1983

A Study of Reading Achievement in Terms of Symbol Reversals in First Grade Children (Louisiana).

Bernard Leon Heydorn

Louisiana State University and Agricultural & Mechanical College

Follow this and additional works at: https://digitalcommons.lsu.edu/gradschool_disstheses

Recommended Citation
https://digitalcommons.lsu.edu/gradschool_disstheses/3851

This Dissertation is brought to you for free and open access by the Graduate School at LSU Digital Commons. It has been accepted for inclusion in LSU Historical Dissertations and Theses by an authorized administrator of LSU Digital Commons. For more information, please contact gradetd@lsu.edu.
INFORMATION TO USERS

This reproduction was made from a copy of a document sent to us for microfilming. While the most advanced technology has been used to photograph and reproduce this document, the quality of the reproduction is heavily dependent upon the quality of the material submitted.

The following explanation of techniques is provided to help clarify markings or notations which may appear on this reproduction.

1. The sign or "target" for pages apparently lacking from the document photographed is "Missing Page(s)". If it was possible to obtain the missing page(s) or section, they are spliced into the film along with adjacent pages. This may have necessitated cutting through an image and duplicating adjacent pages to assure complete continuity.

2. When an image on the film is obliterated with a round black mark, it is an indication of either blurred copy because of movement during exposure, duplicate copy, or copyrighted materials that should not have been filmed. For blurred pages, a good image of the page can be found in the adjacent frame. If copyrighted materials were deleted, a target note will appear listing the pages in the adjacent frame.

3. When a map, drawing or chart, etc., is part of the material being photographed, a definite method of "sectioning" the material has been followed. It is customary to begin filming at the upper left hand corner of a large sheet and to continue from left to right in equal sections with small overlaps. If necessary, sectioning is continued again—beginning below the first row and continuing on until complete.

4. For illustrations that cannot be satisfactorily reproduced by xerographic means, photographic prints can be purchased at additional cost and inserted into your xerographic copy. These prints are available upon request from the Dissertations Customer Services Department.

5. Some pages in any document may have indistinct print. In all cases the best available copy has been filmed.
Heydorn, Bernard Leon

A STUDY OF READING ACHIEVEMENT IN TERMS OF SYMBOL REVERSALS IN FIRST GRADE CHILDREN

The Louisiana State University and Agricultural and Mechanical Col. Ph.D. 1983

University Microfilms International 300 N. Zeeb Road, Ann Arbor, MI 48106

Copyright 1983 by Heydorn, Bernard Leon All Rights Reserved
A STUDY OF READING ACHIEVEMENT IN TERMS OF
SYMBOL REVERSALS IN FIRST GRADE CHILDREN

A Dissertation
Submitted to the Graduate Faculty of the
Louisiana State University and
Agricultural and Mechanical College
in partial fulfillment of the
requirements for the degree of
Doctor of Philosophy
in
The Interdepartmental Program of Education

by
Bernard Leon Heydorn
B.A., University of Ottawa, Canada, 1968
M.Ed., University of Toronto, Canada, 1970
May 1983
ACKNOWLEDGEMENTS

This dissertation is dedicated to my late mother, Elmira, and to my father, Charles. Thank you.

The writer wishes to express his grateful appreciation to the many people who have contributed to his education and to the completion of this study.

Deep appreciation is expressed to his major professor, Dr. Earl H. Cheek, Jr., whose patience, guidance, and friendship sustained the author. The writer further acknowledges his appreciation to Dr. Sam Adams (Alumni Professor); to Dr. Lea McGee; Dr. Carole Ann Wiegel-Crump (minor professor); and to Dr. Rochelle Simms.

Special acknowledgement is made to the school principals, Mrs. Linda Sorrell and Mr. C. R. Hayes; to the guidance counsellor, Mrs. Margaret Huckabee; and to the grade one teachers, Mrs. Rebecca Anderson, Miss Janet Hawkins, Mrs. Willie May Wascome, Mrs. Stephanie Scardina, Mrs. Jan Mitchell, Mrs. Vertha Fortenberry, and Miss Debbie Crawford, all of the East Baton Rouge Parish School System. Special appreciation goes to Dr. Don Hoover and to Dr. Molly Newkome of the East Baton Rouge
Parish School System.

To name the many others who have given invaluable assistance would be impossible, but gratitude must be expressed to my typist, Mrs. Frances Mims, who burned the midnight oil. Appreciation is also expressed to Dr. Alexander Bannatyne, who inspired the writer to pursue studies on the subject of reversals.

The writer wishes to express his deepest appreciation to his brother Jocelyn who was the first to recognize and nurture his scholarly inclinations, and to his other brothers, Raymond, Malcolm, and Trevor; and to his sisters Jerlene and Pamela, who have all sustained the author over the years.

Finally, the writer wishes to express his deepest gratitude to his loving wife Vivienne, and children, Sean, Lisa, and Graham, whose patience, encouragement, and sacrifices have enabled him to complete this journey.
TABLE OF CONTENTS

ACKNOWLEDGEMENTS .................................... ii
LIST OF TABLES ....................................... vii
LIST OF FIGURES .................................... x
ABSTRACT ........................................... xi

CHAPTER I ........................................... 1
Introduction ........................................ 1
Theories of Reversals ............................. 2
Reversals and Reading ............................ 3
Sex Differences in Reversals .................... 4
Reversals and Training ............................ 4
Statement of the Problem ......................... 5
Null Hypotheses .................................. 5
Definition of Terms ................................ 7
Limitations ........................................ 8
Significance of the Study ....................... 8
Organization of the Study ....................... 9

CHAPTER II ......................................... 10
Review of Related Literature ..................... 10
Perceptual Theories ................................ 11
Neurological Theories ............................ 12
Developmental Theories ........................... 19
Theories of Stimulus and Response Properties 22
Reversals and Reading ............................ 25
Reversals Predictive of Reading Achievement 30
Sex Differences .................................... 31
Psychological Factors ............................ 32
Correcting Symbol Reversals .................... 33
Summary .......................................... 35

CHAPTER III ........................................ 37
Methods and Procedures .......................... 37
The Sample ....................................... 37
### TABLE OF CONTENTS (continued)

**CHAPTER III (continued)**  
The Instruments ................................ 37  
Design ........................................ 39  
Procedures ..................................... 41  
Treatment ...................................... 43  
Statistical Treatment .......................... 45

**CHAPTER IV** .................................... 47  
Analysis of Data ............................... 47  
Introduction .................................. 47  
Introduction to Hypotheses 1, 2, and 3 ... 49  
Hypothesis 1 .................................. 49  
Hypothesis 2 .................................. 50  
Hypothesis 3 .................................. 51  
Introduction to Hypotheses 4, 5, and 6 ... 52  
Hypothesis 4 .................................. 54  
Hypothesis 5 .................................. 55  
Hypothesis 6 .................................. 56  
Introduction to Hypotheses 7 and 8 ....... 57  
Hypothesis 7 .................................. 57  
Hypothesis 8 .................................. 59  
Hypothesis 9 .................................. 60  
Additional Findings ........................... 61

**CHAPTER V** .................................... 70  
Summary, Conclusions and Recommendations ... 70  
Introduction .................................. 70  
Summary of Results ............................ 72  
Summary of Additional Findings ............. 74  
Conclusions .................................... 76  
Recommendations for Further Study .......... 88

**BIBLIOGRAPHY** ................................. 91

**APPENDIX A** .................................... 99  
Sample Lesson Plan for the Remediation of Reversals ................................. 100

**APPENDIX B** .................................... 110  
Letter from author seeking assistance in researching his dissertation, addressed to Director of Research and Program Evaluation, School System ................................. 111
TABLE OF CONTENTS (continued)

APPENDIX B (continued)

<table>
<thead>
<tr>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Letter from Administrative Director of Instructional &amp; Curriculum Develop-</td>
<td>112</td>
</tr>
<tr>
<td>ment to Principals of East Baton Rouge Parish, Louisiana, advising of</td>
<td></td>
</tr>
<tr>
<td>opportunity for first grade teachers to participate voluntarily in author's research program</td>
<td></td>
</tr>
<tr>
<td>Letter from author to principals explaining volunteer first grade teacher</td>
<td>113</td>
</tr>
<tr>
<td>participation in author's research</td>
<td></td>
</tr>
<tr>
<td>Letter to parents of participating children, seeking their permission for</td>
<td>114</td>
</tr>
<tr>
<td>involvement of their child</td>
<td></td>
</tr>
<tr>
<td>Request for research approval from the Committee on Use of Humans and</td>
<td>115</td>
</tr>
<tr>
<td>Animals, Louisiana State University</td>
<td></td>
</tr>
<tr>
<td>VITA</td>
<td>116</td>
</tr>
</tbody>
</table>
# LIST OF TABLES

<table>
<thead>
<tr>
<th>TABLE</th>
<th>Description</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Composition of Experimental and Control Groups by Sex</td>
<td>48</td>
</tr>
<tr>
<td>2.</td>
<td>Analysis of Covariance for Reading Achievement on Posttest Scores of Treated Symbol Reversers and Non-treated Reversers</td>
<td>49</td>
</tr>
<tr>
<td>3.</td>
<td>Analysis of Covariance for Reading Achievement on Posttest Scores of Treated Male Symbol Reversers (TMSR) Versus Treated Female Symbol Reversers (TFSR)</td>
<td>50</td>
</tr>
<tr>
<td>4.</td>
<td>Analysis of Covariance for Reading Achievement on Posttest Scores of Non-treated Male Symbol Reversers (NTMSR) Versus Non-treated Female Symbol Reversers (NTFSR)</td>
<td>51</td>
</tr>
<tr>
<td>5.</td>
<td>Analysis of Variance for all Students on the Pretest, Gates-MacGinitie Reading Tests Basic R, Form 1</td>
<td>53</td>
</tr>
<tr>
<td>6.</td>
<td>Analysis of Variance for Symbol Reversing Students (SR) Versus Non-Symbol Reversing Students (NSR) on Pretest, Gates-MacGinitie Reading Tests Basic R</td>
<td>54</td>
</tr>
<tr>
<td>7.</td>
<td>Analysis of Variance for Male Symbol Reversing Students (MSR) Versus Male Non-Symbol Reversing Students (MNSR) on the Pretest, Gates-MacGinitie Reading Tests Basic R</td>
<td>55</td>
</tr>
</tbody>
</table>
LIST OF TABLES (continued)

TABLE

8. Analysis of Variance for Female Symbol
   Reversing Students (FSR) Versus Fe-
   male Non-Symbol Reversing Students
   (FNSR) on the Pretest, Gates-Mac-
   Ginitie Reading Tests Basic R ........ 56

9. Analysis of Covariance for Symbol Re-
   versals on Posttest Scores of
   Treated Symbol Reversers and Non-
   treated Symbol Reversers on the
   Jordan Left-Right Reversal Test,
   Level 1 ................................. 58

10. Analysis of Covariance for Symbol
    Reversals on Posttest Scores of
    Treated Male Symbol Reversers
    (TMSR) Versus Treated Female
    Symbol Reversers (TFSR) on the
    Jordan Left-Right Reversal Test,
    Level 1 ................................. 59

11. Difference in Symbol Reversals Between
    Male and Female Students on the
    Pretest, Jordan Left-Right Reversal
    Test Level 1 ........................... 60

12. Means, Least Square Means, and Differ-
    ences for Pretests and Posttests in
    Reading Achievement for All Groups
    on the Gates-MacGinitie Reading
    Tests Basic R ........................... 62

13. Specific Contrasts for Reading Achieve-
    ment on Gates-MacGinitie Reading
    Tests Basic R ........................... 64

14. Means, Least Square Means, and Differ-
    ences for Pretests and Posttests in
    Symbol Reversals for All Groups on
    the Jordan Left-Right Reversal Test,
    Level 1 ................................. 66

viii
LIST OF TABLES (continued)

TABLE

15. Specific Contrasts for Symbol Reversals on Jordan Left-Right Reversal Test, Level 1 ........... 68
LIST OF FIGURES

FIGURE

3.1. 2 x 3 Experimental Factorial Design .................................. 41
ABSTRACT

This study was designed to investigate reading achievement in first grade children who are symbol reversers vs non-reversers and who are male vs female, and also to determine the effectiveness of a modification of the Kirshner Program (1977) in reducing symbol reversals. The sample was comprised of 115 first grade children in seven classes in two schools in East Baton Rouge Parish, Louisiana. The students were selected from a number of volunteer grade one classes on the basis of their being representative of the district at large in terms of racial composition and socioeconomic factors. The study used a randomized control group pretest-posttest design representing a 2 (sex) x 3 (grouping) experimental factorial design. The instruments used were the Jordan Left-Right Reversal Test, Level 1 (1974) and the Gates-MacGinitie Reading Tests Basic R, Forms 1 and 2 (1978).

An analysis of the data revealed these findings:

There was no significant difference in reading achievement of symbol reversing students with treatment in the remediation of symbol reversals and those without such treatment, despite sex. There was a significant difference in reading achievement between symbol reversing
and non-reversing students, despite sex. There was no significant difference in symbol reversals between symbol reversing students with treatment in the remediation of symbol reversals and those without such treatment, despite sex. There was no significant difference in symbol reversals between sexes overall. There was a significant difference in reading achievement gain in all groups and in the reduction of symbol reversals for the experimental and equivalent control groups. There was no significant difference in reading achievement gain between all groups. There was no significant difference in symbol reversals reduction between the experimental and equivalent control groups. There was a significant difference in symbol reversals reduction between the experimental and control group of non-reversers and between the control group of reversers and non-reversers.

