ABSTRACT

This study was designed to investigate the relationship of eye movements of grade five pupils to variations in readability levels. A further purpose was to assess the effect of these variations on the eye movements of pupils of poor, average, and good reading ability.

Twenty pupils were selected at random for each of three groupings of poor, average, and good readers from a total of 213 grade five students. Each subject's independent, instructional, and frustration level was determined using the Botel Reading Inventory A.

Eye movements were recorded for each subject at each of the three levels using E.D.L.'s Biometric Reading Eye II and passages from the Reading Eye Test Selections. Number of fixations and regressions, average duration of fixation, average reading rate, and comprehension percentage were computed for each recording.

Analysis of variance was used to determine the significance of both inter-group and intra-group variations and post-hoc comparisons were made using Student Newman-Keuls tests. The five per cent level of significance was

set as the acceptable level for significant difference.

Analysis of the results revealed significant differences between poor, average, and good readers in the number of fixations, regressions, average span of recognition, and average reading rate when reading at their independent, instructional, and frustration levels. Poor readers also exhibited a significantly longer average duration of fixation than either average or good readers at their independent, instructional, and frustration levels but no significant difference in average duration of fixation was found between average and good readers at these levels.

No significant differences were found in the number of fixations, number of regressions, and average span of recognition of grade five students reading at their independent or instructional levels.

Significant differences were found in all eye movement components, number of fixations, number of regressions, average span of recognition, average duration of fixation, and average reading rate, of grade five students reading at their independent or frustration levels.

Graphs of the mean values for the eye movements of average and good readers indicated a linear trend from independent to instructional to frustration levels for

average span of recognition and average duration of fixation. The performance of poor readers for average span of recognition and average duration of fixation did not follow the same pattern as that for average and good readers but, rather, suggested a significant relationship between appropriateness of material (instructional level) and eye movement behavior which warrants further investigation. Further support for this relationship was provided by the superior performance of poor and average readers in terms of the number of fixations and regressions exhibited at their instructional level as opposed to the independent or frustration levels.

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CHAPTER I

STATEMENT OF THE PROBLEM AND DEFINITION OF TERMS

Introduction

Eye-movement photography has made a significant contribution to research in reading by allowing the researcher to examine the visual process the reader uses when he engages in reading behavior. It has helped to demonstrate relationships between specific physiological and performance variables, offering insight into both the functional and interpretive aspects of the reading process. Since the teacher's conceptualization of the reading process forms a basis for instructional procedures and materials selected for the child, it is the writer's hope that this study will contribute to a clearer conceptualization of that process. Specifically, the purpose of this study was to investigate the relationship of eye movements to variations in readability levels.

Significance of the Study

Eye-movement photography can provide specific concrete physiological data with which to examine the relationships which exist between specific variations such as

readability in reading material and the reading process. This can provide greater specificity and focus than is possible through more general discussions of the reading process.

A study by Ruddell examined the effect on reading comprehension of written patterns of language structure which occur with high and low frequency in children's oral language. He examined the relationship between reading comprehension and linguistic complexity and found that reading comprehension scores on passages written with high frequency patterns of language structure were significantly superior to comprehension scores on passages written with low frequency patterns of language structure.[1] Strickland's study of the language of elementary school children also supported this relationship between silent reading comprehension and the structure of children's oral language.[2]

Smith studied one hundred and twenty students from nine different grade levels to determine whether syntactically more complex structures increase reading difficulty

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[1]Robert B. Ruddell, "Language Acquisition and the Reading Process," Theoretical Models and Processes of Reading, eds. Harry Singer and Robert B. Ruddell (Newark: International Reading Association, 1969), pp. 1-19.

