A PSYCHOLOGIC AND PHYSIOLOGIC INVESTIGATION OF READING RETARDATION IN CHILDREN

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Abstract

This study is concerned with children who, when everything seems favorable, do not learn to read as well as expected. Numerous factors have been investigated in relation to reading retardation. They are discussed and include defects in vision, audition, speech, health, and neurological structure. Emotional, environmental, educational, and social problems, as well as electroencephalographic patterns, have also been studied.

In view of the spatial relationships, and directional concepts, involved in learning written language, it was felt that spatial orientation and visuo-motor behavior might be related to reading difficulties in children. The present study was set up to investigate general orientation in space, and electroencephalographic patterns which might be related.

Four hypotheses were formulated:

1. The laterality of retarded readers will not be as strongly established as that of the controls.

2. Retarded readers will show more confusion of spatial orientation than will controls.

3. The visuo-motor behavior of retarded readers will be faulty or unusual in comparison to that of the control group.

4. There will ba a greater number of abnormal EEGs among the retarded readers than among the controls. It will also be able to differentiate the groups on the basis of EEG characteristics.

Two groups of children, ten in each, between the ages of eight to eleven inclusive, were selected from the case files of the child Guidance Clinic, and Metropolitan Health Committee. One group was chosen on the basis of a history of reading retardation, the other group, on the absence of any such history.

A number of tests were given to each subject, for the various categories into which the study was divided.

A. Oral, silent, and mirror reading tests were used to establish and compare the reading ability of the groups.

B. To determine lateral preference, twenty-four preference tests were given.

C. To determine the status of spatial orientation U type stylus mazes were used. Subjects were blindfolded while learning them.

D. To determine the status of visuo-motor behavior, the performance scale of the Wechsler Intelligence Scale for children, the Bender-Gestalt, the Draw-a-Person, mirror writing, and mirror drawing tests were used.

E. EEG tracings were recorded during a complete EEG examination using an Offner six channel apparatus.

The results of this research were essentially negative. In mirror drawing the retarded readers made significantly fewer errors per unit time than did the control group. However, there were no other significant differences between the perfomances of the two groups, and the hypotheses, upon which this work was based, were not substantiated.

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Introduction

In our society reading has become very important, with the increased emphasis on higher education. This increases the disability which would otherwise, probably, be minimal, of the children who, when everything seems favorable, do not learn to read. It has been estimated that ten to fifteen percent of the school children in Canada are retarded in reading (43). The amount of research which has been devoted to this subject is tremendous, and the conclusions and opinions are often varied and contradictory (15). Most of the specialized fields, concerned with human behavior, have contributed work to the problem.

Numerous factors have been investigated in relation to reading problems. These factors include defects in vision, audition, speech, health, and neurological structure. Emotional, environmental and social problems, as well as electroencephalograph patterns have also been studied. Their importance in a particular reading retardation case, seems to be an individual thing. A single factor may impede the reading progress of one child, while numerous defects in another

child do not appear to affect this learning at all.

Reading is a form of symbolic language. It involves association of meaning with arbitrary visual symbols which represent the sounds comprising a language. Both sounds and symbols can be built into larger units or words, which are meaningful and are used for communication. A particular order, in time for the phonetic sounds, and in space for their written correlates, must be learned and memorized by all who wish to use these media for communication (19).

Normal children learn spoken language gradually, through the environment, when they have reached the necessary maturational level. Reading and writing are generally taught formally when children are considered able to grasp these more complex concepts.

Custom decrees, in our culture, that the visual symbols (alphabet letters) should be put together in a left to right direction for the formation of words. Reading and writing proceeds the same way. The letters themselves must be presented in a particular orientation, with respect to each other and, to their surrounding space. This constancy is necessary to prevent confusion, just as the order of sounds comprising a spoken word must always be the same, if the word is to be recognized by others speaking the language. Some of the symbols used in writing are identical in form, such as p, b, d, but differ in space relationships and sounds. These letters must be correctly perceived, in regard both to their orientation to the background, and to the particular sounds

they represent. Children learn, through experience and training, the spatial orientation we refer to as near, far, up, down, left, right (18). This learning can be applied to the understanding of written language and the facility to use it. However, most children approach the subject with little or no form of spatial reference. They perceive letters and words in their own individual ways, and approach the subject matter from any direction. If the appropriate direction for reading has been learned, faulty perception of the orientation or form of individual symbols if consistent would not interfere with understanding and would probably never be recognized if writing were not required. This additional use of letters, however, cannot be comprehensible to others, unless it is performed in the accepted manner in regard to direction and background orientation.

Children are expected to learn the traditional manner of reading and writing, as well as correct and consistent perceptions regarding the forms and associated sounds which are involved. If the concepts of up and down, right and left, are understood and useable, it might be expected that they could be applied to this problem by an individual. The better understood, and more firmly established these directional concepts are, the more easily learned should be types of endeavor to which they must be applied (24).

Most people exhibit a superiority in the use of one hand over the other. This may be referred to as lateral preference and extends in varying degrees to other symmetrically paired

organs. The consistent preference of one hand for skilled work, has the advantages of greater ability due to practice, quicker learning, greater strength, speed, and accuracy. Equal dexterity with both hands is extremely rare or unknown (8).

Electroencephalograph patterns of children without consistent lateral preferences have been found to show greater dys-synchrony between the wave forms of the two cerebral hemispheres than do those of children with consistent right sided preference (29). This raises the question of a possible relationship between the strength of lateral preference and the type of wave forms produced by an individual.

In our culture right sidedness is predominant and everything is arranged for the convenience of the right handed person. The direction of gaze in reading and writing is left to right. Many believe (10, 36), that because of the directional and spatial orientations required, a strong right lateral preference is an advantage in learning to read. It gives a consistent frame of reference for the development of a spatial organization which fits into our society. This organization includes, among other things, the visual and manual movements required for reading and writing, and the relationships between figure and ground.

If spatial orientation is so important in written language, it is believed possible that faulty or unusual types, might be related to reading difficulties in children. Although a great deal of work has been done on other aspects of

reading, little seems to be in evidence directly investigating the spatial orientation of individuals. Habits of hand and eye usage have been thought of in relation to the establishment of spatial organization (23), and Castner (8), found faults in drawing and space perception in pre-school children who later developed reading defects.

The present study was concerned with investigating certain selected factors in relation to reading retardation. In general, orientation in space and electroencephalographic relationships have been approached. The method includes comparison of lateral preferences, left-right spatial orientation without visual cues, visuo-motor behavior, and electroencephalograph records between a group of retarded readers and a control group.

This work must be considered as a preliminary investigation endeavoring to unearth general principles from which to plan future research. For this reason a number and variety of tests have been employed.

Chapter II

Theoretical Background and Related Research

Within the time available, it was impossible to do a complete critical survey of the literature. However, Durrill and Murphy (12), Jasper and Raney (26), and Traxler (44), are among those who have reviewed research in the field of readings, while Gray (21), provides yearly summaries of investigations carried out in the previous twelve months.

It appears that most workers would agree with Robinson (41), that a child should have attained a mental age of above six years before instruction in reading is begun, and that progress in reading will be related to the intelligence quotient. Before a child can learn to read he must be at a maturational level where sensory-perceptual-motor activities can be applied constructively to the problem (22). Since eighty to ninety percent of the reading retardation cases are male, one of the explanations used is that boys mature at a slower rate than girls, and a higher proportion of them enter school before they have reached the necessary level of maturation (43).

Some etiological factors related to reading retardation:

1. Visual Factors:

Monroe (36) could not differentiate her reading defect group from her controls by their visual

accuity. Robinson (41), summarizing related research, observed that there was no general agreement on the importance of these factors to reading difficulty. She noted though, that many of the studies have not been done by specially trained persons, and that this may account for some of the experimental results. Another group of workers (16), compared fourth grade students on various eye tests and reading. They found no tendency for the groups with various visual defects to be less efficient in reading. Of course blindness or extreme defects preventing visual reception of the written material, would preclude learning. However, such disorders are generally remedied early and do not have much influence on the particular problem under investigation.

