1-1-1983

# Prediction of the reading and spelling performances of normal and retarded readers a three-year follow-up.

Diane L. Russell
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NAME OF AUTHOR/*NOM DE L'AUTEUR* Diane L. Russell

TITLE OF THESIS/*TITRE DE LA THÈSE* Prediction of the reading and spelling performances of normal and retarded readers: a three-year follow-up.

UNIVERSITY/*UNIVERSITÉ* University of Windsor, Windsor, Ontario

DEGREE FOR WHICH THESIS WAS PRESENTED/ *GRADE POUR LEQUEL CETTE THÈSE FUT PRÉSENTÉE* M. A.

YEAR THIS DEGREE CONFERRED/*ANNÉE D'OBTENTION DE CE GRADE* May 1983

NAME OF SUPERVISOR/*NOM DU DIRECTEUR DE THÈSE* Dr. Byron Rourke



DATED/*DATÉ* May 12/83 SIGNED/*SIGNÉ* Diane L. Russell

PERMANENT ADDRESS/*RÉSIDENCE FIXE*

# PREDICTION OF THE READING AND SPELLING PERFORMANCES OF NORMAL AND RETARDED READERS: A THREE-YEAR FOLLOW-UP

by

Diane L. Russell
B.Sc. University of Victoria, 1977

A thesis
Submitted to the Faculty of Graduate Studies
Through the Department of Psychology
in Partial Fulfillment of the
Requirements for the Degree
of Master of Arts at the
University of Windsor

Windsor, Ontario, Canada

1983

APPROVED BY:

(Chairman)

## ABSTRACT

This study presents the results of a three-year follow-up study of the neuropsychological abilities of normal and retarded readers. The relative predictive accuracy of a number of measures for later reading and spelling levels was determined. These results were compared to those found by Rourke & Orr (1977) in their four-year follow-up study. The results indicated that there were some very accurate predictive measures of reading and spelling achievement levels over the three-year period studied. However, no general patterns emerged for the specific groups on any of the four criterion variables. These results are in sharp contrast to those found by Rourke & Orr (1977). Further comparisons with the original study indicated that neither set of resulting regression equations was cross-validated on the other sample. Several possible procedural, methodological, statistical, and theoretical explanations for these results are offered and discussed.

ACKNOWLEDGEMENTS

First of all, I would like to express my gratitude and appreciation to my supervisor, Dr. Byron Rourke, for all his help, advice, comments, and support during the completion of this thesis. His assistance was invaluable. I would also like to thank the members of my committee, Dr. Art Smith and Dr. Noel Williams for their time and assistance.

The Medical Research Council of Canada has provided financial support for me during my graduate career. I thank them for their continued funding.

I would like to thank Michael Joschko of the Sarnia-Lambton Centre for Children and Youth for his help in the initial contact of the subjects, as well as through the testing and follow-up phases. A special word of appreciation to the school principals and teachers for their assistance and cooperation. My subjects also deserve a thank-you for their patience and cooperation.

Dr. Ken Adams was invaluable in providing statistical advice and Dr. Ted Hirota supplied the information regarding the SYSPUB program (under which the initial drafts were written and edited).

A special word of thanks goes to fellow graduate students, Jennifer Dunn-Geier, Sandy Brown, and Joan Durrant and friends, Liz Aziz and Rose Creve, who kept me sane during my most insane moments and provided the vital support

I needed to keep persevering, even when all looked hopeless.

My parents deserve a big thanks for their continuing love and support during my graduate career. They, along with my sister and brother-in-law, are always there when I need them, providing encouragement and motivation.

Last, but by no means, least, I would like to thank Dave Sandre. He introduced me to WYLBUR, was an enormous help during the "computer" phases of the project, and, above all, provided me with much needed emotional support and stability.

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# CHAPTER I

## INTRODUCTION

The study of children who, during their school years, exhibit a problem in learning is certainly not a new field of research. These children have posed problems for educators for many years. More recently, specific groups of these children have been the focus of attention. One such group is children who are classified as "learning disabled". Definitions are numerous, but one of the most widely accepted has been put forth by Rourke (1978b). The following characteristics are viewed as descriptive of a learning disabled child:

1. Obtains Full Scale IQs on the Wechsler Intelligence Scale for Children (WISC; Wechsler, 1949) within the normal range.
2. Has adequate visual and auditory acuity.
3. Is free of primary emotional disturbance.
4. Lives in a home and community where socioeconomic deprivation is not a factor.
5. Is educated in his/her native language.
6. Has attended school regularly since normal school-entry age.
7. Has experienced only the usual childhood illnesses.
8. Is markedly deficient in at least one school subject area.

(Rourke, 1978b, p. 97)

The definition allows for precise description and identification of the children to be studied. This precision helps to eliminate much of the confusion so often involved in this complex area and allows direct comparisons to be made between studies using the same definition of the population.

One specific area of learning disabilities is that of reading disabilities. Again, descriptions and definitions are numerous but, generally, the disabled reader is not socially or educationally deprived, is of at least average intelligence, and shows no evidence of any gross neurological or emotional handicap (Satz & Friel, 1973). This definition seems to parallel that given by Rourke (1978b) for learning disabled children in general. These children who exhibit specific deficits in reading have been given various labels in the past. Such terms as "specific reading disability" (Money, 1962), developmental dyslexia (Critchley, 1970), and educationally handicapped (Owens, Adams, & Forrest, 1968) have been used. The issue at hand, however, is not the label for the problem, but the problem itself. These children have difficulty in learning to read and it is necessary to provide accurate assessment, diagnosis, and remediation for them.

Perhaps the first question to be answered when studying children with reading disabilities is the following: Why study these children at all? The answer becomes fairly obvious upon examination of the prevalence estimates for this group. Some investigators have suggested that as many as 15

percent of the children in the school system today have a reading disability (Satz, Taylor, Friel, & Fletcher, 1978). Although this figure may be relatively high, the fact remains that a substantial proportion of school children exhibit a problem in learning to read. Without proper identification and subsequent remediation, these children will continue to experience difficulties.

Silver & Hagin (1964) followed 24 reading disabled children for 10 to 12 years. The reading disability persisted into adulthood and the same deficits in perceptual abilities and neurological functioning that were present at initial testing persisted after 10 to 12 years. Silver & Hagin (1967) conclude that

> The neurological and perceptual assessment of patients with reading disability as they moved from childhood to young adulthood shows that, in spite of maturation in some areas, specific reading disability is a long-term problem in the life of an individual, the signs of which can be detected despite adequate educational, vocational, and social functioning. (p.101)

Preston & Yarrington (1967) found that disabled readers showed limited academic aspirations, lower ultimate achievement, and narrower vocational possibilities than did normal readers.

Early learning disabilities are often accompanied or followed by social, emotional, and behavioral disturbances (Eisenberg, 1966; Gates, 1968; Kline, 1972). Balow & Blomquist (1965) considered the social and emotional adjustment of disabled readers, and report that self esteem is

usually poor and depression common, in adults who had childhood reading difficulties. Peter & Spreen (1979) present a fairly typical picture of learning handicapped adolescents and young adults as displaying "limited academic skills, immature and inappropriate behavior, low self-esteem, and lack of motivation after years of school failure, and social rejection" (p.75). Therefore, it would seem feasible to propose that some type of early detection and intervention be implemented to try to prevent or at least to reduce later problems. A valid detection system is needed to identify these children accurately and as early as possible.

Muehl & Forrell (1973) found that early diagnosis, regardless of subsequent remediation, was associated with a better prognosis for reading ability five years later. Future studies will likely reveal that early introduction of remedial techniques will lead to an even more promising prognosis.

Keogh & Becker (1973) identify three problems in the early identification of learning disabilities. The validity of the measures used for identification and prediction must be established. There must be consideration of the implications of the diagnostic data for remedial or educational intervention. And finally, it must be determined if the benefits of early intervention outweigh the possible damaging or negative effects of recognition and labelling. These authors feel that, as of 1973, there were no good predictors

of later academic problems. The Bender-Gestalt test had been used quite frequently up to that point, but it is not a good instrument for making specific predictions about individual children. A need was recognized at that time for valid and accurate predictive measures of future learning disabilities.

Satz et al. (1978) discuss several cautions for research on early detection and intervention, as well as long-term follow-up studies. Prediction errors are a source of much concern and the need for a valid detection system cannot be stressed enough. Both false positive and false negative predictions pose fairly serious problems. The system must be efficient enough to identify the majority, if not all, of the children who will eventually fail at reading. At the same time, those children who will become average or superior readers must not be identified as reading disabled. Thus, both the number of false negatives and the number of false positives must be kept to a minimum. This is possible with the use of multivariate designs that employ multiple measurements of the same subjects over time. Long-term follow-up studies, in which sufficient time elapses between the initial assessment and the criterion measure a number of years later, should be conducted. Large populations of children should be used to reduce attrition effects and to provide a better estimate of the problem in the population. The use of homogeneous groups avoids the problems of confounding variables such as age, sex, race, or socioeconomic

status. A crucial consideration in the use of follow-up studies is the cross-validation of a battery using another group of children. This is necessary to evaluate the predictive validity of the tests administered to the original group.

Kerlinger & Pedhazur (1973) have found that the best method for estimating the degree of shrinkage in a multiple regression coefficient (R or $R^2$) is to perform a cross-validation. This is done by using two samples. For the first sample a regression analysis is performed, and $R^2$ and the regression equation are calculated. The regression equation obtained for the first sample is then applied to the predictor variables of the second sample to produce a predicted value (Y') for each subject. A Pearson r is then calculated between the actual (observed) criterion scores (Y) in the second sample and the predicted criterion scores (Y'). This produces a multiple r from which the $R^2$ value can be calculated.

In a double cross-validation, the procedure outlined above is applied twice. For each sample, $R^2$ and the regression equation are calculated. Each regression equation obtained in one sample is then applied to the predictor variables of the other sample. The Pearson r values are calculated between the actual (observed) and predicted criterion scores for each sample and the $R^2$ values can be determined. The regression equations and $R^2$ values can

then be compared. Kerlinger & Pedhazur (1973) state that "double cross-validation is strongly recommended as the most rigorous approach to the validation of results from regression analysis in a predictive framework" (p.284).

Confounding variables are always a potential source of error and confusion in psychological research. Variables such as age, sex, and IQ must be controlled by either methodological or statistical means. Researchers have found a great discrepancy in incidence rates of specific reading disabilities for males and females. Money & Schiffman (1966) found a disproportionately higher incidence of males in a group of children with specific learning handicaps in the area of reading. Eisenberg (1966), Ingram (1970), and Satz & Sparrow (1970), all found a 6:1 ratio of males to females in their groups of children with specific reading disabilities. Since the proportion of males is so much greater than females, researchers have found it easier to control for sex differences by studying only males. Satz and his co-workers have always used only males in their research. Rourke & Orr (1977) studied only males.

In a recent study, however, Canning, Orr, & Rourke (1980) found that there were essentially no differences between male and female retarded readers at two age levels (6.5 to 8.5 and 10.5 to 12.5 years). Differences were not apparent on a number of perceptual, visual-motor, linguistic, and concept-formation abilities. These results are in sharp

contrast to the findings of most previous research with normal reading children and suggest that male and/or female retarded readers could be studied separately or together in the future.

The age of the child at initial testing may be an important factor in determining which variables will predict later reading ability. Rourke (1978a) concludes that

> Younger (ages 5-7) retarded readers are likely to exhibit significantly impaired performances in visual-perceptual and visuospatial abilities. Older (ages 9-11) retarded readers are likely to exhibit markedly impaired performances in language-related and higher-order concept formation abilities, and (possibly) less obvious or severe impairments in visual-perceptual and visuospatial abilities. The principal reasons for these findings may be that "reading" at ages 5-7 is largely single-word reading, whereas more advanced "reading" requires higher-order conceptual skills for the achievement of rapid scanning with comprehension. (p.170)

Thus it would appear that different variables predict different results depending on the age of the child at initial assessment. Satz's developmental lag theory takes this factor into account in predicting reading failure in differentially mature children.

## Models of Reading Acquisition

The question of which tests should be included in a predictive battery is a controversial issue due partly to the lack of agreement on the nature of the reading process.

Several sequential models for learning to read have been proposed. A widely used and accepted view is that of Gibson(1965). After the initial learning of oral language

in the preschool period, Gibson sees three sequential phases in the process of learning to read. The first stage is learning to differentiate graphic symbols on a visual basis. The second stage is learning to decode letters into sounds. The third stage involves development of the use of higher-order units of linguistic structure. These processes occur in children aged 4 to 8 years. The visual discrimination of letter forms improves with age over this period. All types of visual discrimination do not show the same rate of development, however.

Luria's (1966) stages in learning to read parallel those of Gibson. The perception of letters is the first stage, followed by analysis of the conventional phonetic value of the letters and, finally, the complex fusion of phonetic letters into words. Luria sees the early phases of reading as involving visual-perceptual discrimination and analysis. The child must learn to discriminate the distinctive features of letters to identify them and tell them apart. During the later stages there is a shift and the process involves more complex phonetic and linguistic analysis of letters and words. Luria views a child's reading problem in this light:

> If the child, in the early phases has difficulty in discriminating the essential units of form and orientation of letter stimuli, then he is bound to extract irrelevant information before he proceeds to the following and hierarchically more complex levels of phonetic analysis and fusion of phonetic letters into words. (Satz & van Nostrand, 1973, p.124)

Another requirement of the task of reading seems to be the sequential processing of related material (Doehring, 1968). Doehring found that a small set of visual and verbal tasks correlated highly with a reading/spelling factor in a group of retarded readers and also contributed highly to the differentiation between normal and retarded readers. These tasks all require sequential processing of related material. It was hypothesized that the reading disability in the group of retarded readers could be explained in terms of a disorder of visual, verbal, and visual-verbal sequential processing. Doehring (1968) suggests that

> the identification of a sequential processing deficiency as an intrinsic component of reading disability must be regarded as highly tentative, and may not apply to all forms of reading disability, but it does suggest a potentially useful direction for further inquiry. (p.135)

Doehring used the Underlining Test (Rourke & Orr, 1977) as a measure of visual-perceptual speed, where the subject must scan a succession of nonverbal figures, numbers, or letters, and make a nonverbal response of underlining. The response indicates the subject's successive identification of the particular visual stimulus he is required to pick out from a series of related stimuli. Doehring describes reading as a "sequential processing task which combines the visual requirements of perceptual speed tasks and the verbal requirements of sequential naming tasks" (p.135).

