The process of identifying the likely group membership of a case when the only information known is the subject's raw values on the discriminating variables (say Freedom from Distractibility and Verbal Comprehension) requires the following classification equation in the form,

$$C_i = c_1V_1 + c_2V_2 + \dots + c_pV_p + C_{i0}$$

where  $C_i$  is the classification score for group  $i$ , the  $c_i$ 's are the classification coefficients with  $C_{i0}$  being the constant, and  $V$ 's are the raw scores on the discriminating variables. Each group, able reader and disabled reader, requires a separate classification equation. After computing the  $C_i$  scores for each case, the case is assigned to the group for which the  $C_i$  score was highest. For example, Table IX reports the classification coefficients for able readers and the classification coefficients for disabled readers. These are the coefficients to be used when only raw scores for a discriminating variable are known. An equation is developed using the coefficients for the able group, and an equation is developed using the coefficients for the disabled group. The same raw scores for a case are used in each equation. The two resulting classification scores are compared and the case assigned to the group, able or disabled, for which the classification score was highest. As Table IX indicates, there is always a separate equation for each type of reader for each grade level; thus, if there are two groups, able and disabled readers, each case will have two scores computed. The case would be assigned to the group for which the classification score was highest.

TABLE IX  
 CLASSIFICATION COEFFICIENTS TO BE USED FOR  
 CLASSIFYING CASES OF UNKNOWN  
 GROUP MEMBERSHIP

		Group 1 Able Reader	Group 2 Disabled Reader
2	VC	2.93640	2.54401
	FD	2.71741	2.20629
	CONSTANT	-30.79662	-21.80759
		Group 1 Able Reader	Group 2 Disabled Reader
4	VC	2.69518	2.15820
	FD	2.88255	2.51887
	CONSTANT	-30.83443	-21.59731
		Group 1 Able Reader	Group 2 Disabled Reader
6	VC	1.95020	1.51110
	PO	4.88782	4.50273
	FD	2.07152	1.71762
	CONSTANT	-50.31223	-38.06876

A post-hoc discriminant function analysis was run using the 180 original cases of the main study. The analysis was run to determine if Full Scale IQ from the WISC-R, when presented as the only discriminating variable at grades two, four, and six, would more accurately classify cases as able or disabled readers than would the discriminant function using the three Kaufman factors. The percent of grouped cases correctly classified was reduced from 73.3% to 70.0% at grade two, from 75.0% to 68.3% at grade four, and the two procedures yielded the same percent of correctly classified cases at grade six (73.3%). While the differences in sample hits percentage are small, the information possessed by Verbal

Comprehension, Perceptual Organization, and Freedom from Distractibility leads to more accurate classification than does Full Scale IQ alone. Tests of significance of the differences between these values were not computed. This study was concerned with the practical, diagnostic significance of the three Kaufman factors and not with prediction.

## CHAPTER V

### DISCUSSION AND IMPLICATIONS

#### Introduction

The major purpose of this study was to investigate the possibility of inferring an individual's reader type from multivariate data. Through two-group discriminant function analysis, this study sought a single dimension upon which able and disabled readers, at different levels of development, were appreciably different. The present chapter is divided into two major parts. Part one contains a general summary discussion of the findings described in Chapter IV and an integration of present findings with previous research detailed in Chapter II. Part two discusses the implications of the present study to educational practice.

#### General Summary and Discussion

Since its construction in 1949, the WISC has been the source of countless investigations, each seeking to describe reading disability in terms of subtest scatter. Twenty-four studies covering a span of twenty-five years of research were summarized in Table I. The results of each of these studies were placed into a tabled format representing Kaufman's three factors derived from the Wechsler Intelligence Scale for Children-Revised. Distinct patterns emerged from Table I, indicating that disabled readers generally score lower on the three subtests

Arithmetic, Digit Span, and Coding. However, previous research efforts treated disabled readers as a class, and one is led to believe that this pattern of poor performance is characteristic of poor readers across a broad age range. These three subtests comprise Kaufman's Factor C, Freedom from Distractibility, used in the present study. Present findings indicated that Freedom from Distractibility distinguishes between poor and able readers primarily at grade two. Disabled readers' performance on Factor A, Verbal Comprehension, was not clearly identified as high or low in the earlier studies while, on the other hand, they appeared to obtain their highest scores on Factor B, Perceptual Organization. An historical overview of the research suggested that these three factor patterns were similar across the age range of 8 to 16½ years. The information reported in Table II indicate, additionally, that the majority of the investigations involved exceptional samples.

