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RELATIONSHIPS AMONG THE KEYSTONE VISUAL SURVEY TELEBINOCULAR WITH READING ACHIEVEMENT AND THE DIAGNOSES OF A VISION CLINIC

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RELATIONSHIPS AMONG THE KEYSTONE VISUAL SURVEY TELEBINOCULAR WITH READING ACHIEVEMENT AND THE DIAGNOSES OF A VISION CLINIC

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INTRODUCTION

The prevalence of reading disability in our schools is tragic. Betts[1] reported that 8 to 15 percent of the school population had varying degrees of reading disability. Durrell[2] reported 15.2 percent with disability. Austin, Bush and Huebner[3] reported approximately 16 percent needed special help in grades three through nine.

Reading disability may be mild, moderate or severe, but whatever its degree it must be assumed that there is present a cause or pattern of causes which so handicaps a child that he has difficulty making normal progress in reading. To identify the cause or causes of disability necessitates an inquiry into the impeding factor or factors.

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[1] E. A. Betts, Foundations of Reading Instruction (New York: American Book Company, 1957), pp. 163-164.

[2] D. D. Durrell, Improvement of Basic Reading Abilities (New York: Harcourt, Brace and World, 1940), p. 109.

[3] M. E. Austin, C. L. Bush, M. H. Huebner, Reading Evaluations (New York: Ronald, 1961), p. 12.

The importance of good vision to the optimal development and education of all children should not be underestimated. The need for good visual screening methods are necessary to insure that no child is handicapped by visual impairment. Especially, if that visual impairment can be remediated by treatment or corrected through the use of aids such as eye glasses.

According to Rosenbloom,[4] "Many children experiencing visual problems pass the visual screening procedures used in most schools today." These tests were adequate for the purposes for which they were designed, determining clearness of vision, but gave no information concerning the many additional skills necessary for efficient seeing.

According to Kelly[5] we are not doing an adequate job of vision screening in the public schools. He stated that,

> Conservative estimates of those in the schools needing professional visual care average about 30 percent and except in places where effective visual screening programs are in operation, most of these go undetected for years.

Turner[6] reported that only one in five of the eighteen percent of 12,000 Illinois children who needed professional

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[4]Alfred A. Rosenbloom, Jr., "Promoting Visual Readiness For Reading," International Reading Association Conference Proceedings (New York: Scholastic Magazines, 1961), Volume VI, pp. 89-91.

[5]Charles R. Kelly, Visual Screening and Child Development: The North Carolina Study (Raleigh: North Carolina State College, 1957), pp. 101-102.

[6]C. S. Turner and J. A. Potter, "The Peoria Visual Screening Project," Illinois Medical Journal, III, 1950, pp. 10-12.

attention received it. Such failure of detection of visual defects in the schools appeared to be the result of using ineffective screening devices. Bond[7] stated, "The Snellen Chart is at a disadvantage as a measuring device for use in the schools."

Stump[8] and Vetterli[9] thoroughly criticized the use of the Snellen test. Their most serious criticism involved the fact that, "The Snellen test essentially checks only far-point acuity while most school tasks are near-point activities." Studies by Robinson[10] have shown only low relationships between far-point acuity and near-point acuity.

As one of the senses, seeing affects the performance of the whole child. Gesell[11] pointed out that, "Vision influences not only the child's performance and adjustment in school activities and in society but also his health and welfare." Thus a complete visual examination at annual or

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[7]Guy L. Bond and Miles A. Tinker, Reading Difficulties (New York: Appleton-Century-Crofts, Inc., 1967), p. 108.

[8]Franklin N. Stump, "Visual Performance and School Success," The Educational Focus (New York: Bausch and Lomb Optical Co., February, 1955), p. 91.

[9]C. H. Vetterli, "How Good is 20/20 Vision?", Education, LXXX, 1959, pp. 28, 41-45.

[10]Helen M. Robinson, "Visual Efficiency and Learning To Read," Clinical Studies in Reading II (University of Chicago Press, 1953), p. 185.

[11]Arnold Gesell, Vision: Its Development In Infant And Child (New York: Paul B. Hoeber, 1949), p. 10.

other regularly spaced intervals is important to discover those children who have vision problems.

The two main objectives of a visual-screening program for school children are, according to Blum,[12] (1) to detect those children who have vision problems, or potential vision problems, that may affect the physiological or perceptive processes of vision, and (2) to find those children who have vision problems that interfere with performance in the school. Although these two objectives overlap, they are not identical. Bing[13] has pointed out that some vision problems may not directly affect school performance and some may affect school performance but not affect the visual health. Children in elementary school with both types of problems must be detected by the vision-screening program. The screening program should detect those children who, because of their visual mechanisms, have performance handicaps, detect those children who have visual anomalies that may become performance handicaps at some future time, and detect those children with eye-health problems who should be under professional observation or treatment.

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[12]Henrik L. Blum, Henry B. Peters and Jerome W. Bettman, Vision Screening For The Elementary School (Berkeley and Los Angeles: University of California Press, 1959), p. 23.

[13]Lois B. Bing, "A Critical Analysis of the Literature on Certain Visual Functions Which Seem To Be Related To Reading Achievement," American Journal of Ophthalmology, 1951, Volume XXII, pp. 454-463.

Bond and Tinker[14] indicated that ocular comfort and visual efficiency are desirable prerequisites for easy reading. They stated that, "When a child shows signs of becoming a disability case, the tendency of both parents and teachers is to think of the possibility of visual deficiency." It is true that a child's eyesight may be so poor that it is practically impossible to read. But there seems to be a number of less severe eye defects which constitute handicaps to children in the reading situation. Bond and Tinker[15] pointed out, "When these pupils attempt to read they become uncomfortable, squirmy, and they become distraught to such a degree that they can continue the reading activity for only a short time."

Rosenbloom[16] stated that,

> If the child's growth processes are normal by the time he is seven or eight, the child has developed a mature pattern of binocular vision. If during the growth period something interfers with his ability to fixate or focus or fuse the two images, the child may develop an abnormal adjustment to binocular vision.

This interference may be a task inappropriate for his level of maturity or an interference caused by a physical alteration in visual structure.

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[14]Guy L. Bond and Miles A. Tinker, Reading Difficulties: Their Diagnosis and Correction (2nd ed.; New York: Appleton-Century-Crofts, 1967), p. 101.

[15]Ibid., p. 101.

[16]Alfred A. Rosenbloom, Jr., "Promoting Visual Readiness For Reading," International Reading Association Conference Proceedings (New York: Scholastic Magazines, 1961), Volume VI, pp. 89-91.

Learning to read involves the ability to change, focus, and converge and maintain this complicated posture as the eyes move along the printed page. In an effort to achieve single clear vision so necessary for efficient reading, the child who is not visually mature may attempt adaptations of focusing, fixating or fusing as well as making a variety of other adjustments. It is not uncommon to find the child retreating from the reading act. Not being able to take advantage of the reading act he becomes further retarded in reading subjects until he is finally classified as a retarded reader. His comprehension of material will often be low because his conscious attention must be directed toward maintaining clear and single vision. He may achieve this but fail to remember what he reads. In many instances he may achieve only with repeated tutoring despite a high learning capacity. If he is highly motivated he probably will spend more time at his studies. If not highly motivated, he likely will become discouraged to the point he will announce his dislike for reading.

Definitions

1. Pass-fail: Scoring within the heavy black lines on Form 5A School Survey Cummulative Record constituted a passing score on each item. A subject was considered having failed if the subject's score was outside the heavy black lines.

2. Visual Clinic: A Children's Visual Clinic located on a Military Base staffed by Vision specialist.

3. Vision Problem: Those subjects who failed in one or more areas of the fourteen item Telebinocular test.

Statement of Problem

This study was designed to determine whether or not differences existed between vision characteristics of pupils, as determined by the Keystone Telebinocular and their achievement in reading, as determined by the California Reading Test. The problem was further designed to determine whether or not relationships existed, the direction of these relationships and the strength of these relationships. Another aspect of the problem was to determine whether the Keystone Telebinocular was a reliable instrument for screening children for referral to a specialist.

Several contributory problems examined were:

1. To determine whether a relationship existed between the refractory aspects of vision and reading achievement.

2. To determine whether a relationship existed between the binocular aspects of vision and reading achievement.

Hypotheses

HO_1 There are no significant differences among the mean reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests

and who have no visual problems as determined by the Keystone Telebinocular and the mean reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_2 There are no significant differences among the mean reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the mean reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have binocular visual problems as determined by the Keystone Telebinocular.

HO_3 There are no significant differences among the mean reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the mean reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have refractory visual problems as determined by the Keystone Telebinocular.

HO_4 There is no significant difference between visual problems as determined by the Keystone Telebinocular among boys and visual problems among girls as determined by the Keystone Telebinocular.

HO_5 There is no significant difference between visual scores of children that are recorded as failures as determined by the Keystone Telebinocular and those same children's visual scores when determined by the Visual Clinic.

HO_6 There is no significant relationship between the reading grade equivalent scores of second graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of second graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_7 There is no significant relationship between the reading grade equivalent scores of third graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of third graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_8 There is no significant relationship between the reading grade equivalent scores of fourth graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of fourth graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_9 There is no significant relationship between the reading grade equivalent scores of fifth graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of fifth graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_{10} There is no significant relationship between the reading grade equivalent scores of sixth graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of sixth graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_{11} There are no significant relationships among reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have binocular visual problems as determined by the Keystone Telebinocular.

HO_{12} There are no significant relationships among reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests and who have no visual problems as determined by the

Keystone Telebinocular and the reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have refractory visual problems as determined by the Keystone Telebinocular.

Basic Assumptions

There were a number of basic assumptions to the problem:

1. A large number of elementary school children in a given population could be effectively screened for referral to visual specialists for proper diagnosis and correction of visual problems.

2. A large number of elementary school children in a given population had visual anomalies undetected, severe enough to cause significant achievement problems.

3. A number of elementary school children in a given population had potentially severe anomalies that could be discovered and referrals made in order that preventative type treatment be made before the anomalies were severe enough to cause achievement loss.

Procedures Used

Approximately 1200 elementary school children from two elementary schools in Lawton, Oklahoma were given a visual screening test in October 1969. The grade levels ranged from grade two through grade six. The Keystone Telebinocular was the instrument used to screen the vision of the children.