Doehring tested three groups of children aged 10 to 14: 39 boys composed the specific reading disability group, and

39 normal boys and 39 normal girls. The children were given 109 measures in total, including a neuropsychological test battery, an aphasia test battery, and a number of psychological tests. A multiple stepwise regression analysis showed that word rhyming and oral vocabulary (2 spoken language abilities) and discrimination of reversed figures and visual perceptual speed for single forms (2 visual abilities) were the best discriminators between normal and retarded readers.

The results of this cross-sectional study certainly point to the distinct possibility of the involvement of these sequential processing abilities in the task of reading. The Underlining Test appears to be an accurate measure of some of these abilities and its use seems to be warranted in the further study of reading disabled children.

Predicting Reading Achievement

Even if there were agreement on the stages and processes involved in learning to read, there would still be a need to identify "which factor or factors tested at Time 1, will predict success or failure on selected criteria of reading at Time 2" (Silver, 1978, p.354). Various researchers at various times have associated different abilities or skills with reading ability. Smith (1928) found that the ability to match letters at the beginning of Grade 1 correlated at the 0.87 level with the Detroit Word Recognition Test given 2

weeks later. Barrett (1965a,b) found that visual discrimination and knowledge of letter names could predict reading ability. Dykstra (1965a) also found that knowledge of letter names could predict reading ability. Dykstra (1962) included auditory discrimination of beginning sounds as a predictor of later reading ability. Other authors, such as Hammill & Larsen (1974) found that auditory discrimination and memory, blending, and audiovisual integration were not good predictors of reading ability.

Jansky & deHirsch (1972) conclude in their research that there is no general agreement as to the one skill or even combination of skills that is the best predictor of future reading ability. Predictor variables such as age, sex, socioeconomic status, neurological status, emotional well-being, laterality, body-image, visual perception, auditory perception, oral language, and intersensory integration may all contribute to prediction. Higher integrative functions such as symbolic mediation (Blank & Bridger, 1967), verbal processing (Vellutino, 1978), and neuropsycholinguistic abilities (Rourke, 1978a) may also be involved here.

It is not surprising, therefore, that various researchers have found many different variables useful for predicting the future achievement of children. When different abilities are assessed, each of these may be involved in the process of reading for specific age groups, maturational levels, and ability structures.

In the attempt to identify children who may later suffer problems in learning to read, several types of assessment techniques have been used. Scanning or screening instruments have been used extensively in the initial identification of children who may become reading disabled. Reading readiness tests are also used a great deal in the preliminary process.

Various screening and scanning instruments such as the SEARCH battery (Silver & Hagin, 1975), the Meeting Street School Screening Test (Hainsworth & Siqueland, 1969; Kapelis, 1975), and the Slingerland Prereading Screening Procedure (Kapelis, 1975) have all been used to predict reading achievement. Correlations between predictions made by these screening instruments and future reading achievement levels are moderate, ranging from 0.58 to 0.68. These tests are designed only as screening instruments however, and, if screening indicates a potential problem, further diagnostic testing must be carried out.

Reading readiness tests such as the Gates-MacGinitie Reading Tests have also been used for predicting reading achievement and making practical placement decisions. Miller (1971) and Jansky & deHirsch (1972) reviewed reading readiness tests and found correlations of between 0.40 and 0.65 between predictions made by reading readiness tests and subsequent reading achievement levels. Glazzard (1977) compared a teacher rating scale (Kirk, 1966) and the Gates-MacGinitie Reading Tests and found that each measure could

predict future vocabulary and comprehension levels. Results differed for various age groups.

Battery approaches. Various other longitudinal studies have been carried out using a variety of predictor variables and criterion measures. Feshbach, Adelman, & Fuller (1977) studied 888 middle-class children in a 5-year longitudinal study. They administered the Wechsler Preschool and Primary Scale of Intelligence (WPPSI; Wechsler, 1967), the deHirsch-Jansky Predictive Index of Reading Failure (9 subtests measuring linguistic and perceptual-motor skills), the Bender Motor Gestalt Test (Koppitz scoring system), the Kohn Social Competence Scale (measuring social and emotional functioning), and the Student Rating Scale (SRS). The SRS is a teacher's rating of the child's cognitive, affective, and social functioning in the classroom. It assesses attention, behavioral control, language skills, visual-and auditory-perceptual discrimination, memory, and perceptual-motor coordination. Criterion measures were the Cooperative Primary Reading Tests, a reading inventory, samples of the child's writing, and the SRS. These were assessed in Grades 1 through 3. Correlations between first grade measures of the SRS and reading competence averaged 0.44 for the three grades. The deHirsch-Jansky Index produced an average correlation of 0.45. The WPPSI produced an average correlation of 0.39. Multiple regression analysis produced a multiple correlation coefficient of 0.58 for WPPSI IQ, the SRS, and the deHirsch-Jansky Index in Grade

3. Cross-validation with 844 new children produced a multiple correlation coefficient of 0.50 for the same three variables. The measures were more accurate in predictions for girls than for boys. The authors conclude that the SRS and the deHirsch-Jansky Predictive Index can both predict reading failures in Grades 2 and 3 with modest success. They feel that use of the SRS still produces too many false positives and false negatives to warrant the use of teacher ratings alone in the prediction of reading achievement.

In a study by Gruen (1972), a battery of perceptual-motor tasks was compared to a group of cognitive-intellectual tasks for predictive accuracy in the prediction of reading achievement. These two sets of tests were administered to 204 Grade 1 students and 202 Grade 3 students. The criterion measure was reading achievement (vocabulary and comprehension) at the end of the year. Multiple regression analyses showed that for Grade 1 boys and girls, the perceptual-motor tests explained more of the variance in reading achievement scores than did the cognitive-intellectual tests. However, for Grade 3 boys and girls the cognitive-intellectual tests accounted for more of the variance in reading achievement scores than did the perceptual-motor tests. These results are similar to those obtained by Satz et al. (1978) in their longitudinal research.

Lindgren (1975) tested children at the end of kindergarten and at the end of Grade 1. Stepwise discriminant function

analysis resulted in a hit rate of 91% with only 4% false positives. Letter Naming, Peabody Picture Vocabulary Test IQ (PPVT; Dunn, 1965), Finger Localization, and the Beery Test of Visual Motor Integration (Beery, 1967) were ranked as the best predictors. SES, a family history of reading problems, speech difficulties, and a Behavior Checklist score all ranked lower for prediction of reading abilities. Again we see tests similar to those used by Satz et al. (1978) ranking among the best predictors of reading disabilities.

Searls (1975) reviewed various studies that used WISC scores in diagnosing reading problems. He observed that groups of poor readers have tended to score lower on the following WISC subtests: Information, Arithmetic, Digit Span, Coding, and sometimes Vocabulary. He hypothesized various reasons why poor readers would have low scores on those particular subtests. Information measures memory of general information gained from experience and education. Poor readers may miss out on some of this because they do not read as much or as well as others. In the Arithmetic subtest the ability to attend and to focus concentration in order to extract the relations between numbers is assessed. This ability may extend to letters and words and be deficient in poor readers. Attention, concentration, immediate auditory memory, and auditory sequencing are all measured in the Digit Span subtest. These abilities have all been found to be important in reading and may be deficient in some disabled

readers. Coding involves visual-motor dexterity, the association of meaning with a symbol, the ability to memorize quickly, and the ability to learn from visual stimuli. Certain aspects of these skills seem to be involved in the reading process and may be poorly developed in disabled readers. The Vocabulary subtest has been found to be the best single verbal measure of general intelligence on the WISC. It involves learning ability, word knowledge acquired from experience and education, and reveals the child's quality of language. It may or may not be lower in poor readers. Obviously, these are generalizations based on group results and should not be used for diagnostic purposes with individual children.. However, the research reviewed here shows that certain patterns of performance on the WISC may be used for the initial identification of disabled readers.

Perry, Guidubaldi, & Kehle (1979) conducted a three-year longitudinal investigation. They compared kindergarten competencies to third grade academic functioning. Using WISC IQ, the Wide Range Achievement Test (WRAT; Jastak & Jastak, 1965), and an academic rating done by the teacher, they predicted reading, spelling, and arithmetic performances on the WRAT in Grade 3. The following correlations were obtained:

| Initial Measure | Reading | Spelling | Arithmetic |
|---|---|---|---|
| WISC IQ | 0.37-0.44 | 0.24-0.41 | 0.48-0.53 |
| WRAT Reading | 0.36-0.49 | 0.35-0.49 | 0.34-0.43 |
| WRAT Arithmetic | 0.51-0.52 | 0.32-0.48 | 0.42-0.48 |
| Academic Rating | 0.50-0.51 | 0.36-0.38 | 0.45-0.48 |

The WRAT Arithmetic subtest and the academic rating were the best predictors for reading. WRAT Reading was the best predictor for spelling. WISC IQ was the best predictor for arithmetic.

Long-Term Follow-up Studies

Six major long-term follow-up studies of reading disabled children have appeared in the recent neuropsychological literature. The results and conclusions of these studies will be presented here.

Muehl & Forrell (1973) studied 43 disabled readers in elementary school, through junior high school to high school for a total of 5 years. None of the subjects had gross sensory or neurological deficits. All subjects were initially given the WISC and all had Performance IQs greater than Verbal IQs. EEGs were given initially and also when the students were in high school. All subjects were classified at both times of testing according to their EEG patterns. Using the Iowa Tests of Educational Development as criterion measures, they found the following:

1. Poor readers in elementary and junior high school, as a group, continued to be poor readers in high school 5 years after the initial diagnosis of reading disability.
2. There was no relationship between EEG classification at diagnosis and high school reading performance. There was a consistent trend, however, that favored

the reading performance of the Abnormal/Other EEG group over the Abnormal/Positive Spike (14/second and 6/second positive spikes) group and the Normal EEG groups. This was evident on initial and follow-up testings.

3. Both WISC Verbal IQ and Chronological Age at diagnosis were significantly and independently related to high school reading performance.

Even though results indicated that early diagnosis, regardless of the amount of remedial instruction, was related to better reading performance at follow-up, only 4% of the group read at average or above-average levels at follow-up. Early diagnosis was related to positive consequences, but the subsequent reading levels were nowhere near normal levels. The effect of instruction seemed neglible, in that no matter how much remedial instruction the children received, only those who were diagnosed early improved their reading performance.

Trites & Fiedorowicz (1976) acknowledge the ever-present problems of definition, prevalence estimates, measurement, and treatment choice in the study of children with learning disabilities. Follow-up studies of reading disabled children generally report one of two extreme conclusions: (a) a generally favorable outcome into adulthood or (b) a persistence of the reading problem over time. In a large number of these studies, however, there is a lack or

total absence of quantified measures of academic achievement on standardized tests of reading, spelling, and arithmetic. This lack of quantification makes it virtually impossible to determine the change in academic achievement levels over time.

In an attempt to overcome and avoid some of these problems, Trites & Fiedorowicz (1976) studied two groups of children who had been diagnosed as having a primary reading disability.

> The criteria for specific or primary reading disability generally included, in addition to the lag in reading, a family history of reading disability, no evidence of gross or focal brain damage, average intelligence or greater, and no evidence of severe emotional disturbance. (p.43)

Again, we see a definition similar to that used by Rourke (1978b) in his research. One group consisted of 27 boys, the other of 10 girls. A third group of 10 boys who had a reading disability presumed to be secondary to a neurological disorder was also studied for comparison purposes. The neurological diagnoses included cases of prenatal or perinatal injury (3), epilepsy (3), head injury with brain contusion (2), encephalitis (1), and cyst (1).

All subjects were given an extensive battery of neuropsychological tests on the initial assessment. These included the following:

1. Wechsler Intelligence Scale for Children (WISC; Wechsler, 1949)
2. Peabody Picture Vocabulary Test (PPVT; Dunn, 1965)
3. Boston University Speech-Sound Discrimination

Picture Test

4. Wide Range Achievement Test (WRAT; Jastak & Jastak, 1965)
5. Halstead-Reitan Battery
6. Wisconsin Motor Steadiness Battery (Kløve, 1963)

The children were retested approximately 2.6 years later to obtain information on vocabulary and academic achievement levels.

The main differences between the groups were as follows. The children with brain damage were consistently lower on WISC variables and IQ scores than were the children with primary reading disability. All groups had a lower Verbal IQ than Performance IQ. All tended to have problems on the Digit Span subtest, which measures auditory attention span, among other things. All children had problems in discriminating between similar-sounding words presented auditorily on the Boston Test, moderate right-left confusion, and problems perceiving numbers written on their fingertips. All children had problems on all three achievement tasks, doing only slightly better on arithmetic than on reading and spelling.

All three groups improved in reading, spelling, and arithmetic, but not enough to keep pace with the time interval. For all groups on the three achievement measures, the discrepancy between their grade placement and their actual achievement level increased as they got older. Trites & Fiedorowicz (1976) state that:

> Thus, although the academic difficulties were usually recognized in the early grades, the subjects were behind their classmates in all areas and this gap grew larger over time in spite of remedial help in all cases. (p.47)

This was true for both sexes and for both groups of reading disabled children.

Trites & Fiedorowicz (1976) conclude that, because the deficit is so stable and persistent in these groups, the maturational lag hypothesis cannot adequately explain the existence of the disability well into adulthood. Both the specific reading disability group and the neurologically impaired group look similar in outcome on the achievement tests. However, due to IQ differences and perhaps differences in reading subskills, these groups must be studied separately. The authors caution researchers against using high school completion as a criterion for reading proficiency. Many students can complete high school with as low as fourth grade scores on the achievement tests.

Yule & Rutter (1976) discuss a need to distinguish between two groups of children. Children with "reading backwardness" attain scores on reading accuracy or reading comprehension on the Neale Analysis of Reading Ability Test (Neale, 1958) 2 years, 4 months or more below their chronological age. Children with "specific reading retardation" attain scores on reading accuracy or reading comprehension on the Neale Test 2 years, 4 months or more below the level predicted on the basis of their age and WISC IQ level.

