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An Investigation of the Relationship Between Reading Ability and Performance on the Red Glass Test

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AN INVESTIGATION OF THE RELATIONSHIP BETWEEN READING ABILITY AND PERFORMANCE ON THE RED GLASS TEST

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The primary purpose of this study was to determine if a difference is reading ability existed between children who perceived at equal speeds with both eyes and children who perceived faster with one eye than with the other. The prime motivation for this study was the reported improvement in reading made by children who were involved in a visual training program under the direction of Dr. Frank M. Root, a practicing optometrist in Cedar Falls, Iowa. A part of this visual training program was the use of the Red Glass technique, a procedure designed to equalize the speed of perception in the two eyes. When pupils continued to report improvement in reading as disparities in speed were reduced or eliminated, it was hypothesized that some relationship might exist between equality or inequality of speed of visual perception and reading ability. The present investigation was designed to test this idea in a controlled situation.

An experimental situation was set up using a total of forty-four subjects, twenty-three from first grade and twenty-one from fourth grade, at Malcolm Price Laboratory School in Cedar Falls, Iowa. The Red Glass Test, a procedure allowing for monocular viewing of the stimulus while giving the subject the impression that he is in a binocular setting, was used to determine the speed of perception of each eye. Data available on each subject included (1) intelligence quotient, (2) scores from three different reading tests, and (3) results from the Red Glass Test. Statistical procedures used in the study were the t test of the difference between means of independent random samples and the point biserial correlation.

The results of this study tend to support the null hypothesis. No significant differences were found between the means of the scores on the various reading tests for the groups with equal speeds of visual perception and the means for the groups with unequal speeds. The coefficients of correlation between the Red Glass Test and the various reading tests were generally low and considerably short of significance at the arbitrarily selected .01 level. This was true at the first-grade level and at the fourth-grade level.

It was noted, however, that the observed differences did tend to favor the group with equal speeds in nine out of a total of twelve comparisons for the two grades involved. The coefficients of correlation also tended to support a trend toward some small existing relationship in that they were positive in ten of the twelve analyses. A stronger relationship might be revealed in a more carefully controlled situation with larger groups, a wider spread in reading ability (including more poor readers) and greater differences in speeds of the two eyes of the subjects in the unequal group.

This Study by: Ann Mary Dunbar

Entitled: AN INVESTIGATION OF THE RELATIONSHIP BETWEEN READING ABILITY AND PERFORMANCE ON THE RED GLASS TEST

has been approved as meeting the thesis requirement for the Degree of Specialist in Education.

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CHAPTER I

THE PROBLEM AND DEFINITIONS OF TERMS USED

Elementary and secondary schools have received numerous criticisms in the area of reading. A pupil's failure to make satisfactory progress in reading is the most frequently mentioned factor associated with school retention. While more time is being spent in remedial work and more varied approaches to the reading situation are being tried, experts continue to cite varying percentages of the school population as being retarded in reading. Even the most conservative estimate suggests that some problem does exist.

I. THE PROBLEM

Statement of the problem. The main purpose of the study was to determine whether any relationship existed between reading ability and performance on the Red Glass Test. The hypothesis was that children who show any disparity between right eye and left eye in speed of perceptual recognition on the Red Glass Test do not differ significantly in reading ability from children who show no such difference in speed of perceptual recognition on the Red Glass Test.

Importance of the study. The necessity for additional research into the relationship between reading ability and perceptual recognition has been noted by authors in fields of reading and visual perception. As early as the 1930's Imus, Rothney, and Bear pointed out that since ocular defects could be measured and in many instances corrected, it

was advisable to look for these conditions before attempting remedial measures in reading.[1] Russell presented the challenge in these words: "Educational research, especially in such fields as reading, spelling, and health, needs to explore some of the hypotheses connected with the theory that visual defects and poor reading skills and habits exist in interacting relationships."[2]

The literature in the fields of reading and vision indicated that the challenge presented by Russell has not been met in recent years. Most current authorities in the field use as a major basis of their conclusions, findings reported in considerably earlier studies. No previous investigation has been found which dealt specifically with the relationship between equality or non-equality in speed of perceptual recognition in the two eyes and reading ability. Therefore, an investigation of this relationship, using a recently developed technique, was considered desirable.

Educators have often tended to discount the area of visual functioning as a possible influence on reading ability because of conflicting results reported concerning the relationship between visual acuity and scholastic achievement. Frequently it is assumed that if a child passes an acuity examination and expresses no feeling of visual

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[1]Henry A. Imus, John W. Rothney, and Robert M. Bear, An Evaluation of Visual Factors in Reading (Hanover, New Hampshire: Dartmouth College Publication, 1938), p. 35.

[2]David H. Russell, "Note on a New Theory About Visual Functioning and Reading Disabilities," Journal of Educational Psychology, XXXIV (February, 1943), 120.

discomfort, he has no visual problems. However, as Jobe indicated, some visual maladjustments are not accompanied by discomfort. Visual efficiency may be low and be causing scholastic retardation without the individual being aware of the difficulty.[3] These maladjustments may include not only low acuity but also poor fusion and coordination. The effects of even slight problems in visual functioning on the development of reading are not adequately known, as pointed out by Leton.[4]

It would be presumptuous to say that equalizing the speed of visual perception would remove all reading difficulties. If a relationship does exist between reading and visual functioning, however, then appropriate training might equip the child to make better use of remedial reading work. A training technique designed to equalize the speed of perceptual recognition in the two eyes has been developed by Dr. Frank M. Root.[5] He has reported excellent results in his efforts with many children in terms of visual and academic functioning where this technique was applied as an integral part of a total visual training program. This led him to believe that a possible relationship

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[3]Fred W. Jobe, "The Structure and Function of the Visual Mechanism," Clinical Studies in Reading, II, Helen M. Robinson, editor (Supplementary Educational Monographs, No. 77. Chicago: University of Chicago Press, 1953), p. 128.

[4]Donald A. Leton, "Visual-Motor Capacities and Ocular Efficiency in Reading," Perceptual and Motor Skills, XV (October, 1962), 415.

[5]Frank M. Root, O.D., "A Tachistoscopic Method of Testing and Training Speed of Visual Perception Using Anaglyphs," The Optometric Weekly, L (July 9, 1959), 1355.

exists between equality in speed of visual perception and reading ability. That was the idea which was investigated in this study.

Eberl, in discussing visual training and reading, points out the need for closer cooperation in research so that various disciplines and fields of knowledge can be brought together.[6] It was thought that by considering the relationship between reading and speed of visual perception, a fuller understanding of the operational aspects of vision would be obtained.

Limitations of the study. Certain limitations of the study should be kept in mind. Conclusions may be applied to all subjects of comparable ages only in so far as the groups studied were representative of those particular ages. Also there were no ophthalmological or optometric evaluations available for the subjects in this study. Although all subjects had passed the school visual screening test, other visual factors may have affected the results. In addition, the limitations of the testing instruments could affect the results of this study. Any limitations in the tests or in the operating efficiency of the tachistoscope would be reflected in the results of this study.

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[6]Marguerite Eberl, "Visual Training and Reading." Clinical Studies in Reading, II, Helen M. Robinson, editor (Supplementary Educational Monographs, No. 77. Chicago: University of Chicago Press, 1953), p. 148.

II. DEFINITION OF TERMS USED

Vision: "Vision is a complex sensory-motor response to a light stimulus mediated by the eyes, but involving the entire action system."[7]

Binocular vision: When the two eyes are fixed upon a point straight ahead, each eye has its own visual field. However, the two fields overlap considerably and so form the field of binocular vision. Thus, binocular vision is seeing with both eyes at the same time and fusing the nerve impulses that are transmitted to the visual area in the cortex of the brain so that a single visual impression results.[8]

Perceptual recognition refers to the ability to identify accurately, a visually presented stimulus.

The Red Glass Test is a tachistoscopic method of measuring perceptual recognition using color filters. In this technique the subject is placed in what amounts to a monocular situation, although he still considers himself in a binocular setting. This allows for testing of each eye independently without the subject being aware of monocular vision as is the case when one eye is covered. Scores are based on the time the stimulus is exposed to the subject. A detailed description of the apparatus and procedure is included in Chapter III.

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[7]Arnold Gesell, F. L. Ilg, and G. E. Bullis, Vision: Its Development in Infant and Child (New York: Paul B. Hoeber, Inc., 1949), p. 162.

[8]John F. Fulton, M.D. (ed.), A Textbook of Physiology (Philadelphia: W. S. Saunders Company, 1955), p. 472.

CHAPTER II

REVIEW OF THE LITERATURE

This chapter consists of a summary of studies and comments reported in the literature concerning two broad areas related to the present study. The first area involves relationships between visual perception and reading ability and the second part concerns rapid perception. This review is not intended to be exhaustive, but rather to be representative of the literature.

I. RELATIONSHIPS BETWEEN VISUAL PERCEPTION AND READING ABILITY

A variety of possible relationships between visual perception and reading ability have been studied. Researchers from various disciplines have approached the problem in numerous ways. With this lack of uniformity in procedures, the studies have shown some strikingly different results and the conclusions have been conflicting and confusing. Examples will be cited.

Some investigators have studied the relationship between the "total" act of vision and the "total" act of reading. In an early study by Gray, using subjects from third grade to the college level, it was concluded that "tests showed clearly that eye defects have nothing to do with reading ability."[1]

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[1]Clarence T. Gray, Types of Reading Ability as Exhibited Through Tests and Laboratory Experiments (Supplementary Educational Monographs, Vol. I, No. 5. Chicago: University of Chicago Press, 1917), p. 122.

Another example of the "total" approach was the Dalton study. It was one of the most extensive studies conducted on the relationship between vision and scholarship. Using the Keystone Telebinocular, Dalton conducted a visual survey of 5,821 pupils from the Alhambra, California, public schools. The results of the survey showed little general relationship between the normal-defective vision factor and scholastic achievement.[2] While the number of pupils included in the study was large, the vision examiners used for the survey were not trained clinicians and only one instrument was used.

Park and Burri have reported one of the few investigations in which a direct positive relationship was found between visual abnormalities and reading difficulties. Their 225 subjects in grades one through eight were selected randomly. A correlation of .47 was found between reading scores in terms of mental age expectancy and the total vision scores. However, when reading scores in terms of grade equivalents and eye scores were compared, the correlation was only .16.[3]

An opposite conclusion was presented in a study of 640 high school freshmen by Jackson and Schye. In comparing both mental ability and reading scores to visual abnormalities, there was the unusual finding that students with defective vision scored higher than did

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[2]M. M. Dalton, "A Visual Survey of 5000 School Children," The Journal of Educational Research, XXXVII (October, 1943), 94.

[3]George E. Park and Clara Burri, "The Effect of Eye Abnormalities on Reading Difficulty," Journal of Educational Psychology, XXXIV (October, 1943), 424.

the students with normal vision.[4] However, the measuring device was the Snellen chart, which tests distance vision. Since the pupil rarely uses distance vision for reading, this writer feels the results tend to be somewhat misleading.

Kephart stated that "approximately half of the children in our school systems are visually poorly equipped for their tasks."[5] He reported three studies involving evaluation and training. In the evaluation of 250 students at a polytechnical high school on the west coast, Kephart found what he termed above-grade average performance by 46 per cent of those who met the usual visual standard and by only 28 per cent of those who did not.[6]

In the second study a group of 468 pupils of grade seven were ranked by their teachers in terms of over-all school achievement. Fifty-six per cent of those whose vision was termed adequate were found in the upper half of the ranking, while 47 per cent of those whose vision was inadequate ranked in the upper half.[7]

Using as subjects students at the Colorado Industrial School for Boys, Kephart divided into two groups those having less than adequate

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[4]Thomas Jackson and Virginia Schye, "A Comparison of Vision with Reading Scores of Ninth-Grade Pupils," The Elementary School Journal, XLVI (September, 1945), 33.

[5]Newell C. Kephart, "Visual Skills and Their Relationship to School Achievement," American Journal of Ophthalmology, XXXVI (June, 1953), 796.

[6]Ibid., p. 797.

[7]Ibid., p. 798.

vision. One group received corrective measures and increased their educational standing 1.2 years. Those receiving no corrective measures increased only 0.6 years. He concluded that "improvement of visual skills through professional assistance leads to more rapid progress in achievement."[8]

Another group of investigators has attempted to relate visual perceptive abilities and reading. In 1922 Gates reported the results of a study involving 135 pupils in grades three to eight, inclusive. The subjects were given a series of eight tests requiring detection of small differences between pairs of items, including geometric figures, digits, nonsense syllables, and words. Gates concluded that there did not appear to be any such thing as "general visual perception." There are abilities to perceive words, digits, or figures, and each of these abilities is relatively independent of other perceptual abilities. He reported no cases in which poor reading and spelling were associated with generally inferior perception.[9]

In a later study Gates attempted to confirm the results of his earlier investigation by giving the same kinds of tests to 310 subjects in grades one to seven. He concluded that while "word perception" was closely related to reading, performance on tests of perception of

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[8]Ibid.

[9]Arthur I. Gates, The Psychology of Reading and Spelling (Teachers College, Columbia University Contributions to Education, No. 129. New York: Teachers College, Columbia University, 1922), pp. 28-29.

digits and geometric forms had only a slight correlation with ability in reading.[10]

Having found defects in Gates's investigations, Sister Mary of the Visitation Riley undertook to repeat the studies, making improvements in materials, techniques, and number of tests. The results tended to support some of Gates's conclusions; however, she disagreed with Gates's belief that there was no general visual factor. Her results pointed to visual perceptual abilities as potential correlates or conditions of achievement in reading.[11]

Disturbed by the inconclusiveness of the evidence reported regarding the relationship of visual perceptual ability and reading, Sister Mary Phelan began research. Her subjects, 460 fourth- and fifth-grade pupils, were given a battery of nineteen tests designed to measure abilities in memory, reading, spelling, perception, and cognition. Results indicated more of a functional unity among the perception tests involving syllables and words than among those containing designs or digits.[12]

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[10]Arthur I. Gates, "A Study of the Role of Visual Perception, Intelligence, and Certain Associative Processes in Reading and Spelling," Journal of Educational Psychology, XVII (October, 1926), 444-445.