The screening was done by the school nurses of the local school system. The nurses received special instruction concerning the administering of the Telebinocular Test by the staff of the Visual Clinic. All referrals were made to a Children's Visual Clinic located on a military base.

All subjects of the total population were administered the California Reading Tests to determine the achievement level. Reading grade equivalent scores were used as the data for the statistical analyses. The test was administered in January, 1970.

Thirty children from each grade level, two through six, who had visual problems as determined by the Telebinocular were randomly selected and matched by grade level, age and sex with a group of thirty children selected from each grade level who did not have visual problems. The children were matched so that no two were more than six months apart in age.

An analysis of variance was used to determine whether a significant difference existed for the first hypothesis. An analysis of variance was used to analyze the data because more than two groups were being compared. Wert[17] stated, "It would be impossible to compare each group with every other group and then test the significance." Downie

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[17]James E. Wert, Charles O. Neidt and J. Stanly Akmann, Statistical Methods In Educational Research (New York: Appleton-Century-Crofts, Inc., 1954), pp. 172-173.

and Heath[18] pointed out that when analyzing data by comparing subsamples one by one the fact that subsamples exist in a set is ignored. They further stated, "The elements of such sets are known to interact." This interaction must be taken into account. Analysis of variance does not ignore interaction.

Hypotheses two and three were analyzed by a single analysis of variance. Thirty children were selected randomly, six from each grade level two through six, who had binocular or refractory visual problems as determined by the Telebinocular and matched by grade level, age and sex with a group of thirty children, six from each grade level two through six who did not have visual problems.

Hypothesis four was treated by the use of the Chi Square[19] test since the data were independent. The formula used in the treatment of hypothesis four was $X^2 = \frac{(O-E)^2}{E}$.

Hypothesis five was treated by use of the proportion. The formula used was $\frac{pq}{N}$. It is often feasible to find the proportion of a given sample which exhibits a certain behavior when it is difficult or impossible to measure that attribute directly.[20]

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[18]N. M. Downie and R. W. Heath, Basic Statistical Methods (2nd ed.; New York: Harper and Row, 1965), pp. 176-177.

[19]Sidney Siegel, Non-Parametric Statistics For The Behavioral Sciences (New York: McGraw-Hill Book Co., Inc., 1956), p. 60.

[20]Henry E. Garrett and R. S. Woodworth, Statistics In Psychology and Education (5th ed.; New York: Longmores, Green and Co., 1958), p. 197.

A correlation using a bi-serial coefficient method of correlation was used for testing hypotheses six through twelve at the .05 level of significance. The bi-serial was selected as the statistical method as it was important to calculate the correlation between traits or attributes, when the first members of the group can be measured in the first variable, but can only be classified into two categories in the second or "dichotomous" variable.[21] The formula used was $b = M_p - M_t \cdot \frac{1}{N}$.

Limitations of the Study

The intent was not to match the groups in terms of intelligence scores. The study was limited as the subjects were not matched according to socio-economic backgrounds. Further, the study was limited as the teacher variations were not accountable. A student's mobility could not be controlled in this study, therefore, the possible diversity of instructional background and methods was a limiting factor. Finally the study did not imply causation.

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[21]Henry E. Garrett, Statistics In Psychology And Education (New York: Longmans, Green and Co., 1950), p. 347.

CHAPTER II

A REVIEW OF THE LITERATURE

Research has been concerned with varied possible relationships between reading and vision, both of a general nature and of a specific nature, for many years. Many methods and techniques have been used by investigators to assess the vision problems of school children. Since it would not contribute to our purpose to review all of the many studies reported in the literature, we have selected for review, studies which are representative.

Crider[1] explored the relationship between eye muscle imbalance and visual fusion, alternating vision and ocular dominance. Crider found that 75.24 percent of the pupils (N = 105) with a left eye imbalance tended to read digits with their right eye, while 84.24 percent of the pupils (N = 38) with a right eye imbalance tended to read digits with the left eye.

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[1]B. Crider, "Certain Visual Functions in Relation to Reading Disabilities," Elementary School Journal, XXXV, 1934, pp. 295-297.

Betts,[2] from his clinical investigations of children and the development of the Betts Ready to Read Test concluded that many reading problems were directly related to a lack of binocular coordination and fusion. He found approximately ninety percent of an unreported figure of severely disabled readers who had "faulty binocular coordination and astigmatism."[3]

Good[4] investigated the relationship between "muscle fusion power and reading disability" with matched groups of 25 elementary school children. The experimental group consisted of reading disability cases while the control group consisted of able readers. Poor readers were found to have the least duction power while average readers possessed good duction power. Although no data were provided, after correction of ocular defects, the disabled readers were reported to have made marked improvement. Good concluded, "adduction and abduction weaknesses definitely accompany difficulties in learning to read."[5]

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[2]E. A. Betts, "A Physiological Approach to the Analysis of Reading Disabilities," Educational Research Bulletin, XIII, 1934, pp. 135-140, 163-173.

[3]Ibid., p. 171.

[4]G. H. Good, "Relationship of Fusion Weaknesses To Reading Disabilities," Journal of Experimental Education, VIII, 1939, pp. 115-121.

[5]Ibid.

Dearborn and Anderson[6] explored the relationship of aniseikonia, a fusion problem, to reading disability with similar groups of 100 subjects whose chronological ages ranged from nine to young adult. The investigators found 51 percent of the experimental group evidenced aniseikonia in excess of one percent compared to 23 percent in the control group. The between group difference was sufficient to be statistically significant at the .001 level. Dearborn and Anderson noted that aniseikonia in excess of one percent was normally considered sufficient for visual disturbance while aniseikonia under one percent was not critical. They also concluded that aniseikonia was one of the major factors in "causation and persistance of disability in reading."[7]

Dearborn and Anderson pointed out, "Aniseikonia affected the child's ability to fuse images from both eyes."[8] This lack of fusion ability caused the child to use extra energy when attempting to compensate for his inability. The use of extra energy to force fusion caused ocular and general body fatigue which resulted in shorter periods of task concentration. Aniseikonia was also found to affect peripheral span and length of fixation, both deemed necessary for effective reading.

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[6]W. F. Dearborn and I. W. Anderson, "Aniseikonia as Related to Disability in Reading," Journal of Experimental Psychology, XXIII, 1938, pp. 559-577.

[7]Ibid., p. 577.

[8]Ibid., p. 576.

Park and Burri[9] examined the relationship of various eye conditions and reading achievement in an attempt to determine the degree to which certain visual conditions influenced reading achievement. The investigators found that good readers had fewer than average visual deficiencies than poor readers for their chronological and mental age groups. Poor readers tended to have more than the average number of visual deficiencies for their corresponding chronological and mental age groups. A correlation was reported between visual deficiencies measured in this study (acuity, refractive error, fusion, steropsis, phorias and ductions) and reading proficiency.

The St. Louis Study by Crane, Scobes, Green and Price[10] was a major attempt to evaluate the effectiveness of vision screening at two grade levels. A comparison was made of the screening scores and on ophthalmologists clinical data on 606 first graders and 609 sixth graders.

The reports were based on three steroscopic devices, one of which was the Telebinocular. The results were similar for all three devices although the reports indicated the better trained the tester the more efficient the screening.

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[9]G. E. Park and Clara Burri, "The Effect of Eye Abnormalities on Reading Difficulties," Journal of Educational Psychology, XXXIV, 1943, pp. 420-430.

[10]M. M. Crane, et al., "Study Procedures vs Ophthalmologist Findings," Sight Saving Review, XXII, 1952, pp. 141-153.

The reports indicated that even the best method missed more than one third of the students needing attention.

The North Carolina Study (1956) by Kelly,[11] was of particular interest because the report contained a detailed review of the St. Louis Study. The study was concerned with the testing by means of a Telebinocular, of the vision skills of 213 white pupils, 67 in the first grade, 77 in the fifth, and 69 in the ninth grade. The screening scores were computed with intelligence scores, scholastic achievement, reading skills, and personal adjustment. The same children were followed for five years and the changes in vision and other factors noted. Many derived scores were developed, and relations of significance were shown to exist between the vision scores and the other test results. Kelly's conclusions suggested that a vision-screening program include, as a minimum, tests for visual acuity at the far-point and at the near-point, lateral imbalance (phoria) at the far-point and at the near-point and a test for fusion.

An important aspect of Kelly's study was that 10 out of a total of 19 visual scores which he obtained were "derived" or not obtained directly from the instrument he used. He concluded that students with fusion difficulties may have normal reading scores except for speed which was significantly slower.

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[11] Charles R. Kelly, Visual Screening and Child Development: The North Carolina Study (Raleigh: North Carolina State College, 1957), pp. 101-102.

Kelly also found that stereopsis was not significantly related to reading, although good "depth" scores were associated with "good fusion, good visual acuity and either good lateral imbalance scores or over convergence."[12] Further, good students with poor convergence and exophoria at near-point indicated extreme "visual handicaps with poor fusion, low depth scores and poor near and far visual acuity."[13]

Kelly also found that myopic children who had phorias performed at almost the same level on reading tests as did those without phorias, but hyperopes with phorias at far-point had much poorer reading skills. Generally, myopia with no lateral imbalance and good fusion were associated with good readers while hyperopia, lateral imbalance, over convergence and fusion problems were associated with poor readers.

Kelly stated that most attempts to relate acuity, or keeness of vision, to reading difficulties had in most cases failed. He concluded that most refractive errors, unless clearness of vision was impaired to a marked degree at near-point, were not significant to the over all problem.

A number of researchers have reported positive correlations between deficient reading ability and visual disorders. The following researchers failed to find such

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[12] Ibid., p. 101.

[13] Ibid., p. 102.

relationships regardless of instruments used for screening or testing:

Fendrick[14] compared visual characteristics of 64 reading disability cases with 64 subjects constituting a control group to note "the degree of disparity which might exist for the two reading populations with respect to various physiological measures of vision." Fendrick found no difference between groups in refractive errors needing correction. Good readers receiving nonphonetic reading instruction had significantly better right, left and binocular vision than poor readers with similar instruction. The between group difference was not significant for those subjects taught by the phonetic method. No significant difference for "lateral muscle imbalance at distance or near fixation"[15] was found. A predominant eye or hand did not characterize any group. Seventy-five percent of the good readers and fifty percent of the poor readers in the nonphonetic group had normal vision. An examination with the Keystone Telebinocular tests of reading readiness of beginning readers confirmed right eye superiority of the nonphonetic group.