Yule & Rutter (1976) studied five populations of children who were given tests of nonverbal intelligence and reading attainment. Of these, the children who scored two or more standard deviations below the mean on the reading tests were studied further with audiometric, neurological, and other measures. Between 3.35% and 6% of the children were found to have specific reading retardation based on a definition of underachievement as a reading age at least 2.5 years below the level predicted for a specific age and IQ score. This is a considerably higher proportion than the 2.28% expected on a theoretical basis. Thus, an excess of underachievers exists at the lower end of the distribution of readers.

Differences were found between those children who exhibited general reading backwardness and those with specific reading retardation. Yule & Rutter (1976) conclude that

> general reading backwardness is associated with overt neurological disorder and with abnormalities on a wide range of motor, praxic, speech, and other developmental functions. Specific reading retardation, on the other hand, was found to be associated to a marked degree only with abnormalities of speech and language development. (p.34)

Average intelligence was lower in the backward readers (IQ = 80) than in the group of retarded readers (IQ = 102.5). Of the backward readers, 54.4% were boys, while 76.6% of the retarded readers were boys. Further comparisons showed that more of the backward readers than the retarded readers suffered from organic neurological disorders, constructional apraxias, clumsiness, motor impersistence, and problems in

right-left discrimination. In both groups, about 1/3 of the children had parents or siblings who had reading difficulties and 1/10 had parents or siblings with delayed speech acquisition. One third of the children in both groups were delayed in speech and language development. These rates are three times as great as those found in the general population control group.

These children were followed over a period of 4 to 5 years. In spite of their higher intelligence levels, retarded readers made significantly less progress than the backward readers did in both reading and spelling. Spelling performance was poorer than reading performance in both groups. In contrast, children with specific reading retardation made more progress in arithmetic than did the backward readers. Both groups still performed below the level expected for their chronological age. Yule & Rutter (1976) conclude that "educators cannot assume any longer that bright children with reading difficulties will catch up. Good intelligence in a disabled reader is no talisman against long-lasting reading failure"(p.35).

Maxwell (1972) used data from the Isle of Wight studies and found that children who were poor readers at age 7 made less efficient use of their cognitive skills and had different cognitive structures on the Wechsler Preschool and Primary Scale of Intelligence (WPPSI) than did good readers at the age of 5.

Follow-up studies into adolescence showed that few of the retarded readers read a morning newspaper or read books for pleasure, and that most expected to leave school as soon as possible with no further training. These were teenagers of average intelligence who were obviously suffering from a severe handicap with far-reaching implications.

Paul Satz and his co-workers have been major contributors in the field of reading disabilities. The methodological and conceptual frameworks for their longitudinal research are based on a theory that "postulates that reading disabilities reflect a lag in the maturation of the brain which differentially delays those skills which are in primary ascendancy at different chronological ages" (Satz et al., 1978, p.319). Skills which develop earlier in childhood will be delayed in younger maturationally immature children. These include visual-perceptual, visual-motor, directional-spatial, and cross-modal sensory integrative skills. Language and formal operations are later or slower developing skills and these will be delayed in older children who are maturationally immature. The theory predicts that younger children who exhibit a delay in the above-mentioned skills will eventually fail in reading. These children will then "catch-up" on the early skills, but will subsequently be delayed on the later developing skills. Satz et al. (1978) state that "if the language disorder persists after maturation of the central nervous system is completed, then a permanent

defect in function may occur" (p.321).

Satz & Friel (1974) report on the results of a two-year follow-up of their original sample of 497 white male kindergarten pupils in a public school system in Florida. The standardization battery consisted of the following variables:

1. Day of Testing
2. Age
3. Handedness
4. Finger Tapping (Reitan, 1964)
   a) Total- averaged sum of preferred and nonpreferred hand performance.
   b) Difference- mean difference between the two hands.
5. Peabody Picture Vocabulary Test - IQ score (Dunn, 1959)
6. Recognition-Discrimination Test (Small, 1968)
7. Embedded Figures (Satz and associates, Neuropsychology Laboratory, University of Florida)
8. Verbal Fluency Test (Spreen & Benton, 1965)
9. Developmental Test of Visual-Motor Integration (Beery, 1967)
10. WISC Similarities Subtest (Wechsler, 1949)
11. Alphabet Recitation
12. Right-Left Discrimination Test
13. Finger Localization Test (Benton, 1956)
14. Auditory-Discrimination Test (Wepman, 1958)

15. Dichotic Listening Test (Satz, 1968)
    a) Right Channel Recall
    b) Left Channel Recall
    c) Ear Asymmetry
    d) Total Recall
16. Auditory-Visual Integration Task (Birch & Belmont, 1964)
17. Behavioral Checklist (Ratings by the Examiner)
18. Socioeconomic Status (Rating by the Teacher)

The criterion measures were based on a reading level assessment by the teacher at the end of Grade 1. High Risk (severe and mild) and Low Risk (average and superior) groups were identified. Discriminant function analyses on the 22 predictor variables and the two criterion groups resulted in an overall hit-rate of 84.4% (High Risk = 78.1%, Low Risk = 85.5%). Extreme groups were classified with greater accuracy and most prediction errors occurred in the two middle groups.

Stepwise regression analysis produced the following results. Finger Localization, Recognition-Discrimination, Day of Testing, and Alphabet Recitation cumulatively correctly classified 81.6% of the children into their respective groups. Factor analysis revealed that these four measures all loaded on one factor (a general measure of sensory-perceptual-motor-mnemonic ability). This factor is thought is be related to those skills that develop early

during the preschool years. Finger Localization and Recognition-Discrimination also showed high predictive validity in predicting to kindergarten and first grade reading achievement levels.

Satz et al. (1978) followed these original subjects for another year and obtained criterion measures at the end of Grade 2. The following two criterion variables were used:

1. Classroom Reading Level as indicated by the teacher.
   a) Severely disabled (no readiness)
   b) Mildly disabled (first reader)
   c) Average (second reader)
   d) Superior (above second reader)
2. Classroom Reading Level and a standardized Achievement Test combined.

Predictive accuracy of the tests for Classroom Reading Level alone was fairly high (Overall hit-rate = 78%). When the two criterion measures were combined, the hit-rate dropped to 76%. The extreme groups were again predicted more accurately than were the two average groups.

A stepwise procedure ranked the predictor variables on criterion discrimination. Finger Localization, Alphabet Recitation, and Recognition-Discrimination were the three best predictors. The total hit rate for these variables was 78%. From these results, it would appear that sensori-motor-perceptual abilities are indeed valid predictors of subsequent reading achievement.

This same sample of boys was followed-up six years after the initial testing. Classroom Reading Level was again used as the criterion measure. A stepwise discriminant function analysis ranked the predictor variables in the following order:

1. Finger Localization
2. Peabody Picture Vocabulary Test (IQ score)
3. Beery Test of Visual-Motor Integration
4. Alphabet Recitation

An overall hit-rate of 72% was obtained, with the extreme groups predicted more accurately than the two average groups. An increase in the incidence of severe cases was found (up from 12% initially to 20% after Grade 5). On other related achievement measures, such as handwriting, Math, WRAT Reading, WRAT Spelling, and WRAT Arithmetic, the severe group was found to be significantly lagging behind the other three groups.

In a cross-validation of the original predictive battery, Satz, Friel, & Rudegair (1976) tested a new sample of 181 boys in kindergarten and at the end of Grade 2. Using Classroom Reading Level as the criterion measure, they obtained an overall hit-rate of 72%. As in the previous studies, the predictive accuracy was greatest for the two extreme reading groups. Finger Localization, the Embedded Figures Test, and the WISC Similarities subtest ranked the highest in the discriminative ranking of the tests. The first two tests

still loaded on the general sensorimotor-perceptual factor. However, the third test loaded on a verbal-conceptual factor. Subtle sample differences may have been responsible for these changes.

Another cross-validation study was performed using an eight-variable abbreviated test battery to predict achievement at the end of kindergarten and also at the end of Grade 1. A new sample of kindergarten children was used that included boys, girls, blacks, and whites. The criterion measure was an overall achievement rating made by the teacher. The hit-rate was 74% at the end of kindergarten and 88% at the end of Grade 1. Predictive ranking of the variables was as follows:

1. Socioeconomic Status
2. Alphabet Recitation
3. Finger Localization
4. Peabody Picture Vocabulary Test (IQ score)

To assess the predictive power of language related tasks, a series of 5 language tests was administered to a sample of kindergarten children. Using Classroom Reading Level at the end of Grade 1 as the criterion, it was found that the language battery (Verbal Fluency, ITPA Grammatic Closure subtest, Berry-Talbot Comprehension of Grammar Test, Syntax Test, and the Peabody Picture Vocabulary Test) correctly identified 82% of the children overall. The abbreviated nonlanguage battery discussed above correctly

identified 88% of the children. A combined linear stepwise discriminant analysis using both batteries revealed that Socioeconomic Status ranked highest, followed by Alphabet Recitation, and Finger Localization. When the additional language measures were included, there was no increase in predictive power. Satz et al. (1978) conclude that

> The results suggest that cultural, linguistic, conceptual, and perceptual skills all play an important role in forecasting later reading achievement. In terms of predictive power, however, the contribution of psycholinguistic variables may be secondary to those preconceptual sensory-motor and perceptual skills which have been shown to develop earlier during the ages of five to seven (p.339).

Incidence rates were computed for the original standardization population. The rates increased after Grade 1, plateaued between Grades 2 and 4, then rose again dramatically at Grade 5. By this time the incidence of severe cases was approximately 20%. This is indeed a sobering figure. Of the children in the severely disabled reading group, 95% were still having problems reading at the end of Grade 5.

The prognosis figures were equally distressing. Only 6.1% of the severe cases improved, while 17.7% of the mild cases showed improvement from Grades 2 to 5. 30% of the average readers and 3.2% of the superior readers became problem readers. The only optimistic prognosis was for the superior readers. All other groups showed little or no improvement and many actually got worse.

Peter & Spreen (1979) report the results of a follow-

up study of 177 learning handicapped children seen for neuropsychological testing and educational counselling between the ages of 8 and 12. These subjects were followed up 4 to 12 years later. Originally, the subjects were divided into three groups on the basis of data from a neurological examination: brain damaged, minimally brain damaged, and learning handicapped with no neurological signs. These subjects were compared to 67 normal adolescents and young adults with no history of learning problems or brain damage. The study was designed to "investigate the emotional and behavioral adjustment during late adolescence and young adulthood of a group of subjects who were identified as 'learning handicapped' during their elementary school years" (Peter & Spreen, 1979, p.77). These behavioral and personal adjustment patterns were measured by both a parent rating scale and a self-rated objectively scored personality questionnaire. Degree of neurological impairment, intelligence level, age at follow-up, and sex of the subjects were all considered in the study.

Results indicated that there was a significant relationship between a previous diagnosis of neurological impairment and behavioral deviance (reported by the parents) at follow-up. These findings remained significant when the effects of sex, age, and intelligence were taken into account. The behavioral abnormalities reported by the parents were apparent in adolescence and young adulthood and significantly discriminated between subjects with a neurological handicap and

and those without. All of the subjects with learning handicaps demonstrated deviant behaviors and more personal maladjustment than those subjects in the normal control group.

Intelligence was also related to the behavioral and adjustment outcome of the subjects. Those with higher levels of intelligence showed less overall behavioral pathology and better personal adjustment than those with lower intelligence levels.

Another important factor in the outcome of this study was the sex of the subject. Females showed significantly more maladaptive behaviors and signs of personal maladjustment than males. This result remained significant, regardless of age, intelligence, or degree of neurological handicap. The control group did not exhibit these sex differences.

Peter & Spreen (1979) state that "In summary, this study has indicated a significant relationship between the presence of a learning handicap in childhood and later personal maladjustment"(p.89). The presence of brain pathology was the most significant prognostic indicator of abnormal behavior in adolescence (18.8% of the variance accounted for); followed by intelligence level (17.4%)and sex (14.74%). Personal adjustment outcomes were predicted best by sex (15.29% of the total variance), while degree of brain pathology and intelligence were not significant predictors. The presence of a learning handicap was a very important predictor of adjustment outcome as well, contributing 22.79%

of the total variance.

In 1977, Rourke & Orr reported results from a four-year follow-up study of normal and retarded readers. Their subjects were 23 normal readers and 19 retarded readers. All subjects were male and all were in Grade 1 or Grade 2 in an urban school system in Ontario, Canada. The group was relatively homogeneous socioeconomically and none of the children had any visual or auditory acuity deficits or socio-emotional problems. They were tested at one-year intervals for three years after the initial assessment.

Normal readers had a centile score of 50 or above on the Reading subtest of the Metropolitan Achievement Test (MAT), and a score of 60 or above on either the Word Knowledge or Word Discrimination subtests of the MAT. Retarded readers had MAT Reading subtest centile scores of 20 or below and 35 or below on either the Word Knowledge or Word Discrimination subtests. Full Scale IQ values on the Wechsler Intelligence Scale for Children (Wechsler, 1949) were in the same range for both groups of readers.

There were no significant differences between the groups initially in age, WISC Performance IQ, Peabody Picture Vocabulary Test IQ, and subtests 1, 4, 7, 9, and 13 of the Underlining Test. On all other initial measures (MAT Word Knowledge, MAT Word Discrimination, MAT Reading, WRAT Reading, WRAT Spelling, WISC Verbal IQ, WISC Full Scale IQ, and Underlining subtests 2, 3, 5, 6, 8, 10, 11, 12, and Total)

the Normal Reading (NR) group performed significantly better than did the Retarded Reading (RR) group. On all criterion measures (MAT Reading and Word Knowledge, WRAT Reading and Spelling) the NR group performed better than did the RR group. The differences were statistically significant.

Stepwise regression analyses were performed to determine the best predictors of performance on the MAT and WRAT measures admininstered at the final follow-up. Multiple correlation coefficients for the Combined group ranged from 0.56 to 0.73, with an average of 0.67; for the NR group, values ranged from 0.39 to 0.74, with an average of 0.56; while for the RR group, values ranged from 0.23 to 0.85, with an average of 0.56. The best regression models for the Combined group and the NR group were quite similar to each other. The models for the RR group were different from either of the other two groups. Initial MAT and WRAT Reading performances predicted criterion measures for the NR group, but not for the RR group. For the RR group, the best predictors were the subtests of the Underlining Test. This test also predicted eventual reading and spelling performances for the normal group, but was an even better predictor for the group of retarded readers.