The data questioned sex differences in reversals and the practice of remediating reversals, and advanced a theory for the relationship of symbol reversals to reading achievement. Recommendations for further study were made to practitioners and researchers.
CHAPTER I

Introduction

The subject of reversals has occupied the professional literature of several disciplines for at least five decades (Kaufman, 1980). In this array of studies, symbol reversal errors such as b - d, p - q, have been the focus of a wide and diverse variety of empirical and theoretical investigations. Symbol reversals as used in this study refer to mirror images b - d, inversions p - b, and rotations 6 - 9, of single letters and numerals. Reversals have also been used to describe whole words written or read in reverse order, 'was' for 'saw,' part of a word 'from' for 'form,' or whole phrases rearranged: 'once there was' for 'there once was.' However, these types of reversals are not a concern of the present study.

It is normal that young children would experience reversals when they first start dealing with written symbols. Objects can be perceived without regard to position in space or directional orientation (a car is still a car viewed from any angle). This phenomena in the natural world is referred to as object constancy. In contrast, most written symbols are perceived correctly only if looked upon in accord with
their position in space or their directional value, and the
rule of object constancy does not apply. For example, the
letter 'b' has the same form as the letter 'd,' and thus
the laws of object constancy learned early in life are now
confounded in certain symbols. The result is often a be-
wildering confusion, for the misperception of letter sym-
bols can lead to the misperception of word symbols and
consequently the wrong meaning can be attached to the sym-
bol. In this respect, directionality in perception is
relevant to reading skills.

Many reading specialists and psychologists have been
interested in the phenomenon of reversals (Bannatyne,
1973; Smith, 1978). Many researchers have developed pro-
grams to remediate reversals (Polloway and Polloway, 1980;
Kirshner, 1977; Samuels, 1973). However, there is a lack
of research and conflicting evidence (Jordan, 1974b) with
regard to reading achievement in first grade children in
terms of symbol reversals and sex. The purpose of this
study was thus to provide further insight into the effect
of the remediation of symbol reversals on reading achieve-
ment, to compare the reading achievement of reversing and
non-reversing students, to determine the effectiveness of
remedial training in reducing symbol reversals, and to
examine all of the above in terms of sex.

Theories of Reversals

Educators and psychologists have studied reversals
from many theoretical orientations. These embrace perceptual theories (Davidson, 1935; Gibson et al, 1962); neurological theories (Orton, 1937; Bannatyne, 1973); developmental theories (Monroe, 1932; Jordan, 1974); theories of stimulus properties (Hyman and Cohen, 1975; Nodine and Hart, 1970); linguistic theories (Goodman and Burke, 1980; Smith, 1978); psychological theories (Laurita, 1971; Blanchard, 1935); and theories of sex differences (Jordan, 1974; Aaron and Handley, 1975).

Reversals and Reading

Researchers have also investigated reversals in terms of their relationship to current reading achievement (Lyle, 1969), and as predictors of future reading achievement (Jansky and DeHirsch, 1972). Many reading specialists and researchers have suggested that reversals are characteristic of poor readers, especially those beyond the ages of 7 or 8 years (Boder, 1973; Bryant, 1964; Doehring, 1968; Aliotti, 1980). Other investigators (Shankweiller and Liberman, 1972; Cohn and Stricker, 1979) have obtained negative findings regarding the relationship of reversals to reading. However, this study was designed to explore further the relationship of reversals to reading achievement in first grade children.

Measures of reversals have been used as predictors
of reading achievement (Bannatyne, 1971; Wallbrown et al, 1975; Stevenson et al, 1976). An overview of the research on the predictive validity of reversals tends to indicate a significant positive correlation with reading achievement.

Sex Differences in Reversals

There is conflicting evidence that sex differences in reversals exist in young children. Studies by Jordan (1974b) and Aaron and Handley (1975) supported sex differences in symbol reversals. However, Stevenson et al (1976) in their study of reversals and reading found no significant sex differences in reversals. The present study used the Jordan Left-Right Reversal Test (1974) to clarify the issue of sex and symbol reversals.

Reversals and Training

There is strong evidence within the literature that symbol reversals can be corrected with training (Polloway and Polloway, 1980; Bracey and Ward, 1980; Samuels, 1973; Jeffrey, 1958). However, there is no general agreement as to what method of remediation is most effective. This study which used techniques designed by the researcher and adapted from the Kirshner Program (1977), examined the effectiveness of a program for the remediation of symbol
reversals.

**Statement of the Problem**

The problem was to investigate reading achievement in first grade children in terms of a) symbol reversals; b) sex.

Other significant objectives of the study were:

1. To compare the reading achievement of reversing students and non-reversing students.

2. To determine the effectiveness of specific remedial exercises in reducing symbol reversals.

**Null Hypotheses**

1. There is no significant difference in scores in reading achievement of symbol reversing students who have had treatment in the remediation of symbol reversals and those who have not had such treatment.

2. There is no significant difference in scores in reading achievement between male and female symbol reversing students who have had treatment in the remediation...
tion of symbol reversals.

3. There is no significant difference in scores in reading achievement between male and female symbol reversing students who have had no treatment in the remediation of symbol reversals.

4. There is no significant difference in scores in reading achievement between symbol reversing students and non-reversing students.

5. There is no significant difference in scores in reading achievement between male symbol reversing students and male non-reversing students.

6. There is no significant difference in scores in reading achievement between female symbol reversing students and female non-reversing students.

7. There is no significant difference in scores in symbol reversals of symbol reversing students who have had treatment in the remediation of symbol reversals and those who have not had such treatment.

8. There is no significant difference in
scores in symbol reversals between male and female symbol reversing students who have received treatment in the remediation of symbol reversals.

9. There is no significant difference in scores in symbol reversals between male and female students.

**Definition of Terms**

*Reading* refers to a process of visual perceptual word recognition and cognitive comprehension, used for the purposes of gaining information and enjoyment.

*Reading achievement* refers to letter "sounds," vocabulary, letter recognition, and comprehension as measured by the scores obtained on the *Gates-MacGinitie Reading Tests Basic R* (1978).

*Perception* refers to the apprehension and recognition of symbols by means of the senses.

*Symbol reversal* refers to the misperception of single letters and numbers presented in correct or left-right reversed spatial orientation as measured by the *Jordan Left-Right Reversal Test* (1974).

*Non-reversing students* refer to those students who have scored between zero to three in symbol reversal errors on the *Jordan Left-Right Reversal Test* (1974).
Specific remedial exercises refer to multisensory training exercises in reading, writing, and tracing, which is a modification of the Kirshner Program (1977) put together by the researcher to remediate symbol reversals.

Limitations

All of the students in this study have come from Grade 1 classes, thus generalization of the findings to other grade levels would be inappropriate. The population consisted of selected students from Grade 1 classes in East Baton Rouge Parish in the State of Louisiana. The population was drawn from seven classes in two schools.

Significance of the Study

Research in the area of the effects of the treatment of symbol reversals on the reading achievement of young children has been sparse. Results of this study may indicate that the treatment for the remediation of symbol reversals is beneficial in terms of reading achievement. This may throw some light on the importance of reversals in young children and their relationship to reading achievement. The present investigation may also contribute to the theory of sex differences in reading and symbol reversals in young children. Data on the effectiveness of an innovative program for the remediation of reversals
would be available. The study should add to the growing body of knowledge in the areas of visual perception, reading development, reading diagnosis, and remedial reading. As such, it would be of benefit to parents, teachers, educators, reading specialists, special educators, and psychologists.

**Organization of the Study**

The study was organized into five chapters. Chapter I presented introductory statements, a statement of the problem, the hypotheses, the definitions of terms, the limitations, the significance of the study, and the organization of the study. Chapter II summarized the related literature and research. Chapter III described the methods and procedures used in the study. Chapter IV presented and analyzed the data collected. Chapter V presented the findings, summaries, conclusions, and recommendations.
CHAPTER II

Review of Related Literature

Since the 1920's a wealth of data has accumulated on the subject of reversals. In this vast array of studies, symbol reversal errors such as b - d, have been the focus of a wide and diverse variety of empirical and theoretical investigations. This has been the outgrowth of research in perceptual learning and development (Gibson et al, 1962). It has also been prompted by research on the requisite skills of learning to read (Jansky and DeHirsch, 1972); and by clinical and empirical evidence connecting symbol reversals to reading disability (Orton, 1937; Jordan, 1974).

Some theories of reversals include neurological theories such as Bannatyne (1973); developmental theories (Davidson, 1934; Gibson et al, 1962); linguistic theories (Goodman and Burke, 1980); theories of stimulus properties of letters (Hyman and Cohen, 1975); psychological theories (Laurita, 1971); and theories of sex differences (Jordan, 1974). There is also generally widespread support for the position that symbol reversals can be corrected with training (Moyer and Newcomer, 1977).
Perceptual Theories

There have been several theories over the last five decades associating reversals with the phenomenon of perception. Monroe (1932) in her study of reading and reversals suggested that difficulty in perceiving the orientation of visual patterns was one of the causes of reversals. Support for this theory came from Vernon (1957) who stated:

... On one characteristic of the child's perception there seems to be general agreement: that he does not observe or only observes and remembers with difficulty the orientation of shapes and their order or direction in a sequence. That he overlooks the orientation of shapes is naturally to be expected since one of the things he has learned in early childhood is that objects retain their identity when their spatial position and orientation are changed. (p. 16)

Vernon (1957) went on to state that there is no doubt that certain shapes are particularly easy to reverse and the frequency with which children continue to reverse some letters must have a perceptual basis.

Other writers who have supported the perceptual theory of object constancy in reversals included Money (1962) and Bannatyne (1973). With respect to reading, Vernon (1957) has concluded that in general the child is unlikely to be greatly handicapped in learning to read by any deficiency in the visual perception of word shapes.
One well documented theory relating perception to reversal errors in children is Gibson's (1969) differentiation theory of perceptual development. This is a theory of discrimination learning which is concerned with differences in the distinctive features and dimensions of difference when stimuli are presented. Thus, according to Gibson's theory, children learn to differentiate the visual stimuli by discovering the invariants or distinctive features of the stimuli. In an experiment by Gibson et al (1962) on the development of discrimination of letter-like forms, the above experimenters found that rotation and reversals do not serve as distinctive features of objects. However, Gibson et al (1962) concluded that there is a fast decline in the error curve in rotation and reversals of letter-like forms, and that a child of six is perfectly capable of learning this distinction.

Spache (1953) and Smith (1978) have also supported the theory that children's lack of familiarity with the distinctive features of letter or number symbols can account for their reversals. This notion has found tentative support among some psychologists and educators (Money, 1962; Davison, 1934).

**Neurological Theories**

Neurological factors have been associated with
children's reversals and reading errors for over 50 years (Orton, 1928; Monroe, 1932). During the past decade there has been a dramatic growth of professional interest in children's reading, particularly where neurological dysfunction is felt to be primary (Harris, 1979; Cruickshank, 1981).

Orton (1928) postulated the theory that symbol reversals were the consequence of neurological impairment or delay in the development of cerebral dominance. Orton's theories have never received definitive empirical support (Springer and Deutsch, 1981), but they have had a persuasive effect on diagnostic and remedial techniques over the years. His legacy is thus apparent in the work of Kershner (1971); Jordan (1974); Bannatyne (1973).

For example, Bannatyne (1973) postulated that reversals can be explained by the fact that the two hemispheres of the brain are a mirror image of each other. Most language functions are controlled by the left hemisphere which usually dominates (suppresses) the right hemisphere during linguistic operations. According to Bannatyne, from birth through seven or eight years of age, the brain is not sufficiently developed linguistically to suppress effectively the right hemisphere during verbal functioning. As a result, an image put into the left hemisphere 'b' may come out of the right hemisphere as a
mirror image version of the original 'd.' Bannatyne thus differentiated between mirror image reversals and other types of reversals.

Some support for Bannatyne's theory came from a study conducted by Aliotti (1980). In an experiment with preschool through second grade children, Aliotti hypothesized that children would more frequently select the mirror image design among seven visuo-spatial designs. The seven designs comprised the correct original design and six configuration error designs. The results showed that there was a consistent tendency for all the groups of children to select the mirror image design as a relatively frequent error. In both the first and second grade samples of children, the mirror image reversal choice ranked first. Aliotti also found that the mirror image reversal choice ranked first among a sample of children with learning disabilities.

Contrary to Bannatyne's theory, Spache (1976) stated that reversals are not caused by mirror images of a word in both hemispheres because word images are not received or stored in two dimensions, and so a reversal is impossible. Spache added that reversals are universally common errors of almost all beginners in reading, regardless of age, and these errors tend to disappear as reading skill improves, under ordinary instruction and without any
special corrective steps. He concluded that frequency of reversals was not related to any aspect of laterality or cerebral dominance. However, as Shankweiler and Liberman (1972) pointed out, "the possibility that there is some connection between individual differences in lateralization of function and reading disability is supported by much clinical opinion." (p. 303).

Other neurological explanations of mirror image reversals include that of Rudel and Teuber (1963) who suggested that the bilateral symmetry of the central nervous system about the vertical axis makes it intrinsically difficult to discriminate mirror image forms. Aaron and Handley (1975), in an investigation which explored the relationship between directional scanning and cerebral asymmetries in children three to seven years of age, found well organized response patterns. These authors also found sex differences with regard to the onset of the left-right responses and hemispheric asymmetry of perception for right to left responders.

Further neurological study of mirror image discrimination problems was reported by Bryant (1973). The above author, in a study of children four to seven years of age, stated that children found it as hard to differentiate non-mirror image obliques as they did mirror image obliques. Bryant concluded that "mirror images may have
little or nothing to do with the difficulties which young children experience when discriminating orientation and position." (p. 323).

With regard to reading, Vellutino et al (1975), in a study which evaluated orientation and sequencing performance using a copying task, found no differences in ocular scanning tendencies between normal readers and poor readers. They interpreted their findings to represent strong support for the position that reading disability is not attributable to organic dysfunction in visual spatial processing, and concluded that reversals in poor readers are verbal intrusion errors attributable to prolonged difficulty in letter and word naming.