[2]Ruth B. Strickland, The Language of Elementary School Children: Its Relationship to the Language of Reading Textbooks and the Quality of Reading of Selected Children, Bulletin of the School of Education, Indiana University, Vol. XXXVIII, No. 4, July 1962, p. 86.

or whether all students, regardless of grade level, have the same syntactic skills and thus read with equal facility material written at different levels of syntactic maturity provided the vocabulary and content are held constant. He concluded that for students in grades four, five and six, fourth grade writing appeared to be easier to read than writing by more mature students but more mature students in grades eight through twelve found eighth grade writing easier to read than either the syntactically simpler fourth grade material or the syntactically more complex twelfth grade material. His study would seem to support the relationship between syntactical maturity of the reader and his comprehension.[3]

If it can be demonstrated that changes in readability significantly affect the eye movement components of fixations, regressions, span of recognition, duration of fixation and reading rate, then the following questions may be proposed for further examination and discussion:

1. What is the effect of vocabulary load on eye movement behavior?
2. What is the effect of sentence length on eye movement behavior?

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[3]William L. Smith, "The Effect of Transformed Syntactic Structure in Reading," Language, Reading and the Communication Process, ed. Carl Braun (Newark: International Reading Asscciation, 1971), pp. 52-62.

3. How do linguistic factors such as T-Units and Sentence-Combining Transformations contribute to changes in observed reading behavior?
4. What are the interrelationships among vocabulary, sentence length and linguistic factors and eye-movement behavior?

If there are significant differences in the way in which the eye movements of poor, average, and good readers are affected by changes in the above readability measures, this study may focus attention on some of the following questions:

1. What are some of the characteristics of poor, average, and good readers which may account for this difference?
2. Are certain measured features of the material more crucial to some readers than others in terms of their eye movement efficiency or comprehension?

On the other hand, if this study supports the findings of Morse[4] and Ballentine[5] concerning the stability of eye movement performance on material involving changes in difficulty, the relationship between comprehension and level of difficulty could require further investigation.

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[4]William C. Morse, "The Individuality of Eye Movements," Research in the Three R's, eds. E. W. Hunnicut and W. Iverson (New York: Harper and Brothers, 1958), pp. 33-38.

[5]Francis A. Ballantine, "Age Changes in Measures of Eye Movements in Silent Reading," Monographs in Education, Vol. IV (Ann Arbor: University of Michigan Press, 1951), pp. 67-111.

The Problem

The purpose of this study was to investigate the relationship of eye movements to variations in readability levels. This was accomplished by assessing the reading performance of Grade five pupils reading passages at their independent, instructional, and frustration levels. An attempt was made to relate the eye-movement components measured to the degree of difficulty of each passage.

A further purpose was to assess the effect of variations in readability on the eye movements of pupils of poor, average, and good reading ability.

It was postulated that if changes in eye movements occurred at all there would be significant differences in eye movement components at increasing levels of passage difficulty and when material was presented that was beyond the pupil's instructional level of achievement.

More specifically, the study was designed to answer the following questions:

1. What effect will materials at the pupil's independent, instructional, and frustration levels of reading achievement have on the number of fixations and regressions he exhibits in reading?
2. How will the average span of recognition, average duration of fixation and reading rate the pupil exhibits during reading be affected by reading materials

at his independent, instructional, and frustration levels?

3. What difference will exist among poor, average, and good readers in the number of fixations and regressions exhibited when reading passages at their independent, instructional, and frustration levels of reading achievement?
4. What differences will exist among poor, average, and good readers in the average span of recognition, average duration of fixation and reading rate exhibited in reading passages at their independent, instructional, and frustration levels of reading achievement?

Definition of Terms

The following eye-movement factors will be considered:

Fixations. - The definition of fixation was that provided by Taylor. A fixation or a fixation pause is "that period in reading a line of print during which the eyeball is held stationary for a short time and during which perception takes place.[6]

Saccade. - Following one fixation, the eye jumps to a new fixation point. This interfixation movement is called a

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[6]Stanford E. Taylor, Eye Movement Photography with the Reading Eye (New York: Educational Developmental Laboratories, Inc., 1960), p. 36.

saccade or saccadic movement.

Readability. - Readability is a measure of the degree of difficulty of reading material. In this study the term readability will refer to the perceptual problems of understandability as measured by the following readability formulas: Spache for grades 1-3, Lorge, Yoakam, Dale-Chall, and Flesch 1951 for junior high level and above only.[7]

Regression. - A regression is a saccade followed by a fixation but made in a right to left direction along a line of print. It occurs as the individual is reading the selection in the usual left-to-right sequence and should not be confused with the return sweep as the individual moves to begin the next line of print.

