R E P O R T   R E S U M E S

ED 020 861   24   RE 001 266

THE COLLECTION AND STATISTICAL EVALUATION OF QUANTITATIVE DATA FOR HAND-EYE COORDINATION WITH RESPECT TO DETERMINING ITS CORRELATION WITH READING DISABILITY AT BOTH THE PRIMARY AND SECONDARY SCHOOL LEVELS. FINAL REPORT.

BY- MACLEAN, GEORGE   KEAR, EDWARD
CLARKSON COLL. OF TECHNOLOGY, POTSDAM, N.Y.

REPORT NUMBER BR-6-8324   PUB DATE   JUN 67
CONTRACT OEC-1-6-068324-0653
EDRS PRICE   MF-$0.25   HC-$1.52   36P.

DESCRIPTORS- *READING ABILITY, *EYE HAND COORDINATION, *ELEMENTARY SCHOOL STUDENTS, *HIGH SCHOOL STUDENTS, *READING DIFFICULTY, MEASUREMENT TECHNIQUES, MEASUREMENT INSTRUMENTS, DATA ANALYSIS, READING DIAGNOSIS,

THE POSSIBILITY OF A CORRELATION BETWEEN HAND-EYE COORDINATION AND READING DISABILITY WAS INVESTIGATED. CHILDREN FROM GRADES 2 TO 12 WERE TESTED TO DETERMINE THEIR HAND-EYE COORDINATION USING A PORTABLE TESTING DEVICE FOR QUANTATIVE MEASURE RECENTLY DEVELOPED. THE SUBJECTS INCLUDED APPROXIMATELY 1,700 NORMAL PUBLIC SCHOOL STUDENTS AND 290 STUDENTS DIAGNOSED AS POOR READERS BY READING CLINICS. THE SUBJECT'S READING ABILITY WAS DETERMINED THROUGH THE USE OF THE STANDARDIZED READING TESTS ADMINISTERED BY SCHOOL PERSONNEL. STATISTICAL ANALYSIS OF THE DATA, AFTER IT WAS NORMALIZED FOR THE EFFECT OF AGE, INDICATED NO CORRELATION BETWEEN HAND-EYE COORDINATION AND READING DISABILITY ABOVE THE SECOND- GRADE LEVEL. HOWEVER, SINCE THIS WAS THE YOUNGEST GROUP TESTED, MORE WORK MUST BE DONE IN THE YOUNGER AGE RANGE BEFORE ANY CONCLUSIONS CAN BE REACHED. REFERENCES ARE LISTED, AND 6 APPENDIXES OF DETAILED DATA ANALYSIS ARE INCLUDED. (AUTHOR/BS)

BR-6-8324
P.A. 24

FINAL REPORT
Project No. 6-8324-24
Contract No. OEC-1-6-068324-0653

THE COLLECTION AND STATISTICAL EVALUATION OF QUANTITATIVE DATA FOR HAND-EYE COORDINATION WITH RESPECT TO DETERMINING ITS CORRELATION WITH READING DISABILITY AT BOTH THE PRIMARY AND SECONDARY SCHOOL LEVELS

June 1967

U. S. DEPARTMENT OF
HEALTH, EDUCATION, AND WELFARE

Office of Education
Bureau of Research

THE COLLECTION AND STATISTICAL EVALUATION OF QUANTITATIVE DATA FOR HAND-EYE COORDINATION WITH RESPECT TO DETERMINING ITS CORRELATION WITH READING DISABILITY AT BOTH THE PRIMARY AND SECONDARY SCHOOL LEVELS

Project No. 6-8324
Contract No. OEC-1-6-068324-0653

George Maclean
Edward Kear

June 1967

Clarkson College of Technology

Potsdam, New York

CONTENTS

Appendix

Illustrations

INTRODUCTION

For many years much effort has beer directed at determining the causes of reading disabilities in young children in the hope that by understanding the causes, more effective remedial techniques could be developed. At the present time, these remedial techniques are divided into two distinct processes: the expressive method which involves expressing and completing basic developmental functions, and the receptive method which involves developing responses to various stimuli. As outlined in "Learning Disability-Yesterday, Today, Tomorrow", receptive techniques included remediation of visual preception, remediation of auditory preception, and a system of sound blending and vocal expression in response to a visual stimulus. Each receptive method developed organization in a task which tended to resemble and/or influence the reading task.

However, there are some, who are exponents of the expressive method such as Delacato and Kerhart, who feel that the remediation of poor reading involves more than just the training method employed in the receptive technique. The current controversial work, that of Delacato (1963), is centered on neurological organization and the completion of the entire developmental or sequential hierarchy of motor expression.[1] He feels that the orderly development in humans progresses vertically through the spinal cord and central nervous system up to the level of the cortex, as it does with all mammals. Man's final and unique development takes place at the cortex and is lateral. Lower functions such as body mechanics and coordination are developed before the higher functions such as reading. If a lower level is incomplete, all suceeding higher levels will be affected.[2]

> "Speech and reading are the final 'human' results of neurological organization and hence are clinical indices of the nature and the

---

1. Barbara Bateman, "Learning Disabilities-Yesterday, Today, Tomorrow", Exceptional Children, Dec. 1964, pp 167-177.

2. Carl Delacato, Treatment and Prevention of Reading Problems, 1959, p 19.

quality of neurological organization
of an individual"-Delacato.[3]

S. Allen Cohen represents a different theory. Like Delacato, he feels that gross movements should be achieved before finer tasks are demanded. When a child is forced to do fine-muscle actions before his gross movement has been throughly developed, the conflict which arises often leads to poor visual-motor development which manifests itself in a host of psychological problems including poor body coordination and poor reading. However, unlike Delacato, Cohen feels that if the organization is not complete, development in one area must be at the expense of developments in others.

> "Some youngsters can read and write well before they finish Grade One. Most can not. Of those few who read and write well, many of them have paid the price for their achievement. They will reveal deficiencies in personality, body coordination, self-expression, and any number of visual behaviors that do not allow the organism to function effeciently."[4]

On the other hand, Delacato lists poor gross coordination as a "common" characteristic which could be related to poor reading.[5]

Before any remedial techniques are prescribed, a battery of tests are usually given. These can include a simple qualitative hand-eye coordination test, individual I.Q. tests, The Walton Technique for determining reaction time, the Keystone visual survey test which

---

3. Melvin Robbins, "A Study of the Validity of Delacato's Theory of Neurological Organization", Exceptional Children, April 1966, p 507.

4. S. Allen Cohen, "Applying Dynamic Theory of Vision to Teaching Reading", Journal of Developmental Reading, Autumn 1962, pp 15-20.

5. Carl Delacato, op. cit., p 7.

measures acuity, the Pure Tone Audiometer, the Leavell Test ("The Leavell test is the best single tool clinicians have for uncovering visual-manual-cerebral defects.")[6] and a variety of reading aptitude and achievement tests.

In many reading clinics, one of the first tests administered to a child suspected of suffering from a primary or secondary reading disability is a simple qualitative hand-eye coordination test. It is felt that since hand-eye coordination uses many of the same neurological paths and areas of the brain as does the reading task, that this simple test could be used to indicate if the reading problem might be due to some type of neurological disorder. If this is "commonly" true, as Delacato suggests, then there should be a correlation between hand-eye coordination and reading disability. The purpose of this research is to determine if such a correlation does exist at the primary and secondary school levels.

The reading scores of a large number of subjects were readily available from the public schools but reliable quantitative data on hand-eye coordination was not; nor was the equipment available that could be used to obtain this data accurately. The Leavell Test, like all the other methods to determine coordination, was a qualitative test.

At Clarkson College of Technology, much preliminary research was done in the design of a method to determine quantitatively a subject's hand-eye coordination. The initial testing involved very expensive and quite elaborate equipment (e.g. Analog Computer, function generators, and oscilloscopes). Because of the size of the equipment, it was always necessary to bring the subject to the college laboratory to be tested which involved a great loss of time for the individual. To alleviate this condition, a portable, self-contained, and relatively inexpensive apparatus was designed based on the same principles as those of the preliminary research. To prove this design, three more machines were manufactured as replicas of the

---

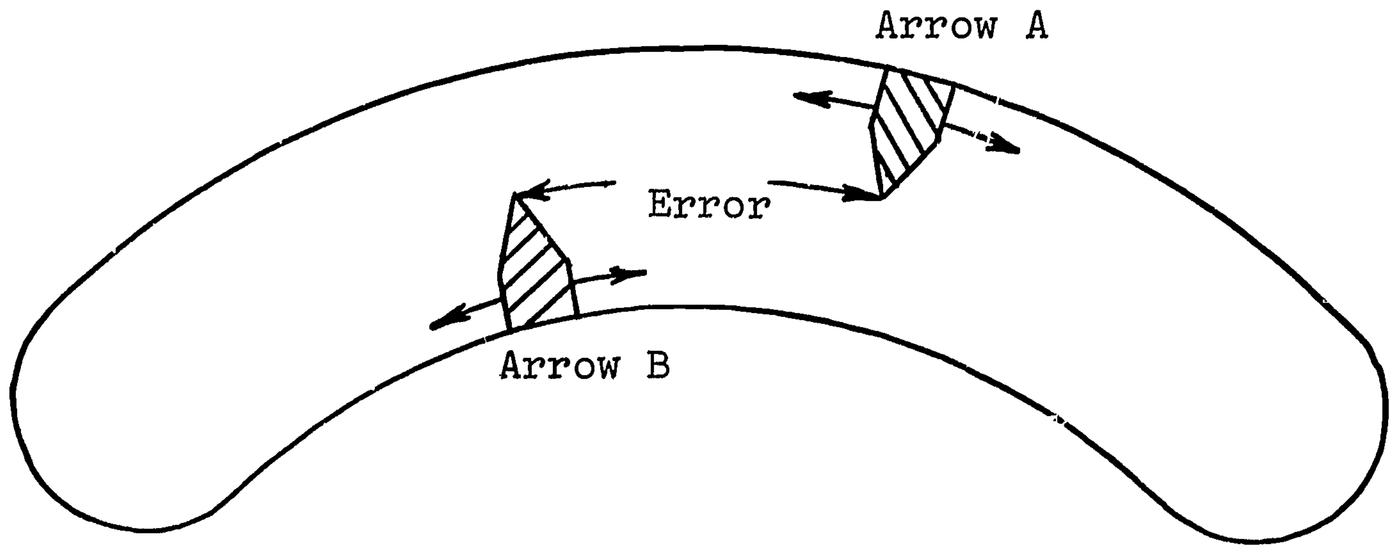
6. Clifford J. Kolson, Clinical Aspect's of Remedial Reading, 1963, p 37.

first. Using these machines, hand-eye coordination data from a large number of subjects was gathered in order to determine the correlation between coordination and reading disability.

METHOD

Machines

The principal of the machines is a pursuit test where the motion is "random" in appearance and cyclic (the motion is shown in Appendix G). The subject views an arrow (arrow A) oriented in the vertical plane which moves back and forth in a "random" oscillating path but always remains pointing inward toward the center of its arch.



The track device is a manually controlled arrow (arrow B) pointing outward, whose length enables the two pointers to be tip to tip when aligned for a zero error. The so-called "random" motion is developed from a floating-linkage design and is cycled by a gear train.

The object of the test is to keep these two pointers in line as close as possible. The error, which is the distance between the two pointers, is translated into a D. C. voltage and is integrated (totalized) over a 45 second interval by means of an analog computer. The score developed by this computer is displayed on a meter on the test administrator's side of the machine and is held until the next test is begun.