In another mirror image study, Barroso and Braine (1974) developed a matching task to judge young children's orientation perception of identical figures that could form mirror images of each other, as well as their perception of non-identical figures that could not form mirror images. In their sample of 3-1/2 to 5-1/2-year-old children, the non-identical stimulus figure group demonstrated the same error pattern as the identical 'mirror image' group. This lead the authors to conclude that mirror image reversals can possibly be explained by the tendency of young children to match proximally related parts of figures. They also concluded that mirror image
confusion was not the basis for the orientation errors observed, and the results also implied that the bilateral symmetry of the body played a minimal role in determining orientation of errors.

Another neurological theory to explain reversals put forward by Frank and Levinson (1976) has pointed to a defect in the part of the brain called the cerebellum. These investigators claimed that dysmetric dyslexic children have a cerebellar-vestibular dysfunction, with a resulting clinical nystagmus, ocular fixation, and sequential scanning dysfunction. These authors have suggested that an instrument which they designed to measure the above functions proved that dysmetric dyslexic children do have the above mentioned defects, while normal and non-dyslexic children do not.

Other neurological explanations of reversals include poor intersensory integration (Birch, 1962); difficulties in space relations with a confusion of figure-ground relationships (Krise, 1952); and difficulties of motor precision of eye movements (Monroe, 1932). Bannatyne (1973) has also suggested that the eyes reading from right to left may account for reversals, and Kephart (1960), in his studies of the slow learner, theorized that a dysfunction in spatial orientation accounted for reversal errors.
Contrary to the above theories, numerous investigators have concluded that the tendency to reverse letters or words is not caused by a perceptual deficit reflecting impaired neurological processes (Caldwell and Hall, 1969; Cohn and Stricker, 1976; Hendrickson and Muehl, 1962; Jeffrey, 1958; Harris and Roswell, 1953; Koenigsberg, 1973). Rather, they suggested that young children are unfamiliar with the discrimination tasks required to recognize letters correctly and therefore reverse letters, for example through lack of attention to directional factors. Smith (1978) has argued that reversals have too often been accounted for by unnecessary and inaccurate medical explanations and treatment, and educational remediation has sometimes resulted in making learning to read more difficult. He added that reversals can be explained by the fact of minimal difference between letters and by object constancy. He concluded that reversals are not caused by 'seeing backwards,' which is a logical and physical impossibility, and because some children may write backwards does not mean that they actually 'see backwards.'

Other critics of neurological or perceptual theories to explain reversals include linguists Goodman and Burke (1980). These authors have stated that reversal errors are neither a perceptual nor neurological problem result-
ing from a graphic short circuit, but are based on miscues which are inherent in the syntactic, semantic, and graphophonic systems of language. They concluded that reversals are the result of miscues in the normal linguistic development of children's language. Harman (1982) took this linguistic explanation of reversals a step further by suggesting that reversals are the result of children not reading with enough comprehension to recognize the inappropriateness of their reversals. She concluded that reversals are the result of their poor reading, and not the cause.

Developmental Theories

Symbol reversals as a developmental phenomenon have been widely publicized in the literature over the last 50 years. Monroe (1932), in her study of reading and reversals, found a developmental reduction in reversal errors in normal children from grade one to grade five. Davidson (1934 and 1935), in her study, showed that mirror image reversals of some letters, d - b, were made by over 90% of kindergarten children, but were dramatically reduced by age 7-1/2 years. She concluded that a mental age of 5-1/2 to 6-1/2 years is necessary to overcome up-down reversals, but overcoming left-right confusion requires a mental age of 7-1/2 years or more. Orton (1937), in his reported studies, also found a developmental
reduction in reversal errors. Gibson et al (1962), in their study of the evolution of graphic discrimination in 4 to 8-year-old subjects found that reversal and transformation errors dropped from 45% error rate at age 4 to 31% at age 5; to 19% by age 6, and to 5% at age 7.

Jordan (1974) did a comprehensive study of the developmental aspects of reversals of children aged 6 to 10, in the standardization of the Jordan Left-Right Reversal Test. The test results supported a developmental reduction in reversal errors from age 6 through age 10. For example, the mean error score at age 6 was 5.83; at age 7, 2.51; age 8, 2.60; age 9, 1.32; and age 10, 1.13.

Heydorn and Cheek (1982), in a survey of reversals in children in grades 1 through 3, used a simultaneous writing test and found a developmental reduction from grade 1 to close to non-existence by grade 3. Aliotti (1980), in his study of the tendency to mirror image in a visual memory test used kindergarten through second grade students and concluded that the mirror image reversal phenomenon is a common developmental characteristic of many children.

A body of researchers who supported the theory that there is a perceptual development from birth of a discrimination ability basic to later form perception included McKenzie and Day (1971); Fantz and Miranda (1975).
This theory is further supported and developed by Hershen-son (1967), who argued that perceptual development is a differentiation process rather than an enrichment of perceptual ability resulting from accumulated experience. Thus, the newborn is provided some sensory capacities with which to synthesize the perceptual world.

In another developmental study, Ilg and Ames (1950) reported a longitudinal study of the characteristic errors that children of ages 15 months to 10 years made with graphic stimuli. The authors found that reversals of letters and words were most typical for 5-1/2 year-olds, but gradually decreased and dropped out by age 8. Support for the reduction of the reversal tendency also came from Wilson and Fleming (1938) who stated that the reversal tendency is expected to be reduced significantly by the second or third grade. These authors, however, suggested that reversals are explainable as specific learnings rather than the result of general tendencies and are accountable for as the result of incomplete observation and other faulty learning processes in the young child.

Moyer and Newcomer (1977) have taken issue with the notion that reversals occur because children have not yet developed the level of perceptual maturation that is necessary to perform the task. These authors argued that
the critical point in interpreting the results of studies of this sort is that they measure only how children typically behave and do not address the causes of children's behavior. What appears to be a clear maturational pattern may in fact reflect children's opportunities for learning a particular kind of right-left or up-down discrimination. Young children may have lacked the opportunity to learn these skills. (p. 426).

Moyer and Newcomer further listed several studies which showed that even 4 and 5-year-old children can be taught to detect letter orientation.

Theories of Stimulus and Response Properties

Some investigators of reversals have criticized theories of development, maturation, learning, and neurological organization because these theories have concentrated on properties of the subject [endogenous] rather than on properties of the stimulus [exogenous] (Hyman and Cohen, 1975). These authors have suggested that the emphasis should shift from a study of human variables and perceptual abilities to research in which more emphasis is placed on controlling the nature of the stimulus. For example, Davidson (1935) found that the up-down of a 'q' and 'd' were discriminated by more than 73% of kindergarten children studied, but the left-right b - d were only discriminated by 13% of the same age children.

Support for the theory of an attraction to the
vertical also came from Wechsler and Pignatelli (1937), who found that rotations of 'b' and 'd' occurred when the vertical axial of these letters changed. Hulsebus (1969) also reported data to support the theory of the young child's attraction to the vertical dimension over the horizontal, concluding that the vertical dimension in children's judgments of size was critically related to age. With regard to reading, Nodine and Hart (1970) demonstrated significantly faster word recognition by kindergartners of both high and low reading readiness levels when stimuli were presented vertically rather than horizontally. These authors also reported that the decision time for girls in these trials was significantly faster than for boys, but accuracy was equivalent for both sexes.

In Hyman and Cohen's (1975) study of the effects of verticality as a stimulus property on the letter discrimination of young children, these authors found that the vertical properties of 'b,' 'd,' 'p,' 'q' influence letter reversal behavior of kindergartners. They suggested that reducing the dominance of the vertical aspects of these letters markedly reduced reversal errors. They argued that

... modification of the stimulus overrides the effects of child development.
Evidently an attraction to the vertical
to a degree of distractibility seems to have an interaction effect with left or right directionality. (p. 48).

They concluded that two error-causing constructs seem to explain 'b,' 'd,' 'p,' 'q' reversals, namely high distractibility to the vertical and poor sense of directionality; and the former, not the latter, carries more weight in producing these reversals. Support for this position has come from Cairns and Steward (1970) and Huttenlocher (1967a,b).

Other supporters of the theory that left-right discriminations are harder than up-down ones included Enterline (1970), and Rudel and Teuber (1963). The above studies pointed to the significance of the spatial layout of the stimuli in affecting the child's accuracy in responding to measures of reversal. Robinson and Higgins (1967) also found in a study of young children (from kindergarten through the third grade) that a large proportion of children are able to discriminate mirror image pairs, although there is still an age-related tendency to judge them as same. However, even the non-discriminators were apparently able to see a difference.

Other investigators of stimulus properties, such as Park (1978), in a study of geometric figure copying tests, found that consonant configuration confusions m - n seem to be least confusing and are mastered first.
That author found that certain orientation errors involving up-down comparisons, for example p - b, are still a problem with some second graders, and hardest to master are b - d left-right confusions. Furthermore, sequence errors, especially those involving letter sequence in medial positions, that is, there - three, gave the most difficulty. The above conclusions were supported by Davidson (1935) and to some extent by Gibson et al (1962).

With regard to response properties, Jordan (1974) found that when letter reversals are compared to number reversals, younger children through age 8-1/2 made a higher mean percentage of number as opposed to letter reversals. Allington (1976), in his study of match to sample tasks for first graders, found that reversal errors in numerals were twice as frequent as errors in letters.

Other response types which altered the error rate in reversal tasks were presented by Nelson and Peoples (1975). According to these authors, the easiest response method is a match to sample technique. Identifying a pair of letters as "same" or "different" was a little harder, while verbal responses requiring the subject to respond by copying the stimulus was the hardest.

**Reversals and Reading**

The ability to observe similarities and differences
in two dimensional stimuli has been traditionally con-
sidered a prerequisite to reading instruction by many
reading authorities (Betts, 1954; Gates et al, 1923;
Kottmeyer, 1947). The issue of perception has resurfaced
and researchers have also looked at the question of
whether the problem in beginning reading is in the per-
ception of individual letters. There is some support for
the position that after the first grade, even those chil-
dren who have made somewhat slow progress in learning
to read do not have significant difficulty in the visual
identification of individual letters (Shankweiller, 1964;
Doehring, 1968).

Many educators, clinicians, parents, and teachers
have recognized the tendency for young children to con-
fuse letters of similar shape that differ in orientation
that is, 'b,' 'd,' 'p,' 'q.' However, some educators and
clinicians have gone a step further and suggested that
reversals are characteristic of poor readers, especially
beyond the ages of 7 or 8 years (Bryant, 1964; Boder,
1973).

Orton (1937) considered the reversal phenomena to
be so central to the problems in reading that he used
the term 'strephosymbolia,' 'twisted symbols,' to desig-
nate specific reading disability. Boder (1973), in her
classification of dyslexics as dysphonetic, dyseidetic,
and mixed dysphonetic dyseidetic, found reversal errors in all three kinds. Many clinicians and researchers, such as Bannatyne (1971); Orton (1937); Johnson and Myklebust (1967); Ginsberg and Hartwick (1971); Eisenberg (1966); and Bryant (1964) have characterized reversals as a primary indicator of dyslexia.

Lyle (1969), comparing retarded and adequate readers in grades 1 to 6, found that poor readers made a significantly higher number and proportion of reversal errors than did adequate readers. A number of other investigators, using a variety of tasks and methodologies, have found poor readers made significantly more reversal errors than normal readers (Lahey and Lefton, 1976; Tjossen et al, 1962; Wechsler and Hagin, 1964; Jordan, 1976; and Aliotti, 1980).

Contrary to the above, other researchers such as Shankweiller et al (1972) have found negative evidence with regard to reversals and reading. In a study of third graders the above writers found that sequence and orientation reversals accounted for only 15% and 10% of total errors made, while consonant errors and vowel errors accounted for 32% and 43% of total errors made. Furthermore, sequence reversals and orientation reversals were wholly uncorrelated with each other, whereas vowel and consonant errors correlated significantly at .73.
These investigators also found that reversal errors were not commutative and, as a result, they argued that optical reversibility or 'seeing backwards' was not supported. They concluded that reversals were only a minor part of all reading errors among poor readers and that letter reversals may be symptomatic but not a cause of reading disability.

Cohn and Stricker (1976), in their study to separate the perceptual from the cognitive issues in letter naming, also found that reversal errors are not commutative. Cohn and Stricker (1979) found that uppercase letters were more easily recognized than lower case. They concluded that reversal errors were not prognostic of reading disability and perceptual reversal or 'seeing backwards' cannot hold true. They suggested that the developmental hierarchy of letter recognition depends on aspects of learning discrimination and spatial orientation.

Contrary to the notion of sequencing and orientation reversals being independent, Lyle (1969) found that these two types of reading reversals correlated about .80 on a factor he labeled 'freedom from perceptual and perceptual-motor distortion.' Support for the similarity of these two types of reversal errors also came from Huttenlocher (1967a).

Schlieper (1980), in her study of letter and word
reversals in meaningful oral reading passages, found that the incidence of reversals was significantly less than in studies which involved letter or word reversals in isolation. She stated that whole word reversals were qualitatively different from letter reversals in a meaningful text in that expectancy and context overrode the text to produce meaningful, sensible, but inaccurate reading. Letter reversals were not randomly distributed in the text but seemed most often elicited when the word was both unfamiliar and contextually analogous. Word reversals, although declining from grade 1 through 3, did not differentiate the poor reader from the total group. The author concluded that the presence of reversal errors is of no special significance in signalling a reading problem in the early grades.

Support for this position came from Smith (1978) who suggested that fluent readers and reading in context lead to fewer reversal errors and even if the reader makes a reversal, he/she makes automatic compensations to get the correct meaning of the text. Smith (1978) also stated that to distinguish reversible letters in isolation is a much more difficult task than in context. Other supporters of this linguistic explanation of reversals include Goodman and Burke (1980) who argued that reversals are the result of miscues in the normal linguistic development of
children's language.

