A study of the relationship between visual reversal tendency and reading failure

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A STUDY OF THE RELATIONSHIP
BETWEEN
VISUAL REVERSAL TENDENCY AND READING FAILURE

A Thesis
presented to
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of the
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In Partial Fulfillment
Of the Requirements for the Degree
Master of Arts

by
Claramary Smith
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The writer wishes to acknowledge her indebtedness to the many faculty and staff members of the University of Omaha whose advice and encouragement have made this study possible, particularly to Dr. A. L. Stephens, Dr. L. N. Garlough, Miss Frances Edwards, and to her major advisor, Dr. W. H. Thompson.

C. S.
INFORMATION: THE PROBLEM

In clinics and hospitals, in schools and other places where children are observed and tested, it has been a matter of observation for a long time that many young children see printed symbols in reverse.

Some clinicians have felt that this visual reversal tendency might be a definite deterrent in terms of reading difficulty.

Since records were available, it was decided that a statistical study could be undertaken in order to test this hypothesis.

THE PROBLEM

The object of this investigation is to try to discover whether or not a significant relationship exists between children's reading difficulties and visual reversal tendencies, as revealed by the Form L of the Stanford-Binet intelligence test. The study is based on records of this test in the files of the Child Study Service of the University of Omaha.
CHAPTER I
PREVIOUS RESEARCH

The subject of reading difficulty has received much attention in recent years and many studies of possible causes of difficulty have been made. An examination of the literature in this field, however, has not disclosed any great amount of investigation of visual reversal tendency as a possible direct cause of reading difficulty.

Where reversal tendencies in reading have been studied, various theories have been advanced in an effort to explain these phenomena. Hinselwood,¹ in 1917, announced his belief that all cases of failure to learn to read, including reversal errors, except for the feeble-minded, are caused by defective prenatal development of a certain cerebral area which stores visual memories of letters and words. Since the theory popular at that time was that recognition of a word depended upon visually stimulated revival of previously stored memories, he called this condition "congenital word blindness".

Other writers, in the medical field, attributed failure to learn to read to delay in cerebral development and not to actual lesions in the brain. This idea was found acceptable because some children do

learn to read well, after being unable to learn initially. Both of these types of theories implied that the difficulty was organic and was not concerned with habits and techniques. Both theories were based on the idea of learning by means of memory and images and a theory of cortical localization and specialization which is no longer held.

In 1925, a psychiatrist, E. T. Orton², published his theory of strephosymbolia (confusion in cerebral dominance) as the reason for visual reversals. He advanced the idea that the image of a word was recorded on the dominant hemisphere, while its "mirrored or antitropic pattern" was recorded on the non-dominant hemisphere. On this basis he explained reversals as "lack of clear hand-dominance..... Children.....who are neither dominantly right-handed nor left-handed or in whom clear dominance has not been well established before they begin to read." Although some work has been done on the relationship of hand and eye dominance and visual reversal, Orton's is a difficult theory to test.

Haefner³, in 1929, published a study of handedness but found no reliable difference in reading ability.

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between those whose tests indicated the least and the greatest dominance in handedness.

Gates and Bennett⁴ conducted a study in Public School 43, Manhattan, N.Y., in which 350 pupils were extensively examined with reading and related tests during a period of a year. They then selected 26 pupils who showed the largest number of reversals errors on a test of isolated words. These students were matched as to reading grade and IQ with pupils who made absolutely no reversals on the test. They found "pupils showing maximum reversal tendencies do not exceed those showing minimum tendencies in lack of hand-dominance; reading defect cases show no greater frequency of lack of hand-dominance than representative readers, and pupils lacking clear-cut hand-dominance do not differ in reading ability or deficiencies from those having clearer dominance". Gates goes on to say that his data fail to confirm orton's hypothesis, although they do not disprove the theory that lack of brain dominance is the source of difficulties, especially reversal errors, in reading. Gates also summarizes other studies by Bonroe⁵, by Ladd⁶, and also by

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6. Ladd, Margaret R., THE RELATION OF SOCIAL, OCCUPATIONAL AND PERSONAL CHARACTERISTICS TO READING ABILITY. (Doctor's dissertation at Teachers College, Columbia University.)
Hildreth\(^7\), and concludes, "It may be said that left-handed children in general show no greater difficulty in reading in general and no greater tendency in particular to make reversal errors than right-handed; that of those who make reversal errors the percentage of left-handed is no greater in proportion than in the population at large, and that among those subject to serious difficulties in reading, the percentage is similar to that found among representative readers".