[11]Sister Mary of the Visitation Riley, Visual Perception in Reading and Spelling: A Statistical Analysis (Catholic University of America Educational Research Bulletin, Vol. IV, No. 1. Washington, D.C.: Catholic Education Press, 1929), p. 43.

[12]Sister Mary Phelan, Visual Perception in Relation to Variance in Reading and Spelling (Catholic University of America Educational Research Monograph, Vol. XII, No. 3. Washington, D.C.: Catholic Education Press, 1940), p. 40.

In analyzing the visual factors that contribute to reading ability, Fendrick conducted perceptual testing of good readers and poor readers and found evidence of a specific visual factor pattern. On nine tests of perception, the differences in the mean scores favored the good readers.[13]

The Thurstones and co-workers made major contributions to this area of study through investigations of visual perceptual abilities as primary intellectual characteristics. Thurstone defined the perceptual function as a "facility in perceiving detail that is imbedded in irrelevant material" and named it the "P-factor."[14] Factor analysis indicated that the P-factor was present and it was included as one of the primary mental abilities. As he stated, "reading is primarily a perceptual function in which the subject makes associations quickly with rapidly changing visual stimuli."[15] He also stated that "It is probable that this factor is of considerable significance in determining the speed of reading and it may be involved in reading disabilities."[16]

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[13]Paul Fendrick, Visual Characteristics of Poor Readers (Teachers College, Columbia University Contributions to Education, No. 656. New York: Teachers College, Columbia University, 1935), p. 51.

[14]L. L. Thurstone, Primary Mental Abilities (Psychometric Monographs, No. 1. Chicago: University of Chicago Press, 1941), pp. 80-81.

[15]L. L. Thurstone, A Factorial Study of Perception (Psychometric Monographs, No. 4. Chicago: University of Chicago Press, 1944), pp. 129-130.

[16]L. L. Thurstone, "The Perceptual Factor," Psychometrika, III (March, 1938), 9.

While investigating auditory discrimination and visual perception in fifteen good readers and fifteen poor readers, Goetzinger, Dirks, and Baer found that only the most difficult part (Section B) of the Gollschaldt visual perception tests differentiated the good from the poor readers.[17]

Since vision and reading are so complex and involve so many factors, the usual approaches have been to try to relate specific difficulties in vision to reading or to try to relate specific factors in the reading act to vision. As early as 1907 Ruediger stated that there was "little or no correlation between reading rate and the physiological phenomena of vision."[18] However, his experiments were conducted with unstandardized material and his subjects were adults whose reading habits were well established.

Areas of visual maladjustment frequently studied are low acuity, refractive errors, aniseikonia, and lack of binocular coordination. While all have a bearing on the subject, the latter two are the most closely related to this study.

Attempts to relate limitations in visual acuity and reading failures have in most cases been unsuccessful. Eames found no statistically reliable difference in visual acuity between a group of 114 reading-

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[17]C. P. Goetzinger, S. D. Dirks, and C. J. Baer, "Auditory Discrimination and Visual Perception in Good and Poor Readers," Annals of Otology, Rhenology, and Laryngology, LXIX (March, 1960), 121-136.

[18]William Carl Ruediger, The Field of Distinct Vision (Archives of Psychology, New York: The Science Press, 1907), p. 62.

disability cases and 143 unselected cases of approximately the same age.[19] Monroe found inadequate visual acuity in her cases but not frequently enough to distinguish reading-defect groups from groups which had no appreciable reading difficulties. She did think, however, that poor visual acuity might interfere with learning to read.[20] In a carefully designed study, Fendrick found a statistically significant difference favoring good readers over poor readers in acuity for distant vision in the right eye, but no significant difference with the left eye or in the binocular setting.[21] Betts concluded that unequal visual acuity might interfere with good binocular vision and thus affect reading.[22]

Refractive errors occur when the light rays entering the eyes do not converge properly. Such errors may be of three types: (1) myopia or nearsightedness, (2) hyperopia or farsightedness, and (3) astigmatism, a blurring of a part of the image. Such errors have been shown to be variously related to reading. Researchers such as Eames,[23]

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[19]Thomas H. Eames, "A Comparison of the Ocular Characteristics of Unselected and Reading Disability Groups," The Journal of Educational Research, XXV (March, 1932), 211-215.

[20]Marion Monroe, Children Who Cannot Read (Chicago: University of Chicago Press, 1932), pp. 80-81.

[21]Fendrick, op. cit., p. 47.

[22]Emmett A. Betts, "Visual Aids in Remedial Reading," Educational Screen, XV (April, 1936), 109.

[23]Thomas H. Eames, "A Frequency Study of Physical Handicaps in Reading Disability and Unselected Groups," The Journal of Educational Research, XXIX (September, 1935), 2.

Farris,[24] and Taylor[25] all reported a greater incidence of nearsightedness in the normal or good reader than in the retarded or poor reader. On the other hand, most of the research has shown a higher incidence of farsightedness among the retarded reading group. However, Hurst concluded from his study that unless visual acuity was impaired to a marked degree, most refractive errors were not relevant to the problem of the retarded reader.[26]

The visual abnormality known as aniseikonia is defined by Dearborn and Anderson as occurring when

> ocular images are unequal in size or shape, so that during binocular vision conflicting excitations arrive at the visual centers in the occipital cortex and present difficulties in the ability of the individual to fuse the incongruent images aroused.[27]

In a study of 100 retarded readers and 100 unselected cases including both children and adults, they found that aniseikonia occurred among the retarded readers more frequently than among the unselected group. Since the difference in the size of the ocular image was more pronounced at reading distance than at 20 feet, Dearborn and Anderson

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[24]L. P. Farris, "Visual Defects as Factors Influencing Achievement in Reading," California Journal of Secondary Education, X (October, 1934), 51.

[25]Earl A. Taylor, Controlled Reading (Chicago: University of Chicago Press, 1937), p. 183.

[26]W. A. Hurst, "Vision and the Retarded Reader," The Canadian Teacher's Guide, X (Winter, 1960), 34-35.

[27]Walter F. Dearborn and Irving H. Anderson, "Aniseikonia as Related to Disability in Reading," Journal of Experimental Psychology, XXIII (December, 1938), 560.

concluded that aniseikonia was one of the factors contributing to disability in reading.

On the contrary, Imus, Rothney, and Bear, in a study of college students, did not find as high an incidence of aniseikonia and did not feel it differentiated the poor reading group from the good readers.[28] The inconsistency in results between the two studies may have been due to a difference in age groups and in definition of retarded reader.

A condition not unlike aniseikonia may exist with the individual who receives the visual stimuli faster with one eye than with the other. As with aniseikonia, the subject may be unaware of its existence and be aware only of the fatigue resulting when working for good binocular fusion.

Betts writes of the problem presented by the fact that man is a binocular creature.

> If we were a one-eyed race, our reading difficulties from the point of vision would probably be fewer. A person using only one eye which has normal visual acuity usually has few visual troubles but cannot enjoy true depth perception. An individual with normal visual acuity in both eyes presents a different problem; not only must the dominant eye fix on a word or phrase, but its companion also must fix on the same target simultaneously and with as much precision and speed. In addition to this, he must fuse (unify or combine) the right-and left-eye images into one for normal interpretation. Some reading problems appear to be traceable to a lack of coordination between the two eyes and to the probable failure to combine the right-eye and left-eye images for correct interpretation.[29]

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[28]Henry A. Imus, John W. Rothney, and Robert M. Bear, An Evaluation of Visual Factors in Reading (Hanover, New Hampshire: Dartmouth College Publication, 1938), p. 121.

[29]Emmett A. Betts, The Prevention and Correction of Reading Difficulties (Evanston, Illinois: Row, Peterson and Company, 1936), p. 157.

Factors usually studied in connection with binocular coordination are fixation ability, fusion, stereopsis, and muscle imbalance.

Judd, employing photography in studying the convergent and divergent behavior of the eyes, concluded that, in general, divergence seemed a simpler form of adjustment than convergence. He reported that fixation did not occur until the slower eye had caught up with the other one.[30]

Parkins, in studying the relationship between reading achievement and fixation ability, concluded that defective fixation could handicap the student "over 50 per cent" in attaining academic knowledge.[31] In a more recent study Hurst found that those subjects with reading problems had one or both of the following defects: (a) inability of the eyes to converge on the object; (b) inability of the eyes to remain converged long enough to complete even a short reading assignment.[32]

Although an image is recorded by each eye, the nerve impulses from both retinas are merged in the brain center so that the individual is aware of only one object. This phenomenon is called fusion. Using the Keystone Telebinocular as the measuring device, Taylor found only

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[30]Charles H. Judd, "Photographic Records of Convergence and Divergence," Psychological Review Monograph Supplements, VIII (June, 1907), 370-423.

[31]George A. Parkins, The Diagnosis and Elimination of Visual Handicaps Preventing Efficient Reading (Rutland, Vermont: Tuttle Publishing Company, 1941), p. 12.

[32]Hurst, op. cit.

12.4 per cent of a "normal" group of high school students had fusing difficulties while 25 per cent of a reading failure group had such problems.[33] Although Witty and Kopel found 29 per cent of poor readers and only 1 per cent of a control group of able readers displaying slow fusion, they did not feel that defective fusion was the only important factor involved.[34]

A recent study by Spache and Tillman offers evidence that defects resulting in poor binocular fusion are strongly related to reading difficulties. Their study involved 114 randomly selected retarded readers and 101 randomly selected non-retarded readers. The retarded readers "failed" the test of binocular acuity in significant numbers, showed marked differences in acuity of the separate eyes, and were poorer in left-eye acuity. The three significant differences suggest a weakness in the binocular system.[35]

Depth perception or stereopsis was studied by Taylor[36] and by Witty and Kopel.[37] They agreed, as do some other investigators, that depth perception does not differentiate good readers from poor readers.

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[33]Taylor, op. cit., pp. 161-168.

[34]Paul Witty and David Kopel, "Factors Associated with the Etiology of Reading Disability," The Journal of Educational Research, XXIX (February, 1936), 457.

[35]George D. Spache and Chester E. Tillman, "A Comparison of the Visual Profiles of Retarded and Non-Retarded Readers," Journal of Developmental Reading, V (Winter, 1962), 108-109.

[36]Taylor, loc. cit.

[37]Witty and Kopel, loc. cit.

Many investigators feel that poor binocular coordination is caused by muscle imbalance. As early as 1910 Whipple mentioned this condition of the eyes as "asymmetry of eye movement."[38] Eames reported that a reading disability group exhibited a slight tendency toward poor vision and a definite tendency toward a high degree of exophoria (the tendency of the visual axis of the eye to deviate outward) for both distance vision and reading vision. The lack of normal adjustment and equilibrium of the binocular muscles in the reading disability group was regarded as very important.[39]

Selzer found a rather definite relationship between eye-muscle imbalance and reading disability. For one study he reported that over 90 per cent of the reading disability cases examined had eye-muscle imbalance. Another study of one hundred non-selected elementary children in Cambridge, Massachusetts, revealed nine cases of lateral imbalance. Five of these nine children also had difficulty with their reading.[40]

Robinson concluded from her observations and studies that when a comparison is made of high and low achievers in reading, tests of

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[38]Guy M. Whipple, Manual of Mental and Physical Tests (Baltimore: Warwick and York, 1910), p. 175.

[39]Thomas H. Eames, "A Comparison of the Ocular Characteristics of Unselected and Reading Disability Groups," The Journal of Educational Research, XXV (March, 1932), 214.

[40]Charles A. Selzer, Lateral Dominance and Visual Fusion: The Application to Difficulties in Reading, Writing, Spelling, and Speech (Harvard Monographs in Education, No. 12. Cambridge: Harvard University Press, 1933), p. 296.

binocular functioning are the only visual tests which distinguish between the two groups consistently.[41] Kelley's longitudinal study started with one hundred subjects in each of three grades: first, fifth, and ninth. Over a four-year period he studied various visual factors and changes in the visual characteristics. One of his conclusions that is particularly applicable to the present study was that good readers were either efficient in binocular vision or completely one-eyed readers.[42] He thus placed a high priority on adequate binocular vision in the reading situation.

Ball expressed the importance of good binocular coordination when he said "certainly a serious impairment of any particular visual function will disrupt visual efficiency, but often it is the more subtle coordination of visual factors which is disrupted and may contribute to reading disability."[43]

In studying the maturation of the visual function in children, Dyer and Harcum presented meaningless stimulus elements simultaneously on both sides of fixation to children in nursery school, kindergarten, first grade, and second grade. Results showed a reduction of errors

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[41] Helen M. Robinson, "Summary, Conclusions, and Implications," Clinical Studies in Reading, II, Helen M. Robinson, editor (Supplementary Educational Monograph, No. 77. Chicago: University of Chicago Press, 1953), p. 159.

[42] Charles R. Kelley, Visual Screening and Child Development: The North Carolina Study. (Raleigh: School of Education, North Carolina State College, 1957), p. 75.

[43] Richard J. Ball, "Visual Functioning in Reading Disability," Education, LXXXII (November, 1961), 175.

with maturation and higher educational levels. The preschool subjects were equally accurate in perception in the two visual fields. The investigators had expected a difference in favor of the left visual field among those who could read. This difference was not evident; actually, fewer errors were made in reproducing stimuli in the right visual field.[44]

As indicated in some of the studies already cited, some writers feel that reading disabilities are largely due to visual malfunctioning. Others conclude that there is no relationship between the two factors. Still others such as Clark, finding little correlation, explain that good vision is only one of the basic factors in good reading. Since some children have strengths in other factors, they can compensate for visual handicaps and become good readers.[45]

II. RAPID PERCEPTION

The area of rapid perception has been studied in various ways. There is a wealth of information on eye movement and its relation to reading. Most of this information indicates a high negative correlation between reading ability and length of fixation. Early works

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[44]Dorothy W. Dyer and E. R. Harcum, "Visual Perception of Binary Patterns of Preschool Children and by School Children," Journal of Educational Psychology, LII (June, 1961), 161-165.