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[14]P. Fendrick, "Visual Characteristics of Poor Readers," Teachers College Contributions to Education, 1935, No. 656, p. 10.

[15]Ibid., p. 10.

Witty and Kopel[16] reported on the relationship of heterophoria and reading disability among 100 third through sixth grade children with average ability in reading but who were functioning one semester or more below grade norms. A group of similar children with normal reading ability were used as a control group. The relationship between all muscle balance difficulties and reading abilities, isolated or in total, demonstrated little positive relationship.

Swanson and Tiffin[17] examined the Betts Test of Visual Sensation and Perception for differentiating between good and poor first year college readers. The researchers concluded there was no statistically significant difference between good and poor readers visually as evidenced by the Betts Tests. No significant differences between groups were found for (1) far-point and near-point fusion, (2) lateral imbalance, (3) vertical imbalance, (4) stereopsis, (5) visual acuity and (6) ametrophia.

Eames[18] investigated the incidence of eye defects among boys and girls. The sample consisted of 443 subjects; 80 percent boys and 20 percent girls, of the Anglo-Saxon race.

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[16]Paul Witty and David Kopel, "Factors Associated With the Etiology of Reading Disability," Journal of Educational Research, XXIX, 1936, pp. 449-459.

[17]D. E. Swanson and J. Tiffin, "Betts Physiological Approach to the Analysis of Reading Disabilities as Applied to the College Level," Journal of Educational Research, XXIX, 1936, pp. 433-448.

[18]T. H. Eames, "Study of The Incidence of Eye Defects and Sex Among Poor Readers," Journal of Educational Research, XXXIII, 1939, pp. 102-104.

The data indicated that there was no parallel between visual defects and sex as had been found between reading ability and sex.

Spache[19] compiled a comprehensive report of 50 separate research studies. Spache reached several general conclusions from this survey: (1) Visual defects did not differentiate good readers from poor readers. (2) Visual defects were a hinderance in individual cases and their correction an advantage. (3) Visual defects may impede both good and poor readers.

Dalton[20] surveyed the visual functioning of 5,821 subjects in grades three through twelve with the Keystone Telebinocular test. Dalton observed that children with normal vision did no better than children with defective vision in general achievement or reading performance. The investigator concluded that "on the average, there was very little, if any, general relationship between normal or defective vision and scholastic achievement."[21]

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[19]G. D. Spache, "The Role of Visual Defects in Spelling and Reading Difficulties," American Journal of Orthopsychiatry, X, 1940, pp. 229-238.

[20]M. M. Dalton, "A Visual Survey of 5,000 School Children," Journal of Educational Research, XXXVII, 1943, pp. 81-94.

[21]Ibid., pp. 81-94.

Park and Burri[22] reported the research results of McFerland, Knehr and Berns who found no correlation between binocular cooperation and phorias for clinical patients and a control group. Correlations between binocular cooperation or phorias and measures of reading efficiently were also found to be unrelated.

Robinson[23] examined the research related to vision and reading. The review concluded that "regardless of age level or tests used, gross measures of visual acuity do not differentiate good readers."[24] Robinson noted that among the refractive errors, hyperopia was found more often among poor readers and myopia among good readers, while astigmatism did not seem to be related to reading.

Bing[25] in her review of the research related to visual functions and reading achievement noted that visual defects may be the cause, a contributing factor, or unrelated to reading performance. Bing attributed the diversity of nonstandardized testing procedures to the lack of

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[22]G. E. Park and C. Burri, "The Relationship of Various Eye Conditions and Reading Achievement," Journal of Educational Psychology, XXXIV, 1943, pp. 290-299.

[23]Helen M. Robinson, Why Pupils Fail In Reading (Chicago: University of Chicago Press, 1946), p. 15.

[24]Ibid., p. 15.

[25]Lois B. Bing, "A Critical Analysis of the Literature on Certain Visual Functions Which Seem to be Related to Reading Achievement," American Journal of Ophthalmology, XXII, 1951, 454-463.

agreement over the definitions of such fundamental words as reading disability, visual defects, and adequate vision.

Edson, Bond and Cook[26] investigated the relationship between various measures of silent reading ability and visual ability. The researchers concluded that reading achievement and vision ability were not significantly related.

Betts[27] from his experience in researching visual and reading factors concluded that although certain visual and reading factors may hinder one child's reading, they may not hinder others. According to Betts some were quite able to compensate for their disability while others were not. Betts concluded that both types of children needed assistance.

Shearer[28] used the Keystone Telebinocular test to investigate the visual functioning of 200 elementary school students reading one or more years below grade level. Shearer found 54 percent of the sample had sight difficulties and gave the following breakdown of difficulties:

Hypermotrophia (over 1 prism Diopter)	16%
Hyperoptic Astigmatism	3%
Myopia (over 1/2 D)	4%
Vertical Phoria (over 1 D)	1%
Esophoria (over 4 D)	2%

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[26]W. H. Edson, G. L. Bond and W. W. Cook, "Relationships Between Visual Characteristics and Specific Silent Reading Abilities," Journal of Educational Research, XXXXVI, 1953, pp. 45-47.

[27]E. A. Betts, Foundations of Reading Instruction (Chicago: American Book Company, 1957), pp. 172-202.

[28]R. V. Shearer, "Eye Findings in Children With Reading Difficulties," Journal of Pediatric Ophthalmology, III, 1966, pp. 47-52.

Exophoria At Near	26%
Poor Convergence	12%
Poor Stereopsis and Fusion Ability	10%

Bond and Tinker[29] from their review of survey studies of visual deficiencies reported that most studies revealed a large number of visual problems among school population. Usually no significant relationship was found between vision difficulties and reading problems.

Pollack and Piekarz[30] concluded from a survey of the research that a relationship existed between nearsightedness and academic success.

Summary

A review of the professional literature indicated that certain physiological factors have been identified as being related to the reading process. Although there is disagreement as to the relative weight assigned to the physiological factors and how to assign that weight, there seems to be a general agreement that reading development can be negatively influenced by physiological factors.

Based on the research cited, it would appear that visual defects may not cause reading disabilities but may impede reading development. No direct relationship has been demonstrated between reading deficiencies and visual defects.

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[29]G. L. Bond and M. A. Tinker, Reading Difficulties (New York: Appleton-Century-Crofts, Inc., 1957), p. 102.

[30]M. E. W. Pollack and Josephine Piekarz, Reading Problems and Problem Readers (New York: David McKay Company, Inc., 1963), pp. 17-19.

It would appear that any visual defect singularly or in combinations may inhibit reading development. The purpose of this study was to investigate the question of whether or not there is a relationship between reading achievement and visual problems. This information would then provide school officials with additional evidence on which to base decisions concerning the development of visual screening programs for the schools not participating in the present program.

CHAPTER III

PROCEDURE OF THE STUDY

The Population

The population of this study consisted of the students of the elementary schools on a nearby military base, grades two through six. The military community of Lawton, Oklahoma has two elementary schools on the base, operated and maintained by the Lawton Public School System. The population of the military base is housed in military housing, ranging from multifamily dwellings for enlisted men and their families to single dwellings for higher ranking officers and their families. All dependents of elementary school age of military families living on the base, kindergarten through sixth grade, attend one of the two elementary schools.

Table 1 shows the enrollment distribution by grade level of the two schools.

Selection of Subjects

The procedure used in this study for the selection of the subjects was to screen the vision of all students grades two through six, using the Keystone Telebinocular as the screening device. Those students who failed on one or more

TABLE 1

ENROLLMENT IN THE TWO MILITARY ELEMENTARY SCHOOLS
1969-1970

Grade	School 1	School 2	Total
1	120	94	214*
2	118	95	213
3	112	117	229
4	110	105	215
5	112	114	226
6	106	103	209
Total	678	628	1306

*Not included in the study.

items of the fourteen item check list were referred to the base Visual Clinic for a follow-up test. The students referred became the experimental group from which samples were randomly selected using the table of random numbers.[1] All students not referred became the control group and were matched by grade, sex, and age with the experimental group.

Following the visual screening test all subjects from both control and experimental groups were administered the California Reading Test. The reading grade equivalent scores of the California Reading Test were compared with the Telebinocular results by grade level, sex and age to produce the statistical evidence recorded in Chapter IV.

The experimental group made up of those students failing one or more items on the Telebinocular visual

[1]Herbert Arkin and Raymond R. Colton, College Outline Series, Tables for Statisticians, Barnes and Noble, Inc., 1963, reprint 1966, pp. 158-161, Table 25.

survey test were referred to a Visual Clinic on the military base.

Table 2 shows the distribution by grade level, age and sex of the experimental group.

TABLE 2

EXPERIMENTAL GROUPS BY GRADE, AGE AND SEX

Grade	Boys	Girls	Total
2	41	23	64
3	39	35	74
4	40	26	66
5	35	37	72
6	34	31	65
Total	189	152	341
Age	**Boys**	**Girls**	**Total**
7	31	16	47
8	36	27	63
9	42	37	79
10	36	37	73
11	28	21	49
12	15	.13	28
13	1	1	2
14	0	0	0
Total	189	152	341

The control group consisted of all students not failing a single item on the Telebinocular visual survey test. Table 3 shows the distribution by grade, age and sex.

TABLE 3

CONTROL GROUP BY GRADE, AGE AND SEX

Grade	Boys	Girls	Total
2	77	72	149
3	73	82	155
4	70	79	149
5	77	77	154
6	72	72	144
Total	369	382	751

Age	Boys	Girls	Total
7	49	55	104
8	63	70	133
9	65	69	134
10	69	85	154
11	70	77	147
12	35	23	58
13	14	1	15
14	4	2	6
Total	369	382	751

Instruments of Measure

The Keystone Visual Survey Telebinocular was the instrument used to screen the vision of the subjects. The Keystone Visual Survey Telebinocular, distributed by the Keystone View Company, Meadville, Pennsylvania, consisted of a binocular viewer and a series of slides. It is employed to detect indications of nearsightedness, farsightedness, astigmatism, muscular imbalance, lack of near-point and far-point fusion, as well as binocular efficiency and stereopsis level

(depth perception).[2] It has the advantage of yielding a fairly comprehensive visual inventory and of appraising the coordination of the eyes under conditions similar to those in reading activities. School Survey Cummulative Record Form Number 5A for use with the Visual Survey was used to record the results of the individuals screened. These forms consisted of fourteen items. Numbers one through nine test at the far-point and ten through fourteen test at near-point.