Another linguistic supporter, Harman (1982), has stated that when children are not reading with comprehension they do not recognize the inappropriateness of their reversals, and thus their reversals are the result of their poor reading and not the cause. Harman has thus concluded that reversals are a symptom of poor reading because they reveal a child's lack of comprehension and not because of a visual, neurological, or psychological problem.

Reversals Predictive of Reading Achievement

There is wide support for the position that reversals can be one significant factor in predicting reading failure. For example, Bannatyne (1971), in a screening battery for preschool children, included a test for matching letter sequences and a simultaneous writing test for reversals in a selected group of thirteen tests. Barret (1965) reported reversal tests as useful predictors of reading achievement in first grade students. Teegarden (1933), in a study of young children's reversals at the beginning of first grade and their reading progress at the end of that year, found strong significant correlations (.54 to .77). Goins (1958), in a study of first grade children, found a correlation of .49 between reversals and scores on a reading test. Of the 14 visual perceptual measures
administered, the reversals test was ranked the second best predictor.

Other support for reversals being predictive of reading came from Jansky and DeHirsch (1972). These investigators, in a refinement of their early predictive index tests, found that the reversals test was a good predictor of reading, the fifth best out of the 21 statistically significant kindergarten measures. Other studies which strongly support the use of reversals as part of a predictive index were conducted by Zaeske (1970); Stevenson et al (1976); and Wallbrown et al (1975). In the Wallbrown et al (1975) study, these authors, using a multiple regression analysis, found that the reversals test was one of the four subtests out of the ten they used that were needed to predict the Gates-MacGinitie reading comprehension scores at the end of first grade. Although there is strong support for a reversals test to be included in a predictive index, as Jordan (1976) cautioned:

A reversals test is not meant to be used as the only diagnostic instrument for minimal neurological dysfunction or dyslexia. When a deviant score is obtained, the teacher or clinician is advised to check on a number of other variables to determine a final diagnosis. (p. 417).

Sex Differences

There is conflicting evidence that sex differences
in reversals exist in young children. Support for sex differences in reversals came from Jordan (1974). In his standardization of the Jordan Left-Right Reversal Test, using a sample of 2,732 children ages 6 through 10, that author found that boys of all ages made more reversals than girls, particularly during ages 6 through 7. Aaron and Handley (1975), in their study of mirror image reversal tendencies in 3 to 7-year-olds, found sex related age differences with left to right responses replacing right to left ones by age 4 in girls and age 6 in boys.

Contrary evidence to the above came from Nelson and Peoples (1975) who in their study of reversals in kindergarten through third grade children found no significant differences in the number of overall errors made by boys or girls. Stevenson et al (1976), in their use of reversals in a predictive index of scholastic achievement found no significant sex differences in the predictive coefficients. There were also no significant differences in the mean performances on the reversals test by boys and girls in this study. Gibson et al (1962) also reported no significant sex differences in children's discrimination of letter-like forms.

**Psychological Factors**

Psychological factors have been associated with symbol
reversals both in terms of reading ability and learning disability. Psychological theories to explain reversals have been put forth by Laurita (1971) and Blanchard (1935). Laurita (1971) suggested a combined approach of directional orientation training and reduction of anxiety techniques to reduce reversals. Laurita has argued that reversals are a response to frustration, and that prolonged instruction to remediate persistent reversals may serve only to intensify the problem, to the point of students developing abnormal fixation and 'experimental neurosis.' Blanchard (1935) suggested that letter reversals may be symptomatic of emotional disturbance.

**Correcting Symbol Reversals**

There is a wide body of knowledge to suggest that symbol reversals can be corrected, even among 4 and 5-year-old children (Jeffrey, 1958; Caldwell and Hall, 1969; Koenigsberg, 1973). Moyer and Newcomer (1977) stated that in order to make successful discriminations, children's attention must be drawn to the directional differences between the symbols. Samuels (1973) proposed that the forms to be learned should be presented simultaneously, so the differences between them can be examined. Moyer and Newcomer (1977) stated that a survey of techniques to correct symbol reversals showed that children may not have learned the importance of directionality as a
distinguishing feature.

Moyer and Newcomer (1977) have suggested the following instructional sequence to correct symbol reversals in young children. The first step is to teach the task of discrimination, followed by a simultaneous match to sample task. This should be followed by a delayed matching task and finally, the teaching of the letter names. In the case of older children exhibiting confusion of letter orientation, the authors stated that the preceding guidelines may be used in a somewhat reversed order.

Many other instructional techniques have been proposed to remediate reversals. For example, Bannatyne (1973) found that a variety of mnemonic devices was helpful. Polloway and Polloway (1980) suggested a system of remediating reversals through stimulus fading from an uppercase letter to a lower case letter. Bracey and Ward (1980) used color cues and flash cards to remediate symbol reversals. Stromer (1977) utilized flash cards and differential feedback techniques to correct symbol reversals. Kirshner (1977) used a visual motor directional pattern program to remediate reversals. Laurita (1971) suggested a combined approach of directional orientation training and reduction of anxiety.

However, Steen and Sowell (1980), following the premise that the tendency to reverse stems from a lack of training about directionality, in a study of children 8
and 9 years of age, found that training in directionality did not significantly affect the number of reversals. The authors concluded that perhaps perceptual rules and training in directionality are not the only learned behavior needed before the reversal tendency can be lessened in older children.

Harman (1982) has suggested a linguistic approach to remediation, focusing on comprehension and the reading of stories rather than letters or words. Support for this position came from Smith (1978) who argued that the only treatment required to help the child avoid reversal errors is a solid regime of meaningful instruction of reading in the context. Bannatyne (1973) has given further support to the position that the best 'cure' for reversals is to teach automatic, fluent, and meaningful reading. Thus he suggested that an inordinate amount of time should probably not be spent on remediating reversals. Bannatyne further suggested that symbol reversals are only one symptom among several others in the reading process.

**Summary**

Theories and research in reversals have progressed significantly since the exploratory work of Orton (1928) and Davidson (1935). Much of the early research centered on neurological theories developed by Orton (1928). The
legacy of Orton's work is still apparent today in the studies of Bannatyne (1973) and Aliotti (1980). Other theories which have given birth to increased research in reversals include developmental theories (Gibson et al., 1962); linguistic theories (Goodman and Burke, 1980); theories of stimulus properties (Hyman and Cohen, 1975); psychological theories (Laurita, 1971); and theories of sex differences (Jordan, 1974).

There is support for the position that reversals may be symptomatic of reading disability, especially beyond the ages of 8 or 9 years (Boder, 1973). Other researchers have suggested that reversals can be one significant factor in predicting reading failure (Jansky and DeHirsch, 1972). There is at present conflicting evidence that sex differences in reversals exist in young children (Jordan, 1974; Nelson and Peoples, 1975). There is generally widespread support for the position that reversals can be remediated with specific intervention (Moyer and Newcomer, 1977).

There is, however, a sparsity of research into the effect of the remediation of reversals on reading achievement. There is also the need to study simple and effective methods for the remediation of reversals. There is need for further research of the reading achievement of reversing versus non-reversing students. The issue of sex differences in reversals also needs further clarification.
CHAPTER III

Methods and Procedures

The Sample

One hundred fifteen first grade children, taken from seven different classes in two separate schools in East Baton Rouge Parish, Louisiana, participated in the study. The students were selected from a number of volunteer grade one classes on the basis of their being representative of the district at large in terms of racial composition and socioeconomic factors. Four classes came from one school and three classes from the other. Schools in which academic readiness programs were being utilized were excluded. Sixty male and 55 female students who had parental permission were selected to participate in the study.

The Instruments


The Jordan Left-Right Reversal Test is a standardized,
norm referenced instrument which measures visual reversals of letters, numbers, and words in subjects from 5 years of age to adult. Level 1 of this test which measures symbol reversals of letters and numbers was utilized in this study because the sample consisted of young children at the grade 1 level. Reliability for this test was given at .96 and the standard error of measurement was 1.52 for students at the grade 1 level. Validity data were given in the form of internal or content validity and external or concurrent validity.

Norms for age and sex groups in this test were derived from a performance of over 4,300 pupils in various parts of the country. Internal validity was defined by Jordan (1978) as agreement among several judges that the symbol presented a clear reversal when reproduced in a left-right position. External validity was defined in terms of differing error rates for samples of neurologically impaired and normal children, and statistically significant correlations between the scores on the test and other perceptual measures.

The Gates-MacGinitie Reading Tests Basic R are standardized, norm referenced tests, designed to measure vocabulary, comprehension, letter recognition, and letter sounds in reading. The Basic R was especially designed for students at the grade 1 level. It thus included a
variety of skills that are widely taught in beginning reading instruction such as sounds of initial and final consonants, consonant combinations, vowel sounds, word analysis, word families, letter recognition, letter matching, simple vocabulary and comprehension.

Standardization of this test was carried out based on stratified sampling techniques in 86 school districts. The norming samples included 5,800 students. Reliability was given at .88 for Basic R Form 1, and .93 for Basic R Form 2, based on Kuder-Richardson Formula 20 (Guilford, 1965). Validity was based on a consensus of commonly used reading materials, and passages were written to suit the knowledge and interests of children beginning to read.

Design

The study used a randomized control group pretest-posttest design. This is represented graphically by Campbell and Stanley (1963) in this way:

\[ R \ T_1 \ X \ T_2 \]

\[ R \ T_1 \ T_2 \]

In this study, \( R \) referred to random assignment to experimental or control group. \( X \) represented the exposure of the experimental group to the experimental treatment. \( T \) referred to the tests given; \( T_1 \) and \( T_2 \) are pretests and
\( T_2 \) and \( T_2 \) are posttests.

Internal validity of this design is assured through strengths in the control of history, maturation, testing, instrumentation, regression, selection, mortality, and the interaction of selection and maturation. Campbell and Stanley (1963) have also pointed out that there may be some threat to external validity in this design through the interaction of pretesting and treatment, the interaction of selection and treatment, and the reactive effects of experimental procedures.

These potential weaknesses in external validity have been minimized in this study in the following ways: The interaction of pretesting and treatment was reduced because experimental testing was comparable to regular classroom examinations. The interaction of selection and treatment was also reduced in that the classes used in this study were representative of the district at large in several characteristics. The reactive effects of experimental procedures were minimized in that the pretest and posttest were presented as part of the routine school testing program and the treatment was presented to the experimental group as part of the normal instructional program.

This study can also be represented as a 2 sex (male and female) x 3 (grouping) experimental factorial design,
a schematic representation of which is given in fig. 3.1.

<table>
<thead>
<tr>
<th></th>
<th>TREATED SYMBOL REVERSERS</th>
<th>NON-TREATED SYMBOL REVERSERS</th>
<th>NON-REVERSERS</th>
</tr>
</thead>
<tbody>
<tr>
<td>MALES</td>
<td>SR/T</td>
<td>SR/NT</td>
<td>NR</td>
</tr>
<tr>
<td>FEMALES</td>
<td>SR/T</td>
<td>SR/NT</td>
<td>NR</td>
</tr>
</tbody>
</table>

EXPERIMENTAL CONTROL GROUP 1 CONTROL GROUP 2

SR Symbol Reversers NR Non-Reversers
T Treatment NT Non-Treatment

Figure 3.1
2 x 3 Experimental Factorial Design

In the 2 x 3 factorial design utilized in this study, the first variable was sex (male or female), and the second variable was grouping (experimental, control group 1, and control group 2). The experimental groups thus consisted of treated symbol reversers; control group 1 consisted of non-treated symbol reversers, and control group 2 consisted of non-reversers.

Procedures

The 115 grade 1 students who participated in the study were group tested by the researcher in September
1982, using the Jordan Left-Right Reversal Test Level 1 (1974), and the Gates-MacGinitie Reading Tests Basic R Form 1 (1978). The results of the Jordan Left-Right Reversal Test showed that 38 of these students, that is, 19 males and 19 females, made three or fewer symbol reversal errors. This group of non-reversers was classified as control group 2. The results of the Jordan Left-Right Reversal Test also showed that 77 students made four or more symbol reversal errors. These students were then randomly assigned either to the experimental group or to the non-treated symbol reversal group. The experimental group thus comprised 38 students which consisted of 22 males and 16 females. The non-treated symbol reversal group which became control group 1, comprised 39 students of which 19 were males and 20 were females.

The experimental group was then given a series of remedial symbol training lessons by their teachers, 20 minutes a session, three sessions a week for eight weeks. The teachers were trained by the researcher in the use of symbol reversal remedial exercises. Remedial lessons were identical in each of the 7 classes for the experimental group. Control group 1, that is, non-treated symbol reversers, and control group 2, that is, non-reversers, received only the regular academic program with no specific instruction in the remediation of
reversals. All groups were then posttested at the end of the experiment with the Jordan Left-Right Reversal Test Level 1 (1974), and the Gates-MacGinitie Reading Tests Basic R, Form 2 (1978) in December 1982.

Treatment

The treatment used in this study was a modification of the Kirshner Program for the remediation of reversals (Kirshner, 1977). The researcher redesigned and expanded the Kirshner Program to provide remediation for both uppercase and lowercase letters, and to include all the letters that could potentially be reversed. The Researcher also redesigned the Kirshner Program into a sequence of steps for the remediation of reversals.

The remedial program is thus based on the principle of providing a visual motor directional pattern that is error free, right from the start. Motor pretraining has been used by Fernald (1943), Montessori (1961), and by Hendrickson and Meuhl (1962) to correct reversals. The program is thus based on the above principle and follows the eight steps listed here for the remediation of reversals:

1. The student uses the 'magic ruler' and a sheet of paper to practice making the reversed symbol (letter or number) in its correct orientation.
2. The student gets further practice in making the correct form of the symbol, using the 'magic ruler.'

3. The student traces over the correct shape of a large form of the symbol, with his index finger.

4. The student practices filling in the large shape of the symbol with smaller versions of the symbol, without using the 'magic ruler.'