Span of Recognition. - The span of recognition is the average number of words or word parts perceived during a fixation. It was calculated by dividing one hundred words read by the number of fixations for one hundred words.

Duration of Fixation. - The duration of fixation is the average length of time the eyes pause during a fixation. It was calculated by dividing the time to read one hundred words (in seconds) by the number of fixations for one hundred words.

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[7]For more details about readability see Appendix C.

Reading Rate. - Reading rate refers to the average number of words read per minute (w.p.m.). It was calculated by dividing six thousand by the time (in seconds) to read one hundred words.

Definitions for the three functional levels of reading performance were determined on the basis of criteria established by the Botel Reading Inventory A.[8]

Independent Level. - was the highest level at which the student scored ninety-five percent or better on the Word Recognition Test and ninety percent or better on the Word Opposites Test.

Instructional Level. - was the highest level at which the student scored between seventy percent and ninety percent on the Word Recognition Test and between seventy percent and eighty percent on the Word Opposites Test.

General Procedures and Limitations

A sample of sixty grade five pupils was drawn from four schools selected at random in the Brandon School Division Number 40. The Canadian Tests of Basic Skills was used as a measure of reading achievement to select approximately twenty pupils for each of three groupings of poor, average, and good readers. Each of these pupils was then tested with the Botel Reading Inventory A to determine

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[8]Morton Botel, Revised Guide to the Botel Reading Inventory (Chicago: Follett Publishing Company, 1966), p. 20.

his independent, instructional, and frustration levels of reading performance.

Pupils were then tested at each of these functional reading levels with graded passages. After each graph recording, the pupil's comprehension was tested with ten true-false questions.

Each graph was then analyzed to determine the number of fixations, regressions, the average duration of fixation, average span of recognition and reading rate. Where possible, this analysis was based upon the middle one hundred words for each passage.

Since there was an attempt to control the number of good, average, and poor readers involved in the study, the generalizations based upon the results must be limited to these categories. No attempt was made to control sampling in terms of intelligence, sex, chronological age, or socio-economic status. However, within this context, generalizations should be possible concerning inter-group and intra-group variations in reading patterns.

Also, the novelty of the equipment and testing procedures used may have resulted in somewhat atypical recordings of eye movements.

Organization of the Study

Chapter I has discussed the purpose, significance, and theoretical framework of the study and included a

procedural summary.

Chapter II will review the literature on eye-movement studies that relate to the present study.

Chapter III will present a detailed description of the design and procedures of the study.

Chapter IV will present the analysis of data and describe the findings of the study.

Chapter V will interpret and consider the implications of the findings. Limitations of the study, as well as suggestions for further research, will also be included in this chapter.

CHAPTER II

REVIEW OF THE LITERATURE

The role of eye movements in the reading processs has been an issue of concern and debate among many educators since the first studies undertaken by P. Javal in the late nineteenth century. While the early research was concerned, for the most part, with descriptive studies that served to define and measure the factors involved in eye movements during reading, later studies placed more emphasis on the measurement of eye movements, their significance to the reading process, and the factors influencing their occurrence during reading. Possibly the research on eye movements in relation to the reading process can best be considered in light of the following questions: (1) What eye movement components are measurable and how can they be measured or described? (2) What influences the individual reader's eye movements? (3) What are the possible uses and limitations of eye movement measurement and analysis? (4) What contributions and limitations are suggested by the research? and (5) What possibilities are suggested for needed research in this area?