A discriminant analysis was performed, using the presence or absence of a gain in MAT Reading performance of 20 or more centile points as the criterion. Underlining subtests 8 and 13 were used, as these were the variables in the best

regression model for the criterion measure in the RR group. The results indicated a predictive accuracy of 73.7%.

There were two subtests of the Underlining Test that appeared most often in the best regression models. These were subtests 4 and 8, which involve nonverbal target and distractor items: gestalt figures in subtest 4 and sequences of geometric forms in subtest 8. The involvement of verbal mediation in these tasks may be an important variable, but its role is not assessed in these measures.

Rourke & Orr (1977) conclude that:

> In summary, if confirmed by cross-validation, the results of the current investigation would suggest that performance on the Underlining Test is a far more potent means of identifying retarded readers who are "at risk" (at ages 7-8) with respect to eventual reading and spelling achievement (at ages 11-12) than are the measures of psychometric intelligence, reading, or spelling which were used. (p.19)

Readers are cautioned regarding the interpretation of the relative predictive accuracy of the measures used, due to the restricted range of WISC Full Scale IQ values and initial MAT subtest scores. The restricted age range and the small number of measures used should also be considered when drawing inferences about specific children.

Only 5 of the 19 children originally classified as "retarded" readers made substantial gains in reading achievement over the four-year period. This paints a fairly dim picture for those students with reading problems early in life. Their later performances are predictable, but the

outlook seems rather bleak.

Several general conclusions can be drawn from the results of the follow-up studies discussed here. These include the following:

1. Children identified as reading disabled early in their school careers generally continue to have problems in reading, spelling, and other related academic areas as they progress through school. They never really seem to "catch up" academically and usually lag behind their age-mates and classmates in all achievement areas.
2. Many of these problems continue to exist, despite what seems to be adequate remedial instruction.
3. Many reading disabled children also experience a variety of socio-emotional and behavioral difficulties associated with their academic problems. These often persist into adolescence and young adulthood.
4. No general agreement exists as to the best predictor(s) of reading ability or disability. More specific research needs to be conducted, dealing with particular age groups and perhaps even various subgroups of reading disabled children. Cross-validation studies are also a necessity in this field of research.

Statement of the Problem

The purpose of the present research was to determine the relative predictive accuracy of the Wechsler Intelligence Scale for Children, the Peabody Picture Vocabulary Test, the Metropolitan Achievement Tests, the Wide Range Achievement Tests, the Rosner Auditory Analysis Test, and the Underlining Test for later reading and spelling levels. In addition, the present investigation was an attempt to cross-validate the results found by Rourke & Orr (1977) in their follow-up study of children with reading disabilities. The cross-validation was performed on a new group of male subjects from the same geographical area as the first group of subjects. A double cross-validation procedure was used to compare the results of the present study and those found by Rourke & Orr (1977) with each other.

# CHAPTER II

# METHOD

## Subjects

In the present study, 42 subjects were initially tested in 1978. Forty subjects were tested again in 1981. There were 26 subjects in the normal reading (NR) group and 14 subjects in the retarded reading (RR) group. The subjects were selected from a population of Grade 2 male students attending 9 schools in an urban school system in Ontario, Canada. The schools were basically the same as those used in the Rourke & Orr (1977) study, which were chosen for geographical proximity and relatively homogeneous socioeconomic status (middle class). At the time of initial testing, the subjects were screened to ensure that they were free of any auditory or visual aucuity deficits and socio-emotional disturbances. The two groups were also matched for age: the age range for the NR group was 84-104 months (Mean = 91.04 months); for the RR group, the range was 84-99 months (Mean = 91.36 months).

The subjects were divided into two groups based on their scores on the Metropolitan Achievement Tests (MAT) at initial testing. Normal readers had a centile score of 50 or above on the Reading subtest of the MAT and a centile score of 60 or above on either the Word Knowledge or Word

Analysis subtests of the MAT. Subjects in the RR group had a centile score of 30 or below on the Reading subtest of the MAT and a centile score of 35 or below on either the Word Knowledge or Word Analysis subtests. The Full Scale IQ range on the Wechsler Intelligence Scale for Children (Wechsler, 1949) was 85-121 for the NR group and 86-117 for the RR group.

Reading, Spelling, and Psychometric Intelligence Measures

The subjects were originally tested in 1978. The following measures were administered to them at that time:

1. Wechsler Intelligence Scale for Children (WISC)
2. Wide Range Achievement Test (WRAT; Jastak & Jastak, 1965)
   a) Reading subtest
   b) Spelling subtest
   c) Arithmetic subtest
3. Metropolitan Achievement Tests (MAT) (Primary II, Form F)
   a) Word Knowledge subtest
   b) Word Analysis subtest
   c) Reading Comprehension subtest
4. Peabody Picture Vocabulary Test (PPVT; Dunn, 1965)
5. Underlining Test (Doehring, 1968; Rourke & Orr, 1977)
6. Rosner Auditory Analysis Test (Rosner & Simon, 1970)

The subjects were retested on the following criterion

measures three years later:

1. Wide Range Achievement Test (WRAT)
   a) Reading subtest
   b) Spelling subtest
   c) Arithmetic subtest (not used in the analyses)
2. Metropolitan Achievement Tests (MAT) (Intermediate Battery)
   a) Reading Comprehension subtest
   b) Word Knowledge subtest

With the exception of the Underlining Test, the measures are quite well known and will not be elaborated on here.

Underlining Test (from Rourke & Orr, 1977)

The 13 subtests of the Underlining Test, originally called "Speed of Visual Perception" by Doehring (1968), are intended to assess speed and accuracy of visual discrimination for various kinds of verbal and nonverbal visual stimuli presented singly and in combination. In general, the visual stimulus becomes more verbal and more complex with each succeeding subtest. The first and last subtests involve the same task in order to permit assessment of practice effect. A short practice item is given for each subtest. An example of the stimulus to be underlined is printed at the top of the page in each case. The score is the total number of stimuli correctly underlined minus the total incorrectly underlined in a specific time period. The task requirement

is locating and underlining a particular stimulus interspersed among similar stimuli. The stimuli change for each subtest, but the response is always a simple underlining response to identify the specific stimulus. Details of the Underlining Test can be found in Appendix A.

Procedure

For Study 1 (initial testing), a number of male students in each school were given the MAT. Those who met the MAT selection criteria stated previously were given the WISC. Normal readers and retarded readers were chosen, based on the MAT criteria, WISC Full Scale IQ criteria, and age pairings stated previously. These students were then given the WRAT, the PPVT, the Rosner Auditory Analysis Test, and the Underlining Test in a random order by a number of experienced psychometrists. The psychometrists were not informed of the MAT scores of any of the subjects and each tested approximately the same number of subjects in the NR and RR groups.

In Study 2 (follow-up testing), 40 of the original 42 subjects were located and given the Reading Comprehension and Word Knowledge subtests of the MAT and the Reading, Spelling, and Arithmetic subtests of the WRAT. Wherever possible, the students were given all tests individually and were assessed in groups only when time and space made this necessary. All follow-up testing was done by one experienced psychometrist who had no knowledge of the ability or

achievement levels of any of the subjects or the group to which each subject belonged.

## CHAPTER III

## RESULTS

The means and standard deviations for the variables used in Study 1, as well as the criterion measures fof Study 2 are contained in Table 1. Values for both the NR and RR groups are included. An inspection of Table 1 indicates that there were no significant differences between the groups in Study 1 in age, WISC Performance IQ, WRAT Arithmetic centile score, and subtests 1, 2, 3, 4, 5, 6, 7, 8, 10, 13, 14, and Total of the Underlining Test. In all other instances, the performance of the NR group exceeded that of the RR group at statistically significant levels. Upon examination of the variables used in Study 2 (follow-up testing), it is apparent that the NR group performed better on all criterion measures than did the RR group, again at statistically significant levels. There were no significant age differences at Time 2.

Although the reading and spelling performances of the RR group remained inferior to those of the NR group at Time 2, closer examination of the individual scores in each group reveals some interesting observations. In the RR group, 11 of the 14 subjects improved their reading performances on the MAT Reading subtest from initial testing to follow-up. Of these 11, 7 improved by 20 or more centile points. 4

TABLE 1

Means and Standard Deviations for Age and Variables in Study 1 and Study 2

| Variable | NR Group | | RR Group | | t | |
|---|---|---|---|---|---|---|
| Study 1: | | | | | | |
| Age (in months) | 91.04 | (4.57) | 91.36 | (4.68) | <1.00 | n.s. |
| MAT Word Knowledge (centile) | 71.04 | (8.09) | 26.21 | (11.49) | 14.40 | a |
| MAT Word Analysis (centile) | 67.46 | (8.17) | 31.79 | (12.78) | 10.77 | a |
| MAT Reading (centile) | 64.62 | (8.61) | 16.07 | (10.31) | 15.87 | a |
| MAT Total (centile) | 68.00 | (7.73) | 20.14 | (11.08) | 16.01 | a |
| WRAT Reading (centile) | 86.92 | (10.76) | 49.93 | (19.06) | 7.88 | a |
| WRAT Spelling (centile) | 66.88 | (18.25) | 45.64 | (17.68) | 3.55 | a |
| WRAT Arithmetic (centile) | 59.00 | (16.98) | 48.43 | (20.65) | 1.74 | n.s. |
| WISC Verbal IQ | 106.92 | (6.66) | 99.14 | (8.65) | 3.17 | a |
| WISC Performance IQ | 111.23 | (9.17) | 107.79 | (10.96) | 1.06 | n.s. |
| WISC Full Scale IQ | 109.81 | (7.56) | 103.43 | (8.49) | 2.44 | b |
| PPVT IQ | 113.77 | (13.39) | 105.36 | (11.36) | 2.00 | b |
| Underlining 1 | 13.12 | (3.91) | 11.86 | (2.35) | 1.10 | n.s. |
| Underlining 2 | 19.08 | (4.71) | 19.64 | (4.62) | <1.00 | n.s. |
| Underlining 3 | 12.62 | (2.50) | 13.07 | (2.95) | <1.00 | n.s. |
| Underlining 4 | 9.00 | (3.92) | 8.71 | (3.79) | <1.00 | n.s. |
| Underlining 5 | 17.19 | (3.46) | 16.21 | (4.12) | <1.00 | n.s. |
| Underlining 6 | 8.15 | (1.43) | 7.93 | (2.43) | <1.00 | n.s. |
| Underlining 7 | 15.92 | (2.80) | 15.71 | (3.50) | <1.00 | n.s. |
| Underlining 8 | 6.46 | (1.48) | 5.79 | (2.12) | 1.18 | n.s. |

cont'd.

TABLE 1

(cont'd.)

| Variable | NR Group | | RR Group | | t | |
|---|---|---|---|---|---|---|
| Underlining 9 | 7.50 | (2.32) | 5.71 | (2.02) | 2.43 | b |
| Underlining 10 | 9.23 | (2.90) | 7.64 | (3.23) | 1.59 | n.s. |
| Underlining 11 | 11.73 | (3.56) | 7.86 | (4.11) | 3.11 | a |
| Underlining 12 | 4.88 | (1.53) | 3.93 | (1.27) | 1.99 | b |
| Underlining 13 | 14.19 | (2.65) | 12.57 | (2.41) | 1.90 | n.s. |
| Underlining 14 | 41.08 | (9.04) | 39.07 | (5.61) | <1.00 | n.s. |
| Underlining Total | 149.08 | (19.42) | 136.64 | (20.63) | 1.89 | n.s. |
| Rosner Auditory Analysis Test | 23.65 | (7.30) | 13.07 | (3.50) | 5.10 | a |
| Study 2: | | | | | | |
| Age (in months) | 131.42 | (4.46) | 131.86 | (4.19) | <1.00 | n.s. |
| MAT Word Knowledge (centile) | 69.69 | (18.29) | 45.14 | (18.89) | 4.00 | a |
| MAT Reading (centile) | 68.85 | (24.40) | 41.71 | (26.68) | 3.25 | a |
| MAT Total (centile) | 69.96 | (21.20) | 43.29 | (21.39) | 3.78 | a |
| WRAT Reading (centile) | 88.50 | (14.54) | 50.93 | (26.62) | 5.80 | a |
| WRAT Spelling (centile) | 69.52 | (16.66) | 37.79 | (22.25) | 4.65 | a |
| WRAT Arithmetic (centile) | 44.31 | (15.80) | 32.57 | (17.04) | 2.18 | b |

Note: Standard deviations are in parentheses.

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[a] t 2.46, $p < .01$.

[b] t 1.98, $p < .05$.

subjects improved up to 20 centile points and only 3 actually got worse. In the NR group, 9 of the 26 subjects increased their score on the MAT Reading subtest by 20 or more centile points, 9 subjects showed increases of up to 10 points, while 8 subjects got worse. WRAT Spelling scores indicate that in the RR group (n = 14), 10 subjects got worse while only 4 subjects made advances of up to 20 centile points. In the NR group (n = 26), 12 subjects got worse, 2 increased their scores by 20 or more centile points, while 12 subjects made increases of up to 20 centile points.

In order to determine the best predictors of performance on the MAT and WRAT criterion measures, individual stepwise regression analyses were computed, using the variables from the original Rourke & Orr (1977) study. The results of these analyses are presented in Table 2. The best regression models contained in Table 2 are divided such that there are individual models for the Combined Group (the NR Group plus the RR Group), the NR (Normal Readers) Group, and the RR (Retarded Readers) Group. The "best regression model" which appears for each group contains only those variables which, when added to each other in a stepwise fashion, constituted a statistically significant increment in the amount of variance accounted for in the criterion measure.

In order to obtain the regression equations (including the beta weights and constant values), the original data from the Rourke & Orr (1977) study were reanalyzed, using step-

wise regression analyses. The results of these analyses are presented in Table 3. Again, the "best regression models" are presented.

A double cross-validation procedure was then performed, using the regression equations from both the 1977 and 1981 data. Correlations between the actual (observed) and predicted scores for each criterion variable were calculated. Table 4 contains the $R^2$ values for each group when the regression equations from the 1977 data were used in predicting the values of the criterion variables from the 1981 data. Table 5 contains the $R^2$ values for each group when the regression equations from the 1981 data were used in predicting the values of the criterion variables from the 1981 data.