5. The student colors the large symbol after it has been filled in with the smaller versions.

6. The student fills in a sheet containing blank squares with the appropriate symbol in its correct orientation, without having access to the symbol, that is, from memory.

7. In this step which is the criterion of mastery test, the student circles the correct form of the symbol which has been mixed in with an array of jumbled letters or numbers in various orientations.

8. If the student fails step 7, he is
re-taught the process and practices from step 1 through to step 7 again.

The remedial program is thus a task analyzed procedure which gives students practice in recognizing and making the correct form of the symbol. The student is remediated from symbol errors to a stage where he can instantly recognize and make the appropriate symbol. A typical lesson plan and supporting examples are given in Appendix A.

**Statistical Treatment**

Three statistical treatments were used to analyze the data: the analysis of covariance, the analysis of variance and the t test. Both the analysis of covariance and the analysis of variance were used to test one or more null hypotheses that the means of the groups sampled came from populations with equal means and differ only because of sampling error. However, the analysis of covariance controls for initial differences between groups. The criterion of rejection for the rejection of the null hypotheses was significance at the .05 level of significance.

In this study, analysis of covariance was used to test hypotheses 1, 2, and 3 with reading achievement being the pretest covariable. The analysis of covariance
was also used to test hypotheses 7 and 8, with symbol reversal being the pretest covariable. The analysis of variance was used to test hypotheses 4, 5, and 6. The t test was used to test hypothesis 9. The additional findings were subjected to single degree of freedom comparisons out of a 2 (sex) x 3 (grouping) x 2 (time) factorial analysis of variance with repeated measures on the last factor (time).
CHAPTER IV

Analysis of Data

Introduction

The purpose of this study was to investigate reading achievement in first grade children in terms of symbol reversals and sex. The study also compared the reading achievement of reversing students and non-reversing students. Finally, the effectiveness of specific remedial exercises in reducing symbol reversals was investigated.

One hundred fifteen grade one children participated in the study. Reading achievement was measured by the Gates-MacGinitie Reading Tests Basic R, Forms 1 and 2. Symbol reversals were measured by the Jordan Left-Right Reversal Test, Level 1. The sample comprised 38 students in an experimental group of treated symbol reversers, 39 students in a control group of non-treated symbol reversers, and 38 students in a second control group of non-reversers. A 2 x 3 experimental factorial design was utilized. Table 1 shows the composition of the experimental and control groups by sex. For the posttesting three students were lost from the experimental group of treated symbol
reversers, and five students were lost from the control group of non-treated symbol reversers. No students were lost from the control group of non-reversers.

Table 1
Composition of Experimental and Control Groups by Sex

<table>
<thead>
<tr>
<th>Sex</th>
<th>Experimental Group Treated Reversers</th>
<th>Control Group 1 Non-treated</th>
<th>Control Group 2 Non-reversers</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>22</td>
<td>19</td>
<td>19</td>
</tr>
<tr>
<td>Female</td>
<td>16</td>
<td>20</td>
<td>19</td>
</tr>
<tr>
<td>Total</td>
<td>38</td>
<td>39</td>
<td>38</td>
</tr>
</tbody>
</table>

The analysis of covariance was used to test hypotheses 1, 2, and 3, with reading achievement being the pretest covariable. The analysis of variance was used to test hypotheses 4, 5, and 6. The analysis of covariance was used to test hypotheses 7 and 8. The t test was used to test hypothesis 9.

The discussion of the research findings is as follows: Each hypothesis is stated in the original order of presentation. The hypothesis is followed by the statistical findings and a discussion of the hypothesis. The chapter is concluded with a presentation of additional findings and a discussion of these findings.
Introduction to Hypotheses 1, 2, and 3

Hypotheses 1, 2, and 3 examined the reading achievement of symbol reversing students who have had treatment in remediation of symbol reversals and compared it with the reading achievement of symbol reversing students who did not have such treatment. Sex differences in terms of the above were also examined.

Hypothesis 1

There is no significant difference at the .05 level of confidence in scores in reading achievement of symbol reversing students who have had treatment in the remediation of symbol reversals and those who have not had such treatment.

Table 2

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Adjusted Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>1</td>
<td>0.56</td>
<td>0.02</td>
<td>0.91</td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>0.05</td>
<td>0.00</td>
<td>0.97</td>
</tr>
<tr>
<td>Sex x Group</td>
<td>1</td>
<td>9.22</td>
<td>0.25</td>
<td>0.62</td>
</tr>
</tbody>
</table>
Statistical Findings and Discussion

The data presented in Table 2 showed that there were no significant differences at the .05 level of confidence in reading achievement between symbol reversing students who have had treatment in the remediation of symbol reversals and those who have not had such treatment. An F-ratio of 0.00 was computed. The null hypothesis was therefore accepted. There were no significant differences in reading achievement between symbol reversing students who have had treatment in the remediation of symbol reversals and those who have not had such treatment.

Hypothesis 2

There is no significant difference at the .05 level of confidence in scores in reading achievement between male and female symbol reversing students who have had treatment in the remediation of symbol reversals.

Table 3

Analysis of Covariance for Reading Achievement on Posttest Scores of Treated Male Symbol Reversers (TMSR) Versus Treated Female Symbol Reversers (TFSR)

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Adjusted Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMSR vs TFSR</td>
<td>1</td>
<td>2.66</td>
<td>0.07</td>
<td>0.79</td>
</tr>
</tbody>
</table>
Statistical Findings and Discussion

The data presented in Table 3 showed that there were no significant differences at the .05 level of confidence in reading achievement between male and female symbol reversing students who have had treatment in the remediation of symbol reversals. An F-ratio of 0.07 was computed. The null hypothesis was therefore accepted. There were no significant differences in reading achievement between male and female symbol reversing students who have had treatment in the remediation of symbol reversals.

Hypothesis 3

There is no significant difference at the .05 level of confidence in scores in reading achievement between male and female symbol reversing students who have had no treatment in the remediation of symbol reversals.

Table 4

Analysis of Covariance for Reading Achievement on Posttest Scores of Non-Treated Male Symbol Reversers (NTMSR) Versus Non-Treated Female Symbol Reversers (NTFSR)

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Adjusted Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>NTMSR vs NTFSR</td>
<td>1</td>
<td>7.21</td>
<td>0.20</td>
<td>0.66</td>
</tr>
</tbody>
</table>
Statistical Findings and Discussion

The data presented in Table 4 showed that there were no significant differences at the .05 level of confidence in reading achievement between male and female symbol reversing students who have had no treatment in the remediation of symbol reversals. An F-ratio of 0.20 was computed. The null hypothesis was therefore accepted. There were no significant differences in reading achievement between male and female symbol reversing students who have had no treatment in the remediation of symbol reversals.

Introduction to Hypotheses 4, 5, and 6

Hypotheses 4, 5, and 6 examined differences in the pretest reading achievement scores between symbol reversing students and non-reversing students. Group comparisons in terms of sex were also examined. Hypotheses 4, 5, and 6 utilized a 2 x 3 analysis of variance with Gates-MacGinitie Reading Tests Basic R pretest being the dependent variable. The overall results of this analysis are shown in Table 5.
Table 5

Analysis of Variance for all Students on the Pretest, Gates-MacGinitie Reading Tests Basic R, Form 1

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>1</td>
<td>22.49</td>
<td>0.69</td>
<td>0.41</td>
</tr>
<tr>
<td>Group</td>
<td>2</td>
<td>742.36</td>
<td>11.37</td>
<td>0.00**</td>
</tr>
<tr>
<td>Sex x Group</td>
<td>2</td>
<td>33.99</td>
<td>0.52</td>
<td>0.60</td>
</tr>
</tbody>
</table>

**Significant at .01 level.

Statistical Findings and Discussion

The data showed that there were significant differences at the .01 level of confidence, among the three groups in the pretest reading achievement scores. As shown in Table 5, the F-ratio was computed at 11.37. This showed that there were one or more significant differences in reading achievement among the groups in the overall analysis of variance. However, there were no significant differences in sex, F-ratio 0.69, and sex by group interactions, F-ratio 0.52, in pretest reading achievement scores.
Hypothesis 4

There is no significant difference at the .05 level of confidence in scores in reading achievement between symbol reversing students and non-reversing students.

Table 6

Analysis of Variance for Symbol Reversing Students (SR) Versus Non-Symbol Reversing Students (NSR) on Pretest, Gates-MacGinitie Reading Tests Basic R

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>SR vs NSR</td>
<td>1</td>
<td>742.12</td>
<td>22.74</td>
<td>.00**</td>
</tr>
</tbody>
</table>

**Significant at .01 level.

Statistical Findings and Discussion

The data presented in Table 6 indicated a statistically significant difference at the .01 level of confidence in reading achievement between symbol reversing students and non-reversing students. An F-ratio of 22.74 was computed. The null hypothesis was therefore rejected. There were significant differences in scores in reading achievement between symbol reversing students and non-reversing students. The mean pretest reading achievement score for
symbol reversing students was 22.53 and the mean pretest reading achievement score for the non-reversing students was 27.92.

**Hypothesis 5**

There is no significant difference at the .05 level of confidence in scores in reading achievement between male symbol reversing students and male non-reversing students.

**Table 7**

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>MSR vs MNSR</td>
<td>1</td>
<td>424.62</td>
<td>13.01</td>
<td>0.00**</td>
</tr>
</tbody>
</table>

**Significant at .01 level.**

**Statistical Findings and Discussion**

The data presented in Table 7 indicated a statistically significant difference at the .01 level of confidence in reading achievement between male symbol reversing
students and male non-reversing students. An F-ratio of 13.01 was computed. The null hypothesis was therefore rejected. There were significant differences in scores in reading achievements between male symbol reversing students and male non-reversing students. The mean pretest reading achievement score for male symbol reversing students was 21.96 and the mean pretest reading achievement score for male non-reversing students was 27.68.

**Hypothesis 6**

There is no significant difference at the .05 level of confidence in scores in reading achievement between female symbol reversing students and female non-reversing students.

**Table 8**

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>FSR vs FNSR</td>
<td>1</td>
<td>322.29</td>
<td>9.87</td>
<td>0.00**</td>
</tr>
</tbody>
</table>

**Significant at the .01 level.**
Statistical Findings and Discussion

The data presented in Table 8 indicated a statistically significant difference at the .01 level of confidence in reading achievement between female symbol reversing students and female non-reversing students. An F-ratio of 9.87 was computed. The null hypothesis was therefore rejected. There were significant differences in scores in reading achievement between female symbol reversing students and female non-reversing students. The mean pretest reading achievement score for female symbol reversers was 23.06 and the mean pretest reading achievement score for female non-reversers was 28.16.

Introduction to Hypotheses 7 and 8

Hypotheses 7 and 8 examined differences in scores in symbol reversals of symbol reversing students who have had treatment in the remediation of symbol reversals and those who have not had such treatment. Sex differences in terms of the above were also examined.

Hypothesis 7

There is no significant difference at the .05 level of confidence in scores in symbol reversals of symbol reversing students who have had treatment in the remediation of symbol reversing and those who have not had such treatment.
Table 9

Analysis of Covariance for Symbol Reversals on Posttest Scores of Treated Symbol Reversers and Non-Treated Symbol Reversers on the Jordan Left-Right Reversal Test, Level I

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Adjusted Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sex</td>
<td>1</td>
<td>9.41</td>
<td>0.55</td>
<td>0.46</td>
</tr>
<tr>
<td>Group</td>
<td>1</td>
<td>10.72</td>
<td>0.62</td>
<td>0.43</td>
</tr>
<tr>
<td>Sex x Group</td>
<td>1</td>
<td>45.18</td>
<td>2.62</td>
<td>0.11</td>
</tr>
</tbody>
</table>

Statistical Findings and Discussion

The data presented in Table 9 showed that there were no significant differences at the .05 level of confidence in symbol reversals of symbol reversing students who have had treatment in the remediation of symbol reversals and those who have not had such treatment. An F-ratio of 0.62 was computed. The null hypothesis was therefore accepted. There were no significant differences in symbol reversals of symbol reversing students who have had treatment in the remediation of symbol reversals and those who have not had such treatment.
Hypothesis 8

There is no significant difference at the .05 level of confidence in scores in symbol reversals between male and female symbol reversing students who have had treatment in the remediation of symbol reversals.

Table 10

Analysis of Covariance for Symbol Reversals on Posttest Scores of Treated Male Symbol Reversers (TMSR) Versus Treated Female Symbol Reversers (TFSR) on the Jordan Left-Right Reversal Test, Level 1

<table>
<thead>
<tr>
<th>Sources of Variation</th>
<th>Degrees of Freedom</th>
<th>Adjusted Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>TMSR vs TFSR</td>
<td>1</td>
<td>47.54</td>
<td>2.76</td>
<td>0.10</td>
</tr>
</tbody>
</table>

Statistical Findings and Discussion

The data presented in Table 10 showed that there were no significant differences at the .05 level of confidence in symbol reversals between male and female symbol reversing students who have had treatment in the remediation of symbol reversals. An F-ratio of 2.76 was computed. The null hypothesis was therefore accepted. There were no significant differences in symbol reversals between male and female symbol reversing students who have had treatment in the remediation of symbol reversals.
Hypothesis 9 examined differences in scores in symbol reversals between male and female students on the symbol reversal pretest.

**Hypothesis 9**

There is no significant difference at the .05 level of confidence in scores in symbol reversals between male and female students.

**Table 11**

<table>
<thead>
<tr>
<th>Sex</th>
<th>Number</th>
<th>Mean</th>
<th>Standard Deviation</th>
<th>t</th>
</tr>
</thead>
<tbody>
<tr>
<td>Male</td>
<td>60</td>
<td>7.15</td>
<td>5.38</td>
<td>.45 ns</td>
</tr>
<tr>
<td>Female</td>
<td>55</td>
<td>6.71</td>
<td>5.08</td>
<td></td>
</tr>
</tbody>
</table>

ns Non-significant.