Given that the Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility factors can be interpreted as meaningful and clinically useful, the present study dealt with the following proposition: The three Kaufman factors represent important and clearly definable dimensions of intellectual functioning. They represent dimensions upon which able and disabled readers, at different levels of development, can be expected to differ. In dealing with this proposition this study had three major purposes:

1. To determine if able and disabled readers, at different levels of development, do differ significantly on the three Kaufman factors, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility.



2. To determine if the two-group discriminant function was any more accurate in predicting group membership than would be possible by chance alone.
3. To determine the relative contribution to the discriminant function of the three variables, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility, at each of the three grade levels.

The first two purposes of this study formed the bases for the two sets of hypotheses tested. Independent samples t-tests were run to test the equality of the group means of able and disabled readers on each of the three Kaufman factors at grades two, four, and six. At each grade level, Verbal Comprehension, Perceptual Organization, and Freedom from Distractibility, do discriminate between able and disabled readers. These differences were significant at the .01 level of probability. Support was not found for the hypotheses of no difference between the means of able and disabled readers on the three Kaufman factors.

Three, within-grade two-group discriminant function analyses were utilized to determine whether group membership, able or disabled, could be predicted on the basis of the three Kaufman factors. At each grade level, two, four, and six, a stepwise variable selection procedure produced a discriminant function equation which statistically separated able and disabled readers on a single dimension. Wilks' lambda, and its associated chi-square statistic, yielded statistical significance at the .001 level of probability for each discriminant function for grades two, four, and six. The relative values of the discriminant function coefficients for each grade level indicated that at grade two

able and disabled readers are distinguished, primarily, along the Freedom from Distractibility dimension. Verbal Comprehension added significantly to the discriminant function at the .01 level of probability. At grade four, Verbal Comprehension contributes most to group membership, its importance being nearly twice that of Freedom from Distractibility. Verbal Comprehension continued to possess the most information necessary for distinguishing between able and disabled readers at grade six while Perceptual Organization and Freedom from Distractibility contribute much less information to the separation of the reader types.

The discriminant function for each grade level was found to correctly classify the cases in this study with much greater accuracy than would be expected by chance alone. Using the Freedom from Distractibility and Verbal Comprehension score at grade two, the cases in this study were classified correctly with 73% accuracy. The same two factors classify cases of known group membership with 75% accuracy at grade four, and all three Kaufman factors contributed in correctly classifying 73% of the cases at grade six.

To the extent that the Bond and Tinker expectancy formula yields similar difference scores with cases other than those used in this study, the present study is justified in using the Bond and Tinker formula in obtaining its difference scores and, ultimately, in assigning students into able and disabled reader groups. The calculated Wherry shrinkage indicated a difference of only .01 and .02 of a point in correlation between the estimated  $r$  and the  $r$  for LIQ and GRS. Membership in the two groups used in this study was determined by a difference score, which represents over or underachievement in reading with the effects of IQ removed. Cases were not assigned to groups based on the

similarity of their IQ scores. The negligible amount of shrinkage of the difference score when applied to other cases verifies and justifies the use of the Bond and Tinker in determining difference scores for this study. It does not completely clear IQ out of the able or disabled reader score because the means of the two groups differed significantly on IQ. The central concern of this study was, however, not whether disabled readers were equivalent on IQ, but rather, whether the Bond and Tinker formula was good for obtaining the difference score which ultimately determined group membership.

#### Implications for Educational Practice

This study utilized simple discriminant function analysis in identifying a single dimension upon which able and disabled readers differ. A quantitative statistical decision procedure such as discriminant function analysis was used for two reasons:

1. Its use provides an objective and operationally specified way of describing how individual readers come to be what they are; i.e., how they get into particular groups.
2. It can be used to assess the relevance of specified information for describing differences among groups.

For the purpose of this study, scores on three discriminating variables were obtained for each of 180 students. Discriminant function analysis determined that some students appear more alike and some more different from one another. In other words, certain modal patterns of factor performance occurred with substantial frequency. A central assumption of this study was that, if the most frequently occurring patterns can be identified, then a majority of individuals in the total

population can be described as being like one of the modal types. Previous research had generally established recurring patterns of disabled readers' performance on the Wechsler Intelligence Scale for Children.