An inspection of Table 2 indicates the following:

1. The $R^2$ values for the best regression models were all very robust. All of them exceeded 0.70. The $R^2$ values for the RR group were higher than those for the NR and Combined groups on all four criterion measures. When arranged in rank-order, the average rank of the $R^2$ values for the RR group was 2.5, while the average rank for both the NR group and the Combined group was 8.5. The average $R^2$ value for the Combined group was .817; for the NR group it was .817; while for the RR group it .977.
2. For the four criterion measures, various variables appeared in the best regression models for the three

TABLE 2

Best Regression Models for the Four Criterion Variables Containing the Predictor Variables Significant Beyond the .10 Level, Regression Equations (including Beta Weights), Constant Values, and $R^2$ Values for the NR, RR, and Combined Groups (1981 data)

| Group | Regression Equation | Constant | $R^2$ |
|---|---|---|---|
| MAT Word Knowledge: | | | |
| Combined | VIQ (.5262) MATWK (.4412) U3 (.3600) U1 (-.2234) | -126.98 | .826 |
| Normal | VIQ (.6957) U3 (.5583) U7 (.5362) U8 (-.5009) U5 (.4074) U1 (-.3403) | -106.46 | .860 |
| Retarded | U5 (-.9950) FSIQ (.9599) U6 (.6933) U8 (-.3562) UTO (.2911) U1 (-.2320) U4 (.1214) | -145.54 | .995 |
| MAT Reading: | | | |
| Combined | FSIQ (.6711) MATWA (.3347) U3 (.2080) U4 (.1656) | -248.15 | .851 |
| Normal | FSIQ (.7457) U3 (.4532) MATWA (.4069) WRATS (.2605) U4 (.2595) MATR (.2522) | -417.05 | .724 |
| Retarded | WRATS (.6873) PIQ (.6187) MATWK (-.4647) VIQ (.2097) | -203.74 | .941 |
| WRAT Reading: | | | |
| Combined | WRATR (.4073) MATWA (.3023) WRATS (.2970) U3 (.1857) U4 (.1552) | -38.08 | .805 |
| Normal | UTO (.8676) U1 (-.8144) U2 (-.4938) U3 (.3886) WRATS (.3281) U6 (.3071) U12 (-.2940) WRATR (.2494) U8 (-.2212) | -12.52 | .930 |
| Retarded | WRATS (.9088) U11 (.4615) U7 (-.4224) U10 (-.3346) U1 (.2871) U4 (-.1350) U5 (-.0738) | 14.08 | .994 |

cont'd.

TABLE 2

(cont'd.)

| Group | Regression Equation | Constant | $R^2$ |
|---|---|---|---|
| WRAT Spelling: | | | |
| Combined | WRATS (.6185) U13 (.4089) MATWA (.4028) UTO (-.3991) U3 (.2548) | -28.48 | .785 |
| Normal | U13 (.6304) WRATS (.6167) U11 (-.4028) U1 (-.3922) MATWA (.3782) MATWK (-.2855) | -1.35 | .752 |
| Retarded | WRATS (1.3840) U7 (-.6490) VIQ (-.3552) MATR (.3032) U12 (-.1668) U5 (-.1189) | 125.13 | .977 |

Note:

MATWK = MAT Word Knowledge subtest; VIQ = WISC Verbal Intelligence Quotient; U = Underlining Test; FSIQ = WISC Full Scale Intelligence Quotient; UTO = Underlining Test Total Score; MATWA = MAT Word Analysis subtest; WRATR = WRAT Reading subtest; WRATS = WRAT Spelling subtest; PIQ = WISC Performance Intelligence Quotient.

TABLE 3

Best Regression Models for the Four Criterion Variables Containing the Predictor Variables Significant Beyond the .10 Level, Regression Equations (including Beta Weights), Constant Values, and $R^2$ Values for the NR, RR, and Combined Groups (1977 data)

| Group | Regression Equations | Constant | $R^2$ |
|---|---|---|---|
| MAT Word Knowledge: | | | |
| Combined | MATWD (.6755) PPVT (.3063) U8 (.1974) | -71.60 | .725 |
| Normal | MATWD (.5644) PPVT (.4954) | -73.82 | .398 |
| Retarded | U10 (.8509) U9 (-.6614) U8 (.5671) U4 (.3176) WRATS (.3040) | -18.79 | .851 |
| MAT Reading: | | | |
| Combined | MATR (.5447) U5 (.2558) FSIQ (.2453) U4 (-.1964) | -82.30 | .705 |
| Normal | VIQ (.8670) U13 (.7885) U4 (-.7869) FSIQ (-.5001) MATR (.3997) WRATS (-.3941) | -8.37 | .703 |
| Retarded | U8 (.4714) U13 (.3865) | -12.88 | .444 |
| WRAT Reading: | | | |
| Combined | WRATS (.4193) U10 (.2663) U8 (.2177) VIQ (.1986) | -50.74 | .702 |
| Normal | WRATR (.8748) MATWK (-.4736) U8 (.2886) | 25.83 | .739 |
| Retarded | U10 (.4725) | 16.64 | .223 |
| WRAT Spelling: | | | |
| Combined | WRATR (.7463) | 11.68 | .557 |
| Normal | WRATR (.6299) | -18.11 | .397 |
| Retarded | U1 (1.0658) U11 (1.0228) UTO (-.8973) U4 (-.5220) VIQ (.2785) | -62.44 | .721 |

cont'd.

Note:

MATWD = MAT Word Discrimination subtest; PPVT = Peabody Picture Vocabulary Test; U = Underlining Test; WRATR = WRAT Reading subtest; WRATS = WRAT Spelling subtest; VIQ = WISC Verbal Intelligence Quotient; PIQ = WISC Performance Intelligence Quotient: FSIQ = WISC Full Scale Intelligence Quotient; MATWK = MAT Word Knowledge subtest; UTO = Underlining Test Total Score.

TABLE 4

$R^2$ Values for the 1977 Regression Equations and the 1981 Data

| Criterion Variable | Group | $R^2$ |
|---|---|---|
| MAT Reading | Combined | .367 |
| | Normal | .079 |
| | Retarded | .081 |
| MAT Word Knowledge | Combined | .450 |
| | Normal | .210 |
| | Retarded | .225 |
| WRAT Reading | Combined | .466 |
| | Normal | .297 |
| | Retarded | .010 |
| WRAT Spelling | Combined | .579 |
| | Normal | .253 |
| | Retarded | .186 |

TABLE 5

$R^2$ Values for the 1981 Regression Equations and the 1977 Data

| Criterion Variable | Group | $R^2$ |
|---|---|---|
| MAT Reading | Combined | .546 |
| | Normal | .002 |
| | Retarded | .384 |
| MAT Word Knowledge | Combined | .445 |
| | Normal | .039 |
| | Retarded | .043 |
| WRAT Reading | Combined | .549 |
| | Normal | .001 |
| | Retarded | .157 |
| WRAT Spelling | Combined | .440 |
| | Normal | .020 |
| | Retarded | .003 |

groups. However, no general patterns emerged. For MAT Word Knowledge, WISC IQ variables (specifically Verbal and Full Scale IQ) and various subtests of the Underlining Test were the best predictors for all three groups. MAT Word Knowledge (initial testing) was also a predictor for the Combined group. For MAT Reading, the models for the Combined group and the NR group were more similar to each other than to the model for the RR group. WISC Full Scale IQ, MAT Word Analysis, and Underlining subtests 3 and 4 were important predictors for the Combined and NR groups. The model for the RR groups contained WISC Performance and Verbal IQs, WRAT Spelling, and MAT Word Knowledge, but no subtests of the Underlining Test. For WRAT Reading, all three models contained the WRAT Spelling subtest and some subtests of the Underlining Test. Various similarities existed between the groups, but no general conclusions could be drawn. For WRAT Spelling, the initial WRAT Spelling subtest was an important predictor for all 3 groups. Various other variables, including those from the Underlining Test also appeared in the regression equations for each group, but no specific similarities were obvious between the groups.

3. It is interesting to note that subtest 3 of the Underlining Test appeared in the regression equations of the Combined group for all 4 of the criterion measures. It

also appeared in the regression equations of the Normal group for all criterion measures except WRAT Spelling. For the Retarded group, subtest 5 of the Underlining Test appeared in the regression equations for all criterion measures, with the exception of MAT Reading.

4. The WRAT Spelling subtest also appeared in 8 of the 9 regression equations for the criterion measures of MAT Reading, WRAT Reading, and WRAT Spelling. The one exception was MAT Reading- Combined group. The WRAT Spelling subtest did not appear in any of the regression equations for MAT Word Knowledge.
5. Various subtests of the Underlining Test appeared in the regression equations of the NR group for all four criterion measures. For the RR group, Underlining subtests appeared in the regression equations for all criterion measures, except MAT Reading.
6. WISC IQ measures were included as predictors for both the NR and RR groups for MAT Word Knowledge and MAT Reading. They were not included for either group for WRAT Reading, and appeared only for the RR group for WRAT Spelling. The PPVT IQ did not appear in any regression equations for any of the criterion measures.
7. MAT and WRAT measures were not good predictors of eventual MAT Word Knowledge performance. Both MAT Reading and WRAT Spelling levels were predicted by MAT

and WRAT variables. Only WRAT variables predicted eventual WRAT Reading performance. This was true for both the NR and RR groups.

A comparison of Tables 2 and 3 indicates that there were few, if any, similarities between the two sets of regression equations (1977 and 1981) for any of the four criterion variables. Individual , as well as average $R^2$ values for the three groups were significantly higher for the 1981 data than for the 1977 data. There were also differences in the rankings of the $R^2$ values between the 1977 and 1981 data.

An inspection of Table 4, which contains the $R^2$ values obtained when the 1977 regression equations were used to predict 1981 criterion values, reveals very low $R^2$ values for both the NR and RR groups on all four criterion measures. The $R^2$ values for the Combined group were slightly higher, but only the WRAT Spelling value was over 0.50 (which indicates 50% of the variance accounted for).

Table 5, which contains the $R^2$ values obtained when the 1981 regression equations were used to predict 1977 criterion values, reveals very low $R^2$ values for both the NR and RR groups on all four criterion measures, with only one exception. That was for the RR group on MAT Reading. The Combined group produced slightly higher $R^2$ values, but only the MAT Reading and WRAT Reading values were above 0.50 (which again indicates 50% of the variance accounted for).

# CHAPTER IV

# DISCUSSION

No general patterns among the predictor variables emerged in the present study. Different combinations of variables were included in the regression equations for the three groups on the four criterion measures. Therefore, no specific conclusions can be drawn regarding the most important or significant predictors of reading disability in the present study. The double cross-validation procedure revealed that the regression equations from neither the 1977 nor the 1981 data could be used to make predictions to the other sample of subjects. This is not a particularly startling outcome due in part to the fact that the present study is not a strict cross-validation of the original Rourke & Orr (1977) study. Very late in the present investigation it was discovered that large discrepancies existed between the two studies with respect to the administration and scoring of the Underlining Test. Appendix B contains a comparison of the means and standard deviations of the Underlining subtests for the 1977 and 1981 (Normal Readers only), along with the norms for the Underlining Test (Rourke & Gates, 1980). Closer inspection of these figures reveals that only subtests 4, 5, 7, 8, and 9 have comparable means and standard deviations across the three sets of values presented.

On all other subtests, the 1977 means and standard deviations are substantially higher than either the 1981 or the normative values. On the other hand, the 1981 means and standard deviations are very similar to the normative data. It is reasonable to assume, therefore, that the changes made in the administration and scoring of the Underlining Test between 1977 and 1981 produced the discrepancies observed here. Corrections would have to be made in the 1977 data to equate the results from the Underlining Test and make the two studies more compatible.

Several other explanations for these results can be suggested. First, the sizes of both samples were relatively small ($n$ = 42 in 1977; $n$ = 40 in 1981). The size of the subgroups in each sample was, therefore, even smaller (NR = 23, RR = 19 in 1977; NR = 26, RR = 14 in 1981). Cohen & Cohen (1975) recommend at least 40 observations (subjects) per independent variable used. Horton (1978) agrees with the usual recommendation of 10 subjects per independent variable used in a study. In the present study, there were 25 independent variables, which would necessitate the use of at least 250 subjects. Obviously, these are idealistic figures. However, small sample sizes often produce unreliable multiple regression coefficients, and may lead to problems in replication.

Another methodological issue concerns the intercorrelations among the predictor variables in both studies. Multi-

collinearity often produces unstable, fluctuating, and unreliable multiple correlation coefficients (Nie, Hull, Jenkins, Steinbrenner, & Bent, 1975). Numerous intercorrelations existed among the variables in this study (See Appendix C). Future studies should consider one of two suggested solutions to the problem of multicollinearity. These are the following:

1. Create a new variable which is a composite of the set of highly intercorrelated variables and use this variable in the regression equation (ie. one composite MAT variable).
2. Use only one of the variables in the highly correlated set to represent the underlying dimension (ie. MAT Reading subtest only).

The third issue concerns the actual characteristics and ability levels of the subjects in the two samples. Post-hoc t-tests revealed that, for the Normal Readers, on initial testing, the subjects in the 1977 study scored significantly higher ($p < .05$) on subtests 1, 2, 3, 5, 6, 8, 9, 10, 11, 12, 13, and Total of the Underlining Test, MAT Word Discrimination/Analysis, and WRAT Spelling subtest than did subjects in the 1981 study. The differences in performance on the Underlining Test have been discussed previously, but these differences could be a factor related to the highly dissimilar regression equations produced in each sample.

In the group of Retarded Readers, the subjects in the

1977 study scored significantly higher ($p < .05$) than did the subjects in the 1981 study on subtests 1, 6, 13, and Total of the Underlining Test on initial testing. However, the 1981 subjects scored significantly higher ($p < .05$) on MAT Word Knowledge, MAT Reading, WRAT Reading, WRAT Spelling, and WRAT Arithmetic than did the 1977 subjects on initial testing. The 1981 subjects showed significantly higher ($p < .05$) performances at follow-up on MAT Word Knowledge and MAT Reading than did the 1977 subjects. These differences in performance could also be related to the differences observed in the regression equations between the two samples.