Eames (15) compared reading failures, ophthalmological cases, and unselected school children, on various visual factors, but did not find an appreciable median of defectiveness greater in any one group than in another. The reading clinic at the University of Chicago (40), finds that two thirds of the people given remedial reading can make adequate progress without referral to a refractionist for correction of vision. They also find that difficulties of vision interfere with reading progress in individual cases, for this reason examination by a competent refractionist is considered important.

2. Auditory and Speech Factors:

In order to learn to read in a public school, a child must be able to use and recognize the vocal

sounds which are associated with written symbols. Other things being favorable speech will depend upon auditory accuity and discrimination. Monroe (36), found many more speech defects in her reading cases than in the controls, and also significantly poorer auditory discrimination. Robinson (41), adds inadequate auditory memory span for sounds as a possible cause of both reading and speech difficulties in some cases, and found dyslaleia was the commonest cause of reading failure among the thirty cases in her study. Eames' (14), conclusion on this subject is that both speech and reading troubles are likely to originate from the same basic defect, and that, essentially the problem is neuro-physiological with psychological overtones.

3. Emotional Problems.

Education has a high prestige value in our society. Serious difficulty with reading which impedes progress in school is consequently very disturbing to the subject. There appears to be a close relationship between personality maladjustment and reading failure (39), but it is difficult to differentiate cause and effect. This is particularly true when the problem has been present for several years. Some children are helped in reading by psychotherapy, others are not. Some emotionally disturbed children respond to a particular type of reading therapy with simultaneous relief of emotional maladjustments. Blau (5), points out that though reading difficulty may start from an emotional disturbance such as negativism, if the child at a later date does become

more receptive to learning, he has missed the basic training and will be handicapped.

4. Physical Factors.

In this category may be included such things as malnutrition, physiological disorders, chronic and acute diseases. Eames (13) compared a group of eight hundred and seventy-five reading failures to four hundred and eighty-six non failures. He found the failure group had twenty-one percent more total disease and disorders and five percent more speech defects. Robinson (41), feels that the importance of these influences on reading is not yet clear.

5. Environmental and Social Factors.

Education of parents, socio-economic status, use of a foreign language in the home and known attitudes apparently have little relationship to reading failure (41). Educational aspects should be considered, particularly for the primary grades, because it is then that faulty habits become established.

6. Neurological Factors.

Damage to sensory or motor areas involved in any of the language functions and their association paths, may interfere with reading. While this is often definite enough to be localized through neurological examination, it is suspected by some workers that sub-clinical damage might also play a part. Statten(43), found a group of reading cases who, although neurological examinations were usually negative gave test performances suggestive of brain damage, and pro-

duced electroencephalographic tracings with abnormal three per second waves in the occipital region. Comparing reading achievers and failures on a group basis however, there appears to be no significant difference in the number of disorders of the nervous system that are found (13).

Lateral preference, cerebral dominance and reading.

Asymmetry of the two cerebral hemispheres has been definitely established regarding the language functions. The entire control of speech, reading and writing is found to be centered in the same side of the brain from which the preferred hand is controlled (8). This is referred to as the dominance of one hemisphere over the other. Because of the crossing of nerve tracts in the brain to the opposite side of the body, the left cerebral hemisphere is dominant in a right handed person, and the right is dominant in a left hander. In adulthood there is little transfer of the language functions from one hemisphere to the other, following injury. However, such a transfer may occur if the injury takes place early in life (9). Handedness can be changed, often with no difficulty, but the language centers do not follow suit. Because of the normally close anatomical relationship of handedness and the language functions, deviations have been considered as possible causes of difficulty in learning to read. By those who believe cerebral dominance to be a fixed hereditary entity, any injuries or training which interfere with the predetermined state are felt to cause cerebral confusion with resulting difficulties in handling language symbols, and with

reduced facility for cooperation between hand and language centers in writing. Those who believe that training determines the location of dominance, feel that failure to establish strong laterality on one side, may lead to difficulty in acquiring language forms because, of the lack of a consistent spatial frame of reference, and cerebral confusion.

Writing involves the focus and alignment of eye, pencil, and paper. Due to the spacing of the two eyes this is not possible if the eyes are focused simultaneously, because a double image will result. For this reason one eye is used for writing (5). In monocular sighting, most people are consistent regarding the eye they use. This is generally taken as an indication of preferred laterality, but because the optic nerves from one eye go to both cerebral hemispheres there is doubt if it is related to dominance (34).

The laterality characteristics of retarded readers have been extensively investigated. Preference is said to be strong when the same hand is used for skilled unimanual activities and for the more difficult aspects of bimanual ones. The non preferred hand has a more supportive role. The strength of lateral preference exhibited by an individual appears to be related to the number and kinds of tests used to measure it (33). Most people, for example, can write with only one hand, but the hand used in picking up objects may depend upon convenience. Estimates of left handedness in the population, have varied from two to thirty percent. Two to six percent is generally accepted as a fair estimate. Mixed

hand and eye preference is found in twenty to forty percent of the population, while left eyedness appears in twenty-five to thirty-three percent (23). There is also a small group of people who are inconsistent in eye or hand use. The remainder of the people are right handed and use the right eye for sighting.

Certain groups of people show higher than average left handedness. Males, mental defectives, delinquents and criminals, neurotics, psychotics, stutterers and reading disabilities. Blau (5), Jasper and Raney (26), feel that this may mean that constitutionally poor biological material tends to lack the maturational determinants of lateral dominance, or that handedness is a learned behavior and unstable or deficient individuals are lacking in learning ability. Blau (5), thinks that left handedness is most often the symptom of an infantile psychoneurosis involving emotional negativism. Other causes he mentions are mental and physical deficiency and faulty education.

Monroe (36), found no significant differences in handedness between her groups of normal and retarded readers but she did find a significantly greater incidence of left eye preference, and left eye with right hand preference among the reading cases. Castner (7), examining children referred to a guidance clinic found left handed, impartial eyed types showed a higher than usual amount of reading retardation. Smith (42), on the other hand discovered no differences in laterality between his retarded readers and reading achievers.

Reading reversals have been associated with lack of cerebral dominance through Orton's (37), theory which sets forth the idea that visual perception results in memory traces being left in the brain. Those traces in the dominant hemisphere are recalled correctly, those from the other side are mirror images. If there is no dominance either image may appear, and confusion in reading and writing occurs. Gates and Bennett(17), following this line of approach compared a group of students showing highest reversal tendency, with a group showing the lowest. They could not differentiate the groups either on hand preference or lack of it. Both groups read equally well.

Clinical Studies in Reading II (40), reports an investigation done on eye-hand preferences, reversals and the reading progress of a group of children starting Grade one through Grade two. At the beginning of Grade one, the right-handed, left eyed children tended to arrange a picture story series in a right to left order. At the end of Grade one there were no significant differences nor did any develop by Grade three.

With reference to Orton's theory, Mintz (35), studying reading and laterality in subnormal boys, found the expected left right reversals in letters and words as well as vertical reversals. Barger (3), working with children severely retarded in reading, but whose disability was not considered to be of psychogenic origin, observed that they frequently reversed letters in printing and made pencil strokes from

below up. This was a double rotation involving both vertical and horizontal axis. Also noted in each child was a condition of latent or active mixed laterality of cerebral dominance. Barger believed that there was a failure on the child's part to adjust to the accepted biaxial conventions in specialized cerebral areas. He felt that a mirror could help the child see the words at his own physiological level. Printed material was placed so that the horizontal axis of some letters, and the vertical axis of all the letters were reversed and inverted. Direction of reading was left to right. This method proved remarkably effective in teaching the children to read, and in two to eight weeks they were able to proceed without it, having worked out some kind of an adjustment. This author feels that the important thing is not the mixed laterality, or verticality but whether or not the child has adjusted to the confusion.