A theory that dominance is really determined by eye-preference rather than hand-preference was published by Parsons\(^3\) in 1924. He contended that one's dominant eye corresponds to the dominant hand. In Gates' study, he found "some tendency for pupils with left-eye dominance.....to be more susceptible to reading difficulty in general and reversal errors in particular". He concludes that "left-eye dominance may be considered......a real, but by no means an invariable, source of difficulty".

The idea of mixed eye-and-hand dominance was put forth by Dearborn\(^9\) as a cause of reading difficulty. Gates, however, and Monroe, in separate studies, found "mixed sinistrals" no more frequent nor significant in


\(^3\) Parsons, E. C., left-handedness. The Macmillan Company, 1924.

\(^9\) Radio talk quoted by Gates. No data in print.
relation to reading difficulty.

The effect of visual deficiencies as a cause of reversal tendency was studied by Gates. He found that "visual defect of some sort" was the most "conspicuous characteristic" of his reversal group.

Schaler and Signatelli compiled a list of reversal errors and found a semantic problem involved since reversal means a "turning over", and in the case of reading errors is expected to mean "a turning over or reorientation of a letter or group of letters about a particular axis.... In the analysis of reversals, one has not only to deal with the fact of rotation (about some imaginary axis) but... also... the plane in which this rotation takes place". For example, "n must be rotated on its depth axis to be read as u". Then p and b are confused, "p has been rotated about its horizontal axis" to become b. Rotation about the vertical axis is illustrated by reading b for d. A number of other factors undoubtedly play their roles: factors such as perspective and relation to background. There is also the factor of fixation. "A letter may be easily transformed into another letter by the simple fact of fixating on a particular part of it, as....... when h is read as n".

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Krise developed, on the basis of the Wechsler and Signatelli study, the hypothesis that reversals are due to lack of familiarity with the relation between the letters and their background. He devised four symbols (one symbol reversed in all the axial rotations) and tested a group of college students with these symbols representing four vowels in common words. The students showed a marked tendency to reversal although this tendency was overcome with further study, which seems to bear out the original hypothesis.

In 1948, Kendall reported a study in which she attempted to determine whether difficulty in learning to read "is associated with unfavorable scores in a test of visual-motor memory or with a tendency to reverse the designs". She concluded "...it does not appear that, for the present sampling of children 6 to 16 years of age, there is any significant relationship between retardation in reading and difficulty in visual-motor integration, whether this takes the form of poor ability to remember the drawings or of a tendency to make errors of orientation."


SUMMARY

An early investigator in this field advanced the idea that reading difficulties, including reversal tendencies, were the result of cerebral lesions. Various others believed that delay in cerebral development was the cause of reading troubles. These theories of cortical localization and specialization are no longer held.

The dominance theories have received much attention: Orton's theory of strephosymbolia, followed by later studies of hand and eye relationships, but no clear-cut findings have appeared.

At the present time, the space perception idea seems to have gained support. It would seem to have a logical basis; before a child is introduced to the reading process he has looked at any object from any direction. He must learn to orient letters and words in a left-to-right progression. Klein's study with college students in which reversals of unfamiliar symbols were overcome with practice, lends credence to this hypothesis.

Kendall's investigation is the one of this group most nearly parallel to the present study, although she used different sources for reading and visual memory tests. She did not find a significant relationship between the areas of visual reversals and reading scores.
CHAPTER II
SOURCE OF DATA

The University of Omaha maintains, jointly with the Omaha Public Schools, a Child Study Service to which children with educational and other difficulties are referred by the public schools.

A study of case reports from the files of this clinic was made for the purpose of determining whether or not a relationship exists between reading difficulty and visual reversal tendency as shown by the Revised Stanford-Binet, Form L, test of intelligence.

CRITERIA USED IN CHOICE OF CASES

Data for this study were obtained from the files of the Child Study Service of the University of Omaha, cases being chosen according to the following criteria:

(1) Only those cases were used for which Form L of the Stanford-Binet test had been administered. Although there are two forms of this test which are used in the clinic, the Form L is more often used than the Form B, thus affording a larger choice of cases and, more important, only Form L includes the reading test and the figure reproduction which furnish the basis for a statistical comparison in this study.