Upon comparison of the t-test results for the 1977 and 1981 data, obvious differences in the Underlining subtests appear once again. In 1977, the Normal Readers scored significantly higher than the Retarded Readers on 9 subtests of the Underlining Test (subtests 2, 3, 5, 6, 8, 10, 11, 12, and Total). However, in 1981, on only 3 subtests (9, 11, and 12) were there significant differences between the Normal and Retarded Readers. Again, this factor may be related to the lack of similarity between the regression equations for each study.

An interesting comparison can also be made between the two samples of retarded readers regarding increments in performance over time. In the 1977 study, only 5 of 19 subjects in the RR group improved their performance on the MAT Reading subtest by 20 or more centile points. In the

1981 study, however, 7 of the 14 retarded readers made advances of 20 or more centile points and 4 more subjects made advances of up to 20 centile points. It is interesting to note that at least 11 of the 14 retarded readers in the 1981 study had some type of remedial help over the three-year follow-up period. These data were not available for the 1977 study. The introduction of remedial instruction in the 1981 study was a factor that could not be controlled for. Its positive effects could be noted in the higher achievement levels for the retarded readers in the 1981 sample for all measures at follow-up.

A factor closely related to remediation is the general attitude towards learning disabled children exhibited in schools, clinics, and the community as a whole. Public awareness and interest has certainly increased in this area over the past few years. Changes have occurred more rapidly in recent years, and these differences may have been reflected in the two studies discussed here. The subjects in the Rourke & Orr (1977) study were first assessed in 1973, whereas the subjects in the present study were seen initially in 1978. Many changes in attitudes toward learning disabilities, remediation, and changes in the remedial techniques themselves have occurred during the time period between 1973 and 1978. The learning disabled children in the present study may have had more and/or better opportunities for improvement in their achievement levels than did those

children in the original Rourke & Orr (1977) study.

Despite the limitations discussed above, several important conclusions can be drawn from the present study. It is apparent that, as a group, the retarded readers did not make significant progress on the three achievement measures (reading, spelling, and arithmetic). When considered individually, some of them improved, some remained at the same level, and some got worse. This is to be expected, considering the usual "regression toward the mean" phenomenon. All were reading and spelling well below the level of the normal group at follow-up, and were also performing below the level expected for their grade and chronological age. Spelling performances were consistently at a lower level than reading performances.

As a group, the normal readers made more progress than did the retarded readers on all measures of achievement. Individually, however, it is distressing to note that the same state of affairs attains for normal readers as for retarded readers. Some of them improved, some remained at the same level, and some actually got worse over the three-year follow-up period. Again, the phenomenon of "regression toward the mean" cannot be ignored, but these facts are indeed distressing and may be cause for concern. If this is a consistent and reliable trend, there exists a need to develop a system of identification for these normal readers who actually regress over a period of time.

Comparisons with the Rourke & Orr (1977) study indicate that the initial degree of impairment in reading and spelling performances may be an important factor in predicting future outcomes in reading disabled children. The subjects in the 1977 study performed at much lower levels initially on the achievement measures than did the subjects in the 1981 sample. This was true for both the normal and retarded readers, but was particularly evident in the group of retarded readers. These differences were also evident upon follow-up testing. These two samples may not be at all comparable in terms of level of performance on academic measures. Again, we have more evidence associated with the problems of a less-than-strict cross-validation study.

The influence of remediation cannot be ignored. It is difficult to make conclusive statements in this regard due to the lack of information on possible remediation of the original sample. However, based on historical reviews of remedial procedures and the more recent introduction of these methods into the classroom, it is quite reasonable to assume that the subjects in the 1977 sample did not receive as extensive remedial instruction as the subjects in the present study. The possible positive consequences of remediation need to be researched in much greater depth.

Future studies with learning disabled children in general and reading disabled children in particular will likely be of much greater use and practical value if a

major factor is taken into consideration. This is the problem of the heterogeneity of the sample. Care was taken, in the present study, to ensure that all children met the strict selection criteria outlined by Rourke (1978a), as well as those criteria associated with this particular research. Even so, it is obvious from recent research (Fisk & Rourke, 1979; Fisk & Rourke, 1983; Petrauskas & Rourke, 1979; Rourke, 1983; Rourke & Strang, 1983; Strang & Rourke, in press) that specific subtypes of learning disabled children exist and do perform differently in terms of neuropsychological test patterns. Future studies should consider not only the level of performance, but also the patterns of performance exhibited by these children. Children with a specific subtype of learning or reading disability may also benefit differentially from remedial instruction. Future studies will have to deal with these various subtypes individually if the results are to be at all meaningful. Torgensen & Dice (1980) stress the need for studies that use "clearly defined, and relatively homogeneous, subgroups of learning disabled children" (p. 535). Researchers would be wise to heed this timely advice.

# APPENDIX A

## UNDERLINING TEST (ROURKE & ORR, 1977)

Underlining 1 (Single Number)

The subject is required to underline the number 4 each time it appears on a printed page containing a random sequence of 360 single numbers. The time limit is 30 seconds.

Underlining 2 (Single Geometric Form)

The subject is required to underline a Greek cross with a pencil each time it appears in random sequence among a series of 235 geometric forms, including squares, stars, circles, triangles, etc. The forms are about 1/4 inches in height. The time limit is 30 seconds.

Underlining 3 (Single Nonsense Letter)

A single nonsense letter is interspersed among 10 structurally similar nonsense letters in a random sequence of 126 letters. The time limit is 60 seconds.

Underlining 4 (Gestalt Figure)

The figure to be identified is a diamond about 1 1/2 inches in height containing a square which in turn contains a diamond. This figure is interspersed among similar figures in a random sequence of 168 figures. The time limit is 60 seconds.

Underlining 5 (Single Letter)

The letter "s" is interspersed among 360 randomized letters. The time limit is 30 seconds.

Underlining 6 (Single Letter in Syllable Context)

162 four-letter nonsense syllables are presented, 47 of which contain the letter "e". The subject is required to underline each syllable containing "e". The time limit is 45 seconds.

Underlining 7 (Two Letters)

The letters "b" and "m" are interspersed among 360 randomized letters. The time limit is 45 seconds.

Underlining 8 (Sequence of Geometric Forms)

Four geometric forms (triangle, Greek cross, circle, crescent) are presented in various orders for a total of 65 "syllables". The subject is required to underline only the groups with the order triangle, cross, crescent, and circle. The time limit is 60 seconds.

Underlining 9 (Four-letter Nonsense Syllable, Unpronounceable)

The subject is required to underline a four-letter nonsense syllable (fsbm) interspersed among 146 four-letter syllables. All syllables are made up of consonants, which renders them unpronounceable. The time limit is 60 seconds.

Underlining 10 (Four-Letter Nonsense Syllable, Pronounceable)

This task is the same as in the previous subtest except that it involves the identification of a pronounceable nonsense syllable (narp) instead of an unpronounceable nonsense syllable. This syllable is interspersed among other nonsense syllables made up of the letters n, a, r, p. The time limit is 60 seconds.

Underlining 11 (Four-Letter Word)

The word "spot" is interspersed among 162 four-letter syllables made up of the letters s, p, o, t. The time limit is 60 seconds.

Underlining 12 (Unspaced Four-Letter Word)

The word "spot" is interspersed among the letters s, p, o, t in various orders, with no syllabic spacing. The time limit is 60 seconds.

Underlining 13 (Single Number)

This task is exactly the same as that in the first subtest, except that the number to be underlined is 5 instead of 4. The time limit is 30 seconds.

Underlining 14 (Boxes)

This subtest measures the speed of underlining. The subject is required to underline as many rectangular boxes as he can in 30 seconds.

# APPENDIX B

## MEANS AND STANDARD DEVIATIONS FOR 1977 AND 1981 NORMAL READERS AND NORMATIVE DATA FOR THE UNDERLINING TEST

| Underlining Subtest | 1977 Mean | 1977 S.D. | 1981 Mean | 1981 S.D. | Norms Mean | Norms S.D. |
|---|---|---|---|---|---|---|
| 1 | 28.04 | (6.73) | 13.12 | (3.91) | 12.93 | (3.09) |
| 2 | 32.13 | (6.96) | 19.08 | (4.71) | 20.14 | (4.73) |
| 3 | 19.60 | (3.95) | 12.62 | (2.50) | 13.74 | (3.43) |
| 4 | 8.09 | (6.31) | 9.00 | (3.92) | 9.12 | (3.84) |
| 5 | 25.00 | (5.93) | 17.19 | (3.46) | 20.21 | (6.39) |
| 6 | 17.74 | (4.59) | 8.15 | (1.43) | 8.58 | (2.26) |
| 7 | 17.22 | (4.70) | 15.92 | (2.80) | 17.16 | (4.88) |
| 8 | 9.78 | (3.84) | 6.46 | (1.48) | 7.04 | (1.75) |
| 9 | 9.35 | (3.66) | 7.50 | (2.32) | 8.12 | (2.66) |
| 10 | 16.83 | (5.37) | 9.23 | (2.90) | 9.77 | (4.29) |
| 11 | 17.83 | (4.81) | 11.73 | (3.56) | 10.23 | (4.08) |
| 12 | 9.26 | (2.32) | 4.88 | (1.53) | 5.21 | (1.70) |
| 13 | 25.22 | (6.63) | 14.19 | (2.65) | 14.28 | (3.44) |
| 14 | not given | | 41.08 | (9.04) | 39.58 | (8.22) |
| Total | 236.09 | (43.91) | 149.08 | (19.42) | 156.53 | (32.69) |

Note: Norms are for ages 7-8.

# APPENDIX C

## INTERCORRELATIONS (ABOVE THE 0.70 LEVEL AMONG THE PREDICTOR VARIABLES (1981 DATA)

| Variables | $R^2$ |
|---|---|
| MAT Word Analysis/ MAT Word Knowledge | .817 |
| MAT Word Analysis/ MAT Reading | .827 |
| MAT Word Knowledge/ MAT Reading | .906 |
| WRAT Reading/ MAT Word Analysis | .757 |
| WRAT Reading/ MAT Word Knowledge | .808 |
| WRAT Reading/ MAT Reading | .762 |
| WRAT Reading/ WRAT Spelling | .704 |
| WISC Full Scale IQ/ WISC Verbal IQ | .843 |
| WISC Full Scale IQ/ WISC Performance IQ | .859 |
| WISC Verbal IQ/ PPVT IQ | .721 |

# SARNIA READING

RAW DATA

Day/Month/Year

| Age (Mo.) | Grade | DOB | Date Tested | Class | MAT Word Knowledge | MAT Word Analysis | MAT % Reading | Total Reading 1+3 | VIQ | WISC PIQ | WISC FSIQ | PPVT 12 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 94 | 2 | 11/02/70 | 12/12/77 | 2 | 14 | 12 | 05 | 06 | 104 | 107 | 106 | 104 |
| 94 | 2 | 03/02/70 | 12/12/77 | 2 | 39 | 33 | 22 | 33 | 90 | 101 | 95 | 97 |
| 96 | 2 | 08/12/69 | 12/12/77 | 2 | 28 | 27 | 22 | 25 | 91 | 99 | 94 | [illegible] |
| 94 | 2 | 10/02/70 | 12/12/77 | 1 | 69 | 67 | 64 | 67 | 96 | 118 | 107 | [illegible] |
| 96 | 2 | 11/12/69 | 12/12/77 | 1 | 73 | 80 | 57 | 64 | 87 | 86 | 85 | [illegible] |
| 91 | 2 | 26/04/70 | 12/12/77 | 1 | 63 | 64 | 57 | 64 | 114 | 107 | 112 | [illegible] |
| 99 | 2 | 10/09/69 | 12/12/77 | 1 | 67 | 67 | 74 | 71 | 99 | 115 | 107 | 111 |
| 85 | 2 | 05/11/70 | 12/12/77 | 1 | 69 | 58 | 71 | 74 | 108 | 118 | 114 | [illegible] |
| 92 | 2 | 17/03/70 | 12/12/77 | 1 | 79 | 80 | 74 | 77 | 103 | 110 | 107 | [illegible] |
| 89 | 2 | 17/04/70 | 12/12/77 | 1 | 69 | 73 | 61 | 67 | 109 | 117 | 114 | 113 |
| 89 | 2 | 18/04/70 | 12/12/77 | 1 | 83 | 70 | 61 | 71 | 106 | 108 | 108 | 113 |
| 87 | 2 | 11/09/70 | 12/12/77 | 1 | 76 | 76 | 68 | 74 | 106 | 106 | 107 | 97 |
| 90 | 2 | 14/07/70 | 15/03/78 | 1 | 90 | 76 | 68 | 80 | 110 | 118 | 115 | 120 |
| 95 | 2 | 21/12/70 | 12/12/77 | 1 | 73 | 64 | 64 | 71 | 115 | 113 | 115 | 129 |
| 91 | 2 | 12/05/70 | 12/12/77 | 1 | 63 | 67 | 64 | 64 | 110 | 108 | 110 | 114 |
| 87 | 2 | 31/08/70 | 16/12/77 | 2 | 39 | 31 | 28 | 33 | 97 | 106 | 101 | [illegible] |
| 85 | 2 | 18/10/70 | 12/12/77 | 1 | 63 | 61 | 50 | 58 | 108 | 114 | 112 | 113 |
| 94 | 2 | 17/04/70 | 16/12/77 | 1 | 63 | 64 | 64 | 64 | 100 | 107 | 104 | 100 |
| 91 | 2 | 14/05/70 | 16/12/77 | 2 | 39 | 34 | 09 | 25 | 94 | 115 | 104 | 93 |
| 84 | 2 | 10/12/70 | 12/12/77 | 2 | 22 | 34 | 02 | 06 | 100 | 120 | 110 | 120 |
| ~~90~~ | ~~2~~ | ~~25/05/70~~ | ~~12/12/77~~ | ~~1~~ | ~~79~~ | ~~76~~ | ~~78~~ | ~~79~~ | ~~105~~ | ~~106~~ | ~~105~~ | ~~111~~ |
| 84 | 2 | 10/12/70 | 16/12/77 | 1 | 79 | 54 | 68 | 74 | 109 | 115 | 113 | 111 |
| 99 | 2 | 17/11/69 | 15/03/78 | 2 | 06 | 44 | 08 | 04 | 86 | 89 | 86 | 93 |
| 92 | 2 | 25/03/70 | 12/12/77 | 2 | 07 | 27 | 06 | 04 | 97 | 104 | 101 | 109 |
| 92 | 2 | 14/07/70 | 15/03/78 | 1 | 72 | 54 | 50 | 56 | 109 | 118 | 115 | 125 |
| 92 | 2 | 28/03/70 | 16/12/77 | 1 | 73 | 73 | 57 | 64 | 115 | 124 | 121 | 132 |
| 94 | 2 | 08/02/70 | 12/12/77 | 1 | 67 | 70 | 68 | 67 | 104 | 106 | 105 | 104 |
| 88 | 2 | 05/08/70 | 16/12/77 | 1 | 79 | 61 | 54 | 64 | 118 | 117 | 119 | 132 |
| 92 | 2 | 09/07/70 | 15/03/78 | 1 | 76 | 70 | 77 | 78 | 116 | 113 | 116 | 125 |
| 93 | 2 | 26/07/70 | 17/05/78 | 2 | 26 | 38 | 28 | 28 | 101 | 90 | 96 | 100 |
| 90 | 2 | 24/10/70 | 17/05/78 | 2 | 38 | 10 | 26 | 34 | 103 | 108 | 106 | 116 |
| 89 | 2 | 15/12/70 | 17/05/78 | 1 | 50 | 62 | 54 | 48 | 106 | 111 | 109 | 104 |
| 104 | 2 | 11/04/69 | 17/05/78 | 1 | 76 | 58 | 77 | 78 | 104 | 111 | 108 | 103 |
| 97 | 2 | 05/03/70 | 21/04/78 | 2 | 20 | 26 | 26 | 23 | 94 | 127 | 110 | 107 |
| 11 | 2 | 08/05/70 | 15/12/77 | 1 | 67 | 76 | 68 | 67 | 104 | 85 | 94 | 97 |