The present study, however, possesses several distinct advantages over those summarized in the literature review: 1) the investigation did not use exceptional samples. Samples were drawn from typical classrooms located in typical communities; 2) this study utilized the difference between actual and expected achievement as its criterion for assigning group membership. Only four of the studies reviewed used this selection criterion. Defining disability in terms of some number of months below grade level placement automatically excludes students achieving above grade level, some of which are disabled readers; 3) this study used students at three levels of maturation as opposed to observing students who represent one homogeneous group with a span of eight years chronologically.

If, on the basis of the results of the present study, the conservative hypothesis is forwarded that second grade disabled readers can be differentiated from able readers by their distractibility, then, 1) the methodologies of the earlier studies investigating subtest pattern analysis of disabled readers should be skeptically reviewed; 2) the efficacy and current popularity of perceptual-deficit hypotheses in explaining reading disability in second grade is not supported; 3) the treatment that the primary disabled reader receives in the contemporary classroom, in terms of remedial education and regular education, should be thoughtfully reevaluated.

The results of this study suggest that, if Freedom from Distractibility is truly a valid factor, then identification of this factor is

just as important as identification of an appropriate methodology for the child so that both the mode and pace of instructional efforts can be made appropriate to the child's readiness to make use of those efforts. What a teacher can expect of a child, in terms of the completeness of a given task, the time involved in preparing, structuring and presenting a particular task, and in evaluating the results of teaching, may need to be reexamined. Unless an adjustment is made for the Freedom from Distractibility factor, considering the cumulative effects of academic learning, school may continue to be a source of frustration for the child. It may mean, contrary to much present practice, that we need to reduce, at the primary level, the amount of time spent in an instructional experience. Not only may one need to adapt the way one teaches to the specific characteristics of the disabled reader, but one may need to restructure the entire learning situation. This may be done by trial lessons and differing methodologies, by experimenting with relaxation techniques with primary disabled readers, and shortening the length of an experience.

The results of this study suggest that by fourth grade, and certainly by sixth grade, the child outgrows his problems with distractibility; at least, this factor becomes less important in distinguishing between able and disabled readers in the intermediate grades. Although one may outgrow distractibility, the reading problem is not likely to disappear unless early adjustments are made for the Freedom from Distractibility factor.

Support for the use of perceptual-deficit hypotheses in explaining reading disability was not obtained at either second or fourth grade. At sixth grade its importance was minimal, in relation to Factor A,

Verbal Comprehension. Rather than indicating defect or deficit, the fact that Perceptual Organization contributes to group separation at grade six may indicate a secondary manifestation of the disabled reader's attempts to cope with the expectations of the learning environment.

Support for a verbal-language deficit hypothesis for explaining reading disabilities was obtained from the present study, especially at fourth and sixth grades. A logical extension of the verbal-language deficit hypothesis, given that Perceptual Organization contributed to group separation at grade six, may be that disabled readers lack the implicit language clues that alert them to the critical differences in letters and words (Vellutino, 1977). Such perceptual inefficiency at grade six, however, would seem to be a consequence of dysfunction in visual-verbal learning rather than an indication of visual-perception deficit in the strict sense.

#### Recommendations

The present study has made a contribution to the existing research on reading disabilities and alternative procedures for utilizing the Wechsler Intelligence Scale for Children-Revised. An alternative hypothesis was advanced which utilized the Freedom from Distractibility factor as a possible explanation for reading disorders at grade two. Additionally, the verbal-language deficit hypothesis, as measured by the Verbal Comprehension factor, was advanced as possibly explaining reading disorders at grade four and six. The following recommendations for future research are forwarded as they relate to the results of the present study:

1. Statistical classification procedures, such as the procedure used in this study, are only probabilistically correct. Replication of this study is recommended. Only when several replications evidence similar results can one feel confident that the results of this study are representative of the majority of individuals in the population of concern.
2. The grade levels used in this study were second, fourth, and sixth. Future studies should utilize students in pre-school, kindergarten, and other grades not included in this study. The classification procedure utilized in discriminant function analysis would gain added importance if developed and applied in a screening situation. While pre-school students are frequently screened for cognitive and perceptual deficits which are assumed to lead to learning problems, seldom, if ever, do these procedures include assessment of the distractibility factor.
3. Educators should be able to prevent many reading problems once they know how to match teaching to a child's development on the distractibility factor. Given that Freedom from Distractibility is a valid factor, and sufficiently accurate in describing disabled readers in the early grades, remedial strategies in dealing with this type of student should be developed, implemented, and tested.

4. The relationship between language ability and reading in the intermediate grades is in need of more qualitative research. The specific language inadequacies which contribute to reading disability in the intermediate grades need to be identified, and remedial strategies developed and tested.



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