LITERATURE ON MEASUREMENT OF EYE MOVEMENT COMPONENTS

In reading, the eyes do not make a continuous sweep across the page. Rather, the reader's eyes progress in a series of alternating pauses and quick jerky movements. The pauses, which are called fixtions, last only a fraction of a second and it is only during this time that the reader can see the stimuli. Jerky movements called saccadic movements follow the fixation pause and allow the reader to move to another point of fixation. If this saccadic movement is made in a right to left direction as opposed to a left to right direction, the fixation pause that follows it is termed a regression. Poor readers tend to make more regressions than good readers. During the fixation pause the reader recognizes letters, words or possibly phrases and the size of the unit recognized is called his span of recognition. The time consumed by the reader during the fixation pause may be calculated as his duration of fixation. The time required for reading will depend upon fixation time and movement time. Good reading is characterized by a wide recognition span, a small number of fixations per line, and a small number of regressions.

Fixations

As a person reads across a line of print, his eyes make a series of stops known as fixations. Tinker found

that fixations occupy from 92 to 94 per cent of the reading time while movement of the eye from one fixation to another involved the remaining 6 to 8 per cent of the reading time.[1] Taylor's studies indicated that the average grade one student made about 224 fixations per 100 words compared to the average college reader who made about 90 fixations per 100 words.[2]

Saccadic Movements

Following one fixation, the eye jumps to a new fixation point. This interfixation movement is called a saccade or saccadic movement. These saccadic movements, stated Tinker, require from ten to twenty-three milliseconds.[3] Thomas determined that the reader does not identify and recognize material while his eyes are in motion. His study involved the projection of electronically activated images so that they would appear only when the subject's eyes went into motion, disappearing when movement ceased. All subjects failed to see the material that was presented while their eyes were in motion. He concluded that readers identify and recognize visual material only during

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[1]Miles A. Tinker, "The Use and Limitations of Eye-Movement Measures in Reading", Psychological Review 40 (July 1933): 381-87.

[2]Stanford E. Taylor, Eye Movement Photography with the Reading Eye (New York: Educational Developmental Laboratories, 1960), p. 50.

[3]Tinker, pp. 381-87.

eye pauses or fixations.[4] Gilbert explored the relationship between speed and accuracy of perception among college students reading simple prose both with and without intervening saccadic movements of the eyes. He concluded that both good and poor readers made more perceptual errors when they read with intervening saccadic movements than they did when reading without intervening saccadic movements.[5] Saccadic movements are also associated with a substantially greater loss in visual perception for poor readers than they are for good readers.[6] In addition, Gilbert's results indicated that both good and poor readers could process simple prose material mentally at a faster rate and more accurately than they actually did when reading with saccadic movements.[7]

Regressions

Most regressions are thought to result from habit rather than from a conscious desire to double check or

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[4]E. Llewellyn Thomas, Speed Reading: Practices and Procedures (Newark, Delaware: University of Delaware Reading-Study Center, 1963), pp. 126-27, cited by Kenneth M. Ahrendt and Donald S. Mosedale, "Eye-Movement Photography and the Reading Process", Journal of the Reading Specialist, March 1971): 150.

[5]Luther C. Gilbert, "Saccadic Movement as a Factor in Visual Perception in Reading". Journal of Educational Psychology 50 (February 1959): 15-19.

[6]Ibid, p. 19.

[7]Ibid.

reread a part that was not well understood.[8] While these regressions may be unconscious, Thomas maintained that they "indicate the time it has taken the reader to recognize that his processing of information is incomplete."[9]

Taylor's studies indicated that total regressions may occupy one-fifth to one-third of the reading time.[10] His normative studies showed that the average grade one reader made 52 regressions per 100 words, while the average college reader made only 15 regressions per 100 words.[11] Research done by Carmichael and Dearborn; Seibert; and Taylor, Frackenpohl, and Petee indicated that the number of regressions a reader makes is as consistent as the number of fixations he makes.[12]

Rereading is sometimes confused with regressions and should be distinguished here as intentionally returning

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[8]Taylor, p. 38.

[9]E. Llewellyn Thomas, "Movements of the Eye". Scientific American 219 (August 1968): 88-95.

[10]Taylor, p. 38.

[11]Taylor, p. 39.