| WRAT Reading | WRAT Spelling | WRAT Arith | Underlining 1 2 | 3 4 | 5 6 | 7 8 | 9 10 | 11 12 | 13 14 | Total | Rows | Handed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 45 | 30 | 21 | 11 17 | 12 05 | 16 05 | 11 04 | 04 03 | 03 04 | 10 36 | 105 | 10 | R0 |
| 66 | 39 | 37 | 09 31 | 18 07 | 13 07 | 15 07 | 08 13 | 12 05 | 11 44 | 156 | 19 | L1 |
| 27 | 32 | 45 | 14 19 | 09 10 | 18 10 | 21 08 | 07 11 | 07 01 | 14 51 | 149 | 12 | R |
| 73 | 39 | 47 | 14 20 | 17 12 | 23 08 | 17 06 | 09 09 | 10 06 | 16 47 | 167 | 29 | R |
| 86 | 58 | 30 | 16 20 | 12 09 | 17 09 | 17 04 | 11 13 | 15 05 | 17 44 | 165 | 16 | L |
| 73 | 58 | 47 | 09 15 | 10 08 | 13 09 | 12 07 | 04 09 | 10 04 | 12 30 | 122 | 20 | R |
| 77 | 47 | 30 | 13 26 | 19 09 | 19 09 | 17 06 | 06 05 | 13 05 | 15 51 | 162 | 20 | L |
| 84 | 55 | 77 | 13 17 | 14 11 | 20 06 | 15 07 | 10 10 | 17 06 | 14 45 | 160 | 15 | R |
| 86 | 63 | 42 | 11 16 | 09 05 | 20 06 | 16 05 | 06 04 | 06 04 | 14 36 | 122 | 20 | R |
| 96 | 45 | 77 | 13 24 | 14 14 | 20 09 | 16 08 | 09 15 | 11 04 | 12 61 | 169 | 29 | R |
| 98 | 96 | 66 | 09 17 | 11 09 | 11 08 | 12 07 | 10 12 | 15 05 | 09 23 | 135 | 30 | R |
| 99 | 96 | 45 | 07 13 | 09 09 | 13 07 | 11 04 | 08 10 | 12 04 | 09 33 | 116 | 33 | L |
| 98 | 63 | 42 | 16 18 | 13 11 | 20 10 | 18 08 | 07 13 | 15 05 | 14 44 | 168 | 35 | R |
| 94 | 78 | 66 | 15 22 | 14 10 | 20 08 | 18 07 | 06 11 | 14 08 | 19 44 | 172 | 17 | R |
| 82 | 66 | 66 | 12 20 | 14 03 | 23 08 | 20 07 | 08 12 | 13 07 | 17 44 | 164 | 11 | R |
| 58 | 47 | 21 | 13 21 | 10 13 | 15 10 | 22 04 | 04 05 | 12 03 | 13 42 | 145 | 07 | L |
| 95 | 84 | 79 | 22 34 | 12 11 | 19 12 | 25 02 | 03 04 | 12 00 | 18 52 | 176 | 19 | R |
| 75 | 68 | 47 | 12 14 | 14 13 | 12 09 | 15 06 | 05 08 | 10 02 | # 28 | 131 | 31 | R |
| 47 | 66 | 50 | 13 24 | 14 16 | 20 12 | 16 08 | 06 08 | 13 03 | 16 44 | 169 | 09 | R |
| 53 | 66 | 79 | 14 20 | 19 10 | 15 07 | 16 07 | 04 07 | 03 05 | 09 33 | 136 | 13 | L |
| ~~96~~ | ~~81~~ | ~~66~~ | ~~11 15~~ | ~~12 08~~ | ~~13 05~~ | ~~16 07~~ | ~~10 08~~ | ~~14 05~~ | ~~13 39~~ | ~~137~~ | ~~20~~ | |
| 99 | 93 | 79 | 09 14 | 13 10 | 17 07 | 13 07 | 05 07 | 06 05 | 14 22 | 127 | 14 | L |
| 50 | 30 | 21 | 13 21 | 15 12 | 15 06 | 12 00 | 03 04 | 04 04 | 11 33 | 120 | 15 | R |
| 23 | 27 | 42 | 10 17 | 14 10 | 12 06 | 12 05 | 05 07 | 04 05 | 12 46 | 119 | 17 | L |
| 77 | 66 | 66 | 25 24 | 13 00 | 18 09 | 14 07 | 06 08 | 04 06 | 17 43 | 151 | 17 | R |
| 81 | 58 | 61 | 12 20 | 12 12 | 20 09 | 16 07 | 11 07 | 12 05 | 14 44 | 159 | 30 | R |
| 92 | 90 | 47 | 14 23 | 13 12 | 19 07 | 18 08 | 08 15 | 16 05 | 17 44 | 175 | 26 | R |
| 88 | 47 | 66 | 10 15 | 14 13 | 14 07 | 16 07 | 07 09 | 07 05 | 13 35 | 137 | 32 | R |
| 99 | 99 | 66 | 10 14 | 11 04 | 14 07 | 15 07 | 06 07 | 07 04 | 13 35 | 119 | 32 | R |
| 82 | 55 | 66 | 08 15 | 11 09 | 13 07 | 18 06 | 03 08 | 14 05 | 14 39 | 131 | 13 | R |
| 77 | 58 | 77 | 11 15 | 12 04 | 12 08 | 16 07 | 09 05 | 05 04 | 14 36 | 122 | 17 | R |
| 97 | 61 | 92 | 16 20 | 17 02 | 19 09 | 14 08 | 07 10 | 12 05 | 16 47 | 155 | 25 | R |
| 58 | 47 | 39 | 14 20 | 12 11 | 14 07 | 16 06 | 08 05 | 15 05 | 14 44 | 147 | 17 | R |
| 19 | 10 | 37 | 09 19 | 11 05 | 24 03 | 12 03 | 06 04 | 05 03 | 13 35 | 121 | 15 | R |
| 87 | 68 | 42 | 10 13 | 11 09 | 12 07 | 14 06 | 07 08 | 10 05 | 11 44 | 123 | 25 | R |

| Age (mo.) | Grade | D.O.B. | Date Tested | Class | Word Knowledge | MAT % Word Analysis | MAT % Reading | Total Reading | WISC V/Q | WISC P/Q | WISC F-S/Q | PPVT I.Q |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ~~97~~ | 2 | ~~04/04/70~~ | ~~17/05/78~~ | 2 | ~~44~~ | ~~22~~ | ~~26~~ | ~~34~~ | ~~97~~ | ~~106~~ | ~~101~~ | ~~75~~ |
| 85 | 2 | 23/10/70 | 5/12/77 | 2 | 36 | 24 | 06 | 19 | 105 | 120 | 113 | 100 |
| 92 | 2 | 19/04/70 | 14/12/77 | 1 | 76 | 84 | 68 | 71 | 110 | 114 | 113 | 108 |
| 88 | 2 | 13/08/70 | 14/12/77 | 1 | 63 | 58 | 57 | 58 | 109 | 125 | 118 | 113 |
| 84 | 2 | 17/11/70 | 14/12/77 | 1 | 69 | 67 | 82 | 77 | 105 | 108 | 107 | 77 |
| 92 | 2 | 15/04/70 | 15/12/77 | 2 | 28 | 58 | 09 | 17 | 105 | 113 | 109 | 73 |
| 85 | 2 | 08/11/70 | 16/12/77 | 2 | 25 | 47 | 28 | 25 | 121 | 110 | 117 | 133 |

| WR Reading | AT Spelling | % Arithmetic | Underlining 1 2 | 3 4 | 5 6 | 7–8 | 9 10 | 11 12 | 13 14 | Total | Rank | Handed |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| ~~42~~ | ~~42~~ | ~~50~~ | ~~01 17~~ | ~~11 05~~ | ~~10 05~~ | ~~15 01~~ | ~~06 09~~ | ~~01 06~~ | ~~07 38~~ | ~~110~~ | ~~14~~ | |
| 39 | 66 | 77 | 14 17 | 14 10 | 24 12 | 20 07 | 06 12 | 07 06 | 13 32 | 162 | 12 | R |
| 94 | 58 | 61 | 12 18 | 10 12 | 17 10 | 15 06 | 09 08 | 16 05 | 12 35 | 150 | 27 | R |
| 77 | 55 | 77 | 12 20 | 11 13 | 14 06 | 17 06 | 06 07 | 11 05 | 14 50 | 142 | 32 | R |
| 90 | 66 | 77 | 15 19 | 09 02 | 19 09 | 17 09 | 13 10 | 16 07 | 17 43 | 162 | 13 | R |
| 66 | 58 | 47 | 11 14 | 10 02 | 12 06 | 14 06 | 06 09 | 13 03 | 09 38 | 115 | 15 | R |
| 47 | 55 | 58 | 16 25 | 14 09 | 18 10 | 15 07 | 09 11 | 08 04 | 17 35 | 163 | 09 | R |

| Age (mo.) | Grade | Date Tested | MAT % Word Knowledge | MAT % Reading | MAT % Total | WRAT % Reading | WRAT % Spelling | WRAT % Arithmetic |
|---|---|---|---|---|---|---|---|---|
| 136 | 5 | 11/04/81 | 34 | 32 | 34 | 39 | 12 | 14 |
| 135 | 5 | 20/05/81 | 42 | 10 | 26 | 37 | 37 | 25 |
| 137 | 4 | 20/05/81 | 20 | 8 | 12 | 7 | 10 | 25 |
| 135 | 5 | 21/05/81 | 90 | 90 | 91 | 94 | 81 | 53 |
| 137 | 5 | 20/05/81 | 30 | 6 | 10 | 92 | 73 | 37 |
| 133 | 5 | 21/05/81 | 84 | 66 | 76 | 88 | 87 | 47 |
| 140 | 5 | 21/05/81 | 77 | 88 | 84 | 95 | 61 | 18 |
| 126 | 5 | 21/05/81 | 82 | 92 | 89 | 94 | 42 | 37 |
| 134 | 5 | 21/05/81 | 68 | 80 | 74 | 73 | 81 | 70 |
| 131 | 5 | 22/05/81 | 68 | 82 | 76 | 98 | 47 | 61 |
| 131 | 5 | 25/05/81 | 80 | 77 | 78 | 97 | 61 | 32 |
| 128 | 5 | 22/05/81 | 82 | 56 | 72 | 98 | 84 | 32 |
| 128 | 5 | 22/05/81 | 70 | 86 | 78 | 99 | 61 | 37 |
| 125 | 5 | 22/05/81 | 77 | 80 | 78 | 99 | 99 | 61 |
| 132 | 5 | 26/05/81 | 80 | 66 | 74 | 97 | 73 | 45 |
| 129 | 5 | 14/05/81 | 62 | 36 | 48 | 53 | 27 | 23 |
| 128 | 5 | 01/06/81 | 58 | 86 | 74 | 98 | 84 | 55 |
| 136 | 5 | 14/05/81 | 58 | 46 | 54 | 95 | 39 | 30 |
| 132 | 5 | 15/05/81 | 56 | 50 | 54 | 86 | 73 | 25 |
| 125 | 5 | 14/05/81 | 52 | 90 | 74 | 73 | 61 | 66 |
| | | | | | | | | |
| 125 | 5 | 26/05/81 | 92 | 77 | 86 | 99 | 88 | 55 |
| 138 | 5 | 27/05/81 | 18 | 10 | 14 | 45 | 30 | 13 |
| 134 | 4 | 15/05/81 | 50 | 44 | 46 | 21 | 21 | 34 |
| 130 | 5 | 28/05/81 | 66 | 32 | 48 | 42 | 61 | 37 |
| 134 | 5 | 14/05/81 | 68 | 82 | 76 | 92 | 50 | 61 |
| 135 | 5 | 15/05/81 | 70 | 90 | 80 | 97 | 99.4 | 45 |
| 130 | 5 | 01/06/81 | 96 | 96 | 98 | 81 | 61 | 23 |
| 131 | 5 | 01/06/81 | 82 | 96 | 91 | 9993 | 98 | 61 |
| 130 | 5 | 27/05/81 | 46 | 18 | 30 | 61 | 53 | 39 |
| 127 | 5 | 27/05/81 | 62 | 36 | 48 | 70 | 61 | 37 |
| 125 | 5 | 27/05/81 | 74 | 56 | 68 | 92 | 84 | 73 |
| 141 | 6 | 01/06/81 | 50 | 54 | 54 | 58 | 25 | 9 |
| 135 | 4 | 01/06/81 | 8 | 32 | 18 | 8 | 4 | 14 |
| 133 | 5 | 01/06/81 | 52 | 32 | 42 | 86 | 87 | 34 |

| Age (Mo) | Grade | Date Tested | MAT % Word Knowledge | MAT % Reading | MAT % Total | WRAT % Reading | WRAT % Spelling | WRAT % Arithmetic |
|---|---|---|---|---|---|---|---|---|
| 128 | 5 | 04/04/81 | 52 | 74 | 64 | 53 | 32 | 53 |
| 134 | 5 | 04/04/81 | 88 | 96 | 94 | 97 | 55 | 39 |
| 129 | 5 | 27/05/81 | 50 | 42 | 46 | 70 | 63 | 47 |
| 126 | 5 | 26/05/81 | 20 | 36 | 28 | 70 | 63 | 53 |
| 133 | 5 | 26/05/81 | 56 | 70 | 64 | 92 | 66 | 61 |
| 127 | 5 | 04/04/81 | 74 | 74 | 74 | 68 | 42 | 27 |

REFERENCES

Balow, B., & Blomquist, M. Young adults ten to fifteen years after severe reading disability. Elementary School Journal, 1965, (Oct.), 44-48.