Scoring within the heavy black lines on Form 5A constituted a passing score on each item. A subject was considered having failed if the subject's score was outside the heavy black line on any single item.[3]

The California Reading Test was administered to all subjects. The California Reading Test was used because the test was designed for ease of administering and the familarity of the teachers with the test. It required a minimum of formal training on the part of the teachers. The norming of the test was related to the population used in this study.[4]

Grade two used Forms W&X, 1957 edition, for lower primary. The reading portion of the test has a reliability

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[2]Manual of Instructions For Use With The Keystone Visual Survey Service, Revised 1964, Keystone View Company, Meadville, Pennsylvania, p. 3.

[3]Ibid., p. 4.

[4]Ernest W. Tiegs and Willis W. Clark, California Achievement Tests Manual, Lower Primary, 1957 ed., California Test Bureau, p. 8, Table 1.

coefficient of .88.[5] The reliability has been tested with other standardized tests. These tests are the Metropolitan Achievement Tests, Primary 1, Form R and the Stanford Achievement Tests, Elementary, Form J, with correlations of .94 and .55 respectively.[6]

Test Form W&X, Lower Primary was used for testing of the second grade as two levels of the test have been developed. The manual recommends the use of this battery for the particular level.

Grade three used Forms W&X, 1957 edition, 1963 Norms, Upper Primary. The reading portion of this battery has a reliability coefficient of .94.[7] The test has been correlated with the Metropolitan Achievement Tests, Primary 2, Form R, and the Stanford Achievement Tests, Elementary, Form J, with a correlation of .86 and .81 respectively for vocabulary and with a correlation of .81 and .84 respectively for reading comprehension.[8]

Test Forms W&X, Upper Primary were developed for higher second grade, third grade and lower fourth grade. The more difficult items were incorporated into this battery.

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[5] Ibid., p. 4.

[6] Ernest W. Tiegs and Willis W. Clark, California Achievement Test Manual, Upper Primary, 1957 ed., California Test Bureau, p. 9, Table 1.

[7] Ibid., p. 12, Tables 10 and 11.

[8] Ernest W. Tiegs and Willis W. Clark, California Achievement Tests Manual, Elementary, 1957 ed., California Test Bureau, p. 8, Table 1.

The fourth, fifth and sixth grades were administered Forms WXYZ, 1957 edition, 1963 Norms, of the California Achievement Tests. The reliability coefficient of the test is .95.[9] The tests have been correlated with the Metropolitan Achievement Tests, Elementary, Form R, and the Stanford Achievement Tests, Intermediate, Form J. The coefficients obtained were .95 and .83 respectively for the vocabulary and .83 and .85 respectively for the comprehension.[10]

Grades four, five and six were administered Forms WXYZ, Elementary. This form was developed especially for the age and grade level.[11]

Treatment of Data

An analysis of variance was used to determine whether a significant difference existed for the first three hypotheses. An analysis of variance was used to analyze the data because more than two groups were being compared. Wert[12] stated "It would be impossible to compare each group with every group and then test the significance." Downie and Heath pointed out that when we analyze our data by comparing

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[9] Ibid., p. 13, Tables 9 and 10.

[10] Ibid., p. 13, Tables 10 and 11.

[11] Ibid., p. 42.

[12] James E. Wert, Charles O. Neidt and J. Stanly Akmann, Statistical Methods In Educational Research (New York: Appleton-Century-Crofts, Inc., 1954), pp. 172-173.

subsamples one by one the fact that subsamples exist in a set is ignored. They stated, "The elements of such sets are known to interact."[13] This interaction must be taken into account. Analysis of variance does not ignore interaction.

Hypothesis four was treated by the use of the Chi Square[14] test since the data were independent. The formula used in the treatment of hypothesis four was $X^2 = \frac{(O - E)^2}{E}$.

Hypothesis five was treated by use of the proportion. The formula used was $\frac{pq}{N}$. It is often feasible to find the proportion of a given sample which exhibits a certain behavior when it is difficult or impossible to measure that attribute directly.[15]

The Bi-serial Correlation Coefficient was chosen to analyze the data of the study to find the direction of the relationships for hypotheses six through twelve. The bi-serial was chosen because one variable was continuous and the second variable had been forced into a dichotomy. The visual screening test was reduced to a pass-fail dichotomy, and as is the procedure in testing dichotomus scoring, the bi-serial r is used as the measure.

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[13]N. M. Downie and R. W. Heath, Basic Statistical Methods (2nd ed.; New York: Harper and Row, 1965), pp. 176-177.

[14]Sidney Siegel, Non-Parametric Statistics For The Behavioral Sciences (New York: McGraw-Hill Book Company, Inc., 1956), p. 60.

[15]Henry E. Garrett and R. S. Woodworth, Statistics in Psychology and Education (5th ed.; New York: Longmans, Green and Co., 1958), p. 197.

Downie and Heath pointed out that, "The Bi-serial r is an estimation of the product-moment correlation coefficient.[16] The standard error of the bi-serial r may be estimated where the proportions in each of the two categories were determined. The ordinate was obtained from the normal probability table and the significance of the bi-serial r was tested by referring to the table of Distribution of "t" probability.[17]

The bi-serial r cannot be manipulated as can the Pearson r. Downie and Heath pointed out, "Another peculiarity of the bi-serial r is that sometimes it may be larger than 1 as computed."[18] Such errors are brought about by departures from normality in the continuous or dichotomized variable or both.

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[16] Ibid., p. 193.

[17] Ibid., p. 298.

[18] Ibid., p. 298.

CHAPTER IV

ANALYSIS OF THE DATA

After the data for the study were gathered, as described in Chapter III, an analysis of variance was computed. An analysis of variance was used to analyze the data for hypotheses one through three. The method of analysis of variance used was described by Wert.[1] The results obtained are displayed in Table 4 and a summary of the work may be found in Appendix B.

TABLE 4

ANALYSIS OF VARIANCE FOR DIFFERENCES AMONG THE MEAN READING ACHIEVEMENT SCORES AND VISUAL PROBLEMS

Source of Variation	df	ss	ms	F
Between Groups	1	1.48	1.48	.69 NS
Between Grade Levels	4	148.48	37.12	17.50*
Interaction	4	4.46	1.11	.55 NS
Within	290	615.39	2.12	
Total	299	769.81		

*Significant at the .05 level

[1]James Wert, Charles O. Neidt and J. Stanly Akmann, Statistical Methods In Educational Research (New York: Appleton-Century-Crofts, Inc., 1954), pp. 172-180.

The only significance obtained was that among grade levels. Thus HO_1 could not be rejected. The data suggested that significant differences did not exist among the mean reading grade equivalent score and visual problems of grades two through six.

The analysis of variance for binocular problems is displayed in Table 5 below. The summary of the work may be found in Appendix B. No significant differences were observed. Thus HO_2 could not be rejected. The data suggested that no significant differences existed among binocular visual problems and the mean reading grade equivalent scores of grades two through six.

TABLE 5

ANALYSIS OF VARIANCE FOR BINOCULAR PROBLEMS

Source of Variation	df	ss	ms	F
Between	1	1.00	1.00	.3 NS
Within	58	193.61	3.34	
Total	59	194.61		

An analysis of variance for refractory problems is displayed in Table 6. The summary of the work may be found in Appendix B.

An F Score of .72 was obtained which was not significant. Thus HO_3 could not be rejected. The data suggests that significant differences did not exist amont refractory

problems and the mean reading grade equivalent scores of grades two through six.

TABLE 6

ANALYSIS OF VARIANCE FOR REFRACTORY PROBLEMS

Source of Variation	df	ss	ms	F
Between	1	1.53	1.53	.72 NS
Within	58	122.75	2.11	
Total	59	124.28		

Table 7 contains data for determining whether or not there were significant differences in the number of visual problems among boys and visual problems among girls. The computed Chi-Square value of .002 was not significant beyond the .05 level of confidence of 3.84. Thus $H0_4$ was not rejected. The data suggested that the visual problems among boys and visual problems among girls were not significantly different.

TABLE 7

CHI SQUARE TWO-BY-TWO CONTINGENCY TABLE FOR VISUAL PROBLEMS AND NON-VISUAL PROBLEMS, GRADES TWO THROUGH SIX

	Boys	Girls	Total	Computed X^2
Problems	189	152	341	
Non-Problems	369	382	751	X^2 - .002 NS
Total	558	534	1092	

Table 8 contains the data for determining if the number of recorded visual scores of children as a result of the Telebinocular were significantly different when those same children's scores were tested by the Visual Clinic. The method used to test the data was $\frac{pq}{N}$. There was a sufficiently high proportion confirmed by the Visual Clinic as having visual problems to indicate that the Telebinocular was an effective instrument for use in the visual screening program.

TABLE 8

SUBJECTS SCREENED BY THE TELEBINOCULAR AND TESTED BY THE VISUAL CLINIC

	Telebinocular	Visual Clinic
Total Screened	1092	341
Failed	341*	297
Proportion	.31	.87

*Referred to the Visual Clinic

To determine whether significant relationships existed a bi-serial correlation was computed for hypotheses six through twelve. A bi-serial r was computed for each grade level using the data from Tables 2 and 3, pages 30 and 31. The method used to compute the bi-serial r was formula described by Downie and Heath.[2] The formula used

[2]N. M. Downie and R. W. Heath, Basic Statistical Methods (2nd ed.; New York: Harper and Row, 1965), pp. 190-195.

to find the value of the bi-serial r was: $r_b = \frac{M_p - M_t}{S_t} \cdot \frac{P}{Y}$ where r_b = bi-serial, M_p = mean score of those passing the visual test, M_t = total mean scores of the sample, S_t = standard deviation score, P = proportion of group passing, and Y = ordinate value.

The significance of the bi-serial r was tested using the formula $S_{r_b} = \frac{P_1 P_2}{Y} \cdot \frac{1}{N}$ where S_{r_b} = significance of the bi-serial, P_1 = proportion of group passing the visual test, P_2 = proportion of group failing visual test, Y = ordinate value, and N = number in the sample.

A bi-serial of -.12 was computed from the samples drawn from Tables 2 and 3, pages 30 and 31, at the second grade level. The bi-serial r of -.12 was tested for significance producing a "t" score of 1.20. The "t" score of 1.20 was not significant at the .05 level of 2.00. Thus HO_6 could not be rejected. The data suggested visual problems among the second grade were not significantly related to reading achievement.