(2) Only cases which gave definite figures for
   (a) memories
   (b) time in seconds
   (c) errors
for the reading test at the 1. year level (third sub-test at this level) of the Stanford-Binet were used. Definite numbers for memories, time and errors were necessary for comparison. In some cases, failure to pass the test was recorded as "can't read this", or only time and errors were recorded, with the space for memories left blank. This probably meant that the child being tested was unable to remember anything he had just read, but the investigator cannot take the responsibility of making such an inference. The case was not used unless records were complete and unmistakable.

(3) Only cases which contained a reproduction, from memory, of the figures used at the 9 year level (third subtest at this level) of the Revised Stanford-Binet test were used. Figure grading, likewise, was required to be clearly distinguishable. The child is asked to reproduce the figure on the test blank, but these reproductions are not always in the same place (sometimes the page is turned around) so unless the "top" was marked on figure reproductions drawn out of alignment with the printed page, the case was not used.

INCIDENCE

All cases were used which met the criteria outlined above. No effort was made to select on any other basis. Thus the proportion of reversals in this study might be expected to reflect, in a general way, the proportion of reversals present in the group of children tested by
the clinic. At the time these data were compiled, all cases in the active file of Form I of the Stanford-Binet test were examined, and all cases in the first half of the inactive file (first half, alphabetically). This search yielded 304 cases which could be used, furnishing data according to criteria above.

A data card was made for each case used. This card listed:

(1) The child's name (used only to find the proper record in case re-examination was necessary)

(2) School attended

(3) School grade placement

(4) Chronological age (CA)

(5) Mental age (MA)

(6) Intelligence quotient (IQ)

(7) The score on the figure reproduction

(8) The results of the reading test; memories, time in seconds, and errors

(9) Tracing of actual figure reproduction, accomplished with carbon paper and a knitting needle

(10) The range covered by the child on the whole Stanford-Binet test

(11) The score on the vocabulary test of the Stanford-Binet test

(12) Any digit or sentence reversals found in the record blank of the test
In those cases where a Gates Reading Test had also been administered, the results were put on the individual's data card. These included number correct, reading grade and reading age.

**DESCRIPTION OF READING TEST**

The third sub-test at the 10 year level of the 1937 Revision of the Stanford-Binet, Form L, uses a paragraph containing 24 facts to be read aloud by the child being tested. This paragraph is to be read in 35 seconds or less, with no more than 2 errors in the reading. After the reading, the child is required to recall at least ten facts. If all of these three criteria are met; 35 seconds or less for reading, 2 errors or less, and 10 or more memories recalled, the test is passed. If any of the criteria are not met, the test is failed.

**DESCRIPTION OF FIGURE REPRODUCTION TEST**

The third sub-test at the 9 year level of the Revised Stanford-Binet, Form L, and the first sub-test at the 11 year level are the same. The child is shown two designs for 10 seconds, then he is asked to reproduce them from memory on the test blank. Only one of these figures was used in this study, since it is possible of reversal. This figure is made up of one continuous line forming squares which turn inward at either end of the figure and an open rectangular elevation between them.

The end squares are the parts of the figure which are of interest here, for in perceiving the design
the process of visual memory may differ from one individual to another, and when reproduced the end squares of the design may both be turned to the left, or to the right, or outward. In some cases the whole figure may be reversed in the horizontal plane and drawn upside down.

The Finet manual directs that reproductions of this figure are to be scored plus 1, plus ½, or -, according to the accuracy of the reproduction. For full credit (plus 1) "all of the elements of the design must be reproduced and the relationship between these elements maintained. Slight irregularities due to lack of motor skill or hasty execution are disregarded". For half credit (plus ½) "all of the elements must be present, but inaccuracies due to omission or addition of details or irregularities in size and shape of the figures are overlooked". This plus ½ group contains reversals. Those reproductions not meeting these standards are given no score. (-).

GROUPING OF CASES FOR STATISTICAL STUDY

Grouping of cases for this study was made on the basis of the Stanford-Finet scores on the figure reproduction. All of the plus 1 scores were put into Group I. Those plus ½ scores which showed no reversal became

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Group II. All of the minus scores (−) became Group III. Those plus \( \frac{1}{2} \) scores which showed reversals were put together to form Group IV. Here, then is the statistical starting point of the study: four groups based on visual memory and reproduction of the figure; and success or failure on the reading test.