Before each day's testing the device is calibrated by a simple procedure which insures standard results. Periodically, the device is checked to compensate for temperature changes which may occur in the machine during the test day. This also is a simple procedure.

Test

The testing was done in the school systems (grades 2, 4, 6, 7, 8, 9, 10, 12) of the Potsdam, Canton, and Syracuse areas:

	Subjects
Potsdam Central School System	820
Congdon Campus School, Potsdam	180
Canton Central School System	710
Syracuse area (poor readers as diagnosed by the Syracuse University clinic)	290
	2000

For each subject, one test of six separate modes was given. The six modes were the six possible hand and eye combinations. They were as follows:

1. Right hand-both eyes
2. Left hand-both eyes
3. Right hand-right eye
4. Right hand-left eye
5. Left hand-left eye
6. Left hand-right eye

The test was administered in a room containing the two machines, two subjects, an observer, and the testing administrator. Before each test, information was obtained from the subject as to the individual's name, age, grade, sex, and hand dexterity. The tests were staggered so that one person would be finished as one was approximately half way through. The observer then took his place at the machine while the subject, who had completed the test, returned to his class to send back a new observer. Since the new subject has observed the test procedure, the only instruction necessary was a reminder to "keep the pointers as close together as possible". No set pattern was followed in determining the order of the six modes tested. At the end of a day's testing, the individuals' school records were examined for their reading levels and I.Q.

Using the procedure stated on the previous page, 12 subjects can be tested in one hour; approximately sixty people can be tested in one school day.

Analysis

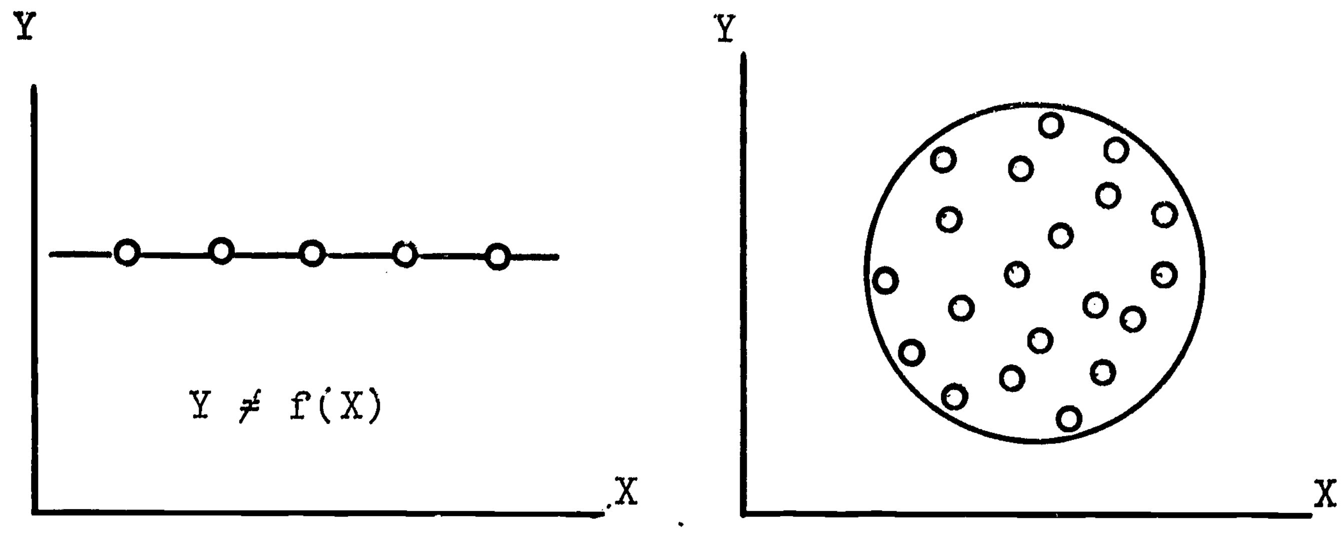
The data that was obtained was recorded on IBM cards as exemplified below.

Test Scores						ID Number	Age (years) (months)	Grade	Reading Level (yr.) (mo.)	I.Q.	M-1 F-2 Sex	Score Factor	Machine Number
22	19	22	17	24	21	351	1112	5	46	95	1	1	2

All of this data was stored in the memory of the digital computer and was sorted by means of a program which was specially written for the IBM 360. This computer program separated and statistically analyzed the data by each of the different characteristics.

The first consideration was to determine if the data was normally distributed. The next consideration was to analyze the data to determine a mean, a standard deviation, and a reliability for the data arranged by age, reading level, sex, dexterity, and I.Q. The reliability tests that were employed were the Spearman-Brown Prophecy Formula (Appendix B-2) and a statistical approach using the Central Limits Theorem and the Law of Variance.

To analyze the data for correlation with reading disability, one specific grade was taken at a time. The subjects' scores were normalized by ages and separated according to reading level; then, the means were calculated. This information was then used to determine a correlation coefficient between reading (dis) ability and hand-eye coordination (Appendix B-1). Also, the same approach was considered using only the worst coordination scores for each individual, where the worst scores might be more representative of any neurological problems. The computer program also determined a "non-correlation" coefficient. This concept is indicative of an independent relationship. A correlation coefficient of 0.0 can mean either random scatter or an independent relationship between two variables as shown below. For a more detailed explanation of this concept, refer to Appendix B-1.



Machine reliability was determined by comparing the test scores from the different machines, in a single age group. Averages and standard deviations were determined and the reliability was calculated by the aforementioned statistical method. The reproducibility of the data was determined in a test (Jan.) and sample retest (June) of 52 sixth graders.

RESULTS

1. To determine if coordination and reading ability are related, one particular grade was used. The sixth grade represented a "typical" result. Scores in this grade were separated according to reading level and then normalized by age. The correlation coefficient for this calculation was 0.198; the "non-correlation" coefficient (Appendix B-1) was -0.940 (Figure 1).

2. Using only the worst score for each individual, the correlation coefficient was -0.179 and the "non-correlation" coefficient was -0.916 (Figure 2).

3. Hand-eye coordination increased as age increased over the range of 8 to 18 years except during the period of adolescence (age 12 years 6 months to age 15 years 6 months). Figure 3 is the curve of coordination verses age. A lower test score is indicative of better coordination. (Appendix C shows the same curve separated according to sex.)

4. The machines were tested against one another, using the age group which included the greatest number of subjects for each machine, to determine their reliability. For the 18 year old age group, machine two produced a mean of 16.565 and machine three produced a mean of 16.260. For the 12 year old group, machine four produced a mean of 22.244 and machine two produced a mean of 22.975. Each individual test score was only readable to the nearest whole number.

5. Data reliability was determined from a test and retest of 52 sixth grade subjects. The January test yielded a group average of 19.564 and a standard deviation of 6.688. The June retest of these same 52 subjects yielded a group average of 18.695 and a standard deviation of 5.072. The one point difference in these averages is the expected change that would occur over a six month period for children in this age category. (Refer back to Figure 3.)

6. The correlation coefficient between reading level and hand-eye coordination, normalized for age, was -0.300; the "non-correlation" coefficient was -0.978 (Appendix F).