[45]B. Clark, "How to Talk to Teachers About Remedial Reading Problems," American Journal of Optometry, XIX (Fall, 1942), 336-351.

in this field were summarized by Huey.[46] Tinker[47] and Buswell[48] made a somewhat later contribution through their studies of adult reading.

Eames investigated the speed of picture recognition and the speed of word recognition by a group of school children. Using 100 children who had reading difficulties and 50 children who were normal readers, he found that poor readers tended to exhibit slower speeds in both picture and word recognition.[49]

Stroud found a significant relationship between rate of reading and rate of visual perception using words. However, there was a somewhat lower relationship between the two factors when numbers were used. While he identified some students with quick perception and low reading rates, he found none with slow perceptual speed and fast reading rates.[50]

Investigations of rapid perception have frequently involved the tachistoscope as the measuring device. A tachistoscope is an apparatus which exposes to the viewer an object, a group of objects, letters, or

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[46]Edmund B. Huey, The Psychology and Pedagogy of Reading (New York: The Macmillan Company, 1924), pp. 51-102.

[47]Miles A. Tinker, "Visual Apprehension and Perception in Reading," Psychological Bulletin, XXVI (April, 1929), 223-240.

[48]Guy T. Buswell, How Adults Read (Supplementary Educational Monographs, No. 45. Chicago: University of Chicago Press, 1937), 158 pp.

[49]Thomas H. Eames, "The Speed of Picture Recognition and the Speed of Word Recognition in Cases of Reading Difficulty," American Journal of Opthalmology, XXI (December, 1938), 1375.

[50]James B. Stroud, "Rate of Visual Perception as a Factor in Rate of Reading," Journal of Educational Psychology, XXXVI (November, 1945), 492.

words for a controlled brief period of time. Volkmann is credited with first using the name, tachistoscope, in 1859. The word is of Greek origin: tachistos, very rapid and skopein, to view.[51] Earlier types of tachistoscopes included a pendulum, a revolving disc, the fall tachistoscope, a screen on a motor, and illuminating tubes. The device used in the present study was an overhead projector with a timed shutter. The timing was by a Keystone No. 55 Flashmeter, a device quite similar to a shutter on a camera which can be set to expose the material for 1/5, 1/10, 1/25, or 1/100 of a second. A more complete discussion of this device and its use appears in Chapter III.

The tachistoscope is thought to be one of the most effective means of measuring time of perception. Whipple presented a list of requirements for a tachistoscope, using the earlier works of Dodge and Wundt:

1. Exposure is short enough to preclude eye-movements.
2. Arrangement of fixation mark and stimulus is such that all parts of exposed objects are seen with "at least equal" distinctness. The exposure field must coincide with the ocular field of direct vision.
3. The exposure of all parts must be simultaneous. No time differences may occur in various parts.
4. Retinal adaptation is favorable. Sudden changes from dark to light are avoided.
5. Persistent after-images must be avoided.
6. Duration must be limited to preclude roving of attention over the exposure field.
7. A ready signal must be given.
8. Relative illumination of pre-exposure, exposure, and post-exposure fields should be capable of experimental modification.

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[51]Guy M. Whipple, Manual of Mental and Physical Tests. Part I, Simpler Processes (Baltimore: Warwick and York, 1914), p. 263.

9. The exposure must be noiseless and free from distraction.
10. It should be possible to arrange for monocular or binocular observation.[52]

Researchers have found that some kind of pre-exposure signal needs to be given. Tinker, Roberts, and Jackson found no significant difference between accuracy of responses to exposure with a constant time between signal and exposure and the accuracy of responses to exposures with an indefinite or irregular time lapse between signal and exposure.[53] The Navy and Air Force, however, both used a regular cadence pattern.

The difference between perception during normal reading and during tachistoscopic presentation has been explored by Dodge[54] and Aveling.[55] They found that in straining to perceive a stimulus in a tachistoscopic setting, energy tends to be diverted from the act of perception itself. In studies using the tachistoscope, investigators are cautioned by Vernon about drawing incorrect conclusions based on the assumption that characteristics observed in this unfamiliar and

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[52]Guy M. Whipple, Manual of Mental and Physical Tests (Baltimore: Warwick and York, 1910), p. 223.

[53]Miles A. Tinker, D. Roberts, and A. Jackson, "Definite and Indefinite Preparation in the Visual Apprehension Experiment," The American Journal of Psychology, XLII (January, 1930), 96-100.

[54]Raymond E. Dodge, "Experimental Study of Visual Fixation," Psychological Review Monograph Supplement, VIII (June, 1907), 33.

[55]F. Aveling, "The Perception of Tachistoscopically Exposed Symbols," The British Journal of Psychology, XXII (January, 1932), 193-199.

artificial condition, also exist in the familiar and more rapid process of normal perception.[56]

Age has been found to be related to the length of the span which can be successfully perceived. Leestma reported a study involving subjects from age seven to seventeen. He used four different kinds of material in terms of meaningfulness: digits, unrelated letters, unrelated words, and related words. He concluded that with more meaningful material the span was longer, more growth occurred, and there was a higher relationship between span and reading ability. He also found the tachistoscopic span to have a higher positive relationship to reading ability than to intelligence.[57]

Feldmann found an increase in visual perception skills with age, and higher scores for girls than for boys at some grade levels. The visual perception scores were highly related to the factor of age-experience and to intelligence. The visual perception scores influenced by age and experience thus showed a developmental trend.[58]

Carroll investigated the use of the tachistoscope as a diagnostic tool. He compiled a list of twenty words each of which he flashed on the screen for 1/5 of a second. The subjects were instructed to write

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[56]M. D. Vernon, The Experimental Study of Reading (Cambridge, England: University Press, 1931), pp. 97-98.

[57]Robert C. Leestma, "Age Changes in Tachistoscopic Span," Dissertation Abstracts, 1957, Vol. 17, p. 94.

[58]Shirley Clark Feldmann, "Visual Perception Skills of Children and Their Relation to Reading" (unpublished doctoral dissertation, Columbia University, New York, 1961), p. 82.

down what they had seen. Reading paragraphs were also made up of these same words. A comparison was made of errors committed in both settings. Carroll concluded that if students could not recognize the words when flashed they also had difficulty in efficiently reading them in the paragraphs. On the basis of this conclusion he felt that a flash meter device could be effective as a diagnostic tool.[59]

Using the tachistoscope as the measuring device, Fox studied a group of first-grade pupils in an effort to determine the relationship between the ability to perceive tachistoscopically-projected images and reading readiness. No attempt was made to test the eyes individually. The subjects were shown certain visual stimuli projected at tachistoscopic speeds. In a booklet containing four possible answers for the question on each slide, the one of the four identical with the projected one was marked by the pupil. The results were scored and compared with the Metropolitan Readiness Tests and the Row-Peterson First Year Readiness Test, which served as prognostic agents.

The results of the experimental test were also compared at the end of the year with four criteria of success in reading. These criteria were (1) silent reading ability as measured by the Gates Primary Reading Test, (2) oral reading ability, as measured by an oral reading comprehension test similar in nature to the oral reading-comprehension section of the Durrell Reading Analysis, (3) reading achievement, as

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[59]Robert P. Carroll, "The Flash Meter as a Diagnostic Instrument," School and Society, XLVIII (July 30, 1938), 150.

evidenced by the number of books read during the year and the level of difficulty of the book in which the child was reading at the end of the year, and (4) teacher judgment, as evidenced by the total of a rating on ten factors in reading. He concluded that a definite positive relationship existed between the ability to perceive tachistoscopically-projected images and reading readiness. He also concluded that the experimental test used was slightly superior to the two readiness tests in predicting success in reading as measured by the established criteria.[60]

Using sixty-four college students as subjects, Gilbert studied the influence of varying the processing times for the first stimulus before the subjects were permitted to encounter an interfering stimulus. He hoped to gain a better understanding of the discrepancy between the speed and span of visual perception as measured by the tachistoscopic tests and the speed of reading easy prose. There was a positive correlation of .50 $\pm$ .14 between the speed and accuracy of visual perception as measured by his test criteria and the length of the fixation pauses in reading simple prose. He also found a greater influence on the span of the slow readers than on that of the fast readers.[61]

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[60]Henry Corbett Fox, "The Relationship Between the Perception of Tachistoscopically Projected Images and Reading Readiness" (unpublished doctoral dissertation, Indiana University, Bloomington, 1951), pp. 102-103.

[61]Luther C. Gilbert, "Speed of Processing Visual Stimuli and Its Relation to Reading," Journal of Educational Psychology, L (February, 1959), 8-14.

In a study designed to investigate whether the rate of conceptual imagery has a relationship to reading efficiency, Rudisill tested forty-three advanced readers and forty-eight retarded readers at the third-grade level. Using tachistoscopically-projected digits and phrases, she concluded that a relationship does exist between visual recognition and reading achievement with rates of responding taken into account. She found a highly significant relationship between reading accomplishment and each of the following factors: (1) span and accuracy of recognition of flashed digits, (2) span and accuracy of recognition of flashed phrases, (3) rate of converting perceived units into words, and (4) rate of converting perceived units into concrete meanings. The t ratios of the differences between the mean scores of the advanced and the retarded readers ranged from 4.89 to 8.46, all significant at the .001 level. The most significant differences between the group means were in span and accuracy of phrase recognition and in rate of concrete responses. The t values were: 8.38 for number of correct oral responses, 7.19 for number of correct concrete responses, and 8.45 for speed of concrete responses. The least significant differences between the means for the two groups were in span and accuracy of digit recognition, and in rate of oral responses. The t ratios for these differences were 5.01 and 4.89.[62]

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[62]Mable Rudisill, "Flashed Digit and Phrase Recognition and Rate of Oral and Concrete Responses: A Study of Advanced and Retarded Readers in the Third Grade," The Journal of Psychology, XLII (October, 1956), 326.

Training for improvement in reading by tachistoscopic method has been carried on for many years. Early investigations by Dallenbach,[63] Eames,[64] and Foster[65] gave evidence that perceptual span could be increased and that this increase could have an effect on reading achievement. However, the technique was not used to any great extent in the schools until Renshaw's work was published. After he had devised a successful program for the training of Navy pilots in quick recognition of planes and ships, he used a similar technique with children and adults in an effort to measure the effect of training on reading skill development. He reported that "tachistoscopic training with digit patterns produces marked increases in reading comprehension and speed as measured by standardized tests."[66]

Cleland, in a training and testing program with college freshmen and sophomores, concluded that tachistoscopic training does produce an increased rate in reading without a loss of comprehension. He investigated various combinations of digits, words, and sentences, and concluded that a ten-minute practice period using digits and a ten-minute

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[63]Karl M. Dallenbach, "The Effect of Practice upon Visual Apprehension in School Children," Journal of Educational Psychology, V (June and September, 1914), 321-334, 387-404.

[64]Thomas H. Eames, "A Study of the Speed of Word Recognition," The Journal of Educational Research, XXI (November, 1937), 81-87.

[65]W. S. Foster, "The Effect of Practice upon Visualizing and upon the Reproduction of Visual Impressions," Journal of Educational Psychology, II (January, 1911), 11-12.

[66]Samuel Renshaw, "The Visual Perception and Reproduction of Forms by Tachistoscopic Methods," The Journal of Psychology, XX (October, 1945), 230.

practice period using phrases and sentences was the most effective training technique for producing a marked increase in rate of reading while maintaining the level of comprehension.[67]

Training programs using the tachistoscopic approach were established in the public schools at Bexley, Ohio,[68] Evanston, Illinois,[69] Gary, Indiana,[70] and Texas City, Texas.[71] Either because of a lack of control groups, or if they did exist a lack of comparability between them and the experimental group, the program failed to demonstrate that tachistoscopic training improved reading skills.

Goins conducted an extensive investigation, using experimental and control groups. Her investigation showed little or no improvement of reading skills after training. However, she did not rule out the

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[67]Donald L. Cleland, "An Experimental Study of Tachistoscopic Training As It Relates to Speed and Comprehension in Reading" (unpublished doctoral dissertation, University of Pittsburgh, Pittsburgh, Pennsylvania, 1950), p. 98.

[68]Josephine H. MacLatchy, "Bexley Reading Study," Educational Research Bulletin, XXV (September 18, 1946), 141-168.

[69]Louis Davis, Vivienne Ilg, Martha Springer, and Doreen Hanck, First Grade Recognition Program (Evanston, Illinois: Row, Peterson and Company, 1946)

[70]Samuel Renshaw, "The Influence of Tachistoscopic Training at Far Point on the Scholastic Achievement of First-Grade Children," Optometric Extension Program, VI, No. 1 (Ducan, Oklahoma: Optometric Extension Program, November, 1945)

[71]Fannie H. Melcer and Barbara G. Brown, "Tachistoscopic Training in the First Grade," The Optometric Weekly, XXXVI (December 6, 1945), 1217-1219.

use of tachistoscopic training for children with specific reading difficulties.[72]

Using an unselected group of fourth- and fifth-grade pupils, Jones and Van Why conducted an experiment on the influence of tachistoscopic training on rate and comprehension. They found a significant change in post-experimental rate with the fourth-grade group, but no such change with the fifth-grade group. Neither group showed any significant improvement in measures of reading comprehension.[73]

Sommerfeld, using the tachistoscope in a college reading improvement program, found little correlation between the span of perception and any of several measures of reading ability.[74] Other investigations of rapid perception, involving techniques such as films and reading pacers, have been conducted at the college level. However, such studies are not directly pertinent to the present investigation.