Of the total group of 304 cases chosen, 107 had perfect figure reproductions, which is scored plus 1 on the Stanford-Binet test. A score of plus \( \frac{1}{2} \) was given to 33 children who reproduce the figure recognizably but not entirely accurately, but did not reverse it. A third group, 108 in number, tried to reproduce the figure but achieved neither a complete nor accurate figure. Of this group of distorted and incomplete reproductions, which is given no score (−), thirteen showed a tendency to right reversal in the drawing, 6 showed reversal to the left, and 7 reversed outward. Group IV numbers 56 cases which were accurate enough reproductions of the figure to merit a score of plus \( \frac{1}{2} \), but all showed reversals; 36 to the right, 5 to the left, 14 outward, and 1 upside down.

Table I shows the number from each group passing and failing the reading test.
<table>
<thead>
<tr>
<th>Group</th>
<th>(plus 1)</th>
<th>(plus 2)</th>
<th>(—)</th>
<th>(plus 2 reversal)</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>*pass *fail</td>
<td>pass fail</td>
<td>pass fail</td>
<td>pass fail</td>
<td></td>
</tr>
<tr>
<td>CA less than 10</td>
<td>2 11</td>
<td>1 1</td>
<td>8 10</td>
<td>3 8</td>
<td>44</td>
</tr>
<tr>
<td>CA tenth year</td>
<td>4 6</td>
<td>2 4</td>
<td>3 10</td>
<td>2 3</td>
<td>34</td>
</tr>
<tr>
<td>CA more than 10</td>
<td>46 38</td>
<td>8 17</td>
<td>42 32</td>
<td>20 20</td>
<td>226</td>
</tr>
<tr>
<td>TOTAL</td>
<td>52 55</td>
<td>11 22</td>
<td>56 52</td>
<td>25 31</td>
<td>304</td>
</tr>
<tr>
<td>% of group passing reading test</td>
<td>48.6</td>
<td>33.3</td>
<td>51.8</td>
<td>44.6</td>
<td></td>
</tr>
</tbody>
</table>

Group I - plus 1 score on figure reproduction
Group II - Plus 2 score on figure reproduction, no reversal
Group III - no score on figure reproduction
Group IV - plus 2 score on figure reproduction, but showing reversal

* - pass and fail refer to the reading test in Form L of the Stanford-Binet
CHAPTER III

STATISTICAL METHOD

After the data were grouped according to figure reproduction, and the number in each of the four groups who passed and failed the reading test was determined, it was necessary to choose a method for comparison.

Since all of the data obtained fell into definite categories; they were discrete, or discontinuous variables, i.e., the reading test was definitely passed or it was definitely failed; the figure reproduction fell into Group I, or Group II, or Group III, or Group IV, the most logical statistical method seemed to be that of Chi-Square.

The Chi-Square method compares the data at hand with a calculated probability, to discover whether the variables are dependent upon or independent of each other. Chi-Square can be used when the data consist of counts and not measures.

The number obtained (Chi-Square) stands for the total amount of discrepancy between theory (calculation) and observation. The majority of the comparisons in this study were made in two-by-two tables.

One sample calculation is included in this report, a three-by-two table comparison of chronological age and reading success or failure. This calculation will be found in Chapter IV.
COMPARISON OF NON-REVERSAL GROUPS

A comparison, made in a three-by-two table, of the three non-reversal groups as to reading success or failure yielded a Chi-Square of 3.498 which, with 2 degrees of freedom, is not considered significant.

COMPARISON OF ALL CASES

All of the 304 cases were compared in a four-by-two table (the four groups compared as to reading success or failure) with a resulting Chi-Square of 3.701. With 3 d.f. this indicates about 30% probability and is not considered significant.

COMPARISONS BETWEEN SEPARATE GROUPS WITHOUT CA DISCRIMINATION

All of the cases were compared, two groups at a time, as to reading success or failure, with the following results:

Group I (perfect reproduction) with Group IV (reversals). Chi-Square .244 shows randomness, not significant.

Group II (½ score) with Group IV (reversals). Chi-Square 1.05, although larger than in the previous comparison is still not significant.