RELATIONSHIP OF TEST SCORES AND READING LEVEL

Grade Six

Scores Normalized for Age

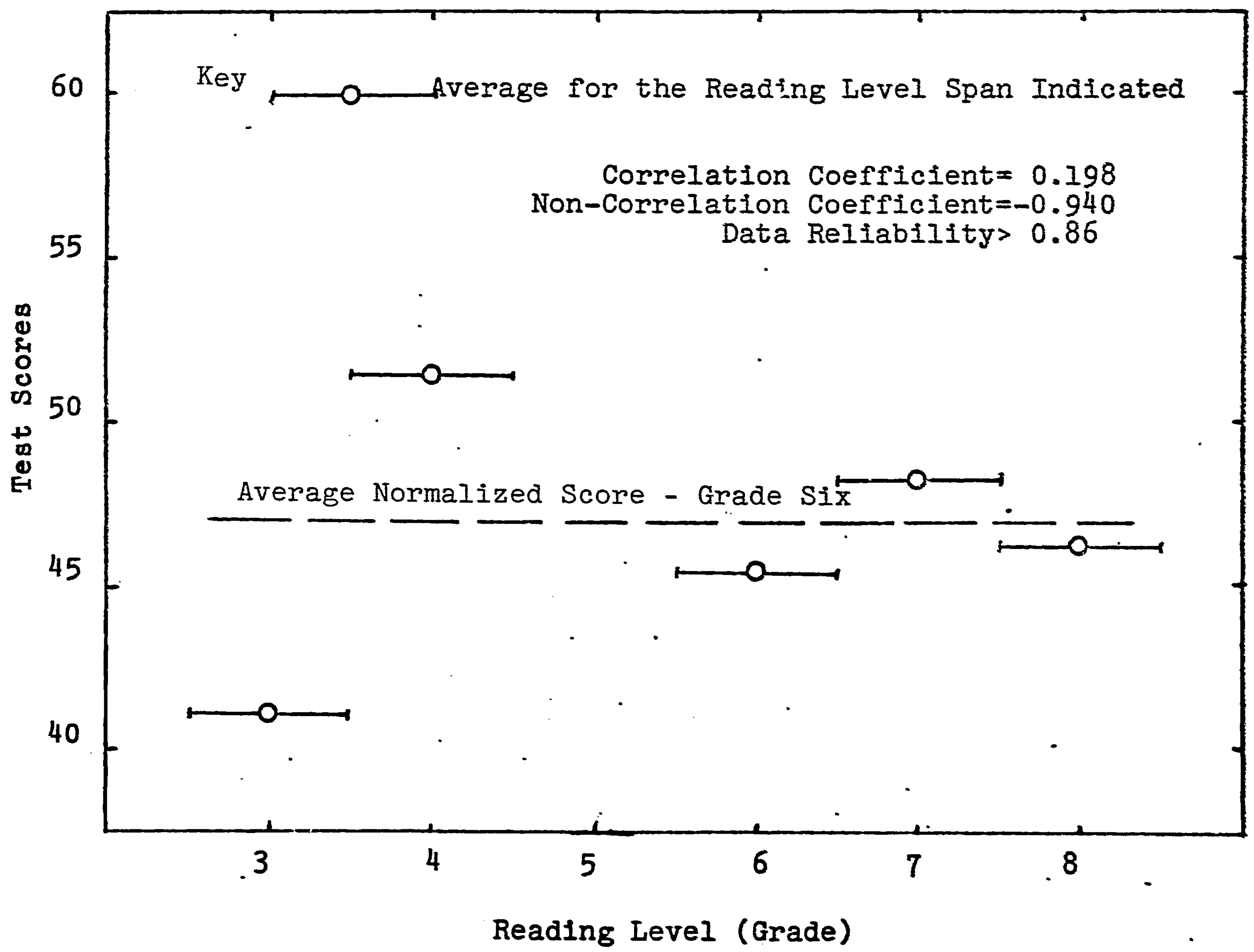


Figure 1

RELATIONSHIP OF TEST SCORES AND READING LEVEL

CONSIDERING THE INDIVIDUALS' WORST MODE

Grade Six

Scores Normalized for Age

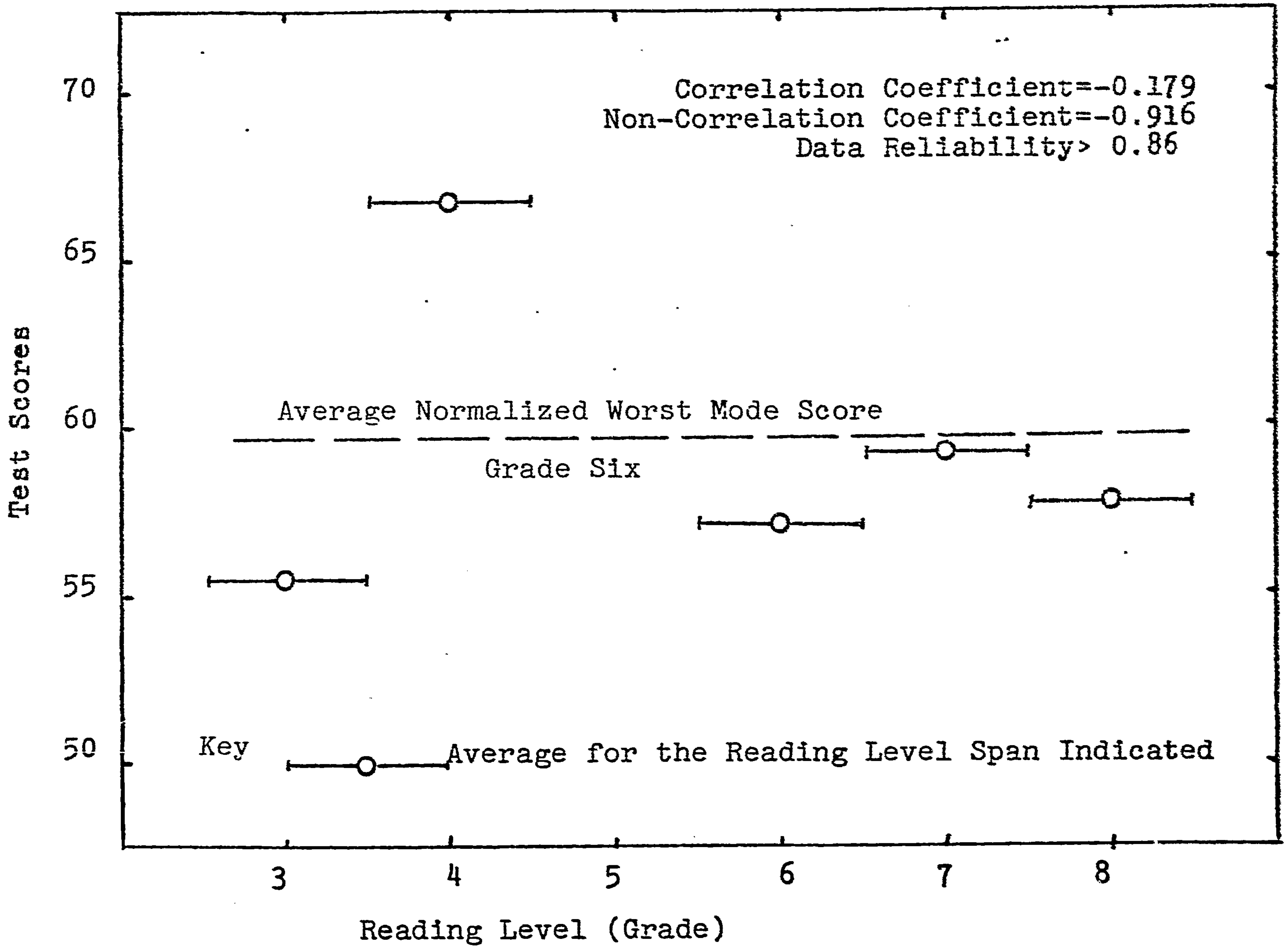


Figure 2

RELATIONSHIP OF TEST SCORES AND AGE

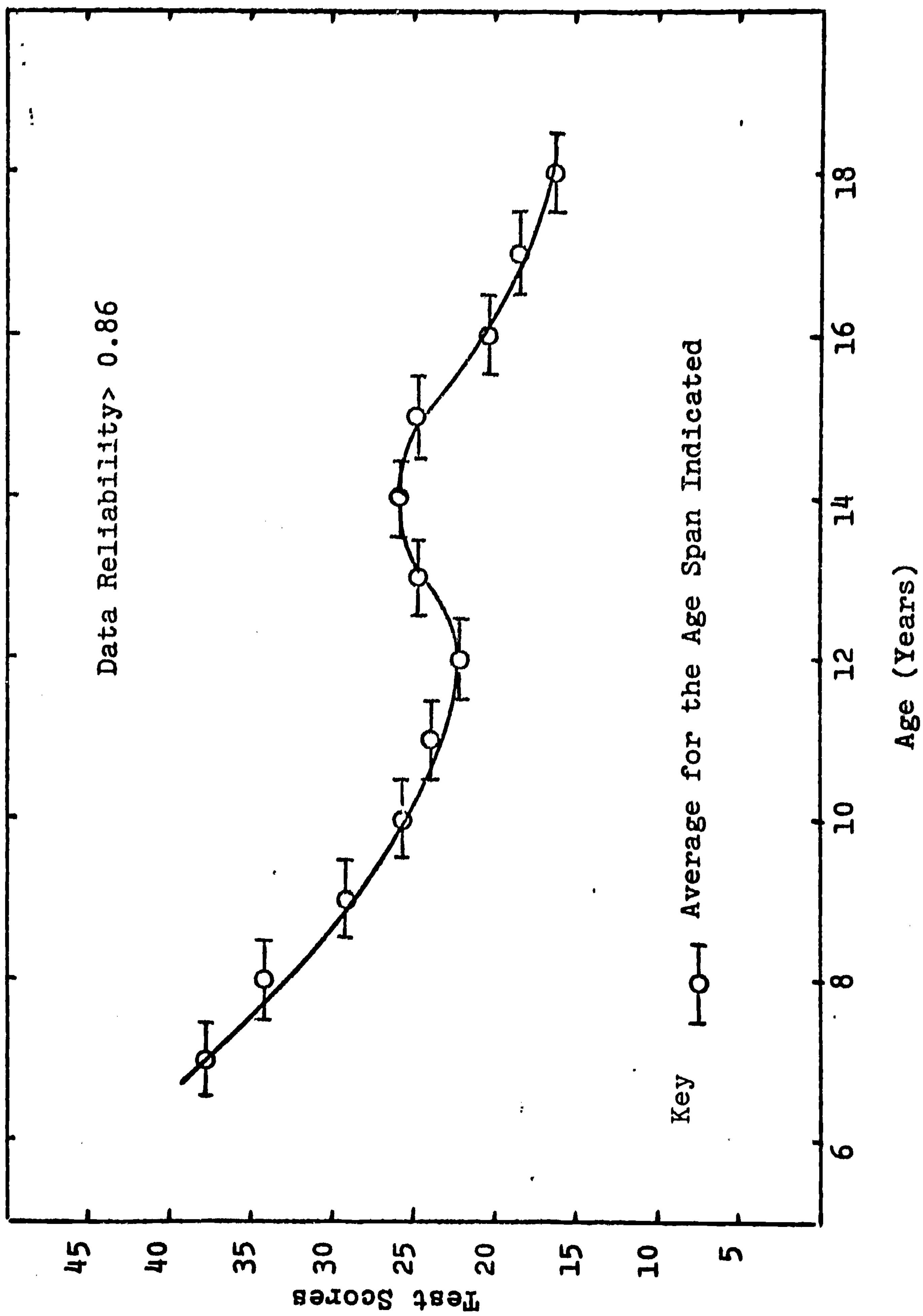


Figure 3

7. The data was not normally distributed but was skewed right. That is, although the data would plot a straight line on probability paper, the mean was always to the right of the median.

8. In general, a minimum of 75 subjects are necessary to obtain a reliability which is greater than 0.85 using the Spearman-Brown Prophect Formula.

9. The correlation coefficient between I.Q. and hand-eye coordination, normalized for age, was -0.890 (Figure 4).

10. Approximately 1% of the subjects were unable to score in at least one of the six modes tested. Two examples of such individuals were:

a. One girl, from a special class, was found to have pure reversal tendencies. Her reaction was always opposite to that which would normally be expected. Her scoring was so poor that she was unable to score even in input position number one - the position that makes the computer least sensitive to the input error signal.

b. In the group of 52 sixth graders that were retested to determine data reliability, one subject was unable to score in any mode during the January test. During the June retest, conducted by a different administrator using another machine, this same subject was again the only one unable to score on the machine.

RELATIONSHIP OF TEST SCORES AND I.Q.

Test Scores Normalized for Age

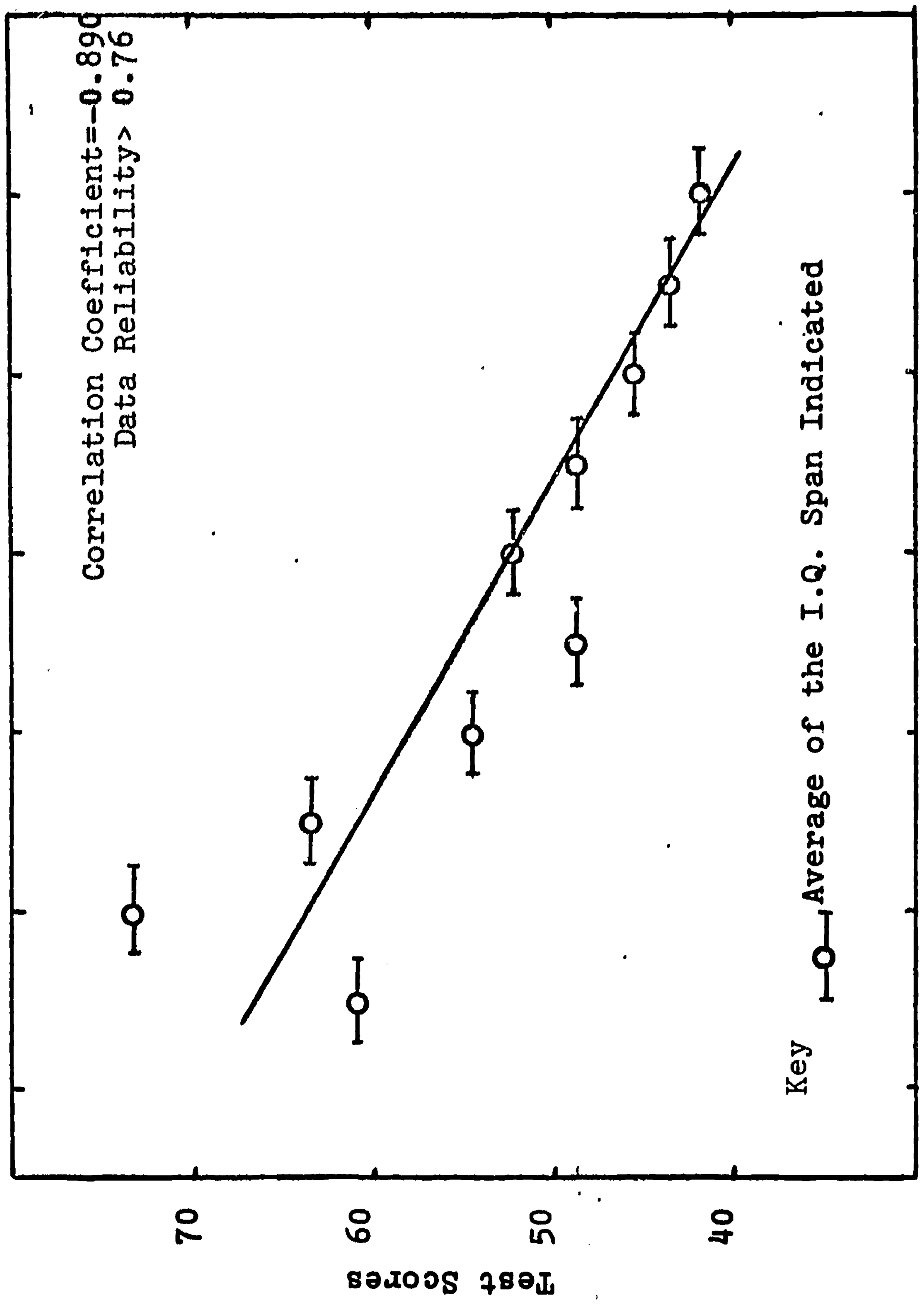


Figure 4

DISCUSSION

The machines have been shown to accurately measure a characteristic defined as hand-eye coordination. It has been proved that they produce reproducible data and the data has been shown to be reliable from the sample re-test. It is felt that these machines not only give a quantitative test of coordination but are possibly the most reliable method of determining hand-eye coordination developed to date. However, their use is not necessarily restricted to determining coordination in the small age span tested (8 years to 18 years). They could be easily adapted to fit requirements, which will be discussed later in the implications.