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[72]Jean Turner Goins, Visual Perceptual Abilities and Early Reading Progress (Supplementary Educational Monographs No. 87. Chicago: University of Chicago Press, 1958), pp. 101-103.

[73]Reginald E. Jones and Earl Van Why, "Tachistoscopic Training in the Fourth and Fifth Grade," Journal of Developmental Reading, VI (Spring, 1963), 177-185.

[74]Ray E. Sommerfeld, "An Evaluation of the Tachistoscope in Reading Improvement Programs," What Colleges are Doing in Reading Improvement Programs, Third Yearbook, Southwest Reading Conference for College and Universities, (Fort Worth, Texas: Texas Christian University, 1954), pp. 7-25.

III. SUMMARY OF THE LITERATURE

Research in reading has been impressive in its extent and quality. A search of reference sources such as Handbook of Research on Teaching, Encyclopedia of Educational Research, and Review of Educational Research indicates that studies dealing with vision and reading have been fewer in recent years than in previous years. The review of past studies shows that controversial issues remain to be investigated. In reviewing the literature concerning relationships between visual perception and reading ability, conflicting reports and contradictory results are found. Betts[75] and Spache[76] both suggest reasons for this disparity, including: (1) variations in measuring devices and tests used, (2) age differences between groups studied, (3) individual differences not taken into consideration, (4) differences in arbitrary standards set by investigators, and (5) variations in teaching approaches used.

Investigations of rapid perception appear to have established it as one of the basic skills in reading. Since this study involved one of the devices for measuring rapid perception, literature on the use of the tachistoscope has been included in the present chapter.

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[75]Emmett A. Betts, "Visual Aids in Remedial Reading," Educational Screen, XV (April, 1936), 108-110.

[76]George D. Spache, Toward Better Reading (Champaign, Illinois: Garrard Publishing Company, 1963), pp. 104-106.

Conclusions reached by those using the tachistoscopic method in research suggest that it is a methodologically sound technique but that there is insufficient research in this field. Variables not yet considered could be important in tachistoscopic procedures. In addition, the results from those programs involving the tachistoscope in a training situation do not necessarily establish it as an indispensable tool for the regular classroom.

CHAPTER III

MATERIALS AND PROCEDURES

The first part of this chapter is a discussion of the selection of the sample. The second section deals with the various reading and intelligence tests used, and the final section is a rather detailed description of the Red Glass Test and its administration to the subjects.

I. THE SAMPLE

For this study the sample consisted of forty-four children enrolled at the Malcolm Price Laboratory School at the State College of Iowa, Cedar Falls, Iowa, during the spring semester in the 1962-1963 school year. Twenty-three were in the first grade and twenty-one in the fourth grade. Permission had been granted to use one of the two sections of first grade in another study. Since the investigator was therefore familiar with one of the two sections of first grade, it was suggested that the same section be used in the present research. When the request for a fourth-grade group was made, one of the two sections was being taught by a student teacher. Permission was granted to use the other section in which the regular classroom teacher was teaching. The sample size was determined by the enrollment in these sections of first grade and fourth grade.

A first-grade group was used for two reasons. Since the period of maximum visual perceptual development is normally between the ages

of three and one-half and seven and one-half years, nearly all the subjects were in the latter portion of this developmental period.[1] Also, there had been sufficient reading instruction to allow for testing of reading achievement. Although these conditions would also be satisfied by a second-grade group, the investigator wanted the youngest group which would meet these requirements.

The major reason for using a group of pupils of fourth-grade level was the fact that most of the visual difficulties which might interfere with reading have been detected and corrected by the time children reach fourth grade. Also, fourth-grade groups have a wider range than first-grade groups in reading achievement scores. Individual differences as reflected in achievement test scores increase from grade one on through formal schooling.

The first-grade group contained twelve girls and eleven boys. Their chronological ages in May, 1963, ranged from six years nine months to seven years seven months. The range in I.Q. scores on the SRA Primary Mental Abilities, Revised[2] was from 97 to 130, with a median of 110 and a mean of 109.9.

The fourth-grade group consisted of eleven boys and ten girls. The ages ranged from nine years seven months to ten years eight months.

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[1]Marianne Frostig and David Horne, The Frostig Program for the Development of Visual Perception - Teacher's Guide (Chicago: Follett Publishing Company, 1964), p. 8.

[2]Thelma G. Thurstone and L. L. Thurstone, SRA Primary Mental Abilities, Revised (Chicago: Science Research Associates, Inc., 1946-1963.)

On the Henmon-Nelson Tests of Mental Ability[3] administered in March of 1963, the median I.Q. score was 123 while the mean score was 121. The I.Q.'s ranged from 101 to 144.

There were both rural and urban children represented in both grades. No extremely wealthy nor extremely poverty-stricken families lived within the area. The sample could be characterized as middle class.

II. DATA GATHERING INSTRUMENTS

The test evidence in this study was obtained primarily from the regular testing program conducted by the school. All of the results were obtained during the academic year in which the study was made, 1962-1963. With one exception the tests were administered in group settings. The examiner in each case was the classroom teacher.

Reading Tests

At the first-grade level, the Gates Primary Reading Tests,[4] the Metropolitan Readiness Tests,[5] and the Basic Sight Word Test[6] had been administered. Resulting scores were used by the investigator to

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[3]Tom A. Lamke and M. J. Nelson, Henmon-Nelson Tests of Mental Ability (Boston: Houghton Mifflin Company, 1957.)

[4]Arthur I. Gates, Gates Primary Reading Tests Form 2 (New York: Bureau of Publications, Teachers College, Columbia University, 1958.)

[5]Gertrude H. Hildreth and N. L. Griffiths, Metropolitan Readiness Tests (Yonkers-on-Hudson, New York: World Book Company, 1949.)

[6]Edward W. Dolch, Basic Sight Word Test (Champaign, Illinois: The Garrard Press, 1942.)

determine reading level. While these tests overlap in function to some extent, each measures reading traits or skills in a somewhat different fashion.

The Metropolitan Readiness Tests,[7] administered in September, 1962, consist of six subtests: (1) word meaning, (2) sentences, (3) information, (4) matching, (5) numbers, and (6) copying. The first four are considered the reading readiness section. By combining the scores on subtests 1-6, a total readiness score is obtained. The tests were devised to measure characteristics of school beginners which contribute to their readiness for first-grade instruction. Scores may be translated into letter ratings to estimate relative reading readiness status. However, since this would limit the grouping to only four categories, the raw scores were used for statistical analysis.

The Gates Primary Reading Tests[8] were administered in February of the 1962-1963 academic year. There are three types of tests: (1) word recognition, (2) sentence reading, and (3) paragraph reading. While the tests are timed, the time allowances are generous and the instruments are not primarily tests of speed. The main purposes of the tests are to measure accuracy, range, and level of reading ability. Although performance on each test is expressed in several ways, the grade equivalent scores were used.

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[7]Hildreth and Griffiths, loc. cit.

[8]Gates, loc. cit.

The Basic Sight Word Test,[9] composed of 220 words, was administered individually to each child. To obtain credit for knowing a word, the subject was required to meet one of the following conditions: (1) pronounce the word correctly at sight, (2) sound it out and then pronounce it correctly on the first trial, or (3) correct himself immediately after a miscall and pronounce the word correctly. These directions were established arbitrarily by Eckstein[10] and Sparrow[11] in their studies. They defined equivalent reader levels based on the number of words in the Basic Sight Word Test known by the subject. Both the total number of words known by the pupil on this test and the appropriate reader level were used for analysis in this study.

There were three reading or related test scores available at the fourth-grade level. These included (1) the achievement section of the Durrell-Sullivan Reading Capacity and Achievement Tests,[12] (2) the reading comprehension test of the Sequential Tests of Educational

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[9]Dolch, loc. cit.

[10]C. Eckstein, "Use of the Dolch Basic Sight Word List as a Measure to Determine Reader Level" (unpublished Master's thesis, State University of Iowa, Iowa City, 1944.)

[11]Julia L. Sparrow, "Accomplishment on the Dolch Basic Sight Word Test as a Measure of Reader Level" (unpublished Master's thesis, State University of Iowa, Iowa City, 1944.)

[12]Donald D. Durrell and Helen Blair Sullivan, Durrell-Sullivan Reading Capacity and Achievement Tests Form A (Yonkers-on-Hudson, New York: World Book Company, 1937.)

Progress,[13] and (3) the vocabulary and reading comprehension sections from the Iowa Tests of Basic Skills.[14] While all these sections are timed, the time specified for each is regarded as sufficiently generous so that speed is not a major factor.

The Durrell-Sullivan Reading Achievement Test, Intermediate Test,[15] consists of two sections. The first is word meaning, which is multiple choice in nature and contains seventy-five items. Paragraph meaning, the second part of the test, includes twelve paragraphs graded in difficulty. Comprehension of each paragraph is measured by five multiple-choice questions which cover five different aspects of reading ability.

The reading comprehension test of the Sequential Tests of Educational Progress[16] was devised to appraise the ability to reproduce ideas, translate ideas and make inferences, analyze motivation, analyze presentation, and criticize. There are no separate scores for each of these factors; the single score is based on the total number of correct responses. Various types of test content are employed such as directions, announcements, letters, poetry, essays, and speeches.

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[13]Sequential Tests of Educational Progress: Reading Form 4A (Princeton, New Jersey: Cooperative Test Division, Educational Testing Service, 1957.)

[14]E. F. Lindquist, A. N. Hieronymus, and others, Iowa Tests of Basic Skills Form 3 (Boston: Houghton Mifflin Company, 1956.)

[15]Durrell and Sullivan, loc. cit.

[16]Sequential Tests of Educational Progress: Reading, loc. cit.

Each type of material is followed by a series of multiple-choice items relating to the passages. There are seventy such test items. By considering the standard error of measurement of the converted score, a confidence interval or percentile rank band is utilized in presenting the test results. In statistical analysis it is usually necessary to use the midpoint of each band or interval; that was done in the present investigation.

The two scores taken from the Iowa Tests of Basic Skills[17] were vocabulary and reading comprehension. The vocabulary portion of the form used consisted of 37 words for grade four. Although a somewhat short subtest, Herrick considered it adequate in comparison with other tests of the same type.[18] The specific skills evaluated in the reading comprehension test are those involved in (1) grasping details and purpose, (2) evaluating a reading selection, and (3) analyzing organization. Most of the reading selections are narrative in style; some poetry is used. The test items deal mainly with the comprehension of specifically mentioned details or implied ones. Norms expressed in grade equivalents and percentile ranks are provided for each grade. The ones employed for the grade equivalents were "Iowa" norms. Performance of Iowa pupils was, in general, somewhat better than that of pupils represented in the "national" norms.

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[17]Lindquist, Hieronymus, and others, loc. cit.

[18]Oscar Krisen Buros (ed.), The Fifth Mental Measurements Yearbook (Highland Park, New Jersey: The Gryphon Press, 1959), p. 32.

Intelligence Tests

The SRA Primary Mental Abilities, Revised,[19] published by Science Research Associates, Incorporated, was used to evaluate the intellectual functioning of the first-grade group. The form for ages five to seven is made up of the following subtests: (1) verbal meaning, (2) spatial ability, (3) perceptual speed, (4) quantitative ability, and (5) motor ability.

At the fourth-grade level, scores from the Henmon-Nelson Tests of Mental Ability, Form A, Grades 3-6,[20] were used. The test is composed of ninety multiple-choice items arranged in order of difficulty without regard to the character of the items. It includes items concerning vocabulary, sentence completion, logical selection, verbal analogies, design analogies, and arithmetic reasoning. A high percentage of the items measure various types of "verbal" ability. The instrument yields a single score which may be expressed as mental age, percentile rank, or deviation I.Q. roughly equated to those on the Stanford-Binet. The I.Q. score was used for this study.

Red Glass Test

The Red Glass Test was developed by Dr. Frank M. Root to measure the speed at which each eye can perceive a flashed stimulus. It differs from other tachistoscopic techniques in that it measures speed in what amounts to a monocular situation although the subject still considers

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[19]Thurstone and Thurstone, loc. cit.

[20]Lamke and Nelson, loc. cit.

himself in a binocular setting. This is achieved by the use of the red glass slide and the red-green filters. The red glass slide gives a red illumination around the projected pattern. The red lens admits the red illumination through the glasses while the green filter allows only the neutral view of the screen with no apparent illumination from the flash. Thus the eye covered by the red filter sees the pattern as black on a neutral background, while the eye covered with the green filter perceives no pattern.

The test has been used with considerable success in private clinical practice, although there have been no controlled studies using the technique. The investigator was instructed in the testing procedure by Dr. Root.

Apparatus. The apparatus for the Red Glass Test consisted of a projection device equipped with a timer, a red glass slide, a screen, red-green filters and a series of glass slides with a four-digit pattern or a three-geometric-form pattern centrally placed on each slide.

The Keystone Tachistoscope, manufactured by the Keystone View Company in Pennsylvania, was the projection device used in this study. It is an overhead projector equipped with a Keystone Flashmeter, a timing device which has a speed range of 1/100 second to one full second. The diaphragm of the shutter was entirely open at all times, allowing for maximum illumination. A standard size (three and one-fourth inches by four inches) red glass slide was developed by inserting red cellophane between two regular glass slides. The edges were taped together so that the entire piece could be handled easily. After this

red glass slide was correctly positioned on the projector, each of the testing slides was in turn placed on top of the red glass, which caused the illumination around the projected pattern to be red. The projector was focused as sharply as possible upon a beaded screen. Since the subject stood beside the projector, the wide angle distortion sometimes criticized in the use of this type of screen was felt to be negligible.

The subject wore a pair of red-green filters for the testing. These filters, made by the American Optical Company, are constructed with a red lens and a green lens. The shape of the frame was such that the subject could wear the red lens in front of the right eye or in front of the left eye simply by turning the glasses over. Two different-sized frames were available so the subject would not be distracted by poor-fitting glasses. If correction lenses were habitually worn for distant vision, the subject wore the red-green filter over his regular lens.