Barrett, T.C. Visual discrimination tasks as predictors of first grade reading achievement. The Reading Teacher, 1965 (a), 18, 276-282.

Barrett, T.C. Predicting reading achievement through readiness tests. Reading and Inquiry, International Reading Association, 1965 (b), 10, 26-19.

Beery, K.E. Developmental Test of Visual-Motor Integration. Chicago: Follett Educational Corporation, 1967.

Benton, A.L. Development of finger localization capacity in school children. Child Development, 1956, 27, 225-230.

Birch, H.G., & Belmont, L. Auditory-visual integration in normal and retarded readers. American Journal of Orthopsychiatry, 1964, 34, 852-861.

Blank, M., & Bridger, W.H. Perceptual abilities and conceptual deficiencies in retarded readers. In J. Zubin & G.A. Jervis (Eds.), Psychopathology of mental development. New York: Grune & Stratton, 1967.

Canning, P.M., Orr, R.R., & Rourke, B.P. Sex differences in the perceptual, visual-motor, linguistic and concept-formation abilities of retarded readers? Journal of Learning Disabilities, 1980, Vol. 13, No. 9, 563-567.

Cohen, J., & Cohen, P. Applied Multiple Regression/Correlation Analysis for the Behavioral Sciences. New York: John Wiley, 1975.

Critchley, M. The Dyslexic Child. Springfield, Illinois: Charles C. Thomas, 1970.

Doehring, D.G. Patterns of Impairment in Specific Reading Disability. Bloomington: Indiana University Press, 1968.

Dunn, L.M. Peabody Picture Vocabulary Test. Nashville, Tennessee: American Guidance Service, 1959.

Dunn, L.M. Expanded Manual for the Peabody Picture Vocabulary Test. Minneapolis, Minnesota: American Guidance Service, 1965.

Dykstra, R. In Barrett, T.C. Visual discrimination tasks as predictors of first grade reading achievement. The Reading Teacher, 1965 (a), 18, 276-282.

Dykstra, R. Summary of the second-grade phase of the co-operative research program in primary reading instruction. Reading Research Quarterly, 1968, 2, 49-70.

Eisenberg, L: The epidemiology of reading retardation and a program for preventive intervention. In J. Money (Ed.), The Disabled Reader: Education of the Dyslexic Child. Baltimore: Johns Hopkins Press, 1966.

Feshbach, S., Adelman, H., & Fuller, W.W., Prediction of reading and related academic problems. Journal of Educational Psychology, 1977, 69(4), 299-308.

Fisk, J.L., & Rourke, B.P. Identification of subtypes of learning disabled children at three age levels: A neuropsychological, multivariate approach. Journal of Clinical Neuropsychology, 1979, 1, 289-310.

Fisk, J.L., & Rourke, B.P. Neuropsychological subtyping of learning disabled children: History, methods, implications. Journal of Learning Disabilities, 1983, 16, in press.

Gates, A.I. The role of personality maladjustment in reading disability. In G. Natchez (Ed.), Children with Reading Problems. New York: Basic Books, 1968.

Gibson, E. Learning to read. Science, 1965, 148, 1066-1072.

Glazzard, M. The effectiveness of three kindergarten predictors for first-grade achievement. Journal of Learning Disabilities, 1977, 10(2), 95-99.

Gruen, R.S. Prediction of end-of-year reading achievement for first and third grade pupils. Proceedings of the American Psychological Association, 1972, 563-564.

Hainsworth, P., & Siqueland, M. Meeting Street School Screening Test. Providence, R.I.: Crippled Children and Adults of Rhode Island, 1969.

Hammill, D.D., & Larsen, S.C. Relationship of selected auditory perceptual skills and reading ability. Journal of Learning Disabilities, 1974, 7, 429-435.

Horton, R.L. The General Linear Model. New York: McGraw-Hill, Inc., 1978.

Ingram, T. T. S. The nature of dyslexia. In F.A. Young & D.B. Lindsley (Eds.), Early Experience and Visual Information Processing in Perceptual and Reading Disorders. Washington, D.C.: National Academy of Sciences, 1970.

Jansky, J., & deHirsch, K. Preventing reading failure: Prediction, diagnosis, intervention. New York: Harper & Row, 1972.

Jastak, J.F., & Jastak, S.R. The Wide Range Achievement Test. Wilmington, Delaware: Guidance Associates, 1965.

Kapelis, L. Early identification of reading failure: A comparison of two screening tests and teacher forecasts. Journal of Learning Disabilities, 1975, 8(10), 638-641.

Keogh, B.K., & Becker, L.D. Early detection of learning problems: Questions, cautions, and guidelines. Exceptional Children, 1973, 40, 5-11.

Kerlinger, F.N., & Pedhazur, E.J. Multiple Regression in Behavioral Research. New York: Holt, Rinehart, & Winston, Inc., 1973.

Kirk, S.A. Teacher Estimates of Kindergarten Pupils' Abilities, 1966. In M. Glazzard. The effectiveness of three kindergarten predictors for first-grade achievement. Journal of Learning Disabilities, 1977, 10(2), 95-99.

Kline, C.L. The adolescents with learning problems: How long must they wait? Journal of Learning Disabilities, 1972, 5, 127-144.

Kløve, H. Clinical neuropsychology. In R.M. Forster (Ed.), The Medical Clinics of North America. New York: Saunders, 1963.

Lindgren, S.D. The early identification of children at risk for reading disabilites: Finger localization ability, verbal skills, and perceptual-motor performance in kindergarten children. Unpublished Master's Thesis, University of Iowa, 1975. In A.L. Benton & D. Pearl (Eds.), Dyslexia: An appraisal of Current Knowledge. New York: Oxford University Press, 1978.

Luria, A.R. Higher Cortical Functions in Man. New York: Basic Books, 1966.

Luria, A.R. In Satz, P.,& Van Nostrand, G.K. Developmental dyslexia: An evaluation of a theory. In P. Satz & J.J. Ross (Eds.), The Disabled learner: Early detection and intervention. Rotterdam: Rotterdam University Press, 1973.

Maxwell, A.E. The WPPSI: A marked discrepancy in the correlations of the subtests for good and poor readers. British Journal of Mathematical and Statistical Psychology, 1972, 25, 283-291.

Miller, W.H. Identifying and Correcting Reading Difficulties in Children. New York: The Center for Applied Research

and Education, Inc., 1971.

Money, J., & Schiffman, G. The Disabled Reader. Baltimore: Johns Hopkins Press, 1966.

Money, J. (Ed.) Reading disability: Progress and research needs in dyslexia. Baltimore: Johns Hopkins Press, 1962.

Muehl, S., & Forrell, E.R. A follow-up study of disabled readers: Variables related to high school reading performance. Reading Research Quarterly, 1973, 9(1), 110-123.

Neale, M.D. Neale Analysis of Reading Ability Manual. London: Macmillan, 1958.

Nie, N.H., Hull, C.H., Jenkins, J.G., Steinbrenner, K., & Bent, D.H. Statistical Package for the Social Sciences. New York: McGraw-Hill, Inc., 1975.

Owens, F., Adams, P.A., & Forrest, T. Learning disabilities in children: Sibling studies. Bulletin of the Orton Society, 1968, 18, 33-62.

Perry, J.D., Guidubaldi, J., & Kehle, T.J. Kindergarten competencies as predictors of third-grade classroom behavior and achievement. Journal of Educational Psychology, 1979, 71(4), 443-450.

Peter, B.M., & Spreen, O. Behavior rating and personal adjustment scales of neurologically and learning handicapped children during adolescence and early adulthood: Results of a follow-up study. Journal of Clinical Neuropsychology, 1979, Vol. 1, No. 1, 75-92.

Petrauskas, R.J., & Rourke, B.P. Identification of subgroups of retarded readers: A neuropsychological, multivariate approach. Journal of Clinical Neuropsychology, 1979, 1, 17-37.

Preston, R.C., & Yarrington, D.J. Status of fifty retarded readers eight years after reading clinic diagnosis. Journal of Reading, 1967, 11, 122-129.

Reitan, R.M. Manual for administration of neuropsychological test batteries for adults and children. Indianapolis, Indiana: Neuropsychological Laboratory, Indiana University Medical Center, 1964.

Rosner, J., & Simon, D.P. The Auditory Analysis Test. Learning Research and Development Center, University of Pittsburgh, 1970.

Rourke, B.P. Neuropsychological research in reading retardation: A review. In A.L. Benton & D. Pearl (Eds.) Dyslexia: An appraisal of current knowledge. New York: Oxford University Press, 1978 (a).

Rourke, B.P. Reading, spelling, arithmetic disabilities: A neuropsychologic perspective. In H.R. Myklebust (Ed.), Progress in Learning Disabilities, (Vol, IV). New York and London: Grune & Stratton, Inc., 1978(b).

Rourke, B.P. (Ed.): Learning Disabilities in Children: Advances in subtype analysis. New York: Guilford, in press.

Rourke, B.P., & Gates, R.D. The Underlining Test: Preliminary Norms. Windsor: Department of Psychology, University of Windsor, 1980.

Rourke, B.P., & Orr, R.R. Prediction of the reading and spelling performances of normal and retarded readers: A four-year follow-up. Journal of Abnormal Child Psychology, 1977, 5(1), 9-20.

Rourke, B.P., & Strang, J.D. Subtypes of reading and arithmetic disabilities: A neuropsychological analysis. In M. Rutter (Ed.), Developmental Neuropsychiatry. New York: Guilford, 1983.

Satz, P. Laterality effects in dichotic listening. Nature, 1968, 218, 277-278.

Satz, P., & Associates. Embedded Figures Test. Chicago: Language Research Associates, 1958.

Satz, P., & Friel, J. Some predictive antecendents of specific reading disability: A preliminary one-year follow-up. In P. Satz and J.J. Ross (Eds.), The Disabled learner: Early detection and intervention. Rotterdam: Rotterdam University Press, 1973.

Satz, P., & Sparrow, S.S. Specific developmental dyslexia: A theoretical formulation. In D.J. Bakker and P. Satz, (Eds.), Specific reading disability: Advances in theory and method. Rotterdam: Rotterdam University Press, 1970.

Satz, P., & Van Nostrand, G.K. Developmental dyslexia: An evaluation of a theory. In P. Satz & J.J. Ross (Eds.), The disabled learner: Early detection and intervention. Rotterdam: Rotterdam University Press, 1973.

Satz, P., Friel, J., & Rudegeair, F. Some predictive antecedents of specific reading disability: A two-, three-, and four-year follow-up. In J.T. Guthrie (Ed.), Aspects of Reading Acquisition. Baltimore: Johns Hopkins Press, 1976.

Satz, P., Taylor, H.G., Friel, J., & Fletcher, J.M. Some developmental and predictive precursors of reading disability. In A.L. Benton & D. Pearl (Eds.), Dyslexia: An appraisal of current knowledge. New York: Oxford University Press, 1978.

Searls, E.F. How to use WISC scores in Reading Diagnosis. Newark: International Reading Association, 1975.

Silver, A.A. Prevention. In A.L. Benton & D. Pearl (Eds.), Dyslexia: An appraisal of current knowledge. New York: Oxford University Press, 1978.

Silver, A.A., & Hagin, R.A. Specific reading disability: Follow-up studies. American Journal of Orthopsychiatry, 1964, 34, 95-102.

Silver, A.A., & Hagin, R.R. SEARCH: A scanning instrument for the identification of potential learning disability: Experimental edition. New York: New York University Medical Center, 1975.

Smith, N.B. Matching ability as a factor in first grade reading. Journal of Educational Psychology, 1928, 19, 560-571.

Small, N. Levels of perceptual functioning in children: A developmental study. Unpublished Master's Thesis, University of Florida, 1968.

Spreen, O., & Benton, A. Spreen-Benton Language Examination Profile (Form A Normal Adults). Iowa: College of Medicine, University of Iowa, 1965.

Strang, J.D., & Rourke, B.P. Arithmetic disability subtypes. In B.P. Rourke (Ed.), Learning disabilities in children: Advances in subtype analysis. New York: Guilford, in press.

Torgesen, J.K., & Dice, C. Characteristics of research on learning disabilites. Journal of Learning Disabilities, 1980, Vol. 13, No. 9, 531-535.

Trites, R.L., & Fiedorowicz, C. Follow-up study of children with specific (or primary) reading disability. In R.M. Knights & D.J. Bakker (Eds.), The Neuropsychology of Learning Disorders. Baltimore: University Park Press, 1976.

Vellutino, F.R. Toward an understanding of dyslexia: Psychological factors in specific reading disability. In A.L. Benton & D. Pearl (Eds.), Dyslexia: An appraisal of current knowledge. New York: Oxford University Press, 1978.

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

Wechsler, D. Wechsler Preschool and Primary Scale Of Intelligence. New York: Psychological Corporation, 1967.

Wepman, J.M. Auditory Discrimination Test. Chicago: Language Research Associates, 1958.

Yule, W., & Rutter, M. Epidemiology and social implications of specific reading retardation. In D.J. Bakker & R.M. Knights (Eds.), The Neuropsychology of Learning Disorders. Baltimore: University Park Press, 1976.

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