**Statistical Findings and Discussion**

The data presented in Table 11 indicated a mean of 7.15 symbol reversals for males and a mean of 6.71 symbol reversals for females. A t value of .45 was computed. This pointed out a non-significant difference at the .05 level of confidence. The null hypothesis was therefore accepted. There were no significant differences in symbol
reversals between male and female students.

Additional Findings

The results of this study were more closely examined to determine the effects of treatment versus non-treatment. Specific contrast questions were then used to examine mean differences in reading achievement and in symbol reversals. Toward this end, single degree of freedom comparisons out of a 2 (sex) x 3 (grouping) x 2 (time) factorial analysis of variance with repeated measures on the last factor (time) was utilized. These results are presented in Tables 12, 13, 14, and 15.
Table 12

Means, Least Square Means, and Differences for Pretests and Posttests in Reading Achievement for All Groups on the Gates-MacGinitie Reading Tests Basic R

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest Means</th>
<th>Posttest Means</th>
<th>Difference</th>
<th>Least Squares Mean Pretest</th>
<th>Least Squares Mean Posttest</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated Symbol Reversers</td>
<td>22.00</td>
<td>25.97</td>
<td>3.97</td>
<td>21.82</td>
<td>25.95</td>
<td>4.13</td>
</tr>
<tr>
<td>Non-Treated Symbol Reversers</td>
<td>23.09</td>
<td>26.53</td>
<td>3.44</td>
<td>22.94</td>
<td>26.52</td>
<td>3.58</td>
</tr>
<tr>
<td>Non-Reversers</td>
<td>27.92</td>
<td>31.87</td>
<td>3.95</td>
<td>27.92</td>
<td>31.87</td>
<td>3.95</td>
</tr>
</tbody>
</table>
Statistical Findings and Discussion

The data presented in Table 12 showed that for the treated symbol reversals group, the mean gain in reading achievement (raw score) was 3.97 and the least squares mean gain was 4.13. For the non-treated symbol reversers the mean gain in reading achievement (raw score) was 3.44 and the least squares mean gain was 3.58. For the non-reversers, the mean gain in reading achievement (raw score) was 3.95 and the least squares mean gain was 3.95.

In addition to examining the mean differences, specific contrasts were used to explore whether differences observed between groups in reading achievement from pretest to posttest were significant by differentiation. Six specific contrast analyses were used to test reading achievement for significance from pretest to posttest. The results are shown in Table 13.
Table 13

Specific Contrasts for Reading Achievement on Gates-MacGinitie Reading Tests Basic R

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_2 - T_1/G_1$</td>
<td>1</td>
<td>2.30</td>
<td>0.12</td>
<td>0.73</td>
</tr>
<tr>
<td>$T_2 - T_1/G_2$</td>
<td>1</td>
<td>0.26</td>
<td>0.01</td>
<td>0.91</td>
</tr>
<tr>
<td>$T_2 - T_1/G_3$</td>
<td>1</td>
<td>1.13</td>
<td>0.06</td>
<td>0.81</td>
</tr>
<tr>
<td>$T_2 - T_1/G_1$</td>
<td>1</td>
<td>277.26</td>
<td>14.66</td>
<td>0.00**</td>
</tr>
<tr>
<td>$T_2 - T_1/G_2$</td>
<td>1</td>
<td>212.19</td>
<td>11.22</td>
<td>0.00**</td>
</tr>
<tr>
<td>$T_2 - T_1/G_3$</td>
<td>1</td>
<td>296.05</td>
<td>15.65</td>
<td>0.00**</td>
</tr>
</tbody>
</table>

**Significant at .01 level.

$T_1$ = Pretest  
$G_1$ = Treated Symbol Reversers  
$T_2$ = Posttest  
$G_2$ = Non-Treated Symbol Reversers  
$G_3$ = Non-Reversers
Statistical Findings and Discussion

The data presented in Table 13 showed that there were no significant differences at the .05 level of confidence in reading achievement gain between treated symbol reversers and non-treated symbol reversers. There were also no significant differences at the .05 level of confidence in reading achievement gain between treated symbol reversers and non-reversers. There were no significant differences at the .05 level of confidence in reading achievement gain between non-treated symbol reversers and non-reversers.

However, the data showed that there were significant differences at the .01 level of confidence in reading achievement gain in all three groups from pretest to posttest in within-groups comparisons.
Table 14

Means, Least Square Means, and Differences for Pretests and Posttests in Symbol Reversals for All Groups on the Jordan Left-Right Reversal Test, Level 1

<table>
<thead>
<tr>
<th>Group</th>
<th>Pretest Means</th>
<th>Posttest Means</th>
<th>Difference</th>
<th>Least Squares Mean Pretest</th>
<th>Least Squares Mean Posttest</th>
<th>Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Treated Symbol Reversers</td>
<td>10.06</td>
<td>6.97</td>
<td>3.09</td>
<td>10.17</td>
<td>6.73</td>
<td>3.44</td>
</tr>
<tr>
<td>Non-Treated Symbol Reversers</td>
<td>8.77</td>
<td>6.82</td>
<td>1.95</td>
<td>8.73</td>
<td>6.72</td>
<td>2.01</td>
</tr>
<tr>
<td>Non-Reversers</td>
<td>1.45</td>
<td>1.58</td>
<td>0.13</td>
<td>1.45</td>
<td>1.58</td>
<td>0.13</td>
</tr>
</tbody>
</table>
Statistical Findings and Discussion

The data presented in Table 14 showed that for the treated symbol reversal group, the mean reduction in symbol reversals was 3.09 and the least squares mean reduction was 3.44. For the non-treated symbol reversers, the mean reduction in symbol reversals was 1.95 and the least squares mean reduction was 2.01. For the non-reversers, the mean difference in symbol reversals was 0.13 and the least squares mean difference was 0.13.

In addition to examining the mean differences, specific contrasts were used to explore whether differences observed between groups in symbol reversals from pretest to posttest were significant by differentiation. Six specific contrast analyses were used to test symbol reversals for significance from pretest to posttest. The results are shown in Table 15.
Table 15
Specific Contrasts for Symbol Reversals on Jordan Left-Right Reversal Test, Level 1

<table>
<thead>
<tr>
<th>Contrast</th>
<th>Degrees of Freedom</th>
<th>Sum of Squares</th>
<th>F-ratio</th>
<th>p</th>
</tr>
</thead>
<tbody>
<tr>
<td>$T_2 - T_1/G_1$ vs $T_2 - T_1/G_2$</td>
<td>1</td>
<td>17.06</td>
<td>2.37</td>
<td>0.13</td>
</tr>
<tr>
<td>$T_2 - T_1/G_1$ vs $T_2 - T_1/G_3$</td>
<td>1</td>
<td>112.44</td>
<td>15.59</td>
<td>0.00**</td>
</tr>
<tr>
<td>$T_2 - T_1/G_2$ vs $T_2 - T_1/G_3$</td>
<td>1</td>
<td>40.22</td>
<td>5.58</td>
<td>0.02*</td>
</tr>
<tr>
<td>$T_2 - T_1/G_1$</td>
<td>1</td>
<td>194.05</td>
<td>26.90</td>
<td>0.00**</td>
</tr>
<tr>
<td>$T_2 - T_1/G_2$</td>
<td>1</td>
<td>66.12</td>
<td>9.17</td>
<td>0.00**</td>
</tr>
<tr>
<td>$T_2 - T_1/G_3$</td>
<td>1</td>
<td>0.33</td>
<td>0.05</td>
<td>0.83</td>
</tr>
</tbody>
</table>

*Significant at .05 level. **Significant at .01 level
$T_1 = $ Pretest $G_1 = $ Treated Symbol Reversers
$T_2 = $ Posttest $G_2 = $ Non-Treated Symbol Reversers
$G_3 = $ Non-Reversers
Statistical Findings and Discussion

The data presented in Table 15 showed that there were no significant differences at the .05 level of confidence in the reduction of symbol reversals between the treated symbol reversal group and the non-treated symbol reversal group. However, there were significant differences at the .01 level of confidence in the reduction of symbol reversals between the treated symbol reversal group and the group of non-reversers. There were also significant differences at the .05 level of confidence in the reduction of symbol reversals between the non-treated symbol reversal group and the non-reversers.

The data also showed that there were significant differences at the .01 level of confidence in the reduction of symbol reversals in both the treated symbol group and the non-treated symbol reversal group. However, there were no significant differences at the .05 level of confidence in the reduction of symbol reversals for the non-reversers.
CHAPTER V

Summary, Conclusions and Recommendations

Introduction

The major purpose of this study was to investigate reading achievement in first grade children in terms of a) symbol reversals, and b) sex. This investigation also sought to compare the reading achievement of reversing and non-reversing students, and to determine the effectiveness of specific remedial exercises in reducing symbol reversals.

One hundred fifteen first grade children taken from seven different classes in two separate schools in East Baton Rouge Parish, Louisiana, comprised the sample. The students were selected from a number of volunteer grade one classes on the basis of their being representative of the district at large in terms of racial composition and socioeconomic factors. The study used a randomized control group pretest-posttest design. This can also be represented as a 2 (sex) x 3 (grouping) experimental factorial design.

The 115 grade 1 students who participated in the
study were group tested by the researcher in September 1982, using the Jordan Left-Right Reversal Test Level 1 (1974) and the Gates-MacGinitie Reading Tests Basic R, Form 1 (1978). Thirty-eight of these students who made three or less symbol reversal errors were classified as control group 2 (non-reversers). Seventy-eight students who made four or more symbol reversal errors were randomly assigned either to an experimental group or to a non-treated symbol reversal group (control group 1). The experimental group was then given a series of remedial symbol training lessons by their teachers, 20 minutes per session, three sessions per week for eight weeks. Control group 2, that is, non-reversers, and control group 1, that is, non-treated symbol reversers, received only the regular academic program. All groups were then posttested at the end of the experiment (8 weeks) with the Jordan Left-Right Reversal Test Level 1 (1974) and the Gates-MacGinitie Reading Tests Basic R, Form 2 (1978) in December 1982.

The data were subjected to an analysis of covariance, the analysis of variance, and the t test. Additional findings were subjected to single degree of freedom comparisons out of a 2 (sex) x 3 (grouping) x 2 (time) factorial analysis of variance with repeated measures on the last factor (time). The analysis of covariance used pretest reading
achievement scores and pretest symbol reversing scores as covariables. The application of the analysis of covariance was utilized to partial out any initial differences that may have existed in the groups and to reduce the experimental error caused by any such differences. Both the analysis of covariance and the analysis of variance were used to test one or more null hypotheses that the means of the groups sampled came from populations with equal means and differ only because of sampling error. The \( t \) test was used to test the significance for samples of the appropriate critical ratio. The data were analyzed and the results were reported in tabular form. A summary of the results of these analyses follows:

**Summary of Results**

Unless otherwise noted, the differences found in the following results were significant at the .05 level of confidence.

1. There was no significant difference in reading achievement scores on the *Gates-MacGinitie Reading Tests Basic R* of symbol reversing students who had had treatment in the remediation of symbol reversals and those who did not have such treatment.

2. There was no significant difference in reading
achievement scores on the **Gates-MacGinitie Reading Tests Basic R** between male and female symbol reversing students who had had treatment in the remediation of symbol reversals.

3. There was no significant difference in reading achievement scores on the **Gates-MacGinitie Reading Tests Basic R** between male and female symbol reversing students who had had no treatment in the remediation of symbol reversals.

4. There was a significant difference in reading achievement scores on the **Gates-MacGinitie Reading Tests Basic R** between symbol reversing students and non-reversing students.

5. There was a significant difference in reading achievement scores on the **Gates-MacGinitie Reading Tests Basic R** between male symbol reversing students and male non-reversing students.

6. There was a significant difference in reading achievement scores on the **Gates-MacGinitie Reading Tests Basic R** between female symbol reversing students and female non-reversing students.

7. There was no significant difference in symbol reversal scores on the **Jordan Left-Right Reversal Test Level 1** between symbol reversing students who had had
treatment in the remediation of symbol reversals and those who did not have such treatment.

8. There was no significant difference in symbol reversal scores on the Jordan Left-Right Reversal Test Level 1 between male and female symbol reversing students who had had treatment in the remediation of symbol reversals.

9. There was no significant difference in symbol reversal scores on the Jordan Left-Right Reversal Test Level 1 between male and female students.

Summary of Additional Findings

Differences within groups from pretest to posttest in reading achievement and symbol reversals are summarized:

1. There was a significant difference in reading achievement scores on the Gates-MacGinitie Reading Tests Basic R of symbol reversing students who had had treatment in the remediation of symbol reversals.

2. There was a significant difference in reading achievement scores on the Gates-MacGinitie Reading Tests Basic R of symbol reversing students who had had no treatment in the remediation of symbol reversals.

3. There was a significant difference in reading achievement scores on the Gates-MacGinitie Reading Tests
4. There was a significant difference in symbol reversal scores on the **Jordan Left-Right Reversal Test Level 1** of symbol reversing students who had had treatment in the remediation of symbol reversals.

5. There was a significant difference in symbol reversal scores on the **Jordan Left-Right Reversal Test Level 1** of symbol reversing students who had had no treatment in the remediation of symbol reversals.

6. There was no significant difference in symbol reversal scores on the **Jordan Left-Right Reversal Test Level 1** of non-reversing students.

Differences in change from pretest to posttest between groups in reading achievement and symbol reversals are summarized:

1. There was no significant difference in changes in reading achievement scores on the **Gates-MacGinitie Reading Tests Basic R** between symbol reversing students who had had treatment in the remediation of symbol reversals and those who did not have such treatment.

2. There was no significant difference in changes in reading achievement scores on the **Gates-MacGinitie Reading Tests Basic R** between symbol reversing students who had had treatment in the remediation of symbol reversals and
non-reversers.