Differentiation is generally made in the literature between extremely retarded readers, and lesser types. The former are called reading disabilities by some and aphasics by others. The latter are referred to as reading retardations. Some writers feel that reading disability is part of a general neurologic hereditary syndrome which is extremely difficult or impossible to cure. These children are believed to have confused cerebral dominance with resultant innate confusion in the spatial orientation of visual symbols. Cole (10), discussing this subject, states that reversal tendencies or mirror writing are found in all these cases. Blau

(8), disagrees with the hereditary aspect of reading difficulties, but agrees that orienation is involved. Hildreth (35), thinks that efforts should be made to establish strong laterality in children in, order to help them learn orientation in space.

Electroencephalographic studies related to reading and Problems of behavior.

The "normal" population of children shows only five to ten percent abnormal electroencephalograms. Children with psychological disorders have sixty to eighty percent abnormal EEGs. The character of the EEG abnormality found in these children, has resulted in the suggestion that unequal and abnormal cortical development may be involved, and that behavior difficulties may be related to this. There is also a high percentage of reading difficulty among such children (27).

Hughs, Leander, and Ketchum (25), studied the electroencephalographs of one hundred and twenty-five children with reading retardation, but without severe behavior disorders. They found abnormal records in seventy-five percent. There were no traces of focal abnormalities, and nothing which could be related to cerebral dominance or lack of it.

Statten (43), describes a group of children with reading retardation who show a correlation between several different things, as follows. Neurological examinations were negative. Psychologists using the Wechsler Intelligence scale for children, the Goodenough Draw-a-Man test, the Bender-Gestalt visual motor test and any other tests deemed necessary report

visuo-motor difficulty. The object assembly, coding and block design sub-tests in the Wechsler Intelligence Scale for Children showed drops in score or performance. Performance IQs were frequently lower than verbal IQs. This discrepancy however, tended to even itself out in older children because the scores of children who can't read generally fall off on information, vocabulary and general comprehension. Drawings in nearly all cases pointed to a visuo-motor problem with Goodenough IQ scores ranging ten to thirty-eight points below the Wechsler Intelligence Scale for Children. Reproductions of the Bender-Gestalt figures were usually poor. Electro-encephalograph reports showed abnormal two to three per second waves in the ocipital region. Psychiatric examination revealed severely emotionally disturbed children who had been a problem to the family since early life. Statten suggests that this might be a group of children who had minimal brain damage in early life. An alternative is that the emotional problems have been severe enough to interfere with maturation at all levels of psychophysical integration.

Another group of workers, Kennard (27), investigating children with problems of behavior divided them with regard to reading retardation. Electroencephalograph and cerebral dominance of the groups were compared. There was more mixed and uncertain dominance among the retarded readers, and the percentage of abnormal electroencephalographs was twice as high. Taking all the children together seventy-two percent showed electroencephalograph abnormality. These figures are

consistent with those usually found.

Discussion.

It appears that reading retardation in general cannot be attributed to any one cause. The same factors may be present in several cases, but have an entirely different individual value in relation to the reading problem. It may at times, be possible to differentiate the vital etiological factors, but, as the thorough study by Robinson (41) shows, even the combined skill of numerous specialists, cannot give a consistently correct estimate of the relative importance of the diverse conditions which are present in a reading case. Monroe felt that "the reading difficulty may result in those cases in which the number or strength of the impeding factors is greater than the number or strength of the facilitating factors" (36, p 110).

Hypotheses upon which the present research is based.

1. The laterality of the retarded readers will not be as strongly established as that of the controls.

2. The retarded readers will show more confusion of spatial orientation than the controls do.

3. The visuo-motor behavior of retarded readers will be faulty or unusual in comparison to that of the control group.

4. There will be a greater number of abnormal EEGs among the retarded readers than among the controls, and it will be possible to differentiate the groups on the basis of particular EEG patterns.

Chapter III

Method

Subjects

For the present investigation two groups of children, ten in each, between the ages of eight and eleven inclusive were selected from the case files of the Child Guidance Clinic, and the Metropolitan Health Committee. The size of the experimental group is small but it represents all the cases which were available at the time. One group was chosen on the basis of a history of reading retardation, and the other group on the basis of an absence of any such history. The subjects were paired with regard to age, intelligence and sex. The basal age of eight years was selected because many children who have had difficulty learning to read catch up by this age (39). Children in higher grades will be severely retarded in all subjects so that reading does not stand out. An effort was made to keep the ages of the subjects in the eight to ten range for greater consistency, but this was not practically possible.

All subjects were in average good health. Birth and developmental histories were not available for some of the children, but no case with known neurological disorders, chronic illnesses or severe physical disabilities was used.

Children are referred to the above agencies because of

behavior and school problems of all types, or for evaluation of intelligence and adjustment. The twenty subjects in this study all showed deviations in behavior or emotional difficulties, on psychological and psychiatric examination, at the time of their referral. Two of the children had been seen first in 1952, sixteen in 1953 and two in 1954. Three of the reading cases came from the Metropolitan Health Committee, all others were from the Child Guidance Clinic. Altogether twenty-four subjects were tested. Two were later discarded because of age and intelligence, one case was not sufficiently retarded in reading to be included, and one child showed possible epilepsy on the electroencephalograph.

The cases could not be paired in regard to socio-economic background or home stability, but the over all group pictures are similar (Table 1).

Tests, apparatus and scoring.

A. To determine reading ability.

Although the children had been selected on the basis of clinical reading, they were re-tested in order to confirm it. The use of similar reading tests for each subject also permitted a better comparison of the present reading status.

1. Oral Reading. Gray's Oral Reading Paragraphs were used. This test is given and scored according to the direction sheet, with the exception that all children, irrespective of grade, started on the first paragraph. Raw scores are converted into B scores which are comparable to

Table I

A Comparison of the Reading Retardation and Control Groups in Terms of Socio-economic Status and Type of Guardianship

Class of Home	Reading Cases	Controls
Poor	3	2
Middle	7	7
Receiving Home	0	1

Type of Guardianship	Reading Cases	Controls
Home Broken and Ward of the Government	1	2
Illegitimate and Ward of the Government	1	2
Living at Home with One Parent	3	2
Living at Home with Both Parents	5	4

grade scores.

2. Silent Reading. The Dominion tests given are achievment tests in silent reading. They were standardized on Canadian children, for each separate grade. There are four tests for Grade one: word recognition, diagnostic paragraph reading, phrase and sentence reading, and a diagnostic test in paragraph reading. For Grade two there is a diagnostic test in paragraph reading, and a vocabulary test. Grades three and four are combined, as are five and six, but they have the same type of tests as Grade two. The vocabulary tests were not used. The other tests were scored according to the directions in the manuals. The score is in grades, years and months.

3. Mirror Reading. The mirror apparatus and the first paragraph from Gray's Oral Reading test were used here. Scoring is in terms of time and errors, with the errors defined by the instruction sheet for Gray's test.

B. To determine lateral preference.

Twenty-four preference tests, three trials for each, were given (Appendix A). The tests were taken from a table shown in the Monograph, Clinical Studies in Reading I (39). To save time some of the tests were not used. These are crossed out in the sample. Those used include seven for hand, seven for eye, seven for foot, and three for ear. Two of the eyedness tests are taken from Crider (11). The hand used for writing was also noted.

Considering the seventy-two choices, eighty percent or

more in favor of one side was taken as indicating strong laterality, left or right as the case might be. Less than eighty percent was considered indicative of mixed preference. This is an arbitrary delineation, and was chosen to allow for expected normal variations.

C. To determine status of spatial orientation.

Spatial mazes have been extensively used for the study of motor learning. Since they are concerned with the learning of the position of certain objects in space (1, 28-29), it was felt that maze learning, without visual cues, should be related to the spatial orientation ability of an individual. Persons without a well established spatial frame of reference might be expected to have difficulty acquiring the directional orientation needed to find the goal.