A bi-serial r of -.16 was computed from the samples drawn from Tables 2 and 3, pages 30 and 31, at the third grade level. The bi-serial r of -.16 was computed for significance producing a "t" score of 1.60. The "t" score of 1.60 was not significant at the .05 level of confidence of 2.00. Thus HO_7 could not be rejected. The data suggested

visual problems among third graders were not significantly related to reading achievement.

A bi-serial r of -.18 was computed for the fourth grade level after samples had been drawn from the data contained in Tables 2 and 3, pages 30 and 31. The bi-serial r of -.18 was computed for significance at the .05 level producing a "t" score of 1.76. The "t" score of 1.76 was not significant at the .05 level of 2.00. Thus the HO_8 could not be rejected. The data suggested visual problems among the fourth grade class were not significantly related to reading achievement.

A bi-serial of -.25 was computed for the fifth grade level after samples had been drawn from the data contained in Tables 2 and 3, pages 30 and 31. The bi-serial r of -.25 was computed for significance at the .05 level producing a "t" score of 2.45. The "t" score of 2.45 was significant at the .05 level of 2.00. Thus HO_9 was rejected. The data suggested visual problems at the fifth grade level significantly related to reading achievement.

A bi-serial r was computed from the samples drawn from Tables 2 and 3, pages 30 and 31, at the sixth grade level. The bi-serial r of .03 was tested for significance producing a "t" score of .28. The "t" score of .28 was not significant at the .05 level of confidence of 2.00. Thus HO_{10} could not be rejected. The data suggested visual

problems among the sixth graders were not significantly related to reading achievement.

A bi-serial r of .012 was computed from the samples drawn from the data contained in Tables 2 and 3, pages 30 and 31. The bi-serial r of .012 was tested for significance producing a "t" score of .11. The "t" score of .11 was not significant at the .05 level of confidence of 2.00. Thus HO_{11} could not be rejected. The data suggested binocular problems in this sample were not significantly related to reading achievement.

A bi-serial of .07 was computed from the samples drawn from the data contained in Tables 2 and 3, pages 30 and 31. The bi-serial r of .07 was tested for significance producing a "t" score of .69. The "t" score of .69 was not significant at the .05 level of confidence of 2.00. Thus HO_{12} could not be rejected. The data suggested that refractory problems in this sample were not significantly related to reading achievement.

Another hypothesis was formulated upon examination of the data. If those pupils who failed the telebinocular test but passed the Vision Clinic test had their scores removed from the sample, would this affect the results of the composite scores significantly? Thus the hypothesis: There are no significant differences among the mean reading grade equivalent scores of those pupils, grades two through six,

as determined by the California Reading Test, and visual scores as determined by the Visual Clinic.

An analysis of variance for the additional hypothesis was computed and is listed in Table 9. An F score of .3 was computed. The F score of .3 was not significant at the .05 level of confidence.

TABLE 9

ANALYSIS OF VARIANCE FOR THE ADDED HYPOTHESIS

Source of Variation	df	ss	ms	F
Between	1	.81	.81	.3 NS
Within	58	151.66	2.61	
Total	59	152.47		

Thus HO_A could not be rejected. The data suggested that removal of the scores of those subjects who failed the telebinocular test but passed the Visual Clinic test did not alter the differences significantly.

CHAPTER V

SUMMARY, FINDINGS, CONCLUSIONS AND RECOMMENDATIONS

Summary

The purpose of this study was to analyze the pass-fail results of the Keystone Telebinocular and a visual clinic's diagnoses; between the Telebinocular results and the reading achievement scores of elementary children grades two through six. A review of the literature indicated that certain aspects of visual problems do affect reading achievement. A characteristic of some good readers cited was poor vision. Another group of studies indicated no relationship existed between vision problems and reading achievement.

Two schools in the Lawton Public School System, Lawton, Oklahoma were chosen for this study. The schools chosen were elementary schools on a nearby military reservation. For this research, all students in grades two through six were given a visual screening test. The Keystone Telebinocular was the instrument used for the screening. The same subjects were administered the California Reading Test in order to determine the reading achievement levels.

Thirty children from each grade level, two through six, who had visual problems as determined by the Telebinocular were randomly selected and matched by grade level, age and sex with a group of thirty children selected from each grade level who did not have visual problems.

Twelve hypotheses were developed and tested by the information obtained from the data collected. Three of the hypotheses were concerned with differences between reading achievement and visual problems. One hypothesis was concerned with the number of boys with visual problems compared to the number of girls with visual problems. One hypothesis was developed to determine whether the Keystone Telebinocular was an adequate screening device. Six hypotheses were developed to determine whether significant relationships existed between reading achievement and visual problems. One additional hypothesis was developed after the data were computed to remove the scores of those pupils who failed the Telebinocular Test but passed the Visual Clinic test.

Findings

The students were grouped into grade level categories, and those with visual problems and those without visual problems. At the grade level the experimental groups were matched with the control groups according to age and sex.

HO_1 There are no significant differences among the mean reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests

and who have no visual problems as determined by the Keystone Telebinocular and the mean reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_1 The only significance obtained was that among grade levels. In and of itself vision does not seem to affect reading achievement.

HO_2 There are no significant differences between the mean reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the mean reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have binocular visual problems as determined by the Keystone Telebinocular.

HO_2 could not be rejected. The data indicated that the differences among reading achievement and binocular aspects of vision were not significantly different.

HO_3 There are no significant differences among the reading grade equivalent scores of pupils of grade two through six, as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the mean reading grade equivalent scores of pupils two through six, as determined by the

California Reading Tests and who have refractory visual problems as determined by the Keystone Telebinocular.

HO_3 could not be rejected. The data indicated that the differences among reading achievement and refractory aspects of vision were not significantly different.

HO_4 There is no significant difference between visual problems among boys as determined by Keystone Telebinocular and visual problems among girls as determined by the Keystone Telebinocular.

HO_4 could not be rejected. The data indicated that the difference between visual problems among boys and visual problems among girls were not significant as determined by the Keystone Telebinocular.

HO_5 There is no significant difference between visual scores of children that are recorded as failures as determined by the Keystone Telebinocular and those same children's visual scores when determined by the Visual Clinic.

HO_5 could not be tested for significance. A simple proportion was determined which indicated 87 percent of those referred were correctly screened. The data indicated the Telebinocular referred a sufficiently high number correctly to be considered worthy of use as a vision screening instrument.

HO_6 There is no significant relationship between the reading grade equivalent scores of second graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of second graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_6 could not be rejected at the .05 level of confidence. The data indicated that the relationship between visual problems and reading achievement was not significant.

HO_7 There is no significant relationship between the reading grade equivalent scores of third graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of third graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_7 could not be rejected at the .05 level of confidence. The data indicated that the relationship between reading achievement and visual problems was not significant.

HO_8 There is no significant relationship between the reading grade equivalent scores of fourth graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of fourth graders as

determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_8 could not be rejected at the .05 level of confidence. The data indicated that the relationship between reading achievement and visual problems was not significant.

HO_9 There is no significant relationship between the reading grade equivalent scores of fifth graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of fifth graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_9 was rejected at the .05 level of confidence. The data indicated that vision had a significant relationship to reading achievement.

HO_{10} There is no significant relationship between the reading grade equivalent scores of sixth graders as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of sixth graders as determined by the California Reading Tests and who have visual problems as determined by the Keystone Telebinocular.

HO_{10} could not be rejected at the .05 level of confidence. The data indicated that the relationships between reading achievement scores and vision were not significant.

HO_{11} There are no significant relationships among reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have binocular visual problems as determined by the Keystone Telebinocular.

HO_{11} could not be rejected at the .05 level of confidence. The data indicated that the relationships among reading achievement and binocular aspects of vision were not significant.

HO_{12} There are no significant relationships among reading grade equivalent scores of pupils of grades two through six, as determined by the California Reading Tests and who have no visual problems as determined by the Keystone Telebinocular and the reading grade equivalent scores of pupils two through six, as determined by the California Reading Tests and who have refractory visual problems as determined by the Keystone Telebinocular.

HO_{12} could not be rejected at the .05 level of confidence. The data indicated that the relationship among reading achievement and refractory aspects of vision were not significant.

Conclusions

The data for this study suggested that there are relationships between visual problems and reading achievement. The relationship was significant at the fifth grade level. The bi-serial r of -.18 at the fourth grade level was within .02 of being significant and the third grade with a bi-serial r of -.16 was within .04 of significance. These scores indicated that at these three grade levels the difference between significance of relationship and non-significant relationship was small. At the second grade level the bi-serial r of -.12 indicated a substantial relationship. The sixth grade sample did not produce a relationship of any consequence.

The scores of all the samples at the grade levels indicated that the relationships were negative in nature. Thus, the conclusion that many of the subjects in the samples made adaptations to compensate for their visual problems. Individual differences in compensational ability for the stresses and strains seem to enable certain children with visual defects to succeed while others fail. For this reason children need complete visual examinations and immediate attention to visual dysfunctions.

The number of visual defects increased up to age eleven as can be noted in Table 2, page 30. It is difficult to determine if the increase in visual defects was associated with school work or would naturally occur with

chronological age. Because there is no known way of determining which child's reading achievement will be influenced by visual defects, correction or training must be provided whenever deficiencies are found.

Binocular problems in this study did not seem to have any relationship to the achievement of reading. The biserial r of -.01 was so small that the deduction must be made that the types of binocular problems in the sample were not related to reading achievement.

In the samples drawn for refractory problems the biserial r of -.07 was so small that the deduction must be made that the relationships of refractory problems are nonexistent. The review of the literature indicated that when researchers broke the refractory and binocular problems into their single aspects, they found a more accurate analysis of the relationships. One study suggested that the Telebinocular was as efficient as other steroscopic devices used in vision screening programs. The report indicated that the more highly trained the individual doing the screening the better the results.

In this study 87 percent of those referred to the Visual Clinic, when screened by the telebinocular and were determined failure, were found to have visual problems. The percent of referrals identified as visually defective would indicate that the telebinocular is a useful instrument in a screening program for public schools. Visual screening is not a visual examination but a means of identifying children

with visual problems who should be referred for visual examination. The screening program provides little more than a rough over-all estimate of visual functions.

The study has given substance to the view that the telebinocular is an effective instrument for use in a visual screening program.