Group III (- score) with Group IV (reversals). Chi-Square .71 indicates no relationship.

Group I (perfect reproduction) with Group II (half score). Chi-Square 2.30, largest difference so far, but
with about 10% probability, not significant.

Group I (perfect reproduction) with Group III (minus score). Chi-Square .213 is the smallest difference in this group of comparisons.

Group II (½ score) with Group III (− score). Chi-Square 3.502 approaches significance. (3.841 is considered significant at the 5% level.)

COMPARISONS BETWEEN SEPARATE GROUPS USING ONLY THOSE WITH CA OF 10 YEARS OR OVER

Since the reading test is given at the ten year level in the Stanford-Binet test, all cases below 10 years of age were removed and another series of comparisons was made as above, two groups at a time, on the basis of reading success or failure, with the following results:

Group I (perfect reproduction) with Group IV (reversals). Chi-Square .047 shows no relationship between these two groups which are basic to this investigation.

Group II (½ score) with Group IV (reversals). Chi-Square 2.00 which is not significant.

Group III (−) with Group IV (reversals). Chi-Square of .20 which shows that these groups are not significantly different in terms of reading success.

Group I (perfect reproduction) with Group II (half score). Chi-Square 4.13 is definitely significant and shows that there is a real difference between these two groups.
Group I (perfect reproduction) with Group III ( - ). Chi-Square .003 is not significant.

Group II ( ½ score) with Group III ( - score). Chi-Square 4.16 shows definite significance.

It will be seen that two significant results were obtained here, using only CA of 10 years and above; between Groups I and II, and between Groups II and III. Comparisons with the reversal group, on the other hand, were not significant at all. Why Group II (the ½ scorers) should show significance is not clear. It will be noted that the comparison of all cases (without CA discrimination) showed a result approaching significance between Group II and Group III.

COMPARISON OF ALL CASES SHOWING REVERSAL TENDENCY WITH NON-REVERSAL CASES

Twenty-six of the figure reproductions which were given a minus score (Group III) showed a reversal tendency. These were combined with the reversal group (Group IV) and the total compared with all the non-reversal cases (the balance of Group III, who did not show reversal tendency, plus all of Groups I and II). This comparison of the reversals with non-reversals on the basis of reading success or failure resulted in a very small Chi-Square, which was not significant.
SUMMARY OF RESULTS

A Chi-Square comparison of all 304 cases as to reading success or failure, made between two groups at a time disclosed no significant relationships, although the comparison of Groups II and III approached significance.

When the cases below 10 years CA were removed, the remaining 260 cases were compared as before, two groups at a time, and two significant relationships were revealed; between Groups I and II, and Groups II and III.

Note that the reversal group did not figure in any significant relationship. Group II is the one which seems to be significantly different from Group I and Group III.
<table>
<thead>
<tr>
<th>Groups</th>
<th>Chi-Square Value</th>
<th>Significance</th>
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<tbody>
<tr>
<td>I and IV</td>
<td>3.701</td>
<td></td>
</tr>
<tr>
<td>II and IV</td>
<td>1.05</td>
<td></td>
</tr>
<tr>
<td>III and IV</td>
<td>.71</td>
<td></td>
</tr>
<tr>
<td>I and II</td>
<td>2.35</td>
<td></td>
</tr>
<tr>
<td>I and III</td>
<td>.213</td>
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<tr>
<td>II and III</td>
<td>3.502</td>
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<td></td>
</tr>
<tr>
<td>III and IV</td>
<td>.20</td>
<td></td>
</tr>
<tr>
<td>I and II</td>
<td>4.12 significant</td>
<td></td>
</tr>
<tr>
<td>I and III</td>
<td>.003</td>
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</tr>
<tr>
<td>II and III</td>
<td>4.16 significant</td>
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</table>
A three-by-two table calculation was used to verify the wisdom of discarding those cases of below 10 years. The resulting Chi-square was 11.78, very highly significant, which seems to verify the fact that this is a reading test for 10 year olds or older.