3. There was no significant difference in changes in reading achievement scores on the Gates-MacGinitie Reading Tests Basic R between symbol reversing students who had had no treatment in the remediation of symbol reversals and non-reversers.

4. There was no significant difference in changes in symbol reversal scores on the Jordan Left-Right Reversal Test Level 1 between symbol reversing students who had had treatment in the remediation of symbol reversals and those who did not have such treatment.

5. There was a significant difference in changes in symbol reversal scores on the Jordan Left-Right Reversal Test Level 1 between symbol reversing students who had had treatment in the remediation of symbol reversals and non-reversers.

6. There was a significant difference in changes in symbol reversal scores on the Jordan Left-Right Reversal Test Level 1 between symbol reversing students who had had no treatment in the remediation of symbol reversals and non-reversers.

Conclusions

From a consideration of the data presented within
the limitations of this study, the following conclusions appear to be warranted:

Treatment for the correction of symbol reversals seemed to have had no significant effect on the reading achievement of symbol reversing first grade students. This finding has thrown into question the widespread practice of remediating symbol reversals in first grade students. As Harman (1982), Smith (1978) and Bannatyne (1973) have suggested, an inordinate amount of time should probably not be spent on remediating reversals. The researcher would suggest that symbol reversals are only one aspect among many others in the complex reading process. To ignore other important factors in reading such as auditory vocal processes like blending, closure, and sequencing, and linguistic processes like phonology, syntax, semantics, vocabulary, and oral language is perhaps not to see the forest for the trees. The results seemed to show that time spent in the first grade classroom remediating symbol reversals might be better used by giving students practice in other aspects of language arts.

The results also showed that there were no significant differences in reading achievement between male and female symbol reversing students who had had treatment in the remediation of symbol reversals. The possibility that
significant sex differences in reading achievement existed in symbol reversing students who had had treatment in the remediation of symbol reversals was not borne out by this study. This result and conclusion also seemed to be demonstrated for male and female symbol reversing students who had had no treatment in the remediation of symbol reversals. Sex differences in early reading favoring females have been supported by Wilson (1939), Samuels (1943), and Ilg and Ames (1950). However, within the parameters of this study, there seemed to be no significant sex differences in reading achievement of either treated or untreated symbol reversing students.

It was brought to the attention of the researcher by several teachers in the study that the program for the remediation of symbol reversals may have an effect on the handwriting skills of students. Several teachers reported that some students in the experimental group seemed to have shown a marked improvement in handwriting. It is possible that a visual-motor training program which incorporated multisensory perceptual motor training like the one used in this study (See Appendix A) may transfer into handwriting skills and eye-hand coordination. This possibility of transfer to handwriting skills could be a topic for further investigation. It may be that a remedial training program for the remediation of symbol reversals may have a
greater effect on handwriting skills than on reading skills.

The result showed a significant difference in reading achievement between symbol reversing students and non-reversing students. This result held true for male symbol reversing students versus male non-reversing students and also for female symbol reversing students versus female non-reversing students. A number of investigators using a variety of tasks and methodologies have found poor readers made significantly more reversal errors than normal readers (Lyle, 1969; Lahey and Lefton, 1976; Tjossen et al, 1962; Wechsler and Hagin, 1964; Aliotti, 1980). Other investigators have taken this a step further and suggested that reversals can be a significant factor in predicting reading failure (Bannatyne, 1971; Barrett, 1965; Teegarden, 1933; Goins, 1958; Jansky and DeHirsch, 1972).

The results of this investigation seem to suggest that there is a relationship between symbol reversals and reading achievement. However, there is no evidence in the present study to suggest that this relationship is a cause and effect relationship. The researcher would suggest that the relationship is more of a correlation rather than one of causality, for the results of the present
study seemed to indicate that training to reduce symbol reversals does not necessarily translate into improved reading scores. The researcher would suggest that symbol reversals may be symptomatic of underlying higher-order neurological functioning. One can only hypothesize as to what precisely this higher-order process may be and how it works. Theories of maturation, cerebral lateralization, perceptual organization, cognitive development, neurological myelination, or intelligence have attempted to explain this high level process. The researcher would theorize that this higher-order factor triggers the skills involved in complex symbolic operations like reading and other linguistic processes and thus may control both reading and reversals. This theory could possibly explain a relationship between reading and reversals.

Other investigators like Boder (1973), Orton (1928), Monroe (1932), Bannatyne (1973), Aliotti (1980), and Johnson and Myklebust (1967) have suggested that symbol reversals are symptomatic of severe reading disability. Orton (1928) has postulated that this can be accounted for by a neurological theory of cerebral dominance, but this theory has never received definitive empirical support. The results of the present study, even though not isolating severe reading disabilities per se, have once
again highlighted the existence of the ubiquitous phenomena of symbol reversals. However, until more direct neurological evidence or more precise instruments are developed to isolate and measure directly underlying higher-order neurological sub-strata like maturation, a conclusive explanation for the existence of symbol reversals may continue to elude investigators. Bone ossification studies and brain myelination may provide fertile ground for more definitive statements on such phenomena as reading, reversals, and maturation. Further investigations are needed in these areas.

The results of the study indicated that there was no significant difference in symbol reversals between symbol reversing students who had had treatment in the remediation of symbol reversals and those who did not have such treatment. The above result also held true for male and female symbol reversing students who had had treatment in the remediation of symbol reversals. This was perhaps the most unexpected result in the study, and it led the researcher to re-examine the literature on the remediation of symbol reversals.

A review of the literature has strongly supported the position that symbol reversals can be corrected with treatment (Polloway and Polloway, 1980; Bracey and Ward,
1980; Moyer and Newcomer, 1977; Stromer, 1977; Laurita, 1971; Sidman and Kirk, 1974; Harman, 1982; Smith, 1978; Deno and Chiang, 1979). However, a critical analysis of all the above reports showed a serious methodological flaw, namely, there were no matched or equivalent control groups. As a result, even though in the above studies treatment seemed to be successful within groups, one also needed to examine how a matched equivalent group would have progressed over the same period of time. The present study which utilized a randomized control group pretest-posttest design showed that there were no significant differences in symbol reversals between symbol reversing students who had had treatment in the remediation of symbol reversals and those who did not have such treatment, over a period of time. This finding surprisingly suggests that maturation and normal instruction seem to do as well as an active, task analyzed program in the remediation of reversals.

A closer examination of the above results showed that there was a significant difference (reduction) in symbol reversals of symbol reversing students who had had treatment in the remediation of symbol reversals in a within-group comparison (See Table 15). However, there was also a significant difference (reduction) in symbol reversals of symbol reversing students who had had no treatment in the
remediation of symbol reversals (see table 15). There was a greater reduction in symbol reversals of students who had had treatment in the remediation of symbol reversals, 3.09, compared to the reduction of symbol reversals of symbol reversing students who had had no treatment, 1.95 (see Table 14). However, when changes (differences) between these two groups were compared, there were no significant differences (see Table 15).

These results were unexpected and throw new light on the issue of the treatment of symbol reversals. As was previously pointed out, many investigators have reported successful training programs for the remediation of reversals, but without using a comparable control group. However, within the limitations of the present study, the results showed that even though a training program may be relatively 'successful,' it seems that maturation and regular instruction work as well over the same period of time. Support for these findings have recently come from Steen and Sowell (1980) and Doyle (1982). For example, Steen and Sowell (1980) did a study of 24 students 8 to 9 years of age who were taken from remedial reading classes. The above authors used an equivalent control group and found that training in the remediation of symbol reversals did not significantly improve the
performance of the experimental group. Doyle (1982), in a study of color-coded cues used in remediating symbol reversals of 23 learning disabled students in grades 3 to 5, used a control group and found no significant differences in the performance of the experimental group compared to the control group. However, these authors did find a significant difference in the reduction of symbol reversals for both experimental and control groups relative to themselves. These results, even though using older students from a learning disabled population, are startlingly similar to the results of the present investigation.

The current study does have some implications for educators, psychologists, parents, teachers, and researchers. For example, Moyer and Newcomer (1977), in their oft-quoted report on reversals in reading, have strongly suggested that when children have difficulty with symbol reversals, it is probably not due to a developmental immaturity in a higher level process but it may simply be that these children have not learned the importance of directionality as a distinguishing feature. They have concluded that symbol reversals are a learned cognitive skill and that young children may have lacked the opportunity to learn these skills. On the contrary, the present study suggests strongly that the students in the experimental group had many opportunities to learn the necessary
discrimination skills but did not do significantly better than those students who had had only regular instruction. The researcher would suggest that the results of the present study seem to imply that maturation and normal instruction did play a part in the reduction of symbol reversals.

It should be added that a visual inspection of the test results of the experimental group of symbol reversers indicated that many students in this group corrected the symbols that they had been trained to correct but made a few new reversal errors on the posttest. This seemed to be also true for the non-treated symbol reversal group. However, the group of non-reversers remained relatively consistently error-free (see Table 14). These observations seem to imply that the tendency for strong symbol reversers to continue to make errors in symbol reversals is persistent in either treated or untreated groups. This would seem to imply the possibility of underlying factors like maturation at work, and thus a simplistic explanation such as lack of training in discrimination may not suffice. The researcher would thus suggest that it may be unwise to fixate on the 'problem' of symbol reversals but rather let maturation and normal instruction take their course. As the results showed with the non-reversal group, once the mysterious phenomena of
reversals had been reduced to a very low incidence, by whatever means, the student was consistently able to make the correct discriminations.

Several teachers involved in the study also reported that with regard to the group of non-reversers, even though students from this group made very few visual perceptual reversal errors, some students made written reversals. This brings to light the possibility of a difference between visual perceptual reversals (decoding) as used in this study and written reversals (encoding). This is an area for further investigation and illustrates the variety of methods and tasks that may be brought to bear on the subject of reversals.

The current study does have implications that there were no significant differences in symbol reversals between male and female students as measured by the Jordan Left-Right Reversal Test, Level 1. Both Jordan (1974) and Aaron and Handley (1975) have suggested that sex differences in symbol reversals exist in young children. However, the results of this study indicated that even though males made more mean symbol reversal errors than females, 7.15 as compared to 6.71, the difference was not significant (See Table 11). This result is surprisingly contrary to that of Jordan (1974) who, in the
standardization of the *Jordan Left-Right Reversal Test* (1974), found significant sex differences in reversals in all ages 6 through 10, and particularly during ages 6 through 7. This result is surprising in that this researcher also used the *Jordan Left-Right Reversal Test Level 1* (1974) in the current study.

Support for the findings of this study that no significant sex differences exist in symbol reversals came from Nelson and Peoples (1975) and Stevenson et al (1976). Nelson and Peoples (1975) studied reversals in kindergarten through third grade children and found no significant sex differences. Stevenson et al (1976), in their study of reversals as a predictive index of scholastic achievement, also found no significant sex differences in reversals. Gibson et al (1962) reported no significant sex differences in children's discrimination of letter-like forms. The findings from the present study would suggest that the topic of sex differences in symbol reversals needs further investigation.

The additional findings of this study indicated that there were significant differences (improvement) in reading achievement within all three groups (See Table 13). Raw score differences (improvement) were approximately the
same (see Table 12). This would seem to indicate that all three groups were benefitting equally from classroom instruction in reading as measured by the Gates-MacGinitie Reading Tests Basic R (1978). As was pointed out previously, the change in the experimental group was not significantly different from the change in the non-treated symbol reversal group in reading achievement (see Table 13). This would seem to indicate that even though the experimental treatment did not seem to lead to an improvement in reading achievement compared to the non-treated symbol reversal group, at least it did not have a detrimental effect.

Recommendations for Further Study

Several questions have arisen from this study resulting in the following recommendations:

1. A longitudinal study utilizing the students in this study should be made to determine the effects of the training program in both reading achievement and symbol reversals over time.

2. Other studies should be made with samples comprising symbol reversing students at other ages, grade levels, diagnostic categories, and geographical locations.

3. A similar study should be implemented with a longer period of treatment to determine if this would be
of more benefit to both the remediation of symbol reversals and to reading achievement.

4. Studies should be made to examine the most effective programs for the remediation of symbol reversals.

5. Studies should be made to determine the effects of the treatment for the remediation of symbol reversals on the handwriting achievement of young children.

6. Studies should be made to determine the relationship between visual perceptual reversals as used in this study and written reversals.

7. Studies should be made to determine the incidence of symbol reversals in left-handed children.

8. Further studies in the area of sex differences in reading and symbol reversals should be initiated.

9. Neurological and neuropsychological studies in the area of neural correlates for perceptual phenomena like symbol reversals could add significantly to the identification and measurement of higher-order neural sub-strata like neurological maturation and cerebral lateralization.

10. There should be further study to determine the effects of symbol type (letter and number) on symbol reversal error score.

11. There should be further study to determine the
effects of stimulus properties like horizontal reversals \( b - p, M - W \), and vertical reversals \( d - b, p - q \), on symbol reversal error score.

12. Studies should be made to determine if racial differences exist in symbol reversals.


Bracey, S. A. and Ward, J. 'Dark, dark went the bog'
Instructional interventions for remediating b and d
reversals. Reading Improvement, 1980, 17, 104-111.

Bryant, N. D. Characteristics of dyslexia and their re­
medial implications. Exceptional Children, 1964,
31, 195-200.

Bryant, P. E. Discrimination of mirror images by young
children. Journal of Comparative and Physiological

Cairns, N. and Steward, M. S. Young children's orienta­
tion of letters as a function of axis of symmetry
and stimulus alignment. Child Development, 1970,
41, 993-1002.

Caldwell, E. C. and Hall, V. C. The influence of concept
training on letter discrimination. Child Development,
1969, 40, 63-71.

Campbell, D. T. and Stanley, J. C. Experimental and
Quasi-Experimental Designs for Research. Chicago:

Cohn, M. and Stricker, G. Inadequate perception vs.

________. Reversal errors in strong, average, and weak
letter namers. Journal of Learning Disability, 1979,
12, 533-537.

Davidson, H. A study of reversals in young children.