[12]Leonard Carmichael and Walter F. Dearborn, Reading and Visual Fatigue (Boston: Houghton Mifflin Co., 1947); Earl W. Seibert, "Reading Reactions for Varied Types of Subject Matter", Journal of Experimental Education 12 (September 1943): 37-44; cited by Stanford E. Taylor, Helen Frackenpohl, and James L. Pettee, "A Report on Two Studies of the Validity of Eye Movement Photography as a Measurement of Reading Performance", Reading in a Changing Society 4 (International Reading Assocation Conference Proceedings, 1959).

to a previously covered line, sentence or paragraph for a second time. A certain amount of this kind of "regressive" movement is desirable, maintained Boyle, when it serves the purpose of verification, phrase analysis, and re-examination of previous sentences. However, the habitual regressions resulting from lack of attention, confidence, or organizational ability contribute to inefficiency in reading.[13]

Span of Recognition

Probably no other eye-movement factor has stirred as much controversy as the span of recognition. Observations and conclusions vary concerning the maximum possible span and the role of peripheral vision in reading. Gray studied the eye movements of persons from fourteen different countries reading their native languages. He observed that the average silent reading span was 1.6 words and concluded that only a very small amount of material is perceived per eye stop.[14] Feinberg studied the degree of visual acuity involved in the reader's peripheral vision. His results indicated that the maximum span of apprehension is about two inches or approximately 5 to 6 words at

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[13]Evalyn Boyle, "The Nature and Causes of Regressive Movements in Reading" Journal of Experimental Education, 11 (September 1942): 16-36.

[14]William S. Gray, The Teaching of Reading and Writing (Chicago: Scott, Foresman and Company, 1956), pp. 53-59.

reading distance. Anything outside the two inches is not visible in a single fixation. The average reader, he claimed, sees only 4 or 5 letters immediately around the focal point of a fixation with 100 per cent acuity. Words that occur one inch from the fixation point are seen with only 30 per cent acuity.[15] Carmichael and Dearborn speculated that:

> Cues from the print on either side of the fixation may have been grasped which, though they are not reportable, are useful in the perception of what has been read during the fixation pause or of what will be read during the next fixation pause. Peripheral vision may also aid in the determination of where the next fixation pause is to be located.[16]

Tinker also recognized the role of peripheral vision in reading. He concluded that eye-movement photographs record the approximate center of the field of vision. This "fixation field" is called the point of fixation. However, when fixating on this point, one also sees and recognizes a part of the peripheral visual field.[17]

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[15]Richard Feinberg, "A Study of Some Aspects of Peripheral Visual Acuity", American Journal of Optometry and Archives of American Academy of Optometry 60 (February-March 1949): 1-23, cited by Kenneth M. Ahrendt and Donald S. Mosedale, "Eye Movement Photography and the Reading Process", Journal of the Reading Specialist (March 1971): 153.

[16]Carmichael and Dearborn, Reading and Visual Fatigue, p. 61, as quoted in Taylor, The Reading Eye, p.40.

[17]Tinker, pp. 381-87.

Much of the controversy over maximum reading rates can be attributed to differences in opinion regarding the importance of peripheral vision to the rapid reader. Walton related speed of perception to rate of reading to determine the upper limits of reading speed. Using a tachistoscope, he studied the largest possible number of letters, letter groups, or letter spaces one could see at one fixation. From his calculations he judged that the highest possible speed was 1451 words per minute.[18] Clymer, in reviewing this study, suggested that the investigation failed to consider that anticipation of meaning in context might increase the perceptual span considerably.[19] Both Tinker and Spache contested the claims of high reading rates. They considered 800 to 900 words per minute to be the upper limit for the very mature reader.[20] Spache based his calculation on the minimum time required for duration of fixation, interfixation movements, and the return sweeps required at the end of each line of print.

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[18]H. Walton, "Vision in Rapid Reading," American Journal of Optometry and Archives of American Academy of Optometry 34 (February 1957): 73-82, cited by T. Clymer and Helen Robinson, "Chapter II: Reading", Review of Educational Research 31 (April 1961): 130-39.

[19]T. Clymer and Helen Robinson, "Chapter II: Reading", Review of Educational Research 31 (April 1961): 137.