Black etching ink was used to inscribe the digits and geometric forms on the clear glass slides. This ink produced a clear, sharp figure and allowed for handling the slides without smearing the designs. The edges of the slides were taped to prevent chipping and to provide a cushion between the slides to reduce surface scratches. Twenty-seven slides, each containing three geometric forms, were used with the first grade. The geometric forms, when projected, measure ten inches by forty-two inches. Geometric forms were chosen for the first grade because of the familiarity of these designs to nearly all

children of ages six and seven. Some children might have been penalized if digits were used, because of difficulty in digit recognition.

Twenty-five slides with four-digit patterns were used with the fourth-grade group. Zero was not used, nor were any digits repeated on any one slide. The four-digit slides, when projected, measure approximately four inches by fourteen inches. Digits, rather than words, were chosen at the fourth-grade level. The recognition of digits demands that the subject see all four digits, whereas with words a subject could use initial letter clues or configuration clues. The digits also eliminate the advantage some subjects might have because of a large sight vocabulary. Examples of slides used for first grade and for fourth grade are shown in Appendix A.

Procedure. Each subject was tested individually. The room was partially darkened; there was light only at the far end of the room behind the subject. A tape line was laid at a point ten feet from the screen. Each subject was instructed to toe this tape. The shutter of the projector was opened and a selected slide was projected as a still picture. The subject covered each eye in turn and checked to determine if he was within acuity range. If the subject was not within acuity range, he was moved closer until he could see the target with either eye. The testing distance was then shortened to this point and noted on the response sheet.

The preferred eye was determined by the use of the "Hole-in-card" test from the Harris Tests of Lateral Dominance. A nine-by-twelve-inch cardboard, with a hole the size of a dime in its center,

was placed on the table in front of the subject with the longer dimension parallel to the edge of the table nearest the subject. The subject was told "This is an aiming test. When I say go, lift up the card in both hands and hold it as far in front of you as you can reach. Look through the hole and tell me as quickly as you can what the picture is."[21] Pictures were held by the examiner just in front of his nose at a distance of ten feet from the subject. Three trials were taken and the sighting eye was recorded for each trial. The red-green filters are arranged so that the red was before the "preferred" eye.

The subject was instructed to look "through" the screen, imagining a fixation point about three to five feet behind the actual surface of the center of the screen. A sample exposure was used to demonstrate the pre-exposure signal of "ready" - "now" - flash. The subject was instructed how to call back verbally what he had seen. The geometric forms were identified in order, causing a verbal response such as "circle, square, triangle"; also accepted were "ball" for circle and "box" for square. With the digits, a pattern such as "7413" was called back "seven, four, one, three" rather than "seven thousand, four hundred thirteen."

The shutter speed was set at 1/100 second and a series of exposures was given. If the subject called back three consecutive

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[21]Albert J. Harris, Harris Tests of Lateral Dominance, Manual of Directions for Administration and Interpretation (New York: The Psychological Corporation, 1958), p. 9.

exposures correctly, then this shutter speed was recorded for the subject. If, however, after six exposures the subject was not able to call back three consecutive exposures correctly, he was asked to reverse the red-green filters. This placed the red lens in front of the "non-preferred" eye. The first exposure was a practice exposure for the second eye and was not considered as a test situation. Six trials were given for the non-preferred eye. Again the subject's success depended on calling back three consecutive exposures correctly. If the subject was unsuccessful at the 1/100 second speed, the shutter speed was changed to 1/50 second. Testing continued, alternating between right and left eye, until the subject could correctly call back three consecutive series.

Each subject had two speeds recorded: one for the right eye and one for the left eye. If these speeds were the same, the subject was in the "equal" group, if they were different the subject was in the "unequal" group. A portion of the recording form with scoring marks is shown in Figure 1, page 46. A "+" was used when the subject correctly called back the pattern and a "o" was used when an incorrect response was given. Other information recorded was (1) name, (2) grade, (3) preferred eye, and (4) group. An example of the recording sheet is found in Appendix B.

Name Thomas Morton Grade level First

Preferred eye Left Reading group Middle C.A. 6-10

Score: Right eye 1/25 Left eye 1/100 Group Unequal

Right eye

Speed	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1/100	0	0	0	0	0	0
1/50	0	+	0	+	+	0
1/25	0	+	+	+		

Left eye

Speed	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1/100	+	0	+	+	+	

FIGURE 1

A PORTION OF THE RECORDING FORM WITH SCORING MARKS SHOWN

CHAPTER IV

ANALYSIS OF THE DATA

The hypothesis tested in this study was that children who show any disparity in perceptual recognition on the Red Glass Test between right and left eye do not differ significantly in reading ability from children who show no such disparity. The investigation was concerned with the question of whether there was a difference in reading ability between those who perceived at the same speed with the right eye as with the left eye and those who perceived faster with one eye than with the other. For the purpose of this study, a time difference as small as 1/100 of a second was considered a visual disparity.

I. METHOD OF ANALYSIS

Two statistical procedures were used to examine this hypothesis: the t test of the significance of the difference between means for independent random samples, and the point biserial correlation. The raw data on which the analyses were based appear in Appendixes C and D.

In a comparison of the means of independent groups, the t test is not valid unless the standard deviations of the populations involved are equal. When there is some doubt that the standard deviations of two groups are the same, Snedecor's F test may be applied to the data.[1]

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[1]Robert H. Koenker, Simplified Statistics (Bloomington, Illinois: McKnight and McKnight Publishing Company, 1961), p. 86.

If the F test indicates no significant differences in the variances at the .01 level of significance, it is considered appropriate to apply a t test.

The statistical formula for t employed in this study was

$$t = \frac{M_1 - M_2}{\sqrt{\left(\frac{\Sigma x^2 + \Sigma y^2}{N_1 + N_2 - 2}\right)\left(\frac{N_1 + N_2}{N_1 N_2}\right)}}$$

This formula gives a precise estimate of the standard error of the difference between means, particularly when the groups are small. After computing the value of t, a comparison was made between the observed value of t and the tabled value of t at the .01 level of probability. If the value of the observed t reached or exceeded the .01 level of probability, the null hypothesis was rejected. If the value of t did not reach the .01 level of probability, the null hypothesis was accepted.

The coefficient of correlation shows the relationship of two sets of measures. Point biserial correlation is used when one variable is continuous and normally distributed and the other variable is dichotomous. The reading test scores and intelligence test scores were considered continuous and normally distributed for the purposes of this study. On the other hand the results of the Red Glass Test were dichotomous, since they were classified into two distinct categories: equal-unequal. Thus the data collected for this study were appropriately analyzed by the use of point biserial correlation. The formula used was $r_{p_{bis}} = \frac{Mp - Mq}{\sigma} \times (pq)$. Since the coefficient obtained could be analyzed as a product-moment correlation coefficient,

the significance of the correlation was tested by the same t test which is used in conjunction with the product-moment correlation. The formula used was $t = \frac{r_{pbis}\sqrt{N-2}}{\sqrt{1-r_{pbis}}}$ By referring to the t table with N - 2 degrees of freedom, a comparison was made of the observed t and the tabled value at the .01 level of probability. If the observed value of t was greater than the tabled value at the .01 level of probability, then the relationship observed was regarded as significant and not due to chance. A correlation from a sample which is judged significant is indicative of a corresponding correlation for the population which differs from zero. The amount of the difference is not indicated.

II. RESULTS OF ANALYSIS

First Grade

The first-grade group consisted of twenty-three pupils, twelve girls and eleven boys. Seven girls (58 per cent) perceived at equal speed and five (42 per cent) perceived faster with one eye than with the other. Ten of the eleven boys (91 per cent) perceived at equal speed and one (9 per cent) perceived faster with one eye than with the other.

These twenty-three pupils had been placed arbitrarily by the teacher in three reading groups: top, middle, and bottom. Of the twelve pupils in the top group, two (17 per cent) perceived faster with one eye than with the other. Of the six in the middle group, two

(33 per cent) perceived dissimilarly; of the five in the bottom group, two (40 per cent) perceived unequally.

The twenty-three pupils were divided into two groups, designated the equal group and the unequal group, for the statistical analysis in this investigation. The equal group included seven girls and ten boys for a total of seventeen who perceived at equal speed. The unequal group consisted of five girls and one boy for a total of six who perceived faster with one eye than with the other.

The two groups first were examined in terms of their I.Q. scores achieved on the SRA Primary Mental Abilities, Revised.[2] (See Table I.) The I.Q. range of the seventeen pupils in the equal group was 99 to 128; the mean was 111.2. The six pupils in the unequal group had I.Q.'s ranging from 97 to 130, with a mean of 108.2. When the significance of the difference of three I.Q. points between the means was investigated, the observed value of t was .58. Entering the table of t with twenty-one degrees of freedom, it is found that the value for the .01 level of probability is 2.831, and for the .05 level, 2.080. Since the observed value of t was .58, the difference between the means of the two groups was not significant and intelligence could not be considered a major factor in the differing performance on the Red Glass Test.

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[2]Thelma G. Thurstone and L. L. Thurstone, SRA Primary Mental Abilities, Revised (Chicago: Science Research Associates, Inc., 1946-1963.)

TABLE I

RESULTS OF THE ANALYSIS OF FIRST-GRADE SCORES ON THE SRA PRIMARY MENTAL ABILITIES

Group	N	Mean I.Q.	Standard deviation of I.Q.	Degrees of freedom	Observed F-ratio	F-ratio at .01	t	t value at .01
Equal	17	111.2	7.80	16				
					2.21*	4.44	.58**	2.831
Unequal	6	108.2	11.60	5				

* The observed F-ratio deals with standard deviation facts.

** The t value was computed with the use of the means of the equal and unequal groups.

The next analysis was concerned with the reading abilities of the two groups. The results on the Basic Sight Word Test,[3] the Metropolitan Readiness Tests,[4] and the Gates Primary Reading Tests[5] were used for these comparisons.

The means and standard deviations of the reading test scores, grade one, are presented in Table II. Results of the F tests are shown in Table III, page 54. Since the F tests indicated no significant differences in the variances of the equal and unequal groups at the .01 level of significance, the t test for the significance of the difference between means for independent random samples was used to compare those who perceived at equal speed (the equal group) and those who perceived faster with one eye than with the other (the unequal group). Results of these t tests are presented in Table IV, page 55. Scores on the Basic Sight Word Test[6] of the seventeen pupils in the equal group ranged from 76 to 220 words of the possible 220, and for the six pupils in the unequal group from 40 to 178. Of the seven pupils whose scores on this test would indicate first reader level or

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[3]Edward W. Dolch, Basic Sight Word Test (Champaign, Illinois: The Garrard Press, 1942.)

[4]Gertrude H. Hildreth and N. L. Griffiths, Metropolitan Readiness Tests Form R (Yonkers-on-Hudson, New York: World Book Company, 1949.)

[5]Arthur I. Gates, Gates Primary Reading Tests Form 2 (New York: Bureau of Publications, Teachers College, Columbia University, 1958.)

[6]Dolch, loc. cit.

TABLE II

MEANS AND STANDARD DEVIATIONS OF READING TEST SCORES FOR THE FIRST GRADE

Test	Group	N	Mean	Standard deviation
Basic Sight Word Test	Equal	17	116.82 *	38.58
	Unequal	6	102.00 *	45.00
Metropolitan Readiness Tests (Total)	Equal	17	81.18 *	9.34
	Unequal	6	76.20 *	6.38
Metropolitan Readiness Tests (Reading)	Equal	17	59.06 *	4.51
	Unequal	6	56.80 *	3.73
Gates Primary Reading Tests (Word Recognition)	Equal	17	2.44 **	.30
	Unequal	6	2.43 **	.27
Gates Primary Reading Tests (Sentence Reading)	Equal	17	2.13 **	.50
	Unequal	6	2.08 **	.37
Gates Primary Reading Tests (Paragraph Reading)	Equal	17	2.22 **	.47
	Unequal	6	2.33 **	.50

* Computed on the basis of raw scores

** Computed on the basis of grade equivalents

TABLE III

RESULTS OF THE F TEST FOR SIMILARITY OF VARIANCES OF THE EQUAL GROUP AND THE UNEQUAL GROUP ON THE READING TESTS
(First Grade)

Variable	Degrees of freedom	Observed F-ratio	F-ratio needed for significance at .01
Basic Sight Word Test	5,16	1.36	4.44
Metropolitan Readiness Tests (Total)	16,5	2.14	9.68
Metropolitan Readiness Tests (Reading)	16,5	1.46	9.68
Gates Primary Reading Tests (Word Recognition)	16,5	1.23	9.68
Gates Primary Reading Tests (Sentence Reading)	16,5	1.83	9.68
Gates Primary Reading Tests (Paragraph Reading)	5,16	1.13	4.44

TABLE IV

RESULTS OF THE t TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN THE MEANS OF THE EQUAL GROUP AND THE UNEQUAL GROUP ON THE READING TESTS (First Grade)

Variable	Degrees of freedom	Difference between the means	Observed value of t	Value of t needed for significance at .01
Basic Sight Word Test	21 (16,5)	14.82	.71	2.831
Metropolitan Readiness Tests (Total)	21 (16,5)	4.98	1.37	2.831
Metropolitan Readiness Tests (Reading)	21 (16,5)	2.26	1.14	2.831
Gates Primary Reading Tests (Word Recognition)	21 (16,5)	.01	.08	2.831
Gates Primary Reading Tests (Sentence Reading)	21 (16,5)	.05	.05	2.831
Gates Primary Reading Tests (Paragraph Reading)	21 (16,5)	.11	.48	2.831

above, six were in the equal group and one was in the unequal group. The means for the equal group (N=17) and the unequal group (N=6) were 116.82 and 102, respectively. The observed t value of .72 was less than the value at the corresponding .01 level of probability and thus indicated no significant difference in performance on this test.