The ratio of nine of ten subjects confirmed by the Visual Clinic as having visual problems, after having failed the Keystone Telebinocular test would indicate the value of the instrument to a screening program. It was true that one of ten were considered not necessary for referral. Where the child's problem was clinical in nature, the need for referral was met.

For contributing problem one there were some relationships associated with refractory aspects of vision. These relationships were not significant to the extent of being significantly related to reading problems, but they did exist. The interpretation of the scores in this study indicated that the subjects in this study with refractory problems had made adaptive increase in distortions to maintain their level of achievement.

For contributing problem two to determine whether relationships existed between binocular aspects of vision and reading achievement the scores obtained from the samples drawn indicated an insignificant relationship existed. If, however, a child does not gain skill and unity of full eye

teaming, these deficiencies can become a great deterrent to immediacy and accuracy of clear single vision for almost every object in the classroom program. These types of problems can influence the essential, primary academic skills so that the student's entire schooling may be jeopardized.

The added hypothesis produced a bi-serial r of -.13. The "t" score of 1.27 was not significant at the .05 level of confidence of 2.00. Removing the scores from the samples of those who were referred by the telebinocular and passed the Visual Clinic's test did not alter the scores appreciably. The conclusion that visual problems in this study were not significantly related to reading achievement must be supported. There was one grade level, grade five, in which a significant relationship was found. Two grade levels, grade four and grade three, near significant relationships were observed. In the four other cases, grade two and grade six and for refractory and binocular problems, little relationship could be observed.

When total visual defects were correlated with reading achievement, no relationship of significance existed. The defects resulted in pupils compensating for strain and stress. This study does not imply that these problems of stress and strain are not important. These problems of stress and strain were not the concern of this study.

Recommendations

Since a positive relationship was not found between visual problems and reading achievement, the following recommendations seem warranted for further study.

1. Research should be conducted to determine the acquired refractive errors during the six years of elementary school as to whether close work is a contributory cause to visual problems.

2. A longitudinal study should be made in reading growth of those students with visual deficiencies after visual corrections has been made.

3. A study should be made to determine the reliability of the different screening devices used in screening programs.

4. A joint study by ophthalmologists, optometrists and reading clinicians as to the relationships between vision and reading achievement.

5. A study should be conducted to determine why certain children have the ability to compensate for stress and strain.

6. A study should be made to determine which child's reading achievement will be influenced by visual problems.

7. An analysis of the possible relationship between visual problems and grade repetition.

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APPENDIX A

PLEASE NOTE:

Page 63, "Keystone Visual Survey Tests", © 1961 by Keystone View Co., not microfilmed at request of author. Available for consultation at the University of Oklahoma Library.

UNIVERSITY MICROFILMS

APPENDIX B

SCORES OF SECOND GRADE

Experimental Group		Control Group	
Number	Reading Scores	Number	Reading Scores
62	4.0	25	3.7
10	3.8	91	3.6
88	3.8	87	3.6
54	3.7	108	3.6
25	3.6	63	3.6
77	3.4	81	3.4
20	3.4	43	3.2
63	3.3	51	3.2
50	3.2	2	2.9
26	3.2	68	2.9
107	3.0	92	2.8
8	2.9	49	2.8
27	2.9	61	2.7
55	2.9	5	2.7
31	2.8	46	2.7
80	2.8	39	2.6
5	2.5	27	2.6
41	2.5	59	2.5
22	2.4	49	2.4
57	2.4	40	2.3
12	2.3	10	2.3
19	2.3	79	2.2
9	2.3	85	2.1
106	2.2	20	2.0
48	2.0	96	2.0
32	1.0	60	1.9
23	1.8	32	1.8
48	1.7	34	1.7
72	1.6	71	1.6
4	1.5	59	1.6

SCORES OF THIRD GRADE

Experimental Group		Control Group	
Number	Reading Scores	Number	Reading Scores
124	4.6	26	4.5
215	4.5	95	4.5
27	4.5	197	4.4
36	4.4	74	4.4
78	4.2	216	4.4
86	4.2	171	4.3
94	4.2	117	4.2
175	4.1	147	4.2
75	4.0	17	4.2
115	4.0	173	4.1
131	4.0	35	4.0
24	4.0	167	4.0
190	3.9	119	4.0
19	3.8	182	4.0
122	3.8	148	3.9
134	3.8	118	3.9
3	3.8	181	3.8
179	3.7	41	3.8
42	3.7	21	3.8
126	3.7	105	3.8
200	3.7	183	3.7
6	3.7	90	3.7
34	3.6	38	3.7
22	3.5	12	3.6
141	3.5	65	3.6
47	3.4	88	3.6
132	3.3	63	3.4
43	3.2	58	3.2
110	3.1	15	2.9
1	2.9	98	2.6

SCORES OF FOURTH GRADE

Experimental Group		Control Group	
Number	Reading Scores	Number	Reading Scores
13	7.9	156	7.4
57	7.7	12	6.9
158	7.4	56	6.8
22	7.2	17	6.6
118	6.8	129	6.6
24	6.6	8	6.3
188	6.6	162	6.2
104	6.5	167	6.2
16	6.5	210	6.2
67	6.5	200	5.9
119	6.3	109	5.7
116	6.1	89	5.4
77	6.1	88	5.4
117	5.9	68	5.3
47	5.8	151	5.1
13	5.4	80	5.1
203	5.3	58	4.9
69	5.3	173	4.9
224	5.1	87	4.9
18	5.0	46	4.6
183	4.9	126	4.6
70	4.3	218	4.6
14	4.1	15	4.4
6	4.0	184	4.2
132	4.0	73	4.1
223	4.0	170	4.1
112	3.9	148	3.9
86	3.8	28	3.9
172	3.8	65	3.8
21	3.3	4	3.7

SCORES OF FIFTH GRADE

Experimental Group		Control Group	
Number	Reading Scores	Number	Reading Scores
135	8.3	201	7.7
89	7.9	165	6.9
138	7.9	94	6.9
210	7.3	187	6.8
61	7.3	132	6.7
23	7.2	124	6.6
16	7.0	102	6.6
32	7.0	183	6.4
54	6.6	169	6.3
116	6.6	22	6.3
115	6.5	148	6.3
120	6.3	223	6.1
144	6.2	36	5.9
175	6.2	179	5.8
24	6.2	72	5.8
193	6.2	21	5.5
197	6.0	126	5.4
59	6.0	171	5.4
123	5.9	192	5.2
152	5.9	67	5.2
184	5.8	168	5.2
19	5.6	66	5.1
222	5.3	229	5.0
133	5.2	74	5.0
219	5.0	176	5.0
20	4.7	84	4.6
2	4.7	38	4.5
140	4.6	131	4.2
155	4.6	154	4.2
160	4.4	7	3.3

SCORES OF SIXTH GRADE

Experimental Group		Control Group	
Number	Reading Scores	Number	Reading Scores
122	9.1	46	9.3
124	8.5	141	8.7
179	8.0	184	8.5
81	8.0	103	7.8
8	7.8	88	7.7
17	7.7	196	7.6
118	7.3	207	7.5
25	7.2	174	7.4
9	7.1	31	7.2
142	7.0	105	7.2
156	7.0	147	7.1
199	6.9	6	6.7
73	6.7	121	6.7
183	6.6	170	6.6
72	6.4	102	6.5
146	6.4	167	6.5
56	6.3	120	6.3
163	6.3	119	6.3
79	6.0	75	6.2
114	5.9	107	6.2
69	5.8	151	6.2
125	5.8	166	6.9
92	5.7	210	5.8
94	5.7	165	5.7
135	5.6	82	5.7
49	5.1	67	5.2
115	4.8	195	5.2
128	4.7	45	5.0
144	4.7	3	4.4
58	4.1	62	3.8

BINOCULAR

Experimental Group		Control Group	
Number	Reading Scores	Number	Reading Scores
122	9.1	86	8.1
85	7.9	103	7.8
61	7.3	198	7.7
14	7.2	96	7.1
29	7.2	147	7.1
142	7.0	109	6.9
116	6.6	213	6.3
219	6.6	219	6.3
72	6.4	3	5.9
170	5.9	176	5.8
102	5.7	210	5.8
53	5.6	224	5.7
32	5.3	208	5.5
29	5.1	2	5.2
209	4.5	40	4.8
222	4.2	84	4.6
109	4.1	41	4.6
58	4.1	95	4.5
38	4.0	226	4.2
112	3.9	26	4.2
3	3.8	159	4.0
9	3.8	211	3.7
172	3.8	101	3.4
55	3.6	189	3.4
34	3.6	105	3.1
111	3.3	5	2.7
159	2.3	136	2.6
38	2.1	109	2.5
90	2.1	102	2.4
206	1.6	123	1.9

REFRACTORY

Experimental Group		Control Group	
Number	Reading Scores	Number	Reading Scores
90	7.5	91	9.3
37	7.4	153	7.8
25	7.2	211	7.7
218	7.1	191	7.2
16	6.5	26	7.1
129	6.4	109	6.9
163	6.3	11	6.9
77	6.2	85	6.6
175	6.2	147	6.3
48	6.1	83	6.3
99	5.9	167	6.2
47	5.8	111	6.2
100	5.6	177	5.7
112	5.4	103	5.5
127	5.3	30	5.1
7	5.3	58	4.9
1	4.8	5	4.6
160	4.4	46	4.5
207	4.3	168	4.4
157	4.0	27	4.2
42	3.7	68	3.7
141	3.5	51	3.7
53	3.4	61	3.7
26	3.2	16	3.6
11	3.1	10	3.5
152	2.5	107	3.2
15	2.4	33	2.7
78	2.1	155	2.7
110	1.9	127	2.4
199	1.8	165	2.3

REJECTS FROM VISUAL CLINIC

Experimental Group		Control Group	
Number	Reading Scores	Number	Reading Scores
119	7.2	191	7.2
200	7.2	121	6.7
250	7.2	85	6.6
270	7.0	48	6.3
240	6.7	180	6.3
150	6.6	7	6.2
180	6.6	75	6.2
190	6.6	49	5.9
210	6.6	48	5.8
280	6.6	77	5.8
230	6.2	21	5.5
220	6.1	159	5.1
139	5.6	27	5.1
260	5.6	97	4.6
140	5.3	41	4.6
160	5.1	3	4.6
170	4.7	130	4.5
88	4.4	15	4.4
118	4.4	172	4.2
129	4.2	73	4.1
98	4.2	120	4.0
68	4.0	94	3.7
108	4.0	140	3.6
78	3.2	150	3.6
31	3.0	160	3.6
11	2.9	17	3.2
24	2.6	37	2.8
41	2.3	61	2.7
58	1.6	5	2.5
51	1.0	85	2.1