There are certain qualifications that are necessary to mention in the report. It is assumed that all the subjects have good vision. If they normally wear glasses to read, they were requested to wear these glasses for the test. Of course, some of those that require corrected vision did not have their glasses with them. However, this situation occurred only rarely which was probably due to the interest shown by the school in regard to their students vision.

The reading scores were taken from the Iowa test whenever possible. Whenever these scores were not available, scores were taken from the New York State Reading Survey Test. The scores were registered by their grade level, not their percentile. In instances where the reading tests were administered more than six months prior to the coordination test, the respective lapsed time was added to that previous score. Since the reading test scores had to be indicative of the reading level at the time of the coordination test, there was little choice but to use the above approach. If similar research was to be carried on, it would be better to administer a reading test at the time of the coordination test.

The data, which was used for the graphs, was an average of all six modes since these results were identical except for the shifts along the vertical axis (Appendix E). This data, arranged by any particular characteristic, always produced skewed normality. A plot of this data on probability paper produced a straight line but the mean was always to the right of the median (Appendix D). This makes a great deal of sense when the scoring characteristics of the machines are investigated. Since the score is a measure of the error and error, whether lagging or leading, will always be positive; the perfect score will be zero. The maximum score or the worst score obtainable is in the range of 600. As can be seen from Figure 3, the average scores obtained were in the range from 10 to 40. There were always subjects who scored very poorly and these scores could not be offset by an equally good score because of the characteristics of the machine. These poor scores tended to shift the mean right of the median, a situation which is referred to as being skewed right.

Hand-eye coordination proved to be a function of age. Because of this fact, all scores had to be normalized by age in order to evaluate the other characteristics. It is felt that a 16 year old who is reading at the fourth grade level should score better than a 12 year old reading at the same level.

A special mention should be given to Figure 1, which is the plot pertaining to reading ability. This shows the "non-correlation" between poor readers and hand-eye coordination in the sixth grade. The sixth grade was picked because it was the grade which contained the largest population and it is "typical" of the grades tested. The worst mode consideration, which was used to quell any remarks that a neurological path block might only be evident in one mode, showed the same result - "non-correlation". In fact, this plot is almost identical to the general consideration except for the expected shift in the vertical direction. Each score is increased by approximately 15 points.

The machines produce identical results. The scores can only be read to the nearest unit so a difference of less than 1.0, as shown in result number 4, is less than the maximum error between any sample pair. Also, the standard deviations of these scores were an order of magnitude larger than the differences in the means.

CONCLUSIONS AND IMPLICATIONS

1. There is a "non-correlation" between reading ability and coordination. Even when the worst mode is considered this "non-correlation" remains unchanged.

2. Hand-eye coordination is definitely a function of age. Any results using coordination must consider this age factor. In general, as age increases so does coordination. (Ages 8-18)

3. Grades 4, 6, 7, 10, 12 all produced curves identical to Figures 1 and 2 for determining the relationship of reading ability and hand-eye coordination.

In grades 3, 5, 9, 11 there was an insufficient amount of data to make any judgment. In grade 2, however, it appeared that there was a correlation in that poor readers have poor coordination and good readers have good coordination. However, since the second grade was the youngest group in our test data and the children of that age appeared to have some difficulty with the test, it is felt that more testing would have to be done in this age group and in younger age groups to determine if such a correlation is valid. The machines used for this report could be altered to make an effective test for pre-school children.

4. There is an obvious effect on coordination during the period of adolescence. This effect, which is a decrease in coordination, seems to affect the girls more than the boys. Also, in general, the girls are slightly less coordinated than the boys (Appendix C).

5. The machines produce reproducible results and show accurate quantitative measurements of hand-eye coordination.

6. The data has been shown to be reliable. Reliability being considered good if the reliability coefficient was greater than 0.7, very good if the coefficient was greater than 0.8, and excellent if the coefficient was greater than 0.9.

7. Although these machines have been shown to give a reliable measurement of coordination, its use has been limited. There are many fields in which a machine such as this might be useful:

a. Medicine - to test the effect of drugs, alcohol and other stimuli.

b. Neurology - to determine the extent of damage or extent of surgical recovery.

c. Traffic science - as a supplement to the driving test, especially for those adults over 65 years of age.

8. Coordination tests with children in the low I.Q. range indicate a wide variety of results. It would seem advisable to test these subjects to measure their physical capabilities, balance this against their mental capacity and determine a measure of their trainability.

9. If the device was to be modified as suggested in conclusion number three, it would be possible to test the pre-kindergarten children, now involved in such programs as Operation Head Start, in an attempt to determine their coordination characteristics.

SUMMARY

One of the most recent theories in the field of reading education and remedial reading techniques concerns neurological organization and the completion of the entire developmental processes. If a lower body function, such as coordination, is incomplete in its development, suceeding high level functions, such as reading, will be effected. If this is generally true, then there should be a correlation between hand-eye coordination and reading (dis) ability. The purpose of this report is to determine if such a correlation does exist at the primary and secondary school levels.

Since other tests which measure coordination yield qualitative scores, it was necessary to design and constr ' a test device which would yield a quantitative measurement of coordination. The data collected from this test device, as well as data collected for each individual (age, sex, grade, I.Q., and reading level), were put on computer cards to be statistically analyzed by specially written programs for the IBM 360 Digital Computer. Some of the results included:

1. There is no relationship between reading (dis) ability and hand-eye coordination.

2. Coordination increases with age (8-18 years) with one exception - during the period of adolescence.

3. The machines produced reproducible and reliable data - a quantitative measurement of hand-eye coordination.

Because of a descrepancy in the results, showing a relationship in reading ability and coordination that occured at the second grade level, it is felt that future work should be directed to this group and preceding ages. The test device would have to be slightly adapted in order to be an effective test for younger children.

Another field of research might be determining which practice techniques were the most effective in improving a specific motor expression. Results from this research would be particularly useful in the field of athletics.

In general, in all fields where coordination or lack of coordination is important, these machines could prove to be a valuable tool of research.

REFERENCES

1. Bateman, Barbara
"Learning Disabilities-Yesterday, Today, and Tomorrow", Exceptional Children, Vol. 31, The Council for Exceptional Children, NEA, Washington, 1964.

2. Delacato, Carl H.
The Treatment and Prevention of Reading Problems, Bannerstone House, Springfield, Illinois, 1959.

3. Robbins, Melvyn
"A Study of the Validity of Delacato's Theory of Neurological Organization", Exceptional Children, Vol. 32, The Council for Exceptional Children, NEA, Washington, 1966.

4. Cohen, Alan S.
"Applying a Dynamic Theory of Vision to Teaching Reading", Journal of Developmental Reading, Vol.6, Purdue Research Foundation, Lafayette, Indiana, 1962.

5. Kaluger, George and Kolson, Clifford J.
Clinical Aspects of Remedial Reading, Bannerstone House, Springfield, Illinois, 1963.

6. Blommers, Paul and Lindquist, E. F.
Elementary Statistical Methods in Psychology and Education, 2nd Ed., Houghton Mifflin Co., Boston, 1960.

7. Thorndike, Robert L. and Hagen, Elizabeth
Measurement and Evaluation in Psychology and Education, 2nd Ed., John Wiley and Sons Inc., New York, 1961.

BIBLIOGRAPHY

1. Clement, William G. "A Study of the Correlation Between Individual Traits and Operator Performance in a Hand-Eye Coordination Test and the Development of Equipment for Obtaining Lag-Lead Information for this Test". Master's Thesis, Clarkson College of Technology, Potsdam, New York, Unpublished.

2. Clement, William G. and Foster, Robert L. "Determination of the Effect of the Learning Process on Manipulation of a Manual Control Device Used in Conjunction with a Primary Reading Defects Test", National Science Foundation Supported Senior Project, Clarkson College of Technology, Potsdam, New York, 1965, Unpublished.

3. Foster, Robert L. "An Investigation of the Correlation Between Age and Performance Index in a Hand-Eye Coordination Test Used in Conjunction with the Determination of Primary Reading Disabilities in Children, Master's Thesis", Clarkson College of Technology, Potsdam, New York, Unpublished.

4. Hutchinson, Gary L. "An Investigation of Coordination Factors and Their Ability to Determine the Existence of Primary Reading Disabilities in Children", Master's Thesis, Clarkson College of Technology, Potsdam, New York, Unpublished.

5. Kaluger, George and Kolson, Clifford J. "The Reading Process and Primary Learning Disability" Bannerstone House, Springfield, Illinois.

6. Kear, Edward B. "The Design and Testing of a Portable Device for Obtaining Hand-Eye Coordination Data", Doctoral Dissertation to be presented to Cornell University, Ithaca, New York.

7. Money, John. "Reading Disability", The John Hopkins Press, Baltimore, 1962.

8. Schenck, Hilbert Jr.,"Theories of Engineering Experimentation", McGraw-Hill Company, Inc., New York, 1961.

Appendix A

THE FRONT AND BACK VIEWS

OF THE TEST DEVICE

Observer's View

Administrator's View

Appendix B

Appendix B-1

CORRELATION COEFFICIENTS

The correlation coefficient was the Pearson r or simple r or, as is more commonly known, the Pearson product-moment correlation coefficient which is expressed as:

$$r = \frac{\Sigma Z_{x_i} Z_{y_i}}{N}$$

Where the Z is the standard form of the scores arranged so that the mean is zero and the standard deviation is unity.

$$Z_i = \frac{X_i - \bar{X}}{\sigma_x}$$

The r values run between minus one and plus one. One or minus one being perfect correlation. That is, a change in the X direction of a standard deviation of X results in a change in the Y direction of a standard deviation of Y (Figure B-1). An r value equal to zero can mean two things. It can mean:

1. that the data is uncorrelated or the points are so scattered that they fall in a circular area rather than an eliptical area (Figures B-3 and B-2).

2. perfect "non-correlation" which can occur when the slope of the data is zero (Figure B-4).

For this reason, two tests were run for reliability. The first test was the usual test. The second test was for a rotation in the axis of 45°. If the first score is good and the second score is good, this shows good correlation (Figure B-5). When the first score is good but the second score is poor, this shows good correlation with an approximate slope of 45° of the original data (Figure B-6). If the first score is poor and the second score is good, this shows good "non-correlation" and an approximate slope of zero degrees for the original data (Figure B-7). If the first score is poor and the second score is poor, the data is said not to be correlated and is randomly scattered in a circular area (Figure B-8).