Five stylus mazes of the U type (1, 27-28) were designed and made up (Appendix B). The mazes were constructed so that directional choices towards the correct alley were either to the left or to the right. The maze paths were cut in a piece of plexiglass nine and one quarter inches square and one quarter of an inch deep. This was glued to another square the same size, which acted as a floor for the alleys. The beginning of the maze was a circle three quarters of an inch in diameter. It opened into the first alley on the right hand side. The end of the maze was also circular and three quarters of an inch in diameter, but it was cut through both sheets of plexiglass. In this way the completion of a run

was marked by the stylus dropping down. The whole was mounted upon rubber legs to prevent skidding. The mazes were designed in sections three and three quarters inches by one inch. One end of each section led into a blind alley and the other end led into a new section or goal. The alleys were three eighths of an inch wide, and a rounded stylus which fitted loosely was used to run the course. One maze was used as a sample (Appendix B). It had only one section. Each successive maze had one more section so that the fifth one had six. Among the four mazes there were eighteen blind alleys. Nine on the left side and nine on the right.

For scoring purposes the maze sections are considered as being composed of four units. One unit from center to the left side, one unit up to the end of the blind alley or the next section. The other half of the section is similarly divided. Each unit is numbered and by writing down the number whenever a unit was traversed half way or more, the child's route could be recorded. Performance was not timed.

The Mann-Whitney test was used to compare the groups on their maze performances. The following excerpt from the article by the authors (32), gives a short description of the test.

> The statistic U is defined as the number of times a y precedes and x in an ordered (ranked) sequence of x's and y's. Thus, under the null hypothesis it would be expected that the number of times a y precedes an x will equal the number of times an x precedes a y. If the obtained U departs from the mean U expected under the null hypothesis, the hypothesis will be rejected at the confidence level given by the relative frequency of departure from $\bar{U}$ of values as small or smaller than the value of U obtained.

Probability values associated with obtained U's of various sizes are given in Mann-Whitney Table I for the case where $n<m<8$ and n and m are the numbers of cases in the two samples. When $n>m>8$, the distribution of U about $\bar{U}$ is approximately normal with a standard error given by:

$$(1) \qquad \sigma_U = \sqrt{\frac{nm(n+m+1)}{12}}$$

Thus probabilities associated with values of U obtained when $n>m>8$ may be obtained by calculating a normal deviate and reading the probability from a table of the normal probability integral.

Note: The Mann-Whitney test is a single tail test since the only alternative to the null hypothesis admitted is that x is smaller than y. For a two-tailed test the obtained probabilities should be doubled. (32, p 50).

The table for the probability values samples of the size used in this research are shown in Appendix C.

D. To determine visuo-motor behavior.

1. The performance section of the Wechsler Intelligence Scale for Children. The full scale WISC was given and scored as prescribed in the manual. The standard test materials, record blanks, and a stop watch were used.

2. The Bender-Gestalt Visuo-Motor Test.(4). The administration and scoring method set forth by Pascal and Suttell (38), was used. The scorer reliability is high, and validity studies on patient and non-patient children and adult groups indicates that the scoring differentiates them. There are no norms available for children, so raw scores were used to compare the group.

3. Draw-a-Person Test. Due to misunderstanding, the instructions for the Machovers Draw-a-Person (31) test were used instead of those for Goodenough's Draw-a-

Man Test of the same type. The drawings of the male figure were scored according to Goodenough's instructions (20), and her norms were used to find IQ scores.

4. Mirror Writing (36, 198). This test involves five three letter words, which must be written mirror style by the subject. The examiner demonstrates each of the words, starting at the right hand side of the paper, and going to the left. The child is asked to read each word after it has been written. The example is then removed and the examiner dictates the words for the child to write. Paper, pencil, and eraser are used. Scoring which is subjective is the percentage of letters correctly reversed.

5. Mirror Drawing (9, 30). Two patterns were designed, suitable for children (Appendix D). One pattern is the mirror image of the other. The first angle is thirty degrees, the following two angles are ninety degrees. A standard mirror apparatus with an adjustable metal shield was used.

Crossing either line is considered an error, but no differentiation was made as to the size of the deviation (2). The purpose of this test was to investigate ability to make sharp changes in direction while guided by a mirror image which makes it necessary to reverse habitual visuo-motor habits. The performance was timed.

E. <u>To determine electroencephalograph patterns</u>.

An Offner six channel apparatus was used. Eight leads were symmetrically placed on frontal, motor,

temporal, and occipital regions of the two sides of the head. Recordings were bipolar. An analysis based on the entire record was made by a qualified examiner. This analysis was directed particularly to normality, amount of theta activity, regular and irregular alpha patterns, amplitude asymmetry, reaction to hyperventilation, and presence or absence of dysrhythmia.

Preparation of examiner for testing.

Administration of the Wechsler Intelligence Scale for children was practiced on fifteen children before starting with the research subjects. Training and supervision were provided by an experienced clinical psychologist, and scoring was also checked by him. After learning the scoring system for the Bender-Gestalt test, scorer reliability was determined for fifteen records scored independently by this examiner and the supervisor. The correlation was high, being about the same as that reported by Pascal and Suttell (38).

Administration of all the other tests used, was practiced on varying numbers of children, depending on the complexity of the procedure, or the necessity of establishing one.

Procedure.

An outline of the research project was given to the parents or social worker concerned, along with a brief description of the tests used and the purpose of the work. The children were generally told, either that they were going to take part in research which might help others, or that the examiner was interested in seeing how children did

Various things. The main idea was to try and present the examination in a way which would be sensible and acceptable to the child.

All subjects were driven from their homes to the University and back again by the examiner. Some were accompanied by an adult or child from their immediate family, for one or both of the sessions. Testing was carried out in the Department of Neurological Research, two periods for each child, either morning or afternoon. The time between tests varied from one to sixteen days depending upon whatever arrangements could be made with parents. The time needed to complete a session differed from child to child, but averaged about three hours, with a break half way through for a walk and refreshments.

Order of presentation of the tests was the same for each subject, with a few exceptions due to refusals, or lack of time in the first session. One reading case was given the WISC, Oral Reading and Draw-a-Person tests by a psychologist at the Child Guidance Clinic, and had the remaining tests the following day at the University. The electroencephalograph examination took place at the end of the first or second testing period, with one exception when it was necessary to give it first.

Session one was given in the following manner.

1. Draw-a-Person following the method given by Machover (31).

2. Bender-Gestalt. This test was given in the manner suggested by Pascal and Suttell. Instructions are as

follows: " I Have here nine simple designs (or figures) which you are to copy, free hand, without sketching, on this paper. Each design is on one of these cards which I will show you one at a time. There is no time limit to this test" (38,p,11). Several sheets of paper, pencil, and eraser were placed on the table at the beginning of the test. The examiner cleared up any points of confusion as much as is possible without being directive.

3. The WISC was given as instructed in the manual. Sometimes it was necessary to alter the order of presentation of sub-tests to hold the child's interest. Occasionally the break for refreshments was taken before the WISC was finished, if the child was particularly slow or restless.

4. Mirror reading, The mirror apparatus was set up and shown to the child. The paragraph to be read was placed so that the top edge of the paper ran along the bottom edge of the upright mirror. This is the method described by Barger (3), and the direction of reading is the normal left to right. The mirror is adjusted so that the image is clear and the instructions given by Monroe (36, p. 197) are used. The performance is timed.