ANALYSIS OF VARIANCE FOR TESTING HYPOTHESIS 1

Grade	Experimental		Control		Total
Second	ΣX =	81.70	ΣX =	79.00	160.7
	$(\Sigma X)^2$ =	6,674.89	$(\Sigma X)^2$ =	6,241.00	
	ΣX^2 =	228.03	ΣX^2 =	219.16	
Third	ΣX =	114.30	ΣX =	116.20	230.5
	$(\Sigma X)^2$ =	13,064.49	$(\Sigma X)^2$ =	13,502.44	
	ΣX^2 =	434.64	ΣX^2 =	452.07	
Fourth	ΣX =	164.00	ΣX =	157.70	321.7
	$(\Sigma X)^2$ =	26,896.00	$(\Sigma X)^2$ =	24,869.29	
	ΣX^2 =	942.48	ΣX^2 =	861.16	
Fifth	ΣX =	190.40	ΣX =	173.70	364.1
	$(\Sigma X)^2$ =	36,252.16	$(\Sigma X)^2$ =	30,171.69	
	ΣX^2 =	1,165.96	ΣX^2 =	1,017.14	
Sixth	ΣX =	194.20	ΣX =	196.90	391.1
	$(\Sigma X)^2$ =	37,713.64	$(\Sigma X)^2$ =	38,769.61	
	ΣX^2 =	1,297.30	ΣX^2 =	1,336.27	
Total	ΣX =	744.60	ΣX =	723.50	1,468.1
	$(\Sigma X)^2$ =	118,328.05	$(\Sigma X)^2$ =	113,524.03	
	ΣX^2 =	4,068.41	ΣX^2 =	3,885.79	

$$SS_t = \Sigma X^2 - \frac{(X)^2}{N}$$

$$= 228.03 + 434.64 + 942.48 + 1,165.96 + 1,297.30 + 219.16 + 452.07 + 861.15 + 1,017.14 + 1,336.27 - \frac{(1,468.1)^2}{300}$$

$$= 7,954.20 - 7,184.39$$

$$= 769.81$$

ANALYSIS OF VARIANCE FOR TESTING HYPOTHESIS 1 (Continued)

$$\text{SS Between Groups} = \frac{(\Sigma X_{ex})^2}{n} + \frac{(\Sigma X_{con})^2}{n} - \frac{(\Sigma X)^2}{N}$$

$$= \frac{(744.6)^2}{150} + \frac{(723.5)^2}{150} - \frac{(1{,}468.1)^2}{300}$$

$$= (3{,}696.19 + 3{,}489.68) - \frac{2{,}155{,}317.61}{150}$$

$$= 7{,}185.87 - 7{,}184.39$$

$$= 1.48$$

$$\text{SS Between Classes} = \Sigma X^2 - \frac{(\Sigma X)^2}{N} = 149.06$$

	Experimental			Control		
Second =	228.03 -	222.49 =	5.54	219.16 -	208.03 =	11.13
Third =	434.64 -	435.48 =	-.84	452.07 -	450.08 =	1.99
Fourth =	942.48 -	896.53 =	45.95	861.15 -	828.97 =	32.18
Fifth =	1,165.96 -	1,208.40 =	-42.44	1,017.14 -	1,005.72 =	11.42
Sixth =	1,297.30 -	1,257.12 =	40.18	1,336.27 -	1,292.32 =	43.95
			48.39			100.67

$$SS_w = \frac{(\Sigma X_2)^2}{n_2} + \frac{(\Sigma X_3)^2}{n_3} + \frac{(\Sigma X_4)^2}{n_4} + \frac{(\Sigma X_5)^2}{n_5} + \frac{(\Sigma X_6)^2}{n_6} - \frac{(\Sigma X)^2}{N}$$

$$= \frac{(160.7)^2}{60} + \frac{(230.5)^2}{60} + \frac{(321.7)^2}{60} + \frac{(364.1)^2}{60} - \frac{(391.1)^2}{60} - \frac{(1{,}468.1)^2}{300}$$

$$= (430.41 + 885.50 + 1{,}724.85 + 2{,}209.98 + 2{,}549.32) - \frac{(1{,}468.1)^2}{300}$$

$$= 7{,}799.56 - 7{,}184.39$$

$$= 615.17$$

ANALYSIS OF VARIANCE FOR TESTING HYPOTHESIS 2

Binocular		Control	
ΣX	= 147.7	ΣX	= 147.8
$(\Sigma X)^2$	= 21,815.29	$(\Sigma X)^2$	= 21,844.84
ΣX^2	= 831.55	ΣX^2	= 818.40

$$SS_t = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

$$= (147.7)^2 + (147.8)^2 - \frac{(295.5)^2}{60}$$

$$= (831.55) + (818.40) - \frac{(295.5)^2}{60}$$

$$= 1,650.0500 - 1,455.3375$$

$$= 194.6125$$

$$\text{SS Between} = \frac{(\Sigma X)^2}{n} - \frac{(\Sigma X_t)^2}{N}$$

$$= (727.17) + (728.16) - \frac{(295.5)^2}{60}$$

$$= 1455.3376 - 1,455.3375$$

$$= 1.0001$$

$$\text{SS Within} = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

$$= 831.5500 - 727.1763 = 103.3737$$

$$= 818.4000 - 728.1613 = 90.2387$$

$$= 194.61$$

ANALYSIS OF VARIANCE FOR TESTING HYPOTHESIS 3

Refractory		Control	
ΣX	= 145.3	ΣX	= 1154.9
$(\Sigma X)^2$	= 21,112.09	$(\Sigma X)^2$	= 23,994.01
ΣX^2	= 729.1	ΣX^2	= 897.18

$$SS_t = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

$$= (729.1 + 897.18) - \frac{(300.2)^2}{60}$$

$$= 1626.28 - 1502.00$$

$$= 124.28$$

$$\text{SS Between} = \frac{(\Sigma X)^2}{n} - \frac{(\Sigma X_t)^2}{N}$$

$$= (703.7313 + 799.8003) - \frac{(300.2)^2}{60}$$

$$= 1503.5316 - 1502.0006$$

$$= 1.5310$$

$$\text{SS Within} = \Sigma X^2 - \frac{(\Sigma X)^2}{n}$$

$$= 729.1000 - 703.7313 = 25.3687$$
$$= 897.1800 - 799.8003 = 97.3797 \quad = 122.7484$$

ANALYSIS OF VARIANCE FOR TESTING ADDITIONAL HYPOTHESIS

Rejected From Clinic		Control	
ΣX	= 148.5	ΣX	= 141.5
$(\Sigma X)^2$	= 22,052.25	$(\Sigma X)^2$	= 20,022.25
ΣX^2	= 831.08	ΣX^2	= 723.05

$$SS_t = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

$$= (831.08 + 723.05) - \frac{(290.0)^2}{60}$$

$$= 1554.13 - 1401.66$$

$$= 152.47$$

$$\text{SS Between} = (\Sigma X)^2 - \frac{(\Sigma X_t)^2}{N}$$

$$= (735.07 + 667.40) - \frac{(290.0)^2}{60}$$

$$= 1402.47 - 1401.66$$

$$= .81$$

$$\text{SS Within} = \Sigma X^2 - \frac{(\Sigma X)^2}{N}$$

$$= 831.08 - 735.07 = 96.01$$
$$= 723.05 - 667.40 = 55.65 \quad = 151.66$$

SECOND GRADE

	Passed	Failed	Freq.	X'	F_tX^1	$F_tX^{1^2}$	F_pX^1
3.7 - 4.0	1	4	5	3	15	45	3
3.3 - 3.6	5	4	9	2	18	36	10
2.9 - 3.2	4	6	10	1	10	10	4
2.5 - 2.8	8	3	11	0	0	0	0
2.1 - 2.4	5	7	12	-1	-12	12	-5
1.7 - 2.0	5	4	9	-2	-18	36	-10
1.3 - 1.6	2	2	4	-3	-12	36	-6
	N=30	N=30	N=60		=+1	=175	=-4

$$r_b = \frac{\bar{X}_p - \bar{X}_t}{S_t}\left(\frac{P}{Y}\right)$$

$$= \frac{2.60-2.66}{.61} \times 1.25$$

$$= -.09 \times 1.25$$

$$= -.12$$

$$\bar{X}_p = 2.65+\frac{-4}{30}(.4)$$

$$= 2.65-.05$$

$$= 2.60$$

$$\bar{X}_t = 2.65+\frac{1}{60}(.4)$$

$$= 2.65+.017(.4)$$

$$= 2.65+.0068$$

$$= 2.66$$

$$S_{r_b} = \sqrt{\frac{P_1P_2}{Y}}\left(\frac{1}{\sqrt{N}}\right)$$

$$= \sqrt{\frac{(.50)(.50)}{.399}}\left(\frac{1}{\sqrt{60}}\right)$$

$$= \sqrt{.625}x.129$$

$$= .7912x.129$$

$$= .102$$

$$t = \frac{-.12}{.102}$$

$$= 1.20*$$

* Not significant

THIRD GRADE

	Passed	Failed	Freq.	X'	F_tX^1	F_tX^{12}	F_pX^1
4.6 - 4.9	0	1	1	3	3	9	0
4.2 - 4.5	9	6	15	2	30	60	18
3.8 - 4.1	11	9	20	1	20	20	11
3.4 - 3.7	7	10	17	0	0	0	0
3.0 - 3.3	1	3	4	-1	-4	4	-1
2.6 - 2.9	2	1	3	-2	-6	12	-4
	N=30	N=30	N=60		=43	=105	=24