### Comparison of CA and Reading Success or Failure

<table>
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<th>At 10</th>
<th>Over 10</th>
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<tbody>
<tr>
<td>PASS</td>
<td>13</td>
<td>11</td>
<td>120</td>
</tr>
<tr>
<td></td>
<td>21/3</td>
<td>16/5</td>
<td>107/15</td>
</tr>
<tr>
<td>FAIL</td>
<td>31/8</td>
<td>23/5</td>
<td>106/15</td>
</tr>
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\[
\frac{(144)(44)}{304} = 20.64 \\
\frac{(160)(44)}{304} = 23.1 \\
\frac{(144)(34)}{304} = 16.1 \\
\frac{(160)(34)}{304} = 17.9 \\
\frac{(144)(226)}{304} = 107 \\
\frac{(160)(226)}{304} = 119 \\
\chi^2 = \frac{34}{21} + \frac{23}{16} + \frac{107}{107} + \frac{23}{15} + \frac{169}{169} = 11.78
CHAPTER V
AN EXPERIMENT IN PAIRING

Since the purpose of this study was the seeking of relationships between visual reversals and reading performance, fifty cases from the reversals group (Group IV) were paired with fifty cases from the perfect reproductions group (Group I) as to age (CA) and intelligence quotient (IQ).

The mean IQ of the cases selected from Group IV was 89.10, from Group I it was 89.12. The mean age in months of the selected cases in Group IV was 145.68 months, for Group I it was 145.86 months.

With age and intelligence controlled for each individual, the comparison resulted in a Chi-Square of 4.00 which is significant at the 5% level, but in an unexpected direction. Of this selected, paired group, 19 of the Group I passed the reading test, while 31 failed it; of the Group IV subjects, 25 passed the reading test and 25 failed it. Thus this result would appear to predict greater reading success for the child who shows a reversal tendency than for perfect visual memory! Any attempt to explain this unexpected outcome is conjecture. Since according to chance, however, such a result might be expected 5% of the time, this may be the one time in twenty in which the difference is a chance difference.
CHAPTER VI
SEARCH FOR FACTORS CAUSING SIGNIFICANT FINDINGS IN
GROUP II COMPARISONS

In an effort to determine, if possible, factors affecting the significant findings concerning Group II, several lines of investigation were pursued:

(1) Extent and detail of reading failure
(2) Sex differences
(3) Intelligence differences
(4) Chronological age differences
(5) Proportion of each main group which passed and failed the reading test

BREAKDOWN OF READING FAILURE

In order to investigate the extent and detail of reading failure, comparisons were made. Table III shows the detail of reading failure by groups.

A comparison of memories only, passed and failed, was made for all the four groups in a four-by-two table calculation. This yielded a Chi-Square of 3.77, which is not significant for 3 d.f.

Comparisons of Groups II and III (memories only) did not yield a significant result, but the comparison of Groups I and II gave a Chi-Square of 4.33 which is significant.

A comparison of errors only did not give any results of significance, nor did a comparison of time only.
# TABLE III

**BREAKDOWN OF READING FAILURE**

<table>
<thead>
<tr>
<th>Number who failed:</th>
<th>all three criteria</th>
<th>memories and time</th>
<th>memories and errors</th>
<th>time and errors</th>
<th>memories only</th>
<th>time only</th>
<th>errors only</th>
<th>Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>11</td>
<td>2</td>
<td>4</td>
<td>22</td>
<td>4</td>
<td>6</td>
<td>6</td>
<td>55</td>
</tr>
<tr>
<td>Group II</td>
<td>7</td>
<td>1</td>
<td>0</td>
<td>7</td>
<td>3</td>
<td>3</td>
<td>1</td>
<td>22</td>
</tr>
<tr>
<td>Group III</td>
<td>20 (6r)</td>
<td>0</td>
<td>2 (1r)</td>
<td>17 (4r)</td>
<td>7 (1r)</td>
<td>5 (1r)</td>
<td>1 (1r)</td>
<td>52</td>
</tr>
<tr>
<td>Group IV</td>
<td>9</td>
<td>0</td>
<td>0</td>
<td>15</td>
<td>2</td>
<td>3</td>
<td>2</td>
<td>31</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td>45 (15r)</td>
<td>3</td>
<td>6 (1r)</td>
<td>61 (19r)</td>
<td>16 (3r)</td>
<td>17 (4r)</td>
<td>10 (3r)</td>
<td>160</td>
</tr>
</tbody>
</table>

(r) -- number showing reversal tendencies
SEX DIFFERENCES

A study of sex differences disclosed the fact that there were only 5 girls in Group II, while there were 28 boys. The percentage of all the girls in the group who failed the reading test is 60%, but 67.8% of the boys in the group failed the reading test. In Group I, 57.1% of all the girls in the group failed the reading test, while 47.9% of the boys failed it. In Group III, 46.3% of all the girls in the group failed the reading test, while 49.3% of the boys in the group failed it. In Group IV, 42.8% of all the girls in the group failed the reading test, while 59.5% of the boys failed it. See Table IV.