________. A study of the confusing letters b, d, p, and
q. Journal of Genetic Psychology, 1935, 47,
458-468.

Deno, S. L. and Chiang, B. An experimental analysis of
the nature of reversal errors in children with
severe learning disabilities. Learning Disability
Quarterly, 1979, 2, 40-45.

Doehring, D. G. Patterns of Impairment in Specific Read­
ing Disability. Bloomington, Indiana: Indiana


Enterline, E. G. Spatial relationships between a standard and comparison figure. Perceptual and Motor Skills, 1970, 30, 959-969.


Gates, A. and Boeker, E. A study of initial states in reading by pre-school children. Teachers College Record, 1923, 24, 469-488.


Kephart, N. C. The Slow Learner in the Classroom. Columbus, Ohio: Charles Merrill, 1960.


Robinson, J. S. and Higgins, K. E. The young child's ability to see a difference between mirror image forms. Perceptual and Motor Skills, 1967, 25, 893-897.


APPENDIX A

Sample Lesson Plan for the Remediation of Reversals
Sample Lesson Plan for the Remediation of Reversals

This program is a modification and expansion of the Kirshner (1977) Program for the remediation of reversals. It is based on the principle of providing a visual-motor directional pattern that is error free, for the 'magic ruler' prevents the student from making the letter or numeral in the wrong direction, right from the start.

STEP 1

Materials: 'Magic Ruler' and sheet of paper.

Suppose the student is reversing the letter d, the teacher says, "What word begins with d? Duck. Now I'm going to make a d."

a) Hold the 'magic ruler' with the non-writing hand.
b) Draw a line with a downward stroke next to the heavy black line by the duck and complete the letter d.

Suppose the student is reversing the letter c or C. The teacher says, "What word begins with the letter c? Cap. Now I'm going to make a c or C."

a) Hold the magic ruler with the non-writing hand.
b) Place the pencil next to the * and make the letter c or C.

Suppose the student is reversing r or R. The teacher says, "What word begins with r? Rabbit. Now I'm going to make an r or R."

a) Hold the magic ruler with the non-writing hand.
b) Draw a line with a downward stroke next to the heavy black line near the letter r or R, and complete the letter.

Suppose the student is reversing '9.'

a) Hold the ruler with the non-writing hand.
b) Draw a line with a downward stroke next to the heavy black line and complete the number.

Suppose the student is reversing n or N. The teacher says, "What word begins with n? Now I'm going to write
a) Hold the ruler with the non-writing hand.
b) Look at the top of the magic ruler, you will see the * and the . Begin the stroke at the * and finish at the .

STEP 2

Materials: Sheet of paper and magic ruler.

Immediately following Step 1 above and working on remediating only one letter or number at a time.

a) Allow the student time to practice each letter or number at least 12 times, using the magic ruler, on a sheet of paper, so that the correct form of the letter or number is made, right from the start.

STEP 3

Materials: Stencilled sheets of large letters and numbers.

a) Have the student trace over the large letter or number with his index finger five to ten times, saying the letter or number as he traces.

STEP 4

Materials: Stencilled sheets of large letters and numbers.

Suppose the child is reversing c or C, teacher says,

a) "Practice making c or C, filling in the large stencilled c, with as many c's or C's as possible, without using the magic ruler."

Suppose the student is reversing b or B. Teacher says,

a) 'Practice making b or B by filling in the large b, or B with as many b's or B's as possible, without using the magic ruler."
STEP 5

Materials: Stencilled sheets of large letters and numbers, crayons.

Suppose the child has a large stencil of C filled in with little c's or C's. The teacher says,

a) "Color the large letter or number, which you have filled in."

STEP 6

Materials: Stencilled sheets with pictures and blank squares.

Suppose the student is reversing c or C, the teacher says, "Look at the sheet with the picture of a cup. The letter c or C is missing."

a) "Fill in each blank space with the letter c or C, without using the 'magic ruler.'" DO NOT PROVIDE A MODEL OF C AT THIS STAGE. N.B. Encourage left to right sequence.

Suppose the student is reversing b or B. The teacher says, "Look at the sheet with the picture of a bus, bed, etc., the letter b or B is missing."

a) "Fill in each blank space with the letter b or B, without using the magic ruler." DO NOT PROVIDE A MODEL OF b or B AT THIS STAGE. N.B. Encourage left to right sequence.

Suppose the student is reversing the number 9. The teacher says, "Look at the sheet with the blank squares, and the jumbled up numbers."

a) "Fill in each blank space with the number 9, without using the magic ruler." DO NOT PROVIDE A MODEL OF 9 AT THIS STAGE. N.B. Encourage left to right sequence.

STEP 7  (CRITERION OR MASTERY TEST).

Materials: Lower half of stencilled sheets (used in Step 5 above) with jumbled letters and numbers.)
This is the criterion or mastery test.

Suppose the student is reversing c or C, the teacher says, "Look at the sheet with a picture of a cup." (PLEASE USE A SHEET IN WHICH THE STUDENT HAS MADE NO MARKS SO THAT A MODEL IS NOT PROVIDED).

a) "Put a circle around all the c's or C's among the jumbled letters."

**SUMMARY OF PROCEDURES**

If the student is still making reversal errors, repeat, reteach, and recycle the program.

Remediate students' **specific diagnosed** reversals.

Remediate only one reversal at a time and give lots of practice. Remediate capital letters and numbers first then lowercase letters last. Try to arrange remediation in such a manner that views and displays of letters and numbers are not readily available to the student. Students who are participating in the study and are part of the control groups should be given only regular classroom instruction and no direct instruction in the remediation of reversals.

The remedial instruction will be for 20 minutes per session, 3 times per week, for 8 weeks.
APPENDIX B

Letters Seeking Approval for Study and Parental Permission
Dr. Don Hoover, Director of Research & Program Evaluation
East Baton Rouge Parish School System
1050 South Foster Drive
Baton Rouge, Louisiana

Dear Dr. Hoover:

The purpose of this letter is to confirm our recent conversation regarding a formal letter of request to do my Ph.D dissertation study, which I hope to conduct in East Baton Rouge Parish. The purpose of the study is to assess reading achievement in terms of symbol reversals in first grade children. Enclosed please see a copy of my dissertation proposal. Please note the changes that have been made in methodology and procedures.

I wish to thank you for your kind assistance in this project, and if any additional information is needed, please do not hesitate to contact me at the above address, or phone 387-3512.

Yours faithfully,

Bernard L. Heydorn

Bernard L. Heydorn
MEMO TO: Principals of Selected Elementary Schools  
FROM: Molly Newkome  
SUBJECT: Research Study on Reversals in Grade One

We know how busy you and your teachers are at this time and thus hesitate to recommend anything that will add to your workload. However, the research study described in the attached letter may be something in which you and your first grade teachers would like to participate. The topic of reversals in first grade and their remediation is one which concerns and perplexes many first grade teachers and thus may be of interest despite the time required.

Please take the time to read Mr. Bernard Heydorn's letter and discuss the project with your first grade teachers. Please be certain that the teachers know that this project is entirely voluntary.

Thank you for your cooperation in this matter.

Molly Newkome  
Administrative Director of Instruction and Curriculum Development

cc: Instructional Directors and Supervisors, K-8  
Dr. Donald Hoover  
Mr. Bernard Heydorn

APPROVED:  
Donald Nelsen - Associate Superintendent for Instruction
3650 Nicholson Drive,
Apt 1142,
Baton Rouge,
Louisiana 70802
1st September, 1982

Dear Principal,

I am a Doctoral student in Education at L.S.U. doing a study of reading achievement in terms of reversals in first grade children. This study has the approval of Dr. Hoover, Director of Research and Program Evaluation, and Dr. Newkome, Administrative Director of Instruction and Curriculum Development (see letter enclosed) of the East Baton Rouge Parish School System.

The purpose of this letter is to request a list of grade 1 teacher volunteers to participate in the program. All teachers who volunteer may not be able to participate due to numbers and locations. However, teachers will be notified if they are selected for the study or not.

The importance of such a study is apparent in that the occurrence of reversals in children has been observed by parents and teachers for many years. Even though many investigators have looked at this issue, there is still a lack of information on the most effective methods of remediating reversals and the effects of the treatment of reversals on reading achievement. The study will also investigate sex differences in reading and reversals.

In terms of procedures for the study, after a list of volunteer teachers has been made, each student who has parental permission for participation in the study will be group tested by this investigator using the Jordan Left-Right Reversal Test (displacement time 20 mins.). Students will then be selected and randomly assigned to six groups. These students will then be group tested by the investigator using the Gates-MacGinitie Reading Test R (displacement time 75 mins). Two groups of students selected from the participating classes will receive an innovative program for the remediation of reversals. The investigator will train the participating teachers who will implement the remedial program. The remedial treatment will be for 20 mins. a session, three times a week, for 8 weeks. The treatment is designed so as to have minimal teacher involvement and maximum effect. All necessary materials will be provided and given to the participating teachers in a packet. At the end of 8 weeks, all groups will be posttested by the investigator using the Jordan Left-Right Reversal Test and the Gates-MacGinitie Reading Test R.

The subject of reversals has interested and baffled teachers for many years. It is suggested that by the teachers participation in this program, they can learn new and innovative techniques for the remediation of reversals and possibly arrive at new insights into this fascinating phenomenon. Their students will also gain from participation in this program as will the School System. At your request, a full report of the study will be made available to you on completion.

If any of your teachers are interested in participating, I would appreciate if they would submit their names to you by Friday, Sept 10th, 1982. I will then check with your office on Monday, 13th September for a list of volunteers. If any additional information is needed, please contact me at 387-3512.

Thanking you for your cooperation and looking forward to working with you and all interested teachers,

Sincerely,

Bernard L. Heydorn
Dear Parents,

I am a Doctoral student in Education at L.S.U. doing a study of reading achievement in terms of reversals in first grade children. This study has the approval of Dr. Hoover, Director of Research, and Dr. Newkome, Director of Curriculum Development, of the East Baton Rouge Parish School System.

The purpose of this letter is to request parental permission for your child's participation in the study.

The importance of such a study is apparent in that in normal growth and development, many children reverse images of letters and numbers. For example, 'b' might be interpreted as 'd', 'r' as 'q', and '6' as '9'. As you can see, this is confusing to a child learning how to read and write, and this has been a problem facing teachers and educators for many years. The study will thus attempt to answer some important questions with regard to reversals and reading.

I wish to assure you that should you allow your child to become a participant in the study, the information gathered will be held in strict confidence, and individual performances will not be disclosed to persons other than the teacher and the principal. Furthermore, as participation in the study is entirely voluntary, you will be free to withdraw your child at any time, should you choose to let your child participate.

If you are interested in allowing your child to participate in the study, please sign below in the space marked PARENT'S SIGNATURE, and return this letter to your child's teacher as soon as possible.

Should you have any further questions, please feel free to call me at 397-3512.

Your interest and cooperation in this study are most appreciated.

Thanking you,

Yours faithfully,

Bernard L. Heydorn

I hereby give consent for my child to participate in the study of reversals and reading achievement.

PARENT'S SIGNATURE
From: Date:

To:

Subject: Request for research approval

Title of Research Project: ______________________________

The attached description of a project entitled ______________________________

will involve the use of human subjects.

The investigator gives assurances to the committee on use of humans and animals for each of the following:

1. The human subjects are volunteers ______________________________

2. Subjects have the freedom to withdraw at any time. ______________________________

3. That the data collected will not be used for any purpose not approved by the subjects. ______________________________

4. The subjects are guaranteed anonymity ____________________________________________

5. The subjects will be informed beforehand as to the nature of their activity ____________________________________________

6. The nature of the activity will not cause any physical or psychological harm to the subjects. ____________________________________________

7. Individual performances will not be disclosed to persons other than those involved in the research, those authorized by the subject. ______________________________

8. If minors are to participate in this experiment, valid consent has been obtained from the parents or guardian. ______________________________

9. That all questions have been answered to the subject's satisfaction. ______________________________

10. All volunteers will consent by signature. ______________________________

Any exceptions or qualifications to the above assurances are explained below:

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

__________________________________________________________________________

Investigator's Name
VITA

Bernard Leon Heydorn was born February 17, 1945 in Georgetown, Guyana. He attended elementary and secondary schools in that city before he moved to Barbados, where he worked at the Royal Bank of Canada, 1963-1965. In 1965 he moved to Ontario, Canada, where he attended the University of Ottawa, from which he graduated cum laude in 1968 with a Bachelor of Arts degree, majoring in Psychology-Education. In 1969, he received a Certificate in Secondary Education from the College of Education, University of Toronto. In 1970, he received a Master of Education in Special Education from the Ontario Institute for Studies in Education, University of Toronto. In 1975 he received a Certificate in Elementary Education from the Ottawa Teachers College in Ottawa, Ontario. In 1976 he received a Certificate in Reading Education from the Ottawa Board of Education. In 1976 and 1977, he received Certificates in Special Education from York University, Toronto. In 1978 and 1979 (part-time) he received advanced training in learning disabilities from the Bannatyne Learning Center, in Miami, Florida. From 1980 to 1983 he pursued a Doctoral Degree (Ph.D) in Reading.
Education at the Louisiana State University in Baton Rouge.


He is married to the former Vivienne Niles, and is the father of three children, Sean, Lisa, and Graham.
EXAMINATION AND THESIS REPORT

Candidate: BERNARD LEON HEYDORN

Major Field: EDUCATION

Title of Thesis: A STUDY OF READING ACHIEVEMENT IN TERMS OF SYMBOL REVERSALS IN FIRST GRADE CHILDREN

Approved:

Earl H. Chubb
Major Professor and Chairman

William Rogers
Dean of the Graduate School

EXAMINING COMMITTEE:

Anne Adams

Lee E. Mallett

Michelle Jones

Carrie Green

Date of Examination:

January 12, 1983