Appendix B

RELATIONSHIP OF CORRELATION COEFFICIENTS AND DATA Z SCORE ARRANGEMENTS

Correlation coefficient=+1.000

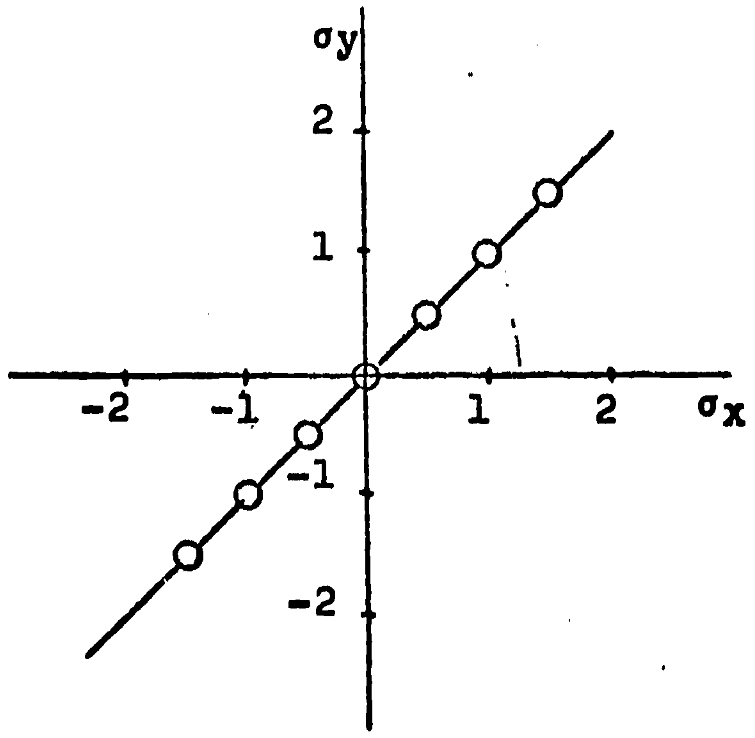


Figure B-1

Correlation coefficient=+0.70

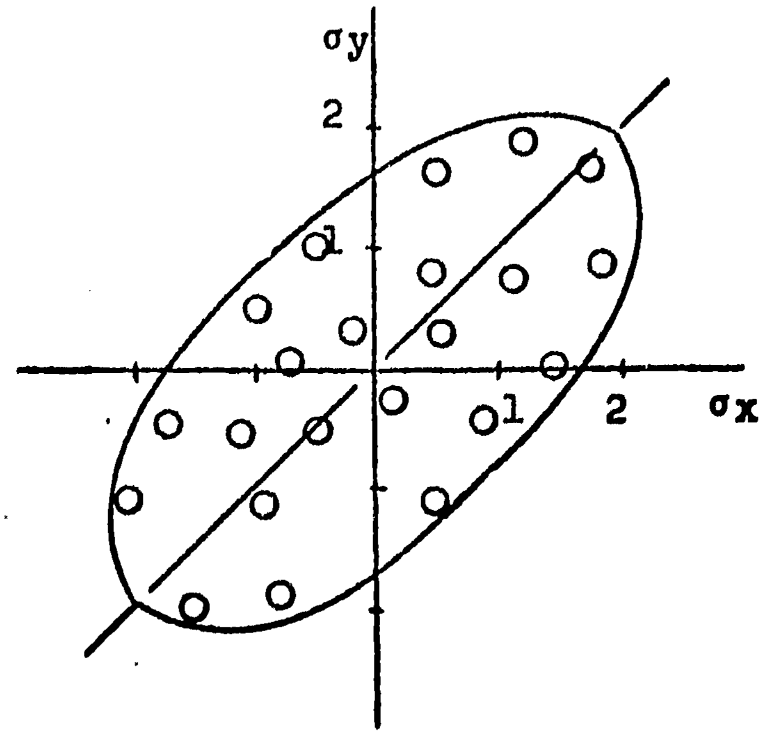


Figure B-2

Correlation coefficient=0.0

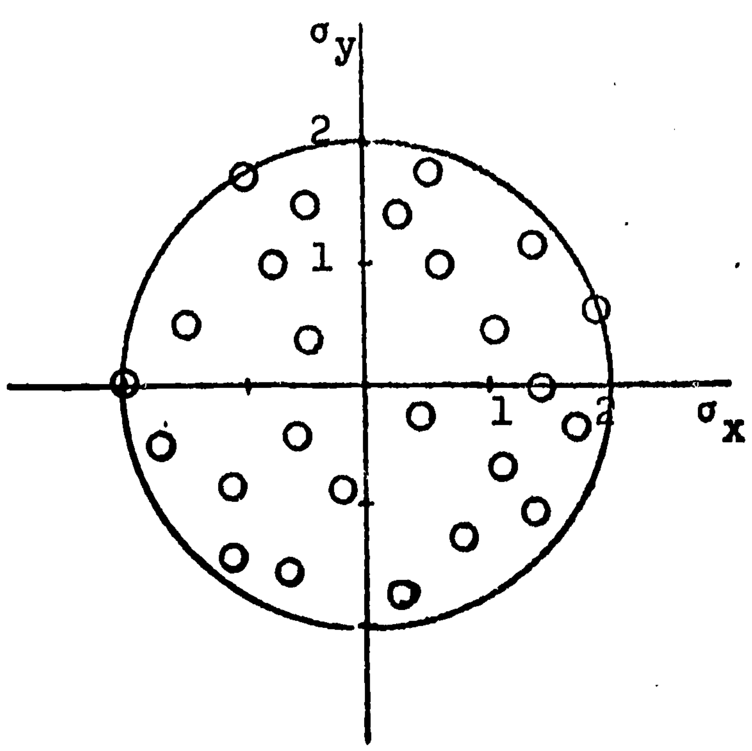


Figure B-3

Correlation coefficient=0.0

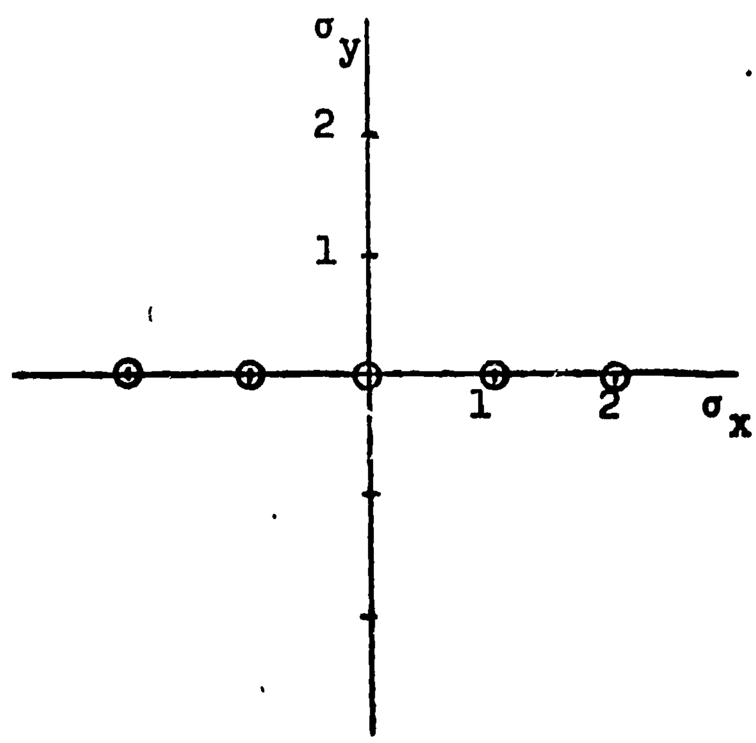
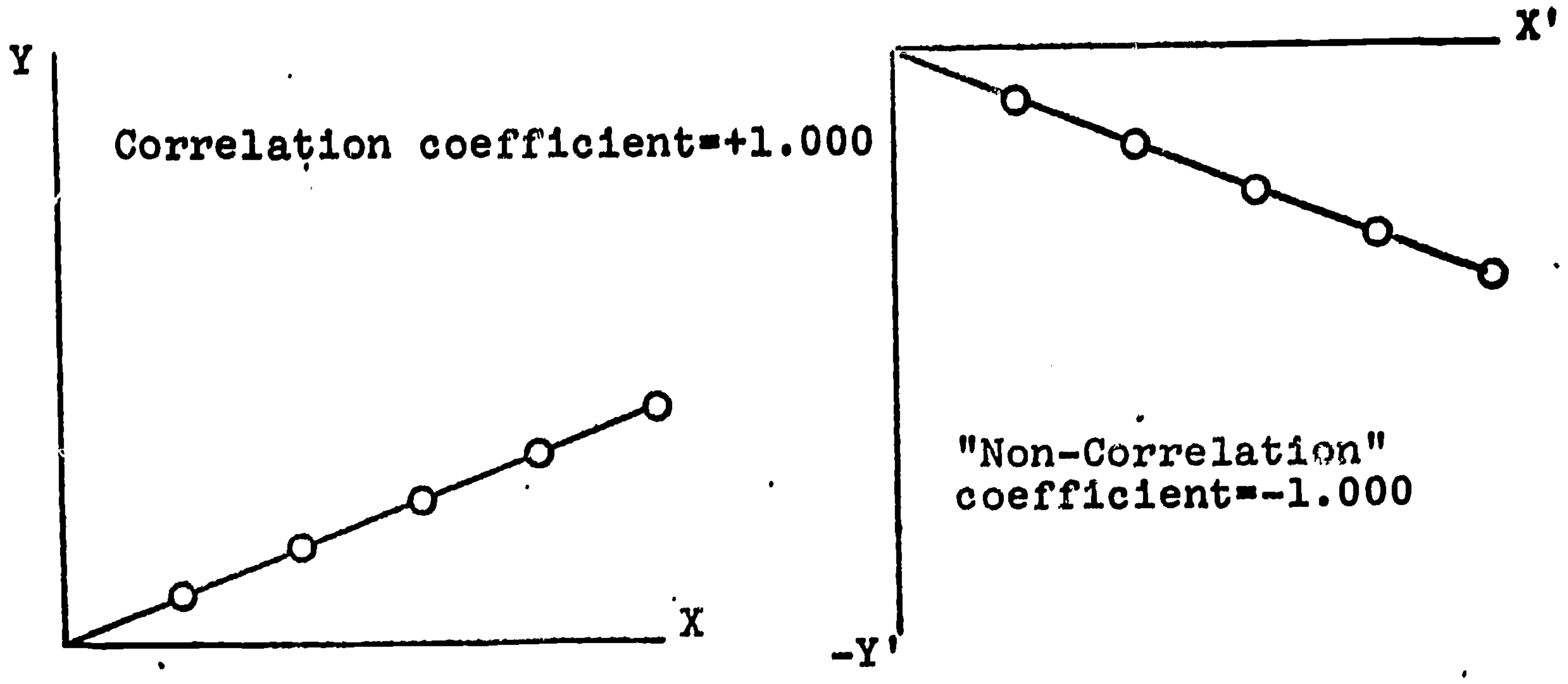


Figure B-4

Appendix B

RELATIONSHIP OF CORRELATION OR "NON-CORRELATION" COEFFICIENTS TO DATA ARRANGEMENT



Original Axis X-Y

Rotated Axis X'-Y'