Two scores were used from the Metropolitan Readiness Tests:[7] (1) the reading readiness score which is based on the first four subtests, and (2) the total readiness score which is the total for all six subtests. In the test manual scores are translated into letter ratings of A, B, C, D, and E and interpreted as Superior, High Normal, Average, Low Normal, and Poor Risk, respectively, in terms of readiness status. When these letter ratings and readiness status were considered, it was found that on the reading readiness section 88 per cent of the students (fifteen students) in the equal group achieved Readiness Status of High Normal or Superior, while 66 per cent (four students) of those in the unequal group were similarly rated. On the total readiness test, eleven (65 per cent) of the seventeen in the equal group received ratings of A or B corresponding to Superior and High Normal Readiness Status while two (33 per cent) of the six in the unequal group achieved A or B ratings. The means for the reading section were 59.06 for the equal group and 56.80 for the unequal group, and the means on the total test were 81.18 and 76.20. Analysis of the reading readiness scores and total readiness scores yielded t values

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[7]Hildreth and Griffiths, loc. cit.

of 1.14 and 1.37, respectively (Table IV). Though neither of these observed values of t indicated a difference significant at the .01 level, the t for the total readiness score did indicate a difference in the means of the two groups significant at approximately the .20 level.

The three scores obtained from the Gates Primary Reading Tests[8] were for word recognition, sentence reading, and paragraph reading. Examination of the grade equivalents for each of the three subtests reveals that all students were above grade level, which was 1.5. Scores at least one grade above grade level were earned by seven pupils on the word recognition subtest. Six of these pupils were in the equal group. Corresponding figures for the sentence reading subtest were three and three, and for the paragraph reading subtest, four and two. Comparisons of the means for the equal group and the unequal group yielded t values of .08, .05, amd .48, respectively; none of these t values reached the .01 level of significance (Table IV).

Point biserial correlation was used to describe the relationship between performance on the Red Glass Test and on the various reading tests, and the coefficients were examined for significance by the use of the t test. Results of these analyses are presented in Table V. It can be seen that none of the correlations were substantial, ranging from -.12 to +.24. A correlation in the neighborhood of .48 would be

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[8]Gates, loc. cit.

TABLE V

POINT BISERIAL CORRELATION BETWEEN THE RED GLASS TEST AND SIX READING TESTS
(First Grade; N=23)

Variable	Correlation coefficient	Observed value of t	Value of t needed for significance at .01
Basic Sight Word Test	.17	.985	2.831
Metropolitan Readiness Tests (Total)	.24	1.134	2.831
Metropolitan Readiness Tests (Reading)	.22	1.034	2.831
Gates Primary Reading Tests (Word Recognition)	.02	.092	2.831
Gates Primary Reading Tests (Sentence Reading)	.05	.230	2.831
Gates Primary Reading Tests (Paragraph Reading)	-.12	.554	2.831

necessary to be significant at the .01 level. It would appear that there is no appreciable relationship between perceptual time similarity or disparity as measured by the Red Glass technique and reading achievement at the first-grade level.

Fourth Grade

The fourth-grade group consisted of twenty-one pupils, ten girls and eleven boys. Three girls (30 per cent) perceived at equal speed and seven (70 per cent) perceived faster with one eye than with the other. Six of the eleven boys (55 per cent) perceived at equal speed and five (45 per cent) perceived faster with one eye than with the other.

These twenty-one pupils had been distributed arbitrarily among three reading groups for classroom instruction: top, middle, and bottom. Of the ten pupils in the top group, six (60 per cent) perceived faster with one eye than with the other; of the nine in the middle group, four (44 per cent) perceived with unequal speed, and both the students in the bottom group perceived unequally.

For the statistical analysis the twenty-one pupils were divided into two groups on the basis of performance on the Red Glass Test. The equal group included three girls and six boys for a total of nine (43 per cent) who perceived at equal speed. The unequal group included seven girls and five boys for a total of twelve (57 per cent) who perceived faster with one eye than with the other.

As with the first grade, the initial analysis was concerned with the intelligence test scores of the two groups. Results of this

analysis are given in Table VI. On the Henmon-Nelson Tests of Mental Ability[9] the I.Q. range of the nine pupils in the equal group was 107 to 136, and the mean was 122.8. The I.Q. range of the twelve pupils in the unequal group was 101 to 144; the mean was 119.6. The difference of 3.2 in the means of the two groups was associated with a value of t of .60. For nineteen degrees of freedom, the t value for the .01 level of significance was 2.861, and for the .05 level, 2.093. Thus the observed value of t of .60 indicated that the difference between the means was not significant and performance on the Red Glass Test was not significantly related to intelligence.

As the next line of investigation, the reading abilities of the two groups were examined. The following tests were employed for this purpose: Durrell-Sullivan Reading Achievement Test;[10] Sequential Tests of Educational Progress: Reading;[11] Iowa Tests of Basic Skills, Vocabulary; and Iowa Tests of Basic Skills, Reading Comprehension.[12]

The means and standard deviations of these test scores for grade four are indicated in Table VII, page 62. Since the F tests indicated

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[9]Tom A. Lamke and M. J. Nelson, Henmon-Nelson Tests of Mental Ability Grades 3-6 Form A (Boston: Houghton Mifflin Company, 1957.)

[10]Donald D. Durrell and Helen Blair Sullivan, Durrell-Sullivan Reading Capacity and Achievement Tests Form A (Yonkers-on-Hudson, New York: World Book Company, 1937.)

[11]Sequential Tests of Educational Progress: Reading Form 4A (Princeton, New Jersey: Cooperative Test Division, Educational Testing Service, 1957.)

[12]E. F. Lindquist, A. N. Hieronymus, and others, Iowa Tests of Basic Skills Form 3 (Boston: Houghton Mifflin Company, 1956.)

TABLE VI

RESULTS OF THE ANALYSIS OF FOURTH-GRADE SCORES ON THE HENMON-NELSON TESTS OF MENTAL ABILITY

Group	N	Mean I.Q.	Standard deviation of I.Q.	Degrees of freedom	Observed F-ratio	F-ratio at .01	t	t value at .01
Equal	9	122.8	10.16	8				
					1.776 *	5.74	.60 **	2.861
Unequal	12	119.6	13.54	11				

* The observed F-ratio deals with standard deviation facts.

** The t value was computed with the use of the means of the equal and unequal groups.

TABLE VII

MEANS AND STANDARD DEVIATIONS OF READING TEST SCORES FOR THE FOURTH GRADE

Test	Group	N	Mean	Standard deviation
Durrell-Sullivan Reading Achievement Test (Word Meaning)	Equal	9	46.44 *	10.88
	Unequal	12	39.00 *	19.24
Durrell-Sullivan Reading Achievement Test (Paragraph Meaning)	Equal	9	28.33 *	9.81
	Unequal	12	25.83 *	14.78
Durrell-Sullivan Reading Achievement Test (Total)	Equal	9	74.78 *	19.88
	Unequal	12	64.89 *	33.69
Sequential Tests of Educational Progress (Reading)	Equal	9	79.17 **	17.71
	Unequal	12	74.67 **	29.09
Iowa Tests of Basic Skills (Vocabulary)	Equal	9	5.76 ***	1.44
	Unequal	12	5.79 ***	.94
Iowa Tests of Basic Skills (Reading)	Equal	9	5.03 ***	.98
	Unequal	12	5.52 ***	1.36

* Computed on the basis of raw scores
** Computed on the basis of the midpoint of the percentile band
*** Computed on the basis of grade equivalents

no significant differences in the variances at the .01 level of significance (Table VIII, page 64), it was considered appropriate to apply a t test of the significance of the difference between means for independent random samples. As was done with first grade, comparisons were made between the mean performance of the group who perceived equally with the two eyes and the group who perceived faster with one eye than with the other. Results of the t test analyses appear in Table IX, page 65. Examination of the table reveals that values of t ranged from .06 to .90 and that none approached the value necessary for either the .05 or the .01 level of significance. Thus there were no significant differences in the mean reading achievement of the two groups at the fourth-grade level as measured by any of these tests.

Though none of the differences between means were significant, it can be noted that there was less difference between the means of the two groups on the Iowa Tests of Basic Skills[13] than on the other reading tests and on only the Iowa Tests of Basic Skills[14] did the obtained differences favor the unequal group. Further examination of the raw data revealed that although 57 per cent of the class perceived with unequal speed, 75 to 80 per cent of those who performed below the expected level for the grade as indicated in the manual on the Durrell-Sullivan Reading Achievement Test[15] were in the unequal group.

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[13] Ibid.

[14] Ibid.

[15] Durrell and Sullivan, loc. cit.

TABLE VIII

RESULTS OF THE F TEST FOR SIMILARITY OF VARIANCES OF THE EQUAL GROUP AND THE UNEQUAL GROUP ON THE READING TESTS
(Fourth Grade)

Variable	Degrees of freedom	Observed F-ratio	F-ratio needed for significance at .01
Durrell-Sullivan Reading Achievement Test (Word Meaning)	11,8	3.127	5.74
Durrell-Sullivan Reading Achievement Test (Paragraph Meaning)	11,8	2.269	5.74
Durrell-Sullivan Reading Achievement Test (Total)	11,8	2.871	5.74
Sequential Tests of Educational Progress (Reading)	11,8	2.698	5.74
Iowa Tests of Basic Skills (Vocabulary)	8,11	2.340	4.74
Iowa Tests of Basic Skills (Reading)	11,8	1.918	5.74

TABLE IX

RESULTS OF THE t TEST OF SIGNIFICANCE OF DIFFERENCE BETWEEN THE MEANS OF THE EQUAL GROUP AND THE UNEQUAL GROUP ON THE READING TESTS (Fourth Grade)

Variable	Degrees of freedom	Difference between the means	Observed value of t	Value of t needed for significance at .01
Durrell-Sullivan Reading Achievement Test (Word Meaning)	19 (11,8)	7.44	.87	2.861
Durrell-Sullivan Reading Achievement Test (Paragraph Meaning)	19 (11,8)	2.50	.47	2.861
Durrell-Sullivan Reading Achievement Test (Total)	19 (11,8)	9.95	.79	2.861
Sequential Tests of Educational Progress (Reading)	19 (11,8)	4.50	.44	2.861
Iowa Tests of Basic Skills (Vocabulary)	19 (11,8)	.03	.06	2.861
Iowa Tests of Basic Skills (Reading)	19 (11,8)	.49	.90	2.861

Both the highest and lowest scores on the two subtests and on the total test were found in the unequal group. On the Sequential Tests of Educational Progress[16] only two pupils scored below grade level and both were in the unequal group. On the Iowa Tests of Basic Skills[17] also, few pupils were below grade level. The one pupil below grade level on vocabulary was in the equal group while two of the three pupils below grade level on reading comprehension were in the unequal group.

The previous discussion has been concerned with analyses of the differences in the mean reading performances of two groups of fourth-grade children differentiated on the basis of equal or unequal perceptual speed as measured by the Red Glass Test. As another approach to the study of the relationship between performance on the Red Glass Test and on various reading tests, the point biserial correlation was used on the data. Each coefficient of correlation was examined for significance by the use of the t test. Results of these analyses are given in Table X, page 67. Examination of these data reveals that correlations ranged from -.21 to +.23, with t values considerably below the value needed to indicate significant relationships. Again, it appeared that any relationships which existed between reading ability, as measured by the tests employed in this study, and performance on the Red Glass Test could have been chance relationships.

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[16] Sequential Tests of Educational Progress: Reading, loc. cit.

[17] Lindquist, Hieronymus, and others, loc. cit.

TABLE X

POINT BISERIAL CORRELATION BETWEEN THE RED GLASS TEST AND SIX READING TESTS (Fourth Grade; N=21)

Variable	Correlation coefficient	Observed value of t	Value of t needed for significance at .01
Durrell-Sullivan Reading Achievement Test (Word Meaning)	.23	1.059	2.861
Durrell-Sullivan Reading Achievement Test (Paragraph Meaning)	.09	.396	2.861
Durrell-Sullivan Reading Achievement Test (Total)	.18	.798	2.861
Sequential Tests of Educational Progress (Reading)	.09	.394	2.861
Iowa Tests of Basic Skills (Vocabulary)	-.14	.664	2.861
Iowa Tests of Basic Skills (Reading)	-.21	1.009	2.861

Summary

Analyses of the data in this investigation were made by the use of the t test of the significance of the difference between means of independent random samples and by the use of point biserial correlation. The pupils' test scores involved in these analyses are found in the Appendixes.

Findings indicated that the null hypothesis could be accepted--there were no significant differences in reading test performances between those pupils who perceived at the same speed with the two eyes and those who perceived faster with one eye than with the other. This was true at the first-grade level and at the fourth-grade level.

Further inspection of the data of the two grade levels revealed that the number and percentage of subjects who perceived at a different speed with the two eyes increased between first grade and fourth grade. In the first grade six subjects (26 per cent) had unequal speed. In the fourth grade eleven pupils (52.3 per cent) had unequal speed. This seeming increase in the number of visual disparities follows a pattern noted in a number of other studies concerned with visual characteristics denoted by the researchers as problems or abnormalities.

Although the t test of the significance of the difference between means for independent random samples indicated no significant differences in performance between the equal group and the unequal group, the obtained differences tended to favor the equal group. In five of the six analyses of first-grade reading scores the observed

means for the equal group were higher than the observed means for the unequal group. At the fourth-grade level four out of the six means for the equal group were higher than corresponding means for the unequal group. The higher mean performance in reading by the students with equal perceptual speeds may be indicative of a relationship which exists and which might be revealed with studies of larger groups containing a greater proportion of poor readers. The Red Glass technique was used by Dr. Root in a clinical setting with poor readers, and so the small number of pupils in the present investigation who read below grade level may have influenced the results. Very few of the subjects actually would be classified as poor readers. The mean test ratings for the classes were in all cases considerably above grade level, and very few children scored below grade level.