A two-by-two table calculation comparing the frequencies of boys and girls failing the test did not yield a significant Chi-Square.

INTELLIGENCE DIFFERENCES

Reference to Table V furnishes the information that children in Group II who passed the reading test had the highest mean for intelligence (mean IQ 101.80) of any subgroup in the study. Those of Group II who failed the reading test, however, were next to the lowest subgroup (mean I 82.30)

CHRONOLOGICAL AGE DIFFERENCES

It will be noted that only 4.6% of those who failed the test in Group II were under 10 years of age (CA), as compared to 20% in Group I, 19.3% in Group III, and
and 25.3% in Group IV.

Of those who passed the test, 3.9% of Group I were under 10 years of age (CA), 9.1% of Group II, 14.3% of Group III, and 12% of Group IV. (See Table V)

PROPORTION OF EACH GROUP PASSING OR FAILING THE TEST

Another point of interest in this regard is the fact that only 33.3% of the total number in Group II passed the test, while 44.6% of Group IV, 48.6% of Group I, and 51.8% of Group III passed it.

SUMMARY OF FINDINGS

Although these are not conclusive findings, it is interesting to note that the extent and detail of reading failure does not seem to have affected the results of Group II comparisons, with the exception of the difference between the memories recalled by Groups I and II. Nor do sex differences appear to have a significant effect. Intelligence may possibly be a factor, since there is a great difference in Iq's between those who passed and those who failed the test. The subgroup who passed the test in Group II was a much smaller proportion than those who passed in any of the other groups. This might warrant further study. Investigation does not seem to reveal that the CA in the groups made a great deal of difference.
<table>
<thead>
<tr>
<th>Group</th>
<th>GIRLS PASS</th>
<th>GIRLS FAIL</th>
<th>BOYS PASS</th>
<th>BOYS FAIL</th>
<th>% of girls who failed</th>
<th>% of boys who failed</th>
</tr>
</thead>
<tbody>
<tr>
<td>Group I</td>
<td>15</td>
<td>21</td>
<td>37</td>
<td>34</td>
<td>57.1</td>
<td>47.9</td>
</tr>
<tr>
<td>Group II</td>
<td>2</td>
<td>3</td>
<td>9</td>
<td>19</td>
<td>60.0</td>
<td>67.8</td>
</tr>
<tr>
<td>Group III</td>
<td>22</td>
<td>19</td>
<td>34</td>
<td>33</td>
<td>46.3</td>
<td>49.3</td>
</tr>
<tr>
<td>Group IV</td>
<td>8</td>
<td>6</td>
<td>17</td>
<td>25</td>
<td>42.8</td>
<td>59.5</td>
</tr>
</tbody>
</table>

**TOTALS** | **47** | **49** | **97** | **111** | **51.04** | **53.3** |
<table>
<thead>
<tr>
<th>Percent of group</th>
<th>GROUP I</th>
<th>GROUP II</th>
<th>GROUP III</th>
<th>GROUP IV</th>
</tr>
</thead>
<tbody>
<tr>
<td>10 CA or over</td>
<td>96.1</td>
<td>90.9</td>
<td>85.7</td>
<td>88.0</td>
</tr>
<tr>
<td>less than 10 CA</td>
<td>3.9</td>
<td>9.1</td>
<td>14.3</td>
<td>12.0</td>
</tr>
</tbody>
</table>

Percentage of each group passing and failing reading test according to CA.
CHAPTER VII
SUPPLEMENTARY DATA

Form I of the Stanford-Binet includes several tests using repetition of digits, some of them in
the order given by the administrator of the tests, and others in reversed order. Performance on these
various tests was recorded and a mean for each group
is included in Table VI.