Figure B-5

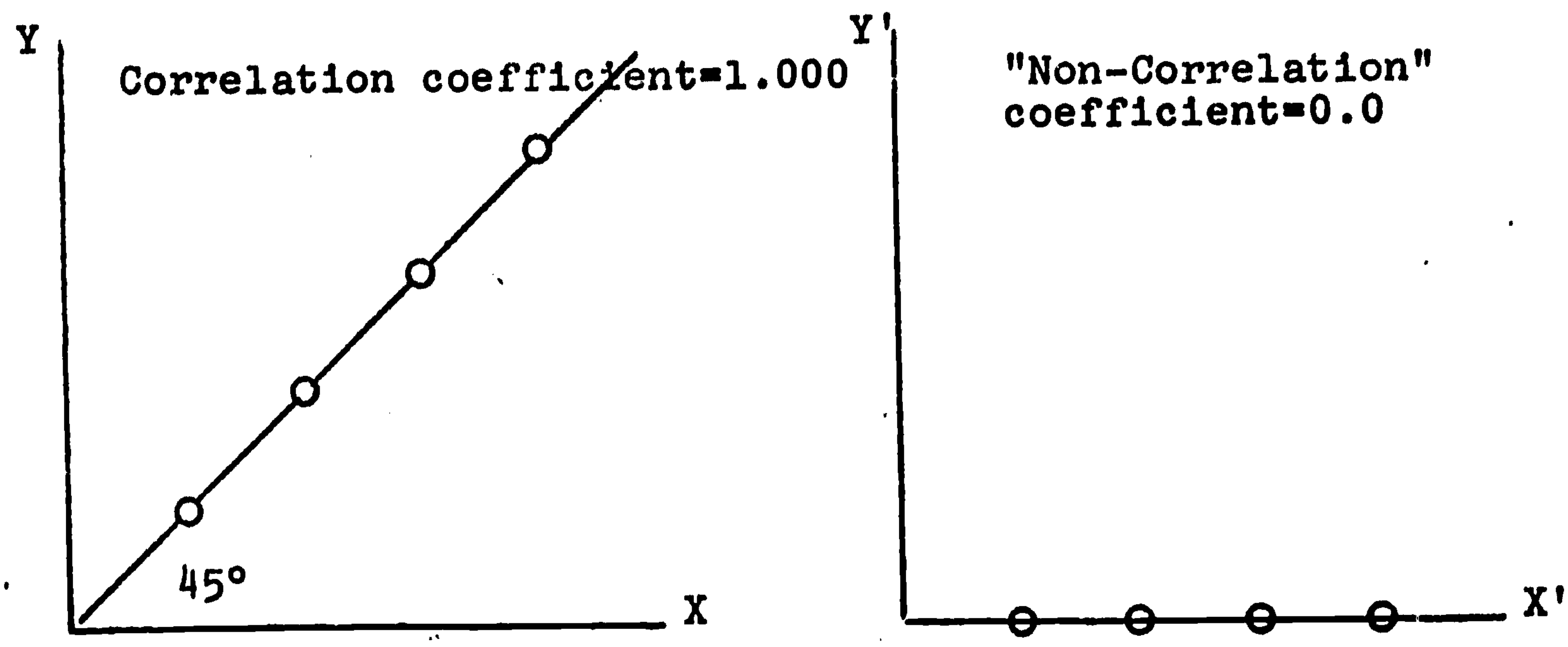


Figure B-6

Appendix B

RELATIONSHIP OF CORRELATION OR "NON-CORRELATION" COEFFICIENTS TO DATA ARRANGEMENT

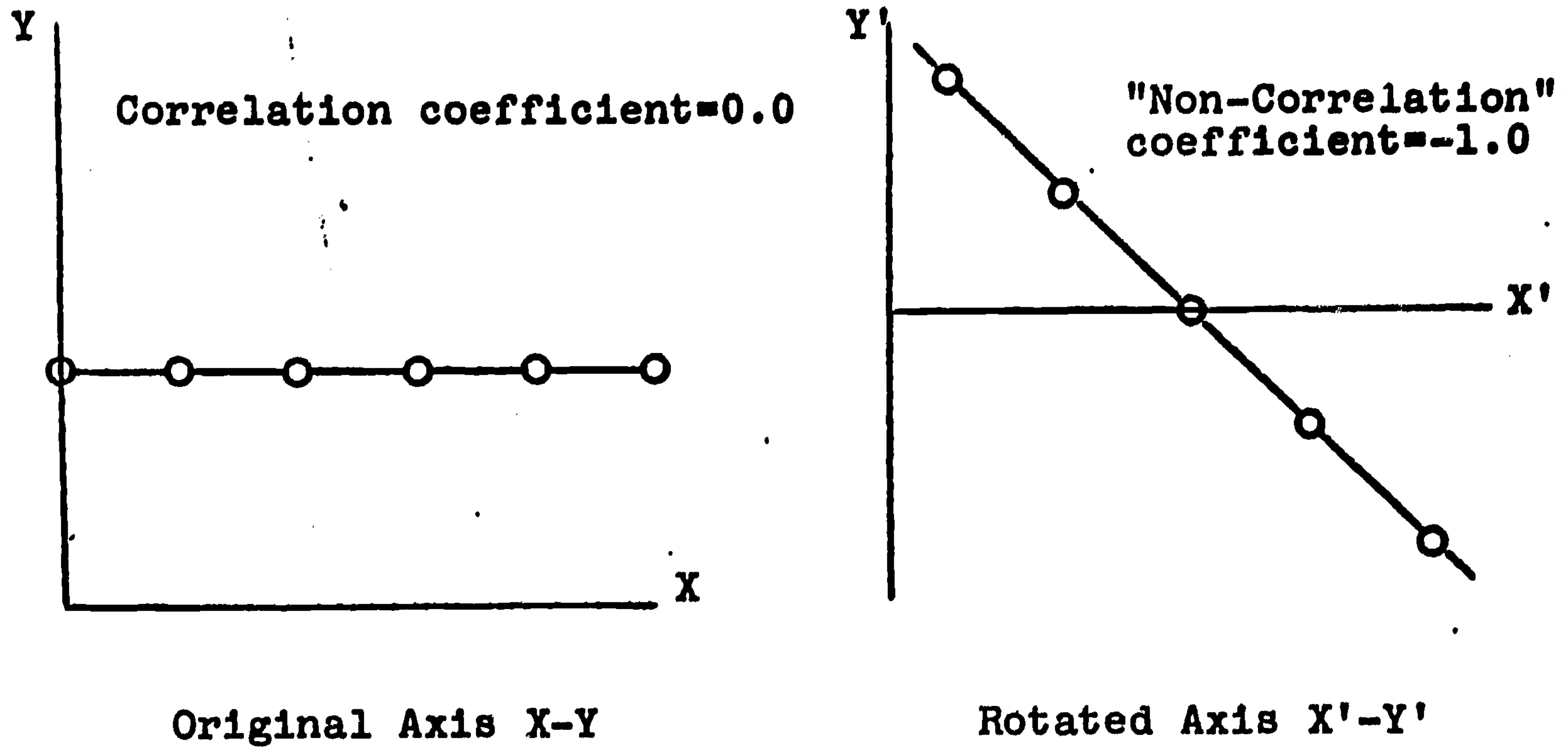


Figure B-7

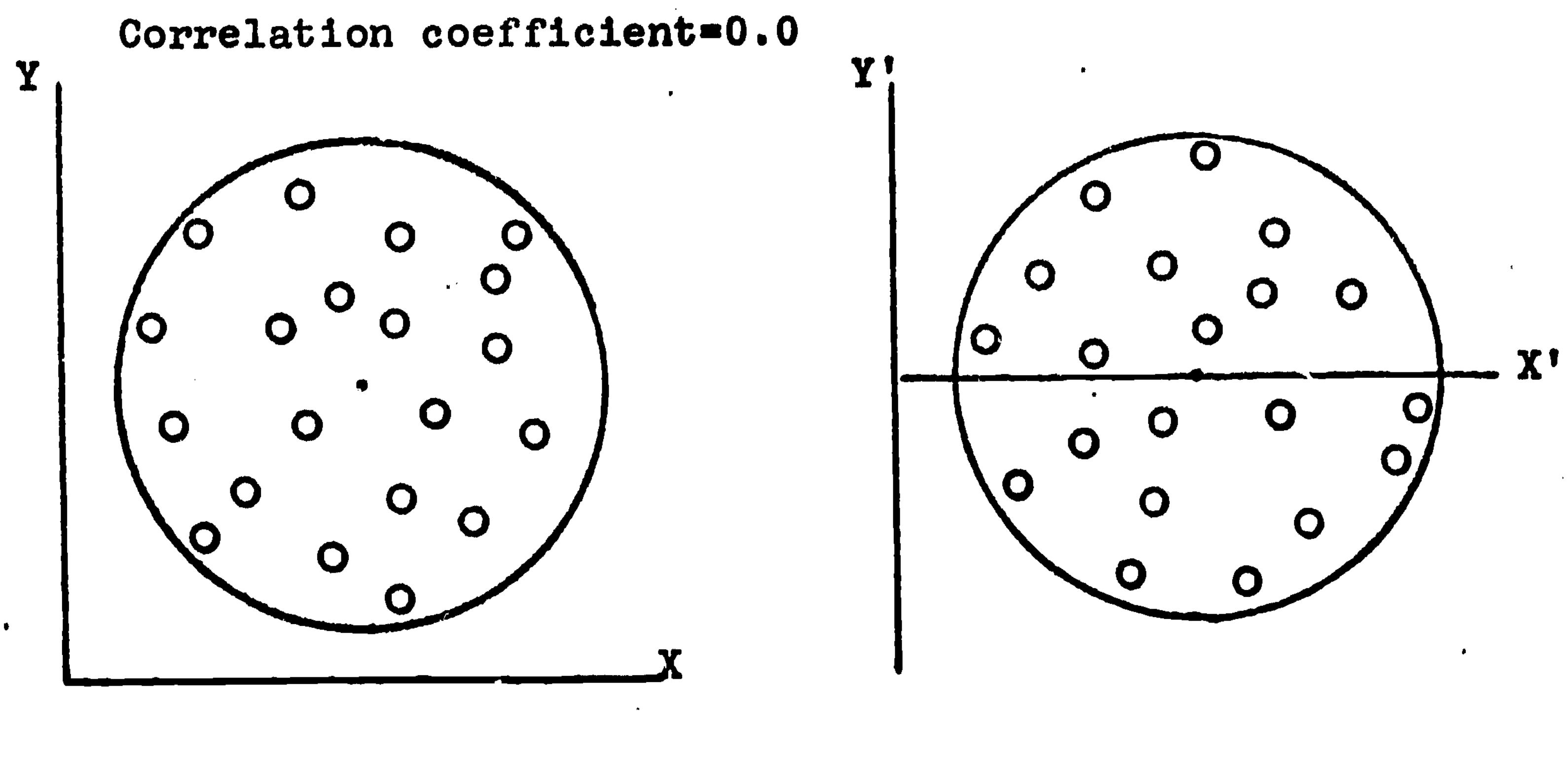


Figure B-8

"Non-Correlation" coefficient=0.0

Appendix B

The value of r is not linear but it is a measure of the closeness of correlation.