Any difference in speed of perceptual recognition was considered a difference, and the pupil was placed in the unequal group. The maximum difference in speed of the two eyes for any one individual in first grade was .03 of a second, and in the fourth grade .96 of a second. Some of these small observed differences in time may not have constituted functional differences in visual perception.

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

The primary motivation for this study was the reported improvement in reading by children who were involved in visual training programs under the direction of Dr. Frank Root, practicing optometrist at Cedar Falls, Iowa. The Red Glass technique had been included in these visual training programs as set up by Dr. Root to equalize speed of perception in the two eyes. He began to feel that some relationship existed between equality or inequality of speed in visual perception and reading ability when pupils continued to report improvement in reading as disparities in speed were reduced or eliminated. The present investigation was designed to test this idea in a controlled situation.

Another motivating factor was the lack of agreement in previous studies of the relationship between visual perception and reading ability. It was hypothesized that the conflicting results reported might have been due to a factor such as the disparity between the two eyes in speed of perception. No previous studies were found which dealt specifically with this relationship, and such an investigation seemed desirable.

I. SUMMARY

The main purpose of this study was to determine if a difference in reading ability existed between children who perceived at equal

speeds with both eyes and those who perceived faster with one eye than with the other.

An experimental situation was set up using a total of forty-four subjects, twenty-three from first grade and twenty-one from fourth grade, at Malcolm Price Laboratory School in Cedar Falls, Iowa. The Red Glass Test, a procedure allowing for monocular viewing of the stimulus while giving the subject the impression that he is in a binocular setting, was used to determine the speed of perception of each eye. Data available on each subject included (1) intelligence quotient, (2) results from three different reading tests, and (3) the results of the Red Glass Test. Statistical procedures used to test the null hypothesis were the t test of the difference between means of independent random samples and the point biserial correlation.

II. CONCLUSIONS

The results of this study tend to support the null hypothesis. For the first-grade and fourth-grade groups studied, there were no significant differences in reading abilities between those who perceived at the same speed with the two eyes and those who perceived faster with one eye than with the other. When the means of the scores on the various reading tests for the groups with equal speeds of visual perception were compared with the means for the groups with unequal speeds, it was found that there were no significant differences at either grade level. It was noted that the observed differences did

tend to favor the group with equal speeds in nine out of a total of twelve comparisons for the two grades involved. The coefficients of correlation between the Red Glass Test and the various reading tests were generally low and considerably short of significance at the arbitrarily selected .01 level. However, again the coefficients tended to support the trend toward some small existing relationship in that they were positive in ten of the twelve analyses.

This observed trend for the equal group to have the higher mean scores in reading plus the predominantly positive correlations of the Red Glass Test with reading test scores may indicate an existing relationship which could be revealed in a more carefully controlled situation with larger groups, a wider spread in reading ability (including more poor readers), and greater differences in speeds of the two eyes of the subjects in the unequal group. The fact that very few subjects in this study would be classified as poor readers, as contrasted with Dr. Root's clinical subjects who described themselves as poor readers, may have influenced the outcome of this investigation. Also, since any difference in observed perceptual speed for the two eyes of an individual resulted in placement in the unequal group, there may have been instances in which the differences were actually too small to be functional differences.

Nevertheless, if there is a positive relationship between equal-unequal visual perception by the two eyes and reading performance, it is probably a weak relationship. Evidence from the present research does not justify any stronger statement.

III. RECOMMENDATIONS FOR FURTHER STUDY

Many questions have arisen in the mind of the investigator during the course of this study and as a result of the findings. Several avenues of investigation have been suggested which might prove valuable both in the study of visual problems and of reading difficulties. Some of the possible areas needing study are as follows:

1. A controlled study in a clinical setting in which records are kept of actual reading progress in addition to other pertinent data.
2. A more extensive study of students in classroom situations which include more students who would be termed poor readers.
3. A study in which a more pronounced difference in the speeds of perceptual recognition in the two eyes is required for placement in the unequal group.
4. An investigation of the incidence of disparity between the right and left eye in speed of perceptual recognition in the general population at various stages of maturation and a definition of what constitutes "abnormal" in this respect at any level.
5. A study of the relationships of dominance and disparity in speed of visual perception.
6. A study of possible neurological difficulties which might be associated with the results of the Red Glass Test.

7. A study of practice effect on, and the reliability of, the performance on the Red Glass Test.

BIBLIOGRAPHY

BIBLIOGRAPHY

A. BOOKS

Betts, Emmett A. The Prevention and Correction of Reading Difficulties. Evanston, Illinois: Row, Peterson and Company, 1936.

Buros, Oscar Krisen (ed.). The Fifth Mental Measurements Yearbook. Highland Park, New Jersey: The Gryphon Press, 1959.

Campbell, William Giles. Form and Style in Thesis Writing. Boston: Houghton Mifflin Company, 1954.

Davis, Louis, Vivienne Ilg, Martha Springer, and Doreen Hanck. First Grade Recognition Program. Evanston, Illinois: Row, Peterson and Company, 1946.

Frostig, Marianne and David Horne. The Frostig Program for the Development of Visual Perception - Teacher's Guide. Chicago: Follett Publishing Company, 1964.

Fulton, M.D., John F. (ed.). A Textbook of Physiology. Philadelphia: W. S. Saunders Company, 1955.

Garrett, Henry E. Statistics in Psychology and Education. New York: Longmans, Green and Company, 1958.

Gesell, Arnold, F. L. Ilg, and G. E. Bullis. Vision: Its Development in Infant and Child. New York: Paul B. Hoeber, Inc., 1949.

Huey, Edmund B. The Psychology and Pedagogy of Reading. New York: The Macmillan Company, 1924.

Imus, Henry A., John W. Rothney, and Robert M. Bear. An Evaluation of Visual Factors in Reading. Hanover, New Hampshire: Dartmouth College Publications, 1938.

Koenker, Robert H. Simplified Statistics. Bloomington, Illinois: McKnight and McKnight Publishing Company, 1961.

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

Parkins, George A. The Diagnosis and Elimination of Visual Handicaps Preventing Efficient Reading. Rutland, Vermont: Tuttle Publishing Company, 1941.

Spache, George D. Toward Better Reading. Champaign, Illinois: Garrard Publishing Company, 1963.

Stedman's Medical Dictionary. Baltimore: The Williams and Wilkins Company, 1961.

Taylor, Earl A. Controlled Reading. Chicago: University of Chicago Press, 1937.

Vernon, M. D. The Experimental Study of Reading. Cambridge, England: University Press, 1931.

Whipple, Guy M. Manual of Mental and Physical Tests. Baltimore: Warwick and York, 1910.

_____. Manual of Mental and Physical Tests. Part I, Simpler Processess. Baltimore: Warwick and York, 1914.

B. BOOKS: PARTS OF SERIES

Buswell, Guy T. How Adults Read. Supplementary Educational Monographs, No. 45. Chicago: University of Chicago Press, 1937.

Fendrick, Paul. Visual Characteristics of Poor Readers. Teachers College, Columbia University Contributions to Education, No. 656. New York: Teachers College, Columbia University, 1935.

Gates, Arthur I. The Psychology of Reading and Spelling. Teachers College, Columbia University Contributions to Education, No. 129. New York: Teachers College, Columbia University, 1922.

Goins, Jean Turner. Visual Perceptual Abilities and Early Reading Progress. Supplementary Educational Monographs, No. 87. Chicago: University of Chicago Press, 1958.

Gray, Clarence T. Types of Reading Ability as Exhibited Through Tests and Laboratory Experiments. Supplementary Educational Monographs, Vol. I, No. 5. Chicago: University of Chicago Press, 1917.

Kelley, Charles R. Visual Screening and Child Development: The North Carolina Study. Raleigh: School of Education, North Carolina State College, 1957.

Phelan, Sister Mary. Visual Perception in Relation to Variance in Reading and Spelling. Catholic University of America Educational Research Monograph, Vol. XII, No. 3. Washington, D.C.: Catholic Education Press, 1940.

Riley, Sister Mary of the Visitation. Visual Perception in Reading and Spelling: A Statistical Analysis. Catholic University of America Educational Research Bulletin, Vol. IV, No. 1. Washington, D.C.: Catholic Education Press, 1929.

Ruediger, William Carl. The Field of Distinct Vision. Archives of Psychology. New York: The Science Press, 1907.

Selzer, Charles A. Lateral Dominance and Visual Fusion: The Application to Difficulties in Reading, Writing, Spelling, and Speech. Harvard Monographs in Education, No. 12. Cambridge: Harvard University Press, 1933.

Thurstone, L. L. A Factorial Study of Perception. Psychometric Monographs, No. 4. Chicago: University of Chicago Press, 1944.

_____. Primary Mental Abilities. Psychometric Monographs, No. 1. Chicago: University of Chicago Press, 1941.

C. TESTS

Dolch, Edward W. Basic Sight Word Test. Champaign, Illinois: The Garrard Press, 1942.

Durrell, Donald D. and Helen Blair Sullivan. Durrell-Sullivan Reading Capacity and Achievement Tests Form A. Yonkers-on-Hudson, New York: World Book Company, 1937.

Gates, Arthur I. Gates Primary Reading Tests Form 2. New York: Bureau of Publications, Teachers College, Columbia University, 1958.

Harris, Albert J. Harris Tests of Lateral Dominance. New York: The Psychological Corporation, 1958.

Hildreth, Gertrude H. and N. L. Griffiths. Metropolitan Readiness Tests. Yonkers-on-Hudson, New York: World Book Company, 1949.

Lamke, Tom A. and M. J. Nelson. Henmon-Nelson Tests of Mental Ability. Boston: Houghton Mifflin Company, 1957.

Lindquist, E. F., A. N. Hieronymus, and others. Iowa Tests of Basic Skills Form 3. Boston: Houghton Mifflin Company, 1956.

Sequential Tests of Educational Progress: Reading Form 4A. Princeton, New Jersey: Cooperative Test Division, Educational Testing Service, 1957.

Thurstone, Thelma G. and L. L. Thurstone. SRA Primary Mental Abilities, Revised. Chicago: Science Research Associates, Inc., 1946-63.

D. PUBLICATIONS OF THE GOVERNMENT, LEARNED SOCIETIES, AND OTHER ORGANIZATIONS

Leestma, Robert C. "Age Changes in Tachistoscopic Span," Dissertation Abstracts, 1957, Vol. 17, pp. 93-94.

Renshaw, Samuel. "The Influence of Tachistoscopic Training at Far Point on the Scholastic Achievement of First-Grade Children," Optometric Extension Program, VI, No. 1 (Ducan, Oklahoma: Optometric Extension Program, November, 1945.)

Sommerfeld, Ray E. "An Evaluation of the Tachistoscope in Reading Improvement Programs," What Colleges are Doing in Reading Improvement Programs, pp. 7-25. Third Yearbook, Southwest Reading Conference for Colleges and Universities. Fort Worth, Texas: Texas Christian University, 1954.

E. PERIODICALS

Aveling, F. "The Perception of Tachistoscopically Exposed Symbols," The British Journal of Psychology, XXII (January, 1932), 193-199.

Ball, Richard J. "Visual Functioning in Reading Disability," Education, LXXXII (November, 1961), 175-178.

Betts, Emmett A. "Visual Aids in Remedial Reading," Educational Screen, XV (April, 1936), 108-110.

Carroll, Robert P. "The Flash Meter as a Diagnostic Instrument," School and Society, XLVIII (July 30, 1938), 150.

Clark, B. "How to Talk to Teachers About Remedial Reading Problems," American Journal of Optometry, XIX (Fall, 1942), 336-351.

Dallenbach, Karl M. "The Effect of Practice upon Visual Apprehension in School Children," Journal of Educational Psychology, V (June and September, 1914), 321-334, 387-404.

Dalton, M. M. "A Visual Survey of 5000 School Children," The Journal of Educational Research, XXXVII (October, 1943), 81-94.

Dearborn, Walter F. and Irving H. Anderson. "Aniseikonia as Related to Disability in Reading," Journal of Experimental Psychology, XXIII (December, 1938), 559-577.

Dodge, Raymond E. "Experimental Study of Visual Fixation," Psychological Review Monograph Supplement, VIII (June, 1907), 1-95.

Dyer, Dorothy W. and E. R. Harcum. "Visual Perception of Binary Patterns of Preschool Children and by School Children," Journal of Educational Psychology, LII (June, 1961), 161-165.

Eames, Thomas H. "A Comparison of the Ocular Characteristics of Unselected and Reading Disability Groups," The Journal of Educational Research, XXV (March, 1932), 211-215.

_____. "A Frequency Study of Physical Handicaps in Reading Disability and Unselected Groups," The Journal of Educational Research, XXIX (September, 1935), 1-5.

_____. "A Study of the Speed of Word Recognition," The Journal of Educational Research, XXI (November, 1937), 81-87.

_____. "The Speed of Picture Recognition and the Speed of Word Recognition in Cases of Reading Difficulty," American Journal of Opthalmology, XXI (December, 1938), 1370-1375.

Farris, L. P. "Visual Defects as Factors Influencing Achievement in Reading," California Journal of Secondary Education, X (October, 1934), 50-52.

Foster, W. S. "The Effect of Practice upon Visualizing and upon the Reproduction of Visual Impressions," Journal of Educational Psychology, II (January, 1911), 11-12.

Gates, Arthur I. "A Study of the Role of Visual Perception, Intelligence, and Certain Associative Processes in Reading and Spelling," Journal of Educational Psychology, XVII (October, 1926), 433-445.

Gilbert, Luther C. "Speed of Processing Visual Stimuli and Its Relation to Reading," Journal of Educational Psychology, L (February, 1959), 8-14.

Goetzinger, C. P., S. D. Dirks and C. J. Baer. "Auditory Discrimination and Visual Perception in Good and Poor Readers," Annals of Otology, Rhenology, and Laryngology, LXIX (March, 1960), 121-136.