5. Mirror Drawing. The test was taped to the baseboard, in front of the mirror, so that it was in the same position for each child. The children were not allowed to look at the drawing, except through the mirror. The arrows which indicate the starting points are closest to the child, and as the sheet was being arranged instructions

were given as follows. "You see the two paths in the mirror? Well, I want you to start at the arrow and draw a line up the path to the end, trying not to go over the lines, and not to lift your pencil off the paper. You are to do it by looking in the mirror, and you must not look underneath. I will put your pencil at the starting place and tell you when to go. Do you understand?" The shield was adjusted so that the child had a clear view and freedom of movement. When a subject deviated from the path and was unable to return, the examiner assisted him back to the point of departure. The deviations sometimes occurred when the child took his pencil off the paper. The order of first trial was alternated between the left and right drawing for each successive subject. The second trial was given immediately, or after a short rest, depending on the subject. Some children gripped the pencil so tightly, or took so long a time on the first trial, that their fingers were tired. Other children succeeded more quickly or with less tension, and were impatient to go on. Both drawings were timed.

Session Two.

1. The preference tests were given, as little games, in whatever order it was felt would hold the child's attention. If a subject inquired about the purpose of these tests, he was told that the examiner was interested in the various ways people do such things. Only one child appeared to realize the purpose of this examination. She was a reading case whose handedness had been a subject of family

controversy.

2. Mirror Writing. The method described by Monroe (36, p.198) was used, with the examiner illustrating the procedure, and the child attempting to imitate it. The words are written from right to left.

3. Reading Tests.

(a) Silent reading tests were given which corresponded to the school grade of the subjects in the control group. The reading group was more difficult, however, because some of them were advanced in school far ahead of their reading ability. There is also the problem of an emotional block, in relation to reading. Some of the children were completely unable to attempt the test for a particular grade, but could handle the one for a lower grade. Since the instructions and examples are the same for grades two to six, if a test was rejected, or answered without being read a lower one was substitued. Children known to be severely retarded were given the grade one tests. One child in the control group marked his paper without reading the stories on which the questions are based. Since the tests are timed it was thought better to give him the test for a lower grade, than to start him over on the same one. These are group tests, and the instructions given in the manual were altered to make them suitable for individuals.

The examiner stayed in the room with the child while he wrote but tried to avoid making him feel closely watched. It was found necessary to encourage and reassure some of the

children so that they would not just give up or refuse to try.

(b) Oral Reading. This test was given as directed on the accompanying score sheet but starting always with paragraph one. Time for each paragraph is recorded.

4. Stylus Mazes. The child was shown the sample, and the following explanation was given. "This is a kind of a maze, It has a beginning here (demonstration), and an ending here. To get from the beginning to the end, you follow this path, into which the end of this pencil fits. If you turn this way, you end up here and can't go any farther. This is called a blind alley. The idea is to get from the beginning to the end of the maze, blindfolded, and without going into any blind alleys. I will let you try this one that you have seen first. Then I will give you some different mazes which are made something the same, but are longer. You will find the way from the beginning to the end, and remember it, so that you can finally go through to the maze without entering a blind alley."

The subject was allowed to take the stylus and go through the different parts of the maze, first with his eyes open, then with them shut. Following this the sample was removed and the subject blindfolded. Celluwipes were folded and placed over the eyes and a folded cloth tied around the head held them in place. Each maze was placed squarely in front of the child, and the examiner placed the stylus at the starting point for each trial. Thirty trials were allowed for each maze, or three errorless runs taken to indicate that the cor-

rect path was learned. In final tabulating of results, however, twenty-seven trials, or two errorless runs were used. The children appeared to feel that one or two successful runs should be enough, and performances often deteriorated when they had to continue. In view of this the final tabulating was based on the limit of twenty-seven trials, or two errorless runs for each maze.

Discussion.

These subjects were generally able to cooperate well, in spite of the length of the testing periods. Reactions to the various parts of the program varied between tests and individuals. It was necessary to use numerous methods of approach in order to hold the children's interest, but the tests were all reasonably short or varied so that boredom was generally avoidable. As little restriction as possible was used. The children were apparently able to accept the rules governing testing. They seemed to understand that although the examiner might like to help them, it was not permitted. The drive from home to the University appeared to help a great deal in establishing a working relationship with these children.

Chapter IV

Results

A. Reading Tests.

1. Mirror Reading.

Table 2 sets forth the statistical data relating to this test. The reading retardation group and controls were compared as to time required for reading the paragraph, and errors made. There are no significant differences.

A ratio of errors over time, was worked out for each child, and used as a basis for group comparisons. This ratio gives an idea of the relationship between time and errors. It reveals that the children retarded in reading make fewer errors, per unit time, than do the controls. Statistically this is a very significant differenee. One explanation for this finding lies in Barger's theory, relating reading disability to a cerebral failure to adjust to the biaxial conventions in reading. He found his cases were able to read print, through a mirror which alters the axis of the letters. He feels that this method enables the children to make an adjustment to horizontal and vertical axis, which they could not do otherwise (3).

Practice may explain this difference also. Children who are accomplished readers probably do more of it than those who are failing. In this way the good readers would have more strongly established habits of orientation and percept-

Table 2

A Comparison of the Reading Retardation and Control Groups in Terms of Reading Grades which have been Reduced to Months

	Oral Reading		Silent Reading		Average Reading	
Statistic	Reading Group	Controls	Reading Group	Controls	Reading Group	Controls
N	10	10	10	10	10	10
Range	0-11	11-49	1-20	20-48	0-18	15-40
M (Months)	5.1	27.4	11.2	36.4	8.8	31.7
σ	3.94	10.53	5.21	10.96	4.97	10.23
σ_M	1.31	3.51	1.74	3.65	1.66	3.41
σ_{D_M}	3.75		4.04		3.79	
D_M	22.3		25.2		22.9	
t	5.95		6.2376		6.0422	

Note: With 18 degrees of freedom a t of 2.101 is significant at the .05 level.
t of 2.878 is significant at the .01 level.
The beginning of Grade one is taken as the zero point, and one school grade equals 10 months.

ion, and could not adjust as well to a change in the spatial orientation of mirrored print. The retarded readers, not being so rigid in their reading habits would make a more facile adjustment.

Table 2 shows the groups differences in relation to time and errors in reading the above mentioned paragraph normally. The control group reads faster than the reading cases, which is to be expected because of the selection of the two groups. The poor readers also make a significantly greater number of mistakes, which is also to be expected.

2. Reading tests.

In terms of the number of years of schooling the reading group totalled thirty-seven and the control group thirty eight. The range of actual grade placement among the retarded readers was grades two and nine months to four and ten months. The similar range for the control group was grades two and nine months to five and ten months.

Looking at Table 2 it is seen that the reading retardation group averages much lower on reading test scores, than do controls. The values obtained indicate very significant differences between these two groups. This was expected because of the basis of selection of the groups.

B. Preference tests.

Table 3 shows the responses of the children to the laterality tests. It is seen that both reading cases, and controls are similar in hand preference. One of the reading cases, writes with his left hand, but scored one hundred percent preference for the right hand on the tests. This

Table 3

The Preferences of Subjects in Regard to Hand, Eye, Ear, and Foot Usage in the Laterality Tests

The Number of Subjects Showing Right, left, or Mixed Laterality Preference

	Hand			Eye			Foot			Ear		
	R	L	M	R	L	M	R	L	M	R	L	M
Reading Retardations	9	1	0	5	3	2	6	0	4	3	1	6
Controls	9	0	1	8	2	0	10	0	0	3	1	6

The Number of Subjects Showing Various Types of Combined Laterality Preferences

	Hand & Eye			Hand, Eye, Foot			Hand, Eye, Foot & Ear		
	R	L	M	R	L	M	R	L	M
Reading Reatrdations	5	0	5	5	0	5	1	0	9
Controls	7	0	3	7	0	3	3	0	7

The Number of Subjects Showing Verious Types of Laterality When the Percentages of Choices are Combined Together and Averaged

	Hand & Eye			Hand, Eye, Foot			Hand, Eye, Foot & Ear		
	R	L	M	R	L	M	R	L	M
Reading Retardations	5	0	5	4	0	6	4	0	6
Controls	8	0	2	7	0	3	7	0	3

Note: R; L; & M stand for right, left, and mixed. Lateral preferences.

would be classified as mixed preference by some authors, but it does not lower the test percentage below 80, so there is no basis for such a classification here.