> "One of the most common and misleading of practices has been that of classifying certain r-values as 'high', 'medium', or 'low'.... Coefficients of correlation as high as .5 between measures of a physical and a mental trait are extremely rare, and a correlation of .6 between two such traits would be considered phenominal."[1]

Even though the correlation coefficient shows a high relationship, this should not be necessarily interpreted as meaning that this is a measure of the extent to which an individual status of one trait is caused by his status in the other. There can be various reasons for a high correlation. One reason could be due to a cause and effect relationship. Another may be because of a correlation to a third factor or several factors. There may be a definite correlation between the two traits, but it does not follow which is true from the statistical evidence of correlation.[2]

Appendix B-2

THE SPEARMAN-BROWN PHOPHECY FORMULA

The Spearman-Brown Prophecy Formula was used to determine a reliability coefficient by a sub-divided test. The data, for which a reliability was wanted, was divided into two groups. For each of these groups, the correlation coefficient or Pearson r was determined. The reliability coefficient was determined by:[3]

$$R = \frac{2r}{1 + r}$$

---

1. Paul Blommers and E. F. Lindquist
<u>Elementary Statistical Methods in Psychology and Education, 1960</u>, p 403.

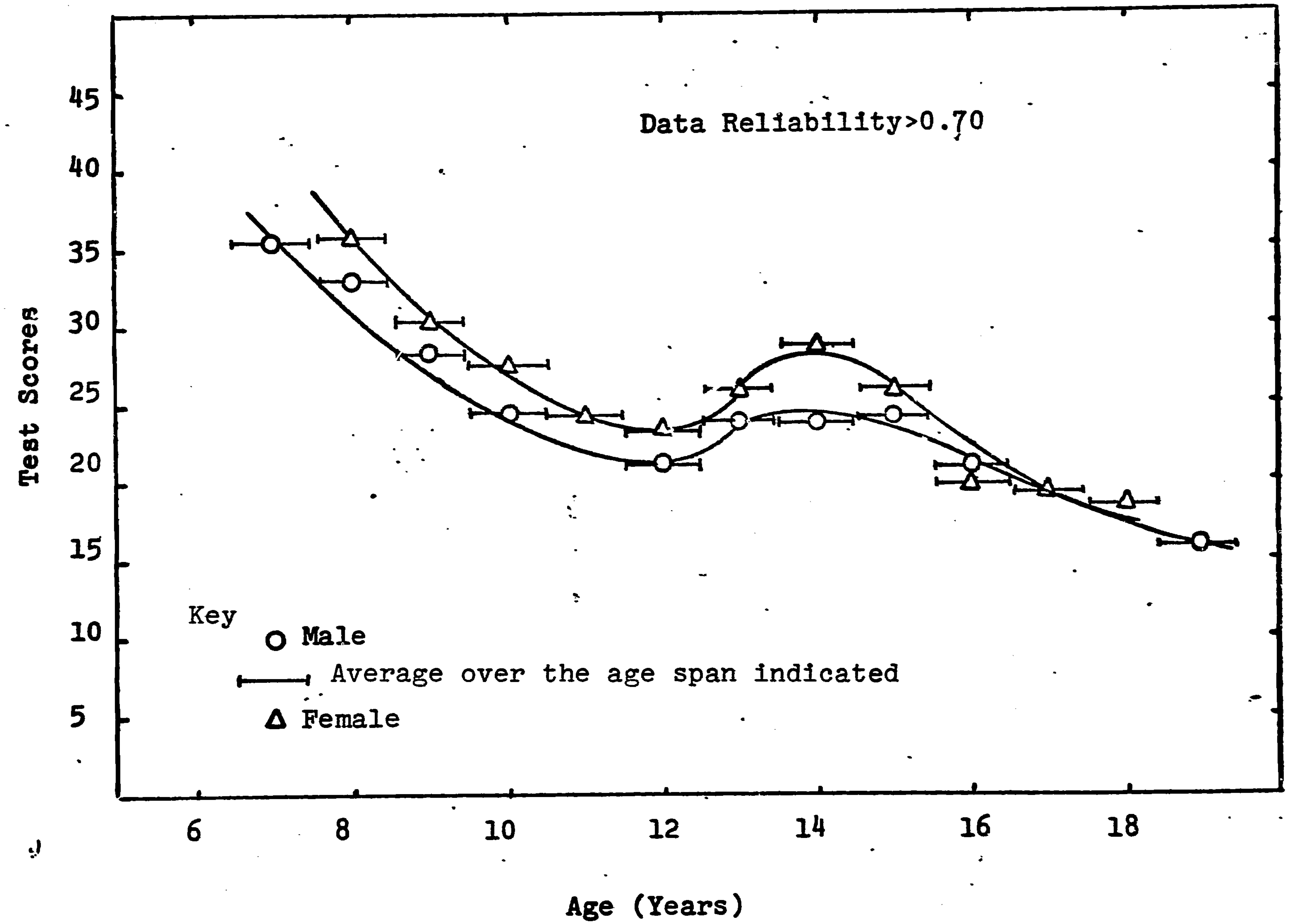
2. Ibid p 405.

3. Robert L. Thorndike and Elizabeth Hagan
<u>Measurement and Evaluation in Psychology and Education, 1961</u>, pp 179-180.