There are two sentences in the Form I, Stanford-
Binet which contain phrases which may be reversed. A
record of these phrase reversals was made for each
group and may be seen in Table VI which also contains
means for intelligence, age, reading memories, reading
time, and reading errors.

It may be noted that the Group II children who
passed the reading test had the highest mean for intel-
ligence, while the mean intelligence was lowest for the
Group III children who failed the test. Mean chrono-
logical age was greatest for the members of Group I who
passed the test, and least for those of Group IV who
failed the test.

That part of Group II which passed the reading test,
stands out as unusual here. It is by far the smallest
in number, its mean IQ is the highest, its mean CA is
only a month above the lowest, it reversed fewer digits
than any of the others, and it is the only group which
has no sentence reversals. It also has the smallest
number of reading errors, and the largest number of
reading memories. Perhaps the reason for the significant findings in comparison of Group II with Groups I and III lies somewhere within these facts.
## TABLE VI

**Tabulation of Group Means**

<table>
<thead>
<tr>
<th>GROUP</th>
<th>PASS</th>
<th>FAIL</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>I</td>
<td>II</td>
</tr>
<tr>
<td>Number of cases in group</td>
<td>52</td>
<td>11</td>
</tr>
<tr>
<td>Mean IQ</td>
<td>92.78</td>
<td>101.80</td>
</tr>
<tr>
<td>Mean age (in months)</td>
<td>158.60</td>
<td>141.00</td>
</tr>
<tr>
<td>Mean reading memories</td>
<td>12.30</td>
<td>13.31</td>
</tr>
<tr>
<td>Mean reading time</td>
<td>25.40</td>
<td>27.18</td>
</tr>
<tr>
<td>Mean reading errors</td>
<td>.92</td>
<td>.727</td>
</tr>
<tr>
<td>Mean auditory digit reversals</td>
<td>3.00</td>
<td>2.54</td>
</tr>
<tr>
<td>Total sentence reversals</td>
<td>1</td>
<td>0</td>
</tr>
</tbody>
</table>
CHAPTER VIII

SUMMARY

Chi-square comparisons of groupings based upon figure reproduction disclosed no significant differences between reversal and non-reversal groups as to reading success or failure. Group II, however, does seem to be significantly different from Groups I and III. Intelligence differences between these groups may possibly be a factor in this result. Sex differences and CA differences do not seem to have had an effect. The small proportion of Group II who passed the reading test might have some bearing on this finding.

CONCLUSIONS

The findings of this study would seem to indicate that, in so far as the Stanford-Binet, Form L, is concerned, there is no significant relationship shown between visual reversal tendency and reading failure.

These findings agree with those of Kendall whose study did not discover any significant relationship between retardation in reading and reversal of designs.

RECOMMENDATIONS FOR FURTHER STUDY

Further studies could be made along the following lines:

(1) Auditory reversals and their relationship, if any, to reading failure.

(2) The relationship of socio-economic factors to reversal tendencies.
(3) Further research might be undertaken to test the validity of the findings concerning Group II, which appears to be significantly different from Groups I and III.

(4) A paired comparison of Groups II and III might throw some light on the unexpected results found when selected pairs from Groups I and IV were compared.

(5) Reversal tendencies as revealed by the figure of the Stanford-Binet test might be compared with reading success and failure on a standardized reading test.

(6) The figure reversal of the Stanford-Binet might be compared with tachistoscopic perception of individual words, to note tendencies to reverse letters of the words.
BIBLIOGRAPHY

BOOKS

Gates, Arthur I., and Bennett, Chester C., Reversal Tendencies in Reading, Bureau of Publications, Teachers College, Columbia University, 1933.

Naefner, Ralph, The Educational Significance of Left-Handedness, Contributions to Education No. 360, Bureau of Publications, Teachers College, Columbia University, 1929.


Monroe, Marion, Children Who Cannot Read, University of Chicago Press, 1932.

Parsons, E. S., Left Handedness. The Macmillan Company, 1924.


PERIODICALS


Kendall, Barbara S. "A Note on the Relation of Retardation in Reading to Performance on a Memory-for-Designs Test", Journal of Educational Psychology, October, 1948.


MISCELLANEOUS

Dearborn (Radio talk quoted by Gates. No data in print)

Ladd, Margaret R. The Relation of Social, Comic and Personal Characteristics to Reading Ability. (Doctor's dissertation at Teachers College, Columbia University.)