Eye preference shows that five reading cases and two controls are not right eyed. These proportions are comparable to those Monroe (54), found among her subjects. The total percentage of left eyedness in the groups is twenty-five, which is similar to the general population.

The control group had definite foot preference which is not usual (23), but both groups are the same regarding ear tests.

Combining the use of lateral organs (Table 3) we see that five reading cases have strong preference for the right hand and right eye. In the other five, preferences are mixed and include right and left combinations as well as mixed eye and mixed hand types. Among the controls seven are strongly right sided and three are mixed. Adding foot preference to the previous two does not change the picture, but when ear preference is considered nine of the reading cases and seven of the controls show mixed preference.

Taking averages of the right and left choices made by individuals it appears that five reading disabilities and eight controls used the right hand and eye more than eighty percent of the time.

Generally speaking hand preference is the strongest. With eye, foot and ear following in that order. Strength of lateral preference decreases when one or more parts of

the body are considered together. Reading retardations show more left sided and mixed preference than normal readers. But the differences are not significant. These findings are in keeping with other reports (23).

C. The Maze Test.

The total number of blind alleys in the four mazes is eighteen, mine on the right and nine on the left. With each section of the maze composed of four units, moving the stylus more than half way, in a left or right direction, along the first section of a wrong alley, constitutes a one unit error. Entering more than half way into the final section of the blind alley was considered a two unit error. In order to compare group performances in relation to both groups of alleys, the performances on all four mazes were combined for each subject. The Mann-Whitney test was used to compare the two groups and Us were obtained as in Table 4.

An attempt had been made to do tests for each maze, The variation of scores within each group and the small average scores obtained for some types of errors, made this impossible.

No significant differences were uncovered in the maze learning ability of these two groups. There is no evidence of spatial confusion or directional preference, which is outstanding for either group. Their performances are similar in all respects.

D. Tests to determine visuo-motor behavior.

1. Wechsler Intelligence Scale for children.

Table 4

Results of the Application of the Mann-Whitney Technique to the Maze Performances of the Reading Retardation and Control Groups. U is Based on the Sum of the Trials and Errors for All Four Mazes

		U
Two Unit Errors	Left	55
	Right	45
	Total	48.5
One Unit Errors	Left	44
	Right	55
	Total	52.5
Total of Both Types of Errors	Left	55
	Right	47.5
	Total	52.5
Total Units Covered		49
Number of Trials		45

Scaled scores are used for calculations. Each member of the control group scored on all sub-tests. There are some omissions in the reading group: one arithmetic, one digit span and three maze sub-tests were spoiled or omitted.

Based on Statten's (43), reference to the performance of his cases on the WISC, an analysis of the test performances of each group has been done.

The standard error of the difference between the means was calculated for each sub-test and the three intelligence scales. The significance of the difference was obtained in the usual manner. There were no significant differences (Tables 5 and 6).

Since there is reason to believe (43) that children retarded in reading might achieve higher scores on performance test than verbal ones this aspect was investigated. The standard error of the difference between the means of the verbal and performance IQ scores, within each group, were determined (Table 7). The formula for correlated data was used. There were no significant differences here.

2. Draw-a-Person.

(a) The two groups were compared for differences in IQ scores on this test (Table 8). There are no significant differences. Applying the Mann-Whitney technique a U value of 43 was obtained indicating no significant difference in the performance of these groups on this test.

Table 5

Comparing Performance in Sub Tests and the Intelligence Scale on the Verbal Section of the WISC

Tests	Reading Group				Control Group						
	N	M	σ	σ_M	N	M	σ	σ_M	D_M	σ_{D_M}	t
Information	10	8.9	1.14	.38	10	9.5	2.20	.73	.7	.82	.73
Comprehension	10	10.2	1.94	.65	10	8.9	2.07	.69	1.3	.95	1.37
Arithmetic	9	9.4	1.64	.58	10	9.7	1.68	.56	.3	.81	.3703
Similarities	10	9.4	1.91	.64	10	10.6	1.36	.45	1.2	.78	1.538
Vocabulary	10	10.5	2.20	.73	10	10.1	1.37	.46	.4	.89	.449
Digit Span	9	8.1	1.85	.65	9	9.0	2.0	.67	.9	.93	.9677
Verbal IQ	10	96.6	7.16	2.38	10	97.6	7.27	2.42	1.0	3.39	.295

Note: With 18 degrees of freedom a t of 2.101 is significant at .05 level.
t of 2.878 is significant at .01 level.
With 17 degrees of freedom a t of 2.110 is significant at .05 level.
t of 2.898 is significant at .01 level.
With 16 degrees of freedom a t of 2.120 is significant at .05 level.
t of 2.947 is significant at .01 level.

Table 6

Comparison of Results from the Performance Sub Tests and IQ Scores, and the Full Scale IQ Scores

Tests	Reading Group				Control Group						
	N	M	σ	σ_M	N	M	σ	σ_M	D_M	σ_{D_M}	t
Pic. Completion	10	11.3	2.24	.76	10	10.3	1.73	.58	1.0	.96	1.041
Pic. Arrangement	10	10	1.84	.61	10	9.2	2.05	.68	.8	.91	.8791
Block Design	10	10.5	1.5	.50	10	8.8	2.52	.84	1.7	.98	1.734
Object Assembly	10	10.2	2.52	.84	10	8.7	2.57	.86	1.5	1.2	1.25
Coding	10	9.5	2.11	.70	10	10.5	1.86	.62	1.0	.93	1.075
Mazes	7	8.7	2.43	.99	10	9.0	1.84	.61	.3	.367	.8174
Performance IQ	10	100.8	7.63	2.54	10	95.9	8.58	2.86	4.9	3.82	1.28
Full Scale IQ	10	98.6	7.58	2.53	10	96.5	7.87	2.62	2.1	3.64	.58

Note: With 18 degrees of freedom a t of 2.101 is significant at the .05 level.
t of 2.878 is significant at the .01 level.
With 15 degrees of freedom a t of 2.131 is significant at the .05 level.
t of 2.947 is significant at the .01 level.

Table 7

Differences Between the Mean Verbal and Performance IQs for the Reading Retardation Group, and for the Control Group

	Reading Group		Control Group	
Statistic	Verbal IQ	Performance IQ	Verbal IQ	Performance IQ
N	10	10	10	10
M	96.6	100.8	97.6	95.9
σ	7.16	7.63	7.27	8.58
σ_M	2.38	2.54	2.42	2.86
σ_{DM}	2.1039		2.234	
DM	4.2		1.3	
t	2.00		.8181	
r	.64		.65	

Note: With 18 degrees of freedom a t of 2.101 is significant at the .05 level.
a t of 2.878 is significant at the .01 level.

Table 8

Comparison of the Reading Retardation and Control Groups in Terms of the IQ Scores Obtained from the Draw-a-Person Performance

Statistic	Reading Cases	Controls
N	10	10
M	89.6	88.5
σ	12.75	16.7
σ_M	4.25	5.59
σ_{D_M}	7.02	
D_M	1.1	
t	.1566	

Note: With 18 degrees of freedom a
t of 2.101 is significant at the .05 level.
t of 2.878 is significant at the .01 level.

Table 9

Correlation Between WISC IQ Scores and Draw-a-Person IQ Scores Using Spearman's Rank-Difference Method

WISC	Reading Cases	Controls
Verbal Scale	-.19	.06
Performance Scale	.09	.03
Full Scale	-.02	-.07

(b) Applying Spearman's Rank-difference correlation method the three WISC IQ scores for each group, were compared to the Draw-a-Person IQ scores. (Table 9). No correlation is found between these various IQ scores for either group.