Appendix C

Relationship Between Test Scores And Age

But Separated By Sex



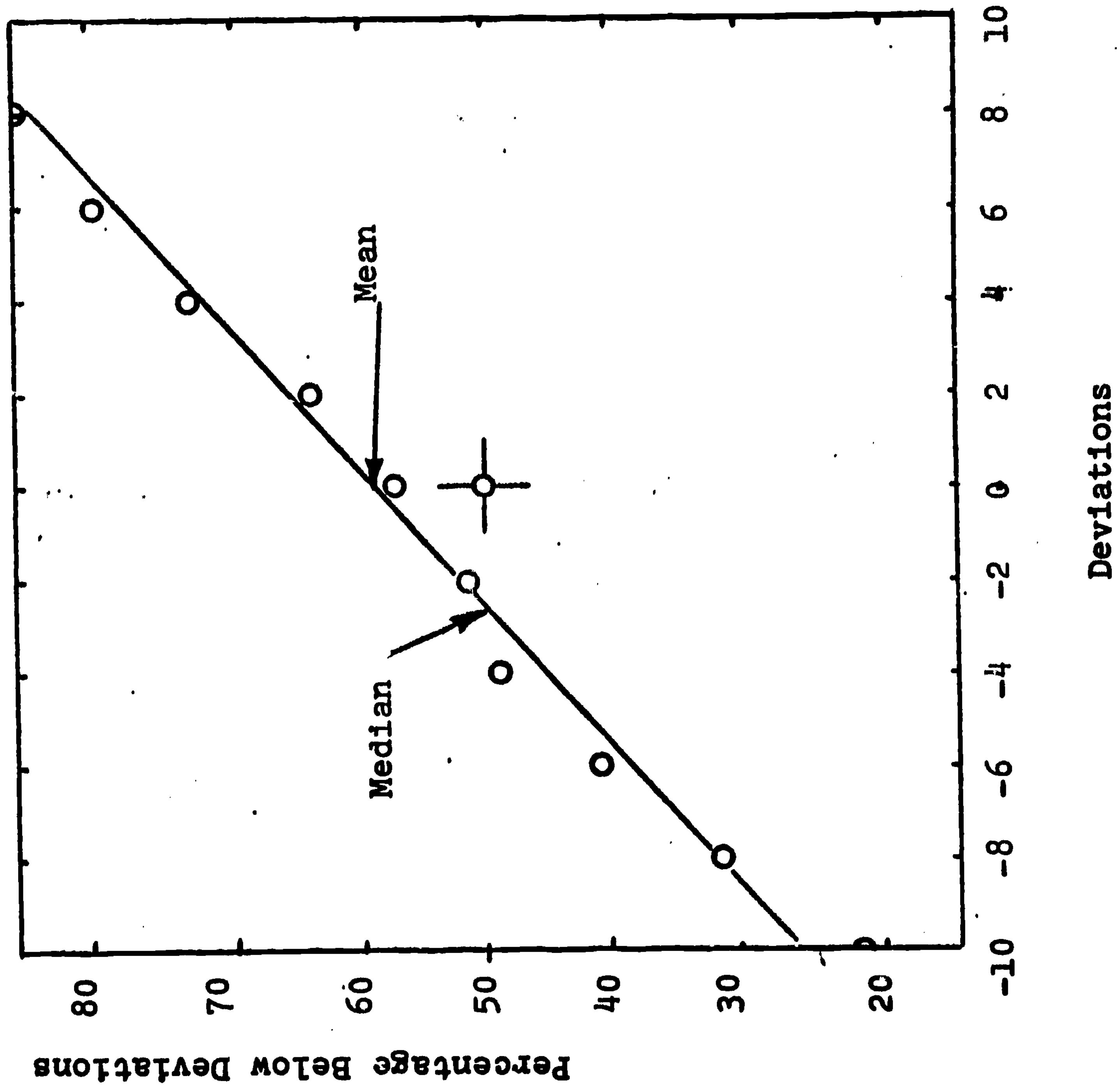
Appendix D

TYPICAL NORMALITY TEST PLOT

Age: 13 Years

No. 82

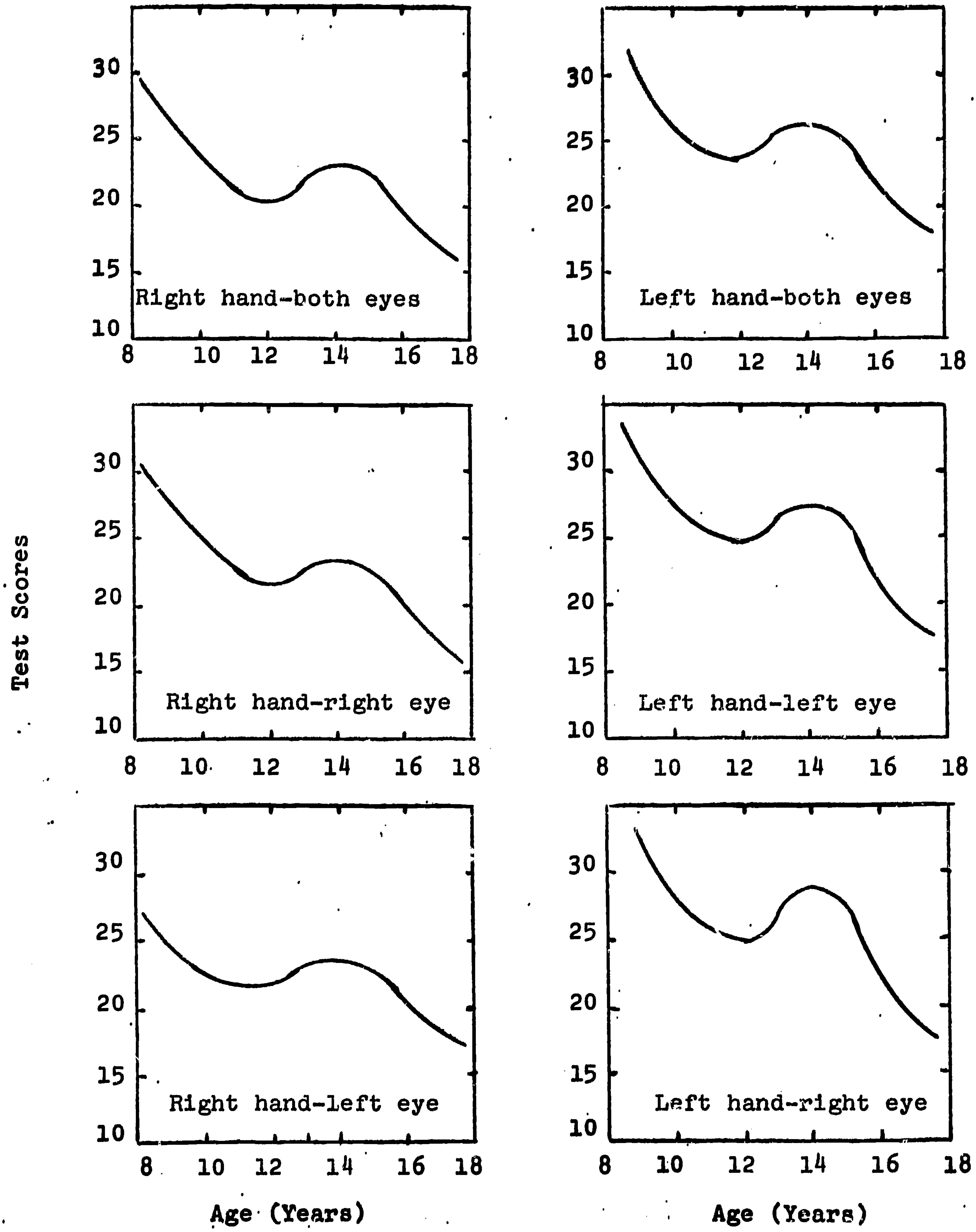
Reliability: 0.926



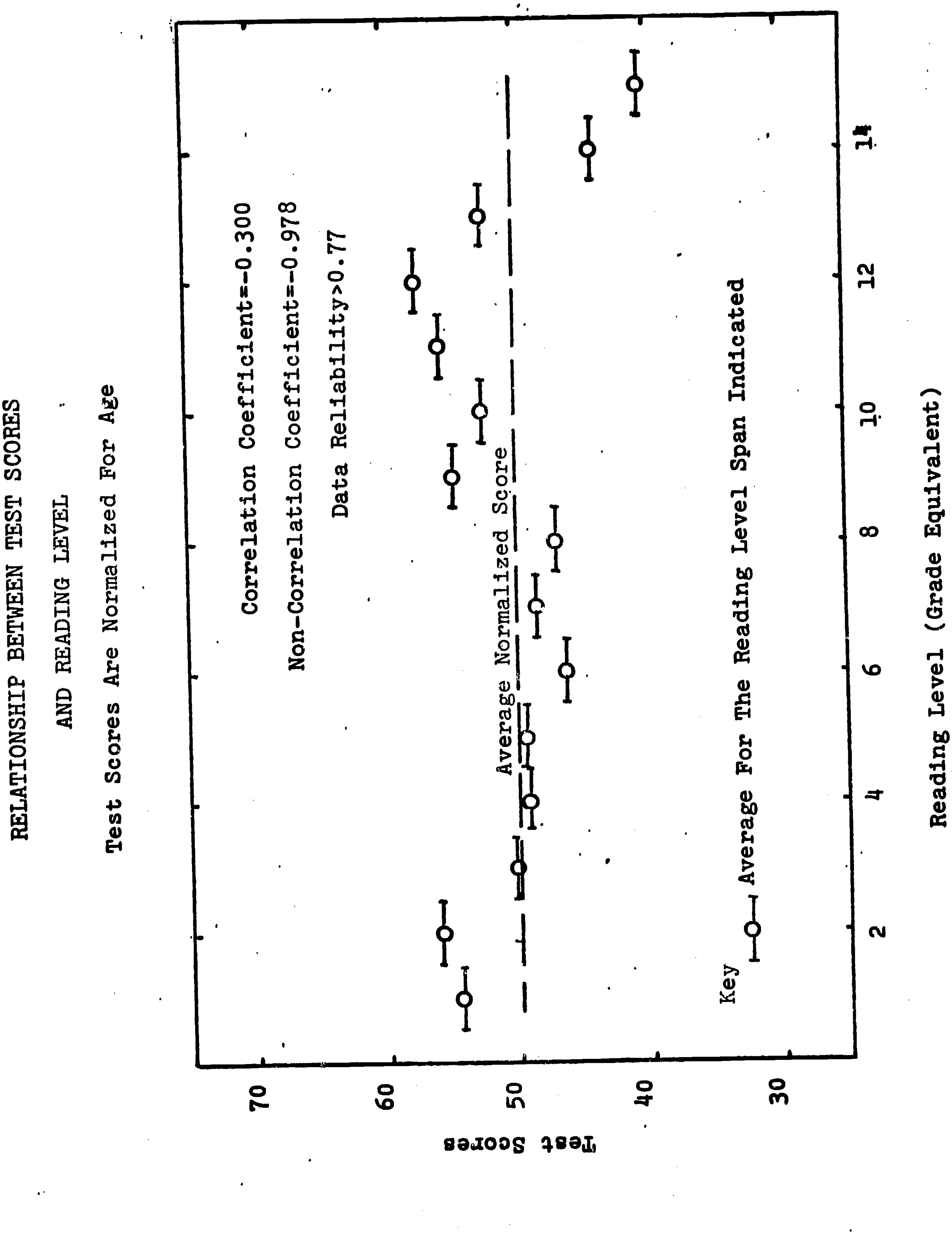
Appendix E

THE RELATIONSHIP BETWEEN HAND-EYE

COORDINATION AND AGE FOR EACH SUB-TEST



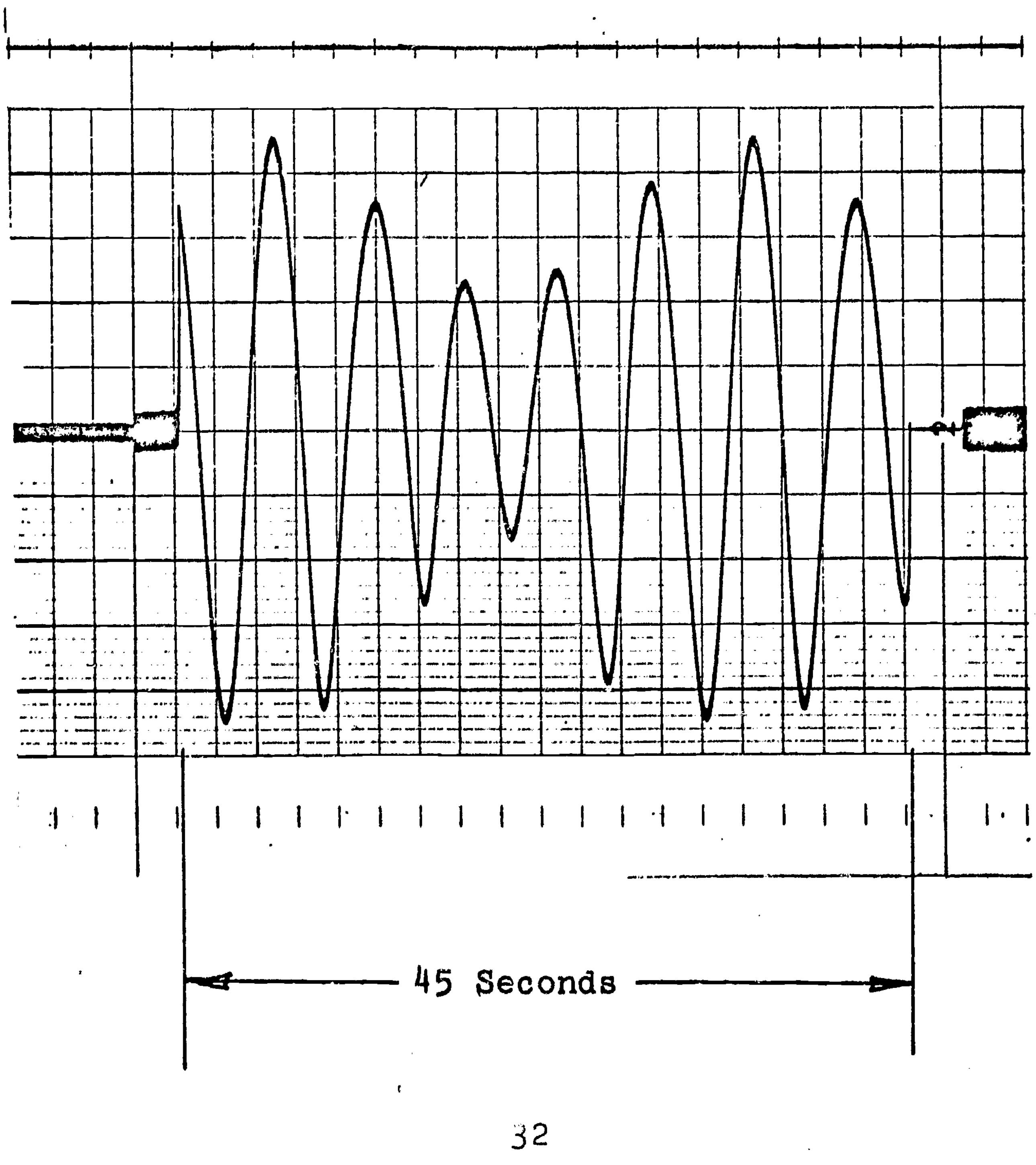
Appendix F


RELATIONSHIP BETWEEN TEST SCORES
AND READING LEVEL
Test Scores Are Normalized For Age
Correlation Coefficient=-0.300
Non-Correlation Coefficient=-0.978
Data Reliability>0.77
Average Normalized Score
Key
Average For The Reading Level Span Indicated
2
4
6
8
10
12
14
Reading Level (Grade Equivalent)
70
60
50
40
30
Test Scores

Appendix G

A GRAPHICAL DESCRIPTION OF

THE "RANDOM" CYCLIC MOTION



OE 6000 (REV. 9-66)

DEPARTMENT OF HEALTH, EDUCATION, AND WELFARE
OFFICE OF EDUCATION

ERIC REPORT RESUME

ERIC ACCESSION NO.				
CLEARINGHOUSE ACCESSION NUMBER	RESUME DATE	P.A.	T.A.	IS DOCUMENT COPYRIGHTED? YES ☐ NO ■
	08-21-67			ERIC REPRODUCTION RELEASE? YES ■ NO ☐

TITLE
The Collection and Statistical Evaluation of Quantitative Data for Hand-Eye Coordination with Respect to Determining Its Correlation with Reading Disability at Both the Primary and Secondary School Levels (Final Report)

PERSONAL AUTHOR(S)
Maclean, George R. Kear, Edward B.

INSTITUTION (SOURCE)
Clarkson College of Technology, Potsdam, N. Y., Mech. Engr.

SOURCE CODE

REPORT/SERIES NO.

OTHER SOURCE

SOURCE CODE

OTHER REPORT NO.

OTHER SOURCE

SOURCE CODE

OTHER REPORT NO.

PUB'L. DATE 08 1967

CONTRACT/GRANT NUMBER Dec 1-6-068324-0653

PAGINATION, ETC.
32 pages

RETRIEVAL TERMS

IDENTIFIERS

ABSTRACT

The possibility of a correlation between hand-eye coordination and reading disability was investigated. Primary and secondary school aged children from grades two to twelve were tested to determine their hand-eye coordination using a portable testing device which had just recently been developed.

The subjects included approximately 1700 "normal" public-school students and 290 students diagnosed as poor readers by reading clinics. The subject's reading ability was determined through use of the standardized reading tests administered by the schools. Statistical analysis of the data, after it was normalized for the effect of age, indicated no correlation between hand-eye coordination and reading disability above the second grade level. At the second grade level there appears to be some correlation, however, since this was the youngest group tested, more work must be done in the younger age range before any conclusions can be reached.

Figure 3