Hurst, W. A. "Vision and the Retarded Reader," The Canadian Teacher's Guide, X (Winter, 1960), 29-35.

Jackson, Thomas and Virginia Schye. "A Comparison of Vision with Reading Scores of Ninth-Grade Pupils," The Elementary School Journal, XLVI (September, 1945), 33-35.

Jones, Reginald E. and Earl Van Why. "Tachistoscopic Training in the Fourth and Fifth Grade," Journal of Developmental Reading, VI (Spring, 1963), 177-185.

Judd, Charles H. "Photographic Records of Convergence and Divergence," Psychological Review Monograph Supplements, VIII (June, 1907), 370-423.

Kephart, Newell C. "Visual Skills and Their Relationship to School Achievement," American Journal of Ophthalmology, XXXVI (June, 1953), 794-799.

Leton, Donald A. "Visual-Motor Capacities and Ocular Efficiency in Reading," Perceptual and Motor Skills, XV (October, 1962), 407-432.

MacLatchy, Josephine H. "Bexley Reading Study," Educational Research Bulletin, XXV (September 18, 1946), 141-168.

Melcer, Fannie H. and Barbara G. Brown. "Tachistoscopic Training in the First Grade," The Optometric Weekly, XXXVI (December 6, 1945), 1217-1219.

Park, George E. and Clara Burri. "The Effect of Eye Abnormalities on Reading Difficulty," Journal of Educational Psychology, XXXIV (October, 1943), 420-430.

Renshaw, Samuel. "The Visual Perception and Reproduction of Forms by Tachistoscopic Methods," The Journal of Psychology, XX (October, 1945), 217-232.

Root, O. D., Frank M. "A Tachistoscopic Method of Testing and Training Speed of Visual Perception Using Anaglyphs," The Optometric Weekly, L (July 9, 1959), 1355-1359.

Rudisill, Mable. "Flashed Digit and Phrase Recognition and Rate of Oral and Concrete Responses: A Study of Advance and Retarded Readers in the Third Grade," The Journal of Psychology, XLII (October, 1956), 317-328.

Russell, David H. "Note on a New Theory About Visual Functioning and Reading Disabilities," Journal of Educational Psychology, XXXIV (February, 1943), 115-120.

Spache, George D. and Chester E. Tillman. "A Comparison of the Visual Profiles of Retarded and Non-Retarded Readers," Journal of Developmental Reading, V (Winter, 1962), 101-109.

Stroud, James B. "Rate of Visual Perception as a Factor in Rate of Reading," Journal of Educational Psychology, XXXVI (November, 1945), 487-498.

Thurstone, L. L. "The Perceptual Factor," Psychometrika, III (March, 1938), 1-17.

Tinker, Miles A. "Visual Apprehension and Perception in Reading," Psychological Bulletin, XXVI (April, 1929), 223-240.

_____, D. Roberts, and A. Jackson. "Definite and Indefinite Preparation in the Visual Apprehension Experiment," The American Journal of Psychology, XLII (January, 1930), 96-100.

Witty, Paul and David Kopel. "Factors Associated with the Etiology of Reading Disability," The Journal of Educational Research, XXIX (February, 1936), 448-459.

F. ESSAYS AND ARTICLES IN COLLECTIONS

Eberl, Marguerite. "Visual Training and Reading," Clinical Studies in Reading, II, Helen M. Robinson, editor. Supplementary Educational Monographs, No. 77. Chicago: University of Chicago Press, 1953. Pp. 141-148.

Jobe, Fred W. "The Structure and Function of the Visual Mechanism," Clinical Studies in Reading, II, Helen M. Robinson, editor. Supplementary Educational Monographs, No. 77. Chicago: University of Chicago Press, 1953. Pp. 123-128.

Robinson, Helen M. "Summary, Conclusions, and Implications," Clinical Studies in Reading, II, Helen M. Robinson, editor. Supplementary Educational Monographs, No. 77. Chicago: University of Chicago Press, 1953. Pp. 159-164.

G. UNPUBLISHED MATERIALS

Cleland, Donald L. "An Experimental Study of Tachistoscopic Training as it Relates to Speed and Comprehension in Reading." Unpublished doctoral dissertation, University of Pittsburgh, Pittsburgh, Pennsylvania, 1950.

Eckstein, C. "Use of the Dolch Basic Sight Word List as a Measure to Determine Reader Level." Unpublished Master's thesis, State University of Iowa, Iowa City, 1944.

Feldmann, Shirley Clark. "Visual Perception Skills of Children and Their Relation to Reading." Unpublished doctoral dissertation, Columbia University, New York, 1961.

Fox, Henry Corbett. "The Relationship Between the Perception of Tachistoscopically Projected Images and Reading Readiness." Unpublished doctoral dissertation, Indiana University, Bloomington, 1951.

Sparrow, Julia L. "Accomplishment on the Dolch Basic Sight Word Test as a Measure of Reader Level." Unpublished Master's thesis, State University of Iowa, Iowa City, 1944.

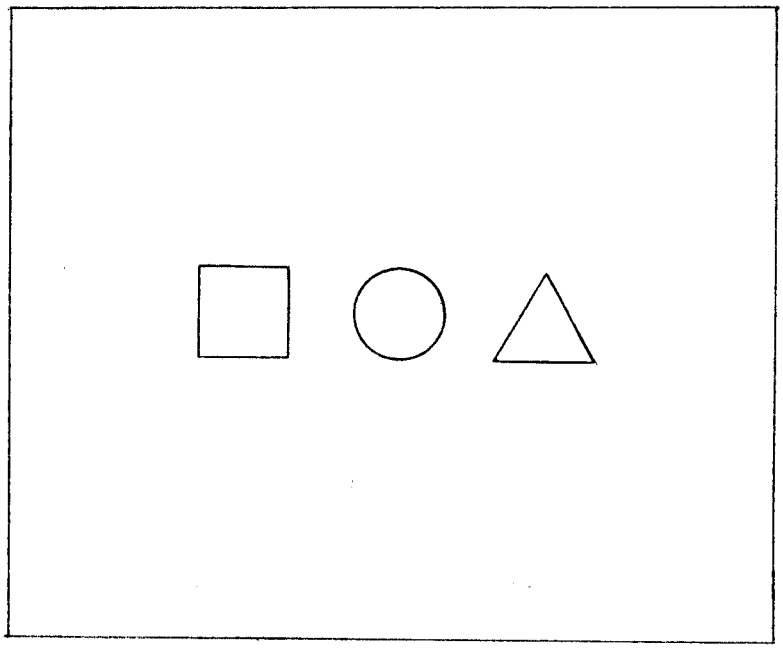
APPENDIXES

APPENDIX A

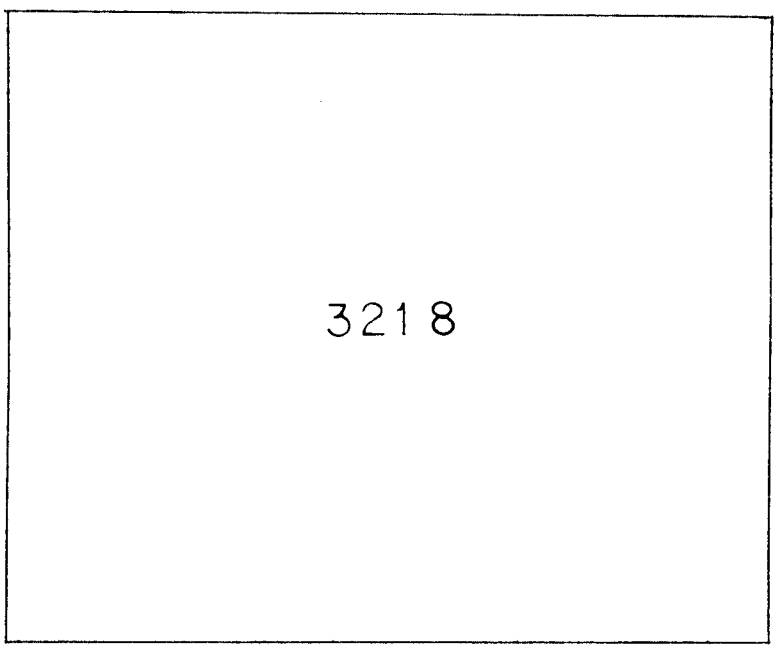
EXAMPLES OF SLIDES USED FOR THE RED GLASS TEST FOR FIRST GRADE AND FOR FOURTH GRADE

APPENDIX A

EXAMPLES OF SLIDES USED FOR THE RED CLASS TEST



For First Grade



For Fourth Grade

APPENDIX B

COPY OF SCORING FORM USED WITH THE RED GLASS TEST

Name _____ Grade level _____

Preferred eye _____ Reading group _____ C.A. _____

Score: Right eye _____ Left eye _____ Group _____

Right eye

Speed	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1/100						
1/50						
1/25						
1/10						
1/5						
1/2						
1 sec.						

Left eye

Speed	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Trial 6
1/100						
1/50						
1/25						
1/10						
1/5						
1/2						
1 sec.						

APPENDIX C

RAW DATA FOR EACH CHILD ON WHICH ANALYSES WERE BASED (First Grade)

APPENDIX C

RAW DATA FOR EACH CHILD ON WHICH ANALYSES WERE BASED
(First Grade)

Subject	SRA PMA Quot.	Gates Primary Reading Tests PWR	PSR	PPR	Metropolitan Readiness Test Reading	Total	Dolch Basic Sight Word Test	Red Glass Test Right Eye	Left Eye	Reading Group	Sex
1.	118	3.32	3.45	3.55	64	90	220	1/100	1/100	Top	F
2.	114	2.27	2.45	2.20	57	85	152	1/100	1/100	Top	M
3.	101	2.70	1.53	2.10	61	89	136	1/100	1/100	Top	M
4.	111	2.37	2.50	2.60	62	85	102	1/25	1/100	Top	F
5.	112	2.70	2.60	2.10	59	86	118	1/100	1/100	Top	M
6.	111	2.37	1.95	2.20	58	81	118	1/100	1/100	Top	F
7.	128	2.60	2.70	3.10	60	90	146	1/100	1/100	Top	F
8.	111	2.60	2.40	2.20	64	87	158	1/100	1/100	Top	F
9.	103	2.90	1.75	3.22	57	81	178	1/100	1/50	Top	F
10.	110	2.43	1.90	1.85	56	81	110	1/100	1/100	Top	F
11.	106	2.10	2.00	2.22	58	82	96	1/100	1/100	Top	M
12.	120	2.27	1.75	2.10	63	93	132	1/100	1/100	Top	F
13.	97	2.43	2.35	2.00	52	72	106	1/50	1/100	Middle	F
14.	110	2.20	2.13	2.20	58	76	92	1/100	1/100	Middle	M
15.	121	2.20	2.30	2.10	60	85	96	1/100	1/100	Middle	M
16.	112	2.33	2.15	1.90	58	74	78	1/100	1/100	Middle	F
17.	103	2.43	2.15	2.20	55	71	106	1/50	1/100	Middle	F
18.	99	2.30	1.90	1.95	59	77	76	1/100	1/100	Middle	M
19.	110	2.15	1.60	1.90	45	53	78	1/100	1/100	Bottom	M
20.	105	2.05	1.50	1.85	58	72	40	1/100	1/25	Bottom	M
21.	104	2.23	1.80	2.10	61	76	82	1/100	1/100	Bottom	M
22.	130	2.40	2.20	2.10	57	76	80	1/100	1/50	Bottom	F
23.	103	2.70	1.62	1.95	53	75	94	1/100	1/100	Bottom	M

APPENDIX D

RAW DATA FOR EACH CHILD ON WHICH ANALYSES WERE BASED (Fourth Grade)

APPENDIX D

RAW DATA FOR EACH CHILD ON WHICH ANALYSES WERE BASED
(Fourth Grade)

Subject	Henmon-Nelson I.Q.	Durrell-Sullivan Reading Achievement Test WM	PM	Total	Sequential Tests of Educational Progress (Reading)	Iowa Tests of Basic Skills Voc.	Reading	Red Glass Test Right Eye	Left Eye	Reading Group	Sex
1.	128	58	35	93	90.5	50	49	1/100	1/100	Top	M
2.	125	65	53	118	96.5	77	69	1/50	1/25	Top	M
3.	101	7	11	18	31.0	57	55	1/50	1/100	Bottom	F
4.	133	38	20	58	92.0	58	55	1/10	1/5	Top	F
5.	126	42	19	61	88.0	54	41	1/100	1/50	Middle	F
6.	136	42	31	73	90.5	77	55	1/100	1/100	Top	M
7.	135	61	47	108	90.5	71	60	1/100	1/100	Top	M
8.	124	60	49	109	98.8	64	69	1/100	1/50	Top	F
9.	104	22	14	36	56.5	46	29	1/25	1 sec.	Middle	M
10.	120	52	22	74	64.5	56	45	1/50	1/50	Middle	F
11.	115	38	17	55	69.0	50	49	1/5	1/2	Middle	F
12.	110	26	13	39	48.5	26	31	1/100	1/100	Middle	F
13.	107	44	28	72	92.0	60	61	1/100	1/100	Middle	M
14.	119	53	35	88	95.5	58	64	1/100	1/25	Top	F
15.	101	13	6	19	12.5	57	55	1/100	1/25	Bottom	M
16.	123	22	17	39	61.5	48	47	1/50	1/100	Middle	M
17.	129	49	31	80	84.0	62	48	1/50	1/50	Middle	F
18.	144	51	36	87	96.5	64	69	1/100	1/50	Top	M
19.	119	57	33	90	98.2	64	60	1/100	1/10	Top	F
20.	119	50	29	79	95.5	56	60	1/100	1/100	Middle	M
21.	121	36	19	55	56.5	60	44	1/100	1/100	Top	M