3. Bender-Gestalt.

The groups are compared on the basis of the raw scores for each child (Table 10). No difference is apparent between the groups. A U of 57.5 also indicates no difference. Comparison of the records shows that reading cases did not have any more rotations in drawing, than the controls did, and the figures were generally well done with regard to the original Gestalt. A meaningful analysis of age differences in such a small group is not possible, but the scores do not appear to change in any consistent way between the children of various ages.

4. Mirror writing.

The average percentage score for the reading group is seventy-one percent and for the controls is sixty-three percent. A U of thirty-two was obtained, which indicates no significant difference exists between the groups on this type of performance.

5. Mirror Drawing.

The group performances were compared with reference to total errors, total time (Table 11), and the ratio of time to errors. Errors and time were also considered separately for trial one, trial two, the right path, and the

Table 10

Comparison of the Reading Retardation and Control Groups on the Basis of Bender-Gestalt Raw Scores

Statistic	Reading Cases	Controls
N	10	10
M	48.8	52.9
σ	10.36	15.05
M	3.45	5.02
σ_{DM}	6.1	
DM	4.1	
t	.6721	

Note: With 18 degrees of freedom
a t of 2.101 is significant at the .05 level.
a t of 2.878 is significant at the .01 level.

Table 11

Comparison of the Reading Retardation and Control Groups in Terms of Errors, Time, and the Ratio of Errors Over Time, for Mirror Reading and Normal Reading

	Mirror Reading								
	Reading Group N is 10			Controls N is 10					
	M	σ	σ_M	M	σ	σ_M	D_M	σ_{D_M}	t
Time	127.6	49.71	18.75	149	78.4	26.1	21.4	32.18	.6650
Errors	9.1	2.93	1.19	12.9	10.01	3.34	3.8	3.55	1.0929
Errors / Time	.0738	.0127	.0048	.0871	.056	.0186	.0133	.006	3.883

	Normal Reading								
	Reading Group N is 10			Controls N is 10					
	M		M	M		M	D_M	D_M	t
Time	50.3	29.5	11.12	18.8	6.37	2.12	31.5	11.32	2.7853
Errors	5.75	5.04	1.91	1.3	1.68	.56	3.45	1.97	2.2588
Errors / Time	.0991	.0636	.0225	.0645	.0381	.0127	.0346	.258	1.3023

Note: With 18 degrees of freedom a t of 2.101 is significant at the .05 level.
t of 2.878 is significant at the .01 level.

left path. No significant differences were found between the two groups (Table 12). Ratios of errors to time, for trials one and two, and a similar ratio of total errors over total time were worked out for both reading cases and controls. The U test indicates no differences between the groups. The mean times for the reading group on trial one and trial two, are seen to be 225.8 and 1.23 seconds respectively. Corresponding times for the control group are 138.4 seconds, and 137.7 seconds. Application of the Chi squared method to determine if these differences in group performances are significant resulted in a Chi squared of 1.2857 which is not significant.

Drawing performance was next analyzed by comparing the reading cases and controls with reference to the number of errors made during the first inch after each turn. Then they were compared as to the number of errors made during the distance of one inch before, and one inch after each turn. U. tests here indicate no significant differences.

Considering the possibility of a correlation existing between the drawing performances of each individual, correlations of .26 and .01 were obtained for reading cases and controls respectively. These indicate no significant correlation.

D. Electroencephalograph Data.

The reading disability group has seven abnormal records as against the controls who have three. Chi squared for these differences is 1.8 which is not significant. In

Table 12

Comparison of the Scores of the Reading Retardation and Control Groups in Terms of Errors and of Time in the Mirror Drawing Performance

	Errors								
	Reading Cases N is 10			Controls N is 10					
	M	σ	σ_M	M	σ	σ_M	D_M	σ_{D_M}	t
Trial 1	13.9	11.5	3.83	11.3	5.91	2.09	2.6	4.36	.5963
Trial 2	11	9.52	3.17	13.1	1.12	3.97	2.1	5.08	.4133
Right Path	11.4	10.45	3.48	11.2	6.97	2.47	0.2	2.47	.0816
Left Path	13.5	10.74	3.58	12.4	10.65	3.78	1.1	5.21	.2130

	Time								
	Reading Cases N is 10			Controls N is 10					
	M		M	M		M	D_M	D_M	t
Trial 1	225.8	129.44	45.74	138.4	40.65	14.36	87.4	47.94	1.83
Trial 2	123	88.9	31.5	137.7	24.0	24.0	14.7	39.6	.3712
Right Path	152.7	127.52	45.2	118.6	17.3	17.4	34.1	48.4	.7045
Left Path	196.3	112.67	39.8	157.5	19.9	19.9	38.8	45.5	.8769

Note: With 18 degrees of freedom a t of 2.101 is significant at the .05 level.
t of 2.878 is significant at the .01 level.

regard to theta activity five reading cases show it in marked degree, and only one control does. However, the Chi squared value for this difference is 2.02, again not significant. The remaining aspects of the records; quality of alpha, amplitude asymmetry, reaction to hyperventilation and dysrhythmia do not differentiate the two groups.

Chapter V

Summary and Conclusions

A study was undertaken to investigate certain factors, which it was thought might differentiate reading failures and reading achievers. Spatial orientation, visuo-motor behavior, laterality preferences and electroencephalograph patterns, were compared between a group of retarded readers, and a group of average readers.

Standard of children's tests, and tests adapted from adult forms were given to twenty subjects, children with problems of behavior, half of whom were retarded in reading. Whenever possible testing procedure either followed standardized instruction and scoring technique, or was based on methods used by other workers. In the remaining cases procedures were worked out on the basis of preliminary practice with ordinary children, and the methods followed by other investigators using similar tests.

Generally speaking, the two groups of children do not appear to be significantly different, in respect to the tests given. Intelligence levels are nearly the same, since this was one of the considerations in selection. There was, though some difficulty here, in view of the fact that some of the children had not been tested for over a year. There was no way of estimating in advance at what level these disturbed children might be functioning. Reading tests

differentiate the two groups markedly. It was observed also that the oral reading achievement for both groups was generally lower than silent reading scores. This difference went as high as a grade and six months for one retarded reader, and two grades for one of the controls.

Preference tests indicate that the groups are about the same in habits of preference. The only two children who wrote with their left hands were among the reading retardations. This latter group also had five members who were left or indefinite in eye preference, as against two left eyed subjects among the controls. These differences are not statistically significant.

Comparison of the groups with reference to performance on the mazes, shows them to be similar for this type of behavior. It was felt that this was the most difficult test in regard to maintaining the subjects motivation. Some of the children became very frustrated and discouraged, others showed anger and tended to attack the problem. These factors probably had a negative effect on the performance of some of the children. Whether this would even itself out in considering group performances is not known.

Results of an analysis of the Wechsler Intelligence Scale for Children has already been discussed. The reading group tended to do better on performance tests, then verbal ones, but otherwise the groups were alike.

Monroe (36), found that her reading-defect groups were

better mirror readers than were her controls. This was in terms of time and errors. While the present worker did not find significant differences in those categories, a ratio of errors over time revealed that the retarded readers made fewer errors per unit time, as compared to the controls. Possible reasons for this finding have been discussed in relation to results. It may be concluded, with the exception of the above mentioned tests that, performances of these small groups on the tests used were not significantly different.

Chapter VI

Suggestions for Further Research

Although the results of this investigation were essentially negative, it is possible that a similar study with younger children might yield more significant results. Confusion in spatial orientation is more common in young children (35), and the visuo-motor performance on the Bender-Gestalt test is different with pre-school children than with grade two subjects (22). These second grade children who were successfully learning to read, gave performances more closely resembling those of adults than of pre-school children. Several writers have observed that the development of preferred laterality continues through childhood. The stage of development that the child is in when he starts school, might be important for learning to read, as well as the adjustment he is able to make to conventional habits of direction. Since the child cannot usually go back and pick up, training that he has missed, normal spatial orientation or visuo-motor behavior which is acquired at a latter age, will not help him.