$$r_b = \frac{\bar{X}_p - \bar{X}_t}{S_t}\left(\frac{P}{Y}\right)$$

$$= \frac{3.87-3.84}{.33} \cdot \frac{.50}{.399}$$

$$= \frac{.03}{.33} \times 1.25$$

$$= .07 \times 1.25$$

$$= .16$$

$$\bar{X}_p = 3.55 + \frac{24}{30}(.4)$$

$$= 3.55 + .32$$

$$= 3.87$$

$$\bar{X}_t = 3.55 + \frac{43}{60}(.4)$$

$$= 3.55 + .2864$$

$$= 3.84$$

$$S_{r_b} = \sqrt{\frac{P_1P_2}{Y}}\left(\frac{1}{\sqrt{N}}\right)$$

$$= \sqrt{\frac{(.50)(.50)}{.399}}\left(\frac{1}{\sqrt{60}}\right)$$

$$= \sqrt{.625} \times .129$$

$$= .7912 \times .129$$

$$= .102$$

$$t = \frac{.16}{.102}$$

$$= 1.60^*$$

*Not significant

FOURTH GRADE

	Passed	Failed	Freq.	X'	F_tX^1	$F_tX^{1^2}$	F_pX^1
7.8 - 8.2	0	1	1	4	4	16	0
7.3 - 7.7	1	2	2	3	9	27	3
6.8 - 7.2	2	2	4	2	8	16	4
6.3 - 6.7	3	6	9	1	9	9	3
5.8 - 6.2	4	3	7	0	0	0	0
5.3 - 5.7	4	3	7	-1	-7	7	-4
4.8 - 5.2	5	3	8	-2	-16	32	-10
4.3 - 4.7	4	1	5	-3	-15	45	-12
3.8 - 4.2	6	8	14	-4	-56	224	-24
3.3 - 3.7	1	1	2	-5	-10	50	-5
	N=30	N=30	N=60		=-74	=426	=-45

$$r_b = \frac{\bar{X}_p - \bar{X}_t}{S_t}\left(\frac{P}{Y}\right)$$

$$= \frac{5.25-5.385}{.94} \times 1.25$$

$$= -.15 \times 1.25$$

$$= -.18$$

$$\bar{X}_p = 6.00+\frac{-45}{30}(.5)$$

$$= 6.00-.75$$

$$= 5.25$$

$$\bar{X}_t = 6.00+\frac{-74}{60}(.5)$$

$$= 6.00-.615$$

$$= 5.385$$

$$S_{r_b} = \sqrt{\frac{P_1P_2}{Y}}\left(\frac{1}{\sqrt{N}}\right)$$

$$= \sqrt{\frac{(.50)(.50)}{3.99}}\left(\frac{1}{\sqrt{60}}\right)$$

$$= .7912x.129$$

$$= .102$$

$$t = \frac{.18}{.102}$$

$$= 1.76*$$

*Not significant

FIFTH GRADE

	Passed	Failed	Freq.	X'	F_tX^1	F_tX^{12}	F_pX^1
8.0 - 8.7	0	1	1	3	3	9	0
7.3 - 7.9	1	4	5	2	10	20	2
6.5 - 7.2	6	6	12	1	12	12	6
5.7 - 6.4	8	10	18	0	0	0	0
4.9 - 5.6	10	4	14	-1	-14	14	-10
4.1 - 4.8	4	5	9	-2	-18	36	-8
3.3 - 4.0	1	0	1	-3	-3	9	-3
	N=30	N=30	N=60		=-10	=100	=-13

$$r_b = \frac{\bar{X}_p - \bar{X}_t}{S_t}\left(\frac{P}{Y}\right)$$

$$= \frac{5.75-5.93}{.89} \times 1.25$$

$$= \frac{-.18}{89} \times 1.25$$

$$= -.25$$

$$\bar{X}_p = 6.05+\frac{-13}{30}(.7)$$

$$= 6.05+(-.30)$$

$$= 5.75$$

$$\bar{X}_t = 6.05+\frac{-10}{60}(.7)$$

$$= 6.05+(-.12)$$

$$= 5.93$$

$$t = \frac{.25}{.102}$$

$$= 2.45^*$$

Significant

$$S_{r_b} = \sqrt{\frac{P_1P_2}{Y}}\left(\frac{1}{\sqrt{N}}\right)$$

$$= \sqrt{\frac{(.50)(.50)}{.399}\left(\frac{1}{\sqrt{60}}\right)}$$

$$= \sqrt{.625}x.129$$

$$= .7912x.129$$

$$= .102$$

SIXTH GRADE

	Passed	Failed	Freq.	X'	F_tX^1	F_tX^{12}	F_pX^1
9.0 - 9.8	1	1	2	3	6	18	3
8.1 - 8.9	2	1	3	2	6	12	4
7.2 - 8.0	7	6	13	1	13	13	7
6.3 - 7.1	8	10	18	0	0	0	0
5.4 - 6.2	7	7	14	-1	-14	14	-7
4.5 - 5.3	3	4	7	-2	-14	28	-6
3.8 - 4.4	2	1	3	-3	-9	27	-6
	N=30	N=30	N=60		=-12	=109	=-5

$$r_b = \frac{\bar{X}_p - \bar{X}_t}{S_t}\left(\frac{P}{Y}\right)$$

$$= \frac{6.564-6.540}{1.06} \times 1.25$$

$$= \frac{.024}{1.06} \times 1.25$$

$$= .03$$

$$\bar{X}_p = 6.7+\frac{-5}{30}(.8)$$

$$= 6.7-.136$$

$$= 6.564$$

$$X_t = 6.7+\frac{-12}{60}(.8)$$

$$= 6.7-.16$$

$$= 6.54$$

$$t = \frac{.03}{.102}$$

$$= .28*$$

*Not significant

$$S_{r_b} = \sqrt{\frac{P_1P_2}{Y}}\left(\frac{1}{\sqrt{N}}\right)$$

$$= \sqrt{\frac{(.50)(.50)}{.399}}\left(\frac{1}{\sqrt{60}}\right)$$

$$= \sqrt{.625}x.129$$

$$= .7912x.129$$

$$= .102$$

BINOCULAR

	Passed	Failed	Freq.	X'	F_tX^1	F_tX^{12}	F_pX^1
8.6 - 9.5	0	1	1	4	4	16	0
7.6 - 8.5	3	1	4	3	12	36	9
6.6 - 7.5	3	6	9	2	18	16	6
5.6 - 6.5	6	4	10	1	10	10	6
4.6 - 5.5	5	2	7	0	0	0	0
3.6 - 4.5	5	11	16	-1	-16	16	-5
2.6 - 3.5	5	1	6	-2	-12	24	-10
1.6 - 2.5	3	4	7	-3	-21	63	-9
	N=30	N=30	N=60		=-5	=181	=-3

$$r_b = \frac{\bar{X}_p - \bar{X}_t}{S_t}\left(\frac{P}{\bar{Y}}\right)$$

$$= \frac{4.96-4.975}{1.56}\,\frac{.50}{.399}$$

$$= -0096 \times 1.25$$

$$= -.012$$

$$\bar{X}_p = 5.05+\frac{-3}{30}(.9)$$

$$= 5.05-.09$$

$$= 4.96$$

$$\bar{X}_t = 5.05+\frac{-5}{60}(.9)$$

$$= 5.05-.075$$

$$= 4.975$$

$$S_{r_b} = \sqrt{\frac{P_1P_2}{Y}}\left(\frac{1}{\sqrt{N}}\right)$$

$$= \sqrt{\frac{(.50)(.50)}{.399}}\left(\frac{1}{\sqrt{60}}\right)$$

$$= \sqrt{.625}x.129$$

$$= .7912x.129$$

$$= .102$$

$$t = \frac{.01}{.102}$$

$$= .11^*$$

*Not significant

REFRACTORY

	Passed	Failed	Freq.	X'	F_tX^1	$F_tX^{1^2}$	F_pX^1
8.8 - 9.7	1	0	1	4	4	16	4
7.8 - 8.7	1	0	1	3	3	9	3
6.8 - 7.7	5	4	9	2	18	36	10
5.8 - 6.7	5	8	13	1	13	13	5
4.8 - 5.7	4	5	9	0	0	0	0
3.8 - 4.7	4	3	7	-1	-7	7	-4
2.8 - 3.7	6	5	11	-2	-22	44	-12
1.8 - 2.7	4	5	9	-3	-27	81	-12
	N=30	N=30	N=60		=-18	=206	=-6

$$r_b = \frac{\bar{X}_p - \bar{X}_t}{S_t}\left(\frac{P}{Y}\right)$$

$$= \frac{5.07-4.98}{1.65} \times 1.25$$

$$= .07$$

$$\bar{X}_p = 5.25+\frac{-6}{30}(.9)$$

$$= 5.25-.18$$

$$= 5.07$$

$$\bar{X}_t = 5.25+\frac{-18}{60}(.9)$$

$$= 5.25-.27$$

$$= 4.98$$

$$S_{r_b} = \sqrt{\frac{P_1P_2}{Y}}\left(\frac{1}{\sqrt{N}}\right)$$

$$= \sqrt{\frac{(.50)(.50)}{3.99}}\left(\frac{1}{\sqrt{60}}\right)$$

$$= \sqrt{.625}x.129$$

$$= .7912x.129$$

$$= .102$$

$$t = \frac{.07}{.102}$$

$$= .69*$$

*Not significant

ADDED

	Passed	Failed	Freq.	X'	F_tX^1	$F_tX^{1^2}$	F_pX^1
7.0 - 7.9	1	4	5	3	15	45	3
6.0 - 6.9	6	8	14	2	28	56	12
5.0 - 5.9	6	4	10	1	10	10	6
4.0 - 4.9	8	7	15	0	0	0	0
3.0 - 3.9	5	2	7	-1	-7	7	-5
2.0 - 2.9	4	3	7	-2	-14	28	-8
1.0 - 1.9	0	2	2	-3	-6	18	0
	N=30	N=30	N=60		26	164	8

$$r_b = \frac{\bar{X}_p - \bar{X}_t}{S_t}\left(\frac{P}{Y}\right)$$

$$= \frac{4.69-4.84}{1.48}\ \frac{.50}{.399}$$

$$= \frac{-15}{1.48} \times 1.25$$

$$= -.10 \times 1.25$$

$$= -.13$$

$$\bar{X}_p = 4.45+\frac{8}{30}(.9)$$

$$= 4.45+.24$$

$$= 4.69$$

$$\bar{X}_t = 4.45+\frac{26}{60}(.9)$$

$$= 4.45+.39$$

$$= 4.84$$

$$S_{r_b} = \sqrt{\frac{P_1P_2}{Y}}\left(\frac{1}{\sqrt{N}}\right)$$

$$= \sqrt{\frac{(.50)(.50)}{.399}}\left(\frac{1}{\sqrt{60}}\right)$$

$$= \sqrt{.625}x.129$$

$$= .7912x.129$$

$$= .102$$

$$t = \frac{.13}{.102}$$

$$= 1.27^*$$

*Not significant