Since there are numerous things which might cause retardation in reading, and since it is difficult to fully evaluate them in relation to a group study, it might be more profitable to analyze the test performances of large numbers of subjects, trying to find out if smaller groups would show constellations of behavior which would differentiate

them in any way.

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TEST OF PREFERENCE

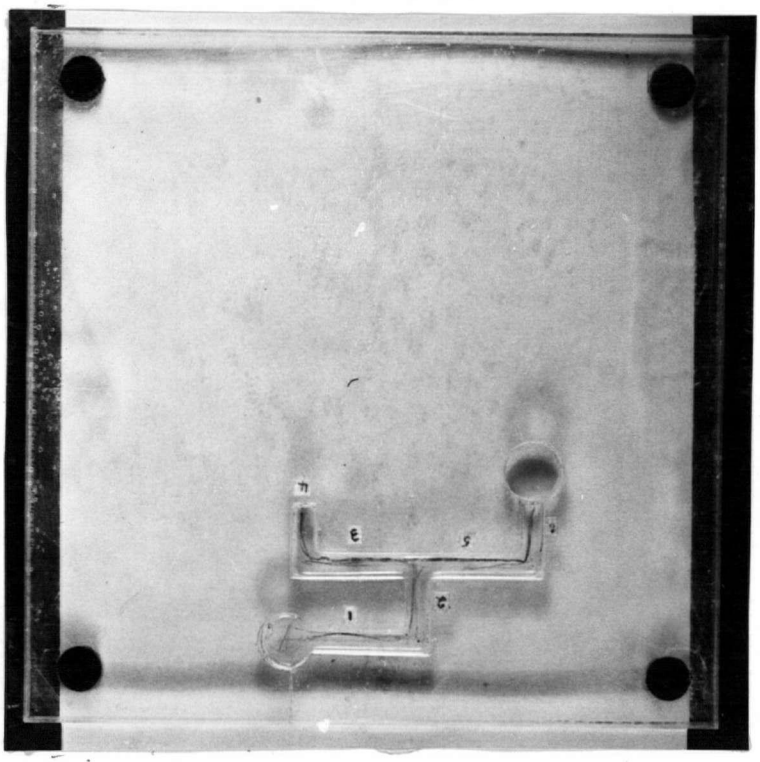
NAME: EXAMINER: DATE OF TEST:

Activities with Hand	Right	Left	Activities with Foot	Right	Left
Shooting a marble along a line.			Pushing a ball carefully keeping it on a line.		
Tapping with marble, keeping to demonstrated rhythm.			Tapping toe imitating demonstrated rhythm.		
Replacing blocks in form board.			Pushing blocks so that they do not upset.		
~~Stopping an object spun by examiner.~~			~~Stopping an object spun by examiner.~~		
Snapping finger and thumb together.			Moving top block without disturbing blocks below.		
Bouncing a ball three times using one hand.			Draw or write something on floor with toe of shoe for examiner to guess.		
Moving a block by shooting a marble at it.			Pushing a ball hard enough to disturb tower of two blocks.		
Balancing a ruler resting on two blocks.			Lifting ruler resting on two blocks.		
TOTAL NO.			TOTAL NO.		

Activities with Eye	Right	Left	Activities with Ear	Right	Left
Manoptoscope			~~Object always held by examiner in front of child's nose. Listening to watch, later imitating rhythm of tick.~~		
Ring Test (Crider)					
Spot Test (Crider)					
Sighting tube					
Looking steadily through hole in cardboard to picture middle of three on wall.			Listening to shall		
			~~Listening near hole in card to detect contents in box.~~		
Sighting over pencil			Counting number of taps under table.		
Touching pointer fingers held horizontally one foot from eyes so as to line up with examiner's nose. Vary distance.			Listening to question whispered through mailing tube.		
			~~Listening at wall or screen to discover what is going on.~~		
TOTAL NO.			TOTAL NO.		

APPENDIX B

Sample Maze



Maze 5

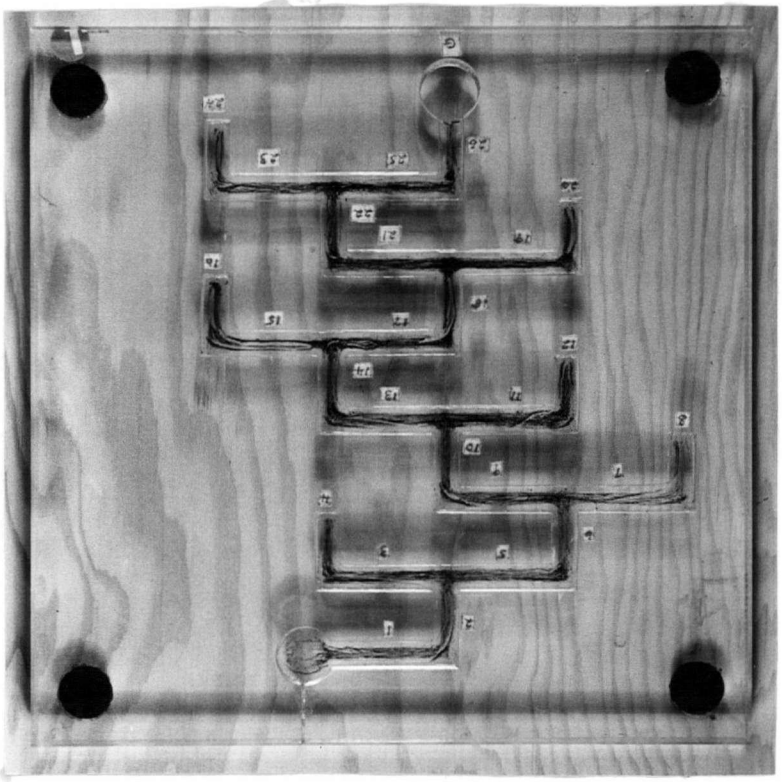


TABLE II

Critical Probabilities of Obtaining a U as Small or Smaller than that Tabulated in Comparing Samples of n and m

(Tabulated P levels are based on a two-tail test of significance.)

m	n / P	9	10	11	12	13	14	15	16	17	18	19	20
8	.05	16	18	20	22	25	27	30	32	34	37	39	41
	.01	9	11	13	15	16	18	20	22	24	26	28	29
	.001	2	3	4	5	6	8	9	10	11	13	14	15
9	.05	18	21	24	26	29	32	35	37	40	43	46	48
	.01	11	14	16	18	20	22	24	26	29	31	33	35
	.001	3	5	6	8	9	11	12	14	15	17	18	20
10	.05		24	27	30	33	36	40	43	46	49	52	55
	.01		16	18	21	24	26	28	31	34	36	39	41
	.001		6	8	10	12	14	16	17	19	21	23	25
11	.05			31	34	38	41	45	48	52	55	59	62
	.01			21	24	27	30	33	36	39	42	45	48
	.001			10	12	14	17	19	21	23	26	28	30
12	.05				38	42	46	50	54	58	62	66	70
	.01				27	31	34	37	40	44	47	50	54
	.001				15	17	20	22	25	27	30	33	35
13	.05					46	51	55	59	64	68	72	77
	.01					34	38	42	45	49	53	56	60
	.001					20	23	26	29	32	34	38	40
14	.05						55	60	65	70	74	79	84
	.01						42	46	50	54	58	62	66
	.001						26	29	32	36	39	42	46
15	.05							65	70	75	81	86	91
	.01							50	55	59	64	68	73
	.001							33	37	40	44	47	51
16	.05								76	82	87	93	98
	.01								60	64	69	74	79
	.001								40	44	48	52	56
17	.05									88	94	100	106
	.01									70	75	80	85
	.001									49	53	57	62
18	.05										100	106	113
	.01										81	86	92
	.001										58	62	67

APPENDIX D