[20]Miles A. Tinker, "Recent Studies of Eye Movements in Reading", Psychological Bulletin 55 (July 1965): 215-31.

In addition, he considered 2.5 to 3.0 words to be the maximum number of words that the eye could possibly see in a single fixation during continuous reading.[21] McLaughlin, however, believed that Spache's and others' view of reading provided too narrow a definition. He postulated a theory of "parellel processing" by which the speed reader simultaneously decodes fragments of several sentences seen in peripheral vision with 50 per cent acuity or less.[22]

Duration of Fixation

Taylor's studies of eye-movement photographs indicated that the average duration of fixation ranges from about one-third of a second for first graders to approximately one-quarter of a second for typical college-level readers and is rarely shorter than one-fifth of a second even for the exceptionally competent reader. He also noted that there was usually an inverse relationship between duration of fixation and span of recognition. That is, a person who made fewer fixations usually had a longer average duration of fixation and a person who made more

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[21]George D. Spache, "Is this a Breakthrough in Reading?", The Reading Teacher 15 (January 1962): 258-66.

[22]G. Harry McLaughlin, "Reading at Impossible Speeds", Journal of Reading 12 (March 1969): 449-54; 502-10.

fixations usually had a shorter average duration of fixation.[23]

Observation and Measurement of Eye Movements

Methods for the observation and measurement of eye movements range from the very simple to the complex. Among the most commonly used are the various types of opthalmographs and special movie cameras, the first of which was invented by Dodge in 1901.[24] In this process, as the individual reads a selection, small beams of light are reflected from his eyes to a photographic film. More recently, electrical recordings of eye movement patterns are becoming more common. Some studies have involved the use of photocells, oscilloscopes, computers and other recording equipment. One instrument monitors the corneal reflection from each eye by means of independent pairs of photocells and the signals are amplified and recorded immediately on heat sensitive paper by two heat pens.[25]

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[23]Stanford E. Taylor, Helen Frackenpohl, and James L. Pettee, "Grade Level Norms for the Components of the Fundamental Reading Skill". E.D.L. Research and Information Bulletin, No. 3 (New York: Educational Developmental Laboratories, Inc., 1960).

[24]Henry P. Smith and Emerald V. Dechant, Psychology in Teaching Reading (Englewood Cliffs, New Jersey: Prentice-Hall, Inc., 1969), pp. 124-28.

[25]E.D.L./Biometrics Reading Eye II Operator's Manual (New York: Educational Developmental Laboratories, Inc., 1969), p. 1.

Much less sophisticated methods can be used, however, by the classroom teacher who wishes to observe a child's eye movements. Bond and Tinker suggested that a small mirror on a table between the child and the examiner, would allow the examiner to observe the number of fixations per line.[26] Harris described the Miles Peep-Hole Method. A hole is punched in the center of a page of reading material and as the person reads, the examiner can look through the hole and observe the eye movements.[27]

Summary

The observation of eye-movement components of reading behavior can provide a physiological basis for understanding the reading process, demonstrating relationships between specific physiological and performance variables. Eye-movement photography has demonstrated the progress in eye-movement efficiency that develops through the grades and has provided some information about the role of fixations and regressions in the process of perception in reading and the relationship of fixations to movements of the eye. The research is somewhat contradictory, however,

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[26]Guy L. Bond and Miles A. Tinker, Reading Difficulties: Their Diagnosis and Correction (New York: Appleton-Century-Crofts, 1967), pp. 234-35.

[27]Albert J. Harris, How to Increase Reading Ability (New York: David McKay Company Inc., 1940), pp. 511-16.

concerning the maximum possible span of recognition and the role of peripheral vision in perception in reading. In addition, the research has demonstrated the relatively small range of variation that exists in the durations of fixation employed by readers. Finally, the research methods designed for the observation of eye movements have become more sophisticated and objective over the years.

The present study will attempt to add to this body of basic research on eye movements and their relationship to reading. It will concentrate on examining the effect of variations in readability on eye-movement components using some of the most recent equipment for the observation and analysis of eye movements. That is, the study will be concerned with the degree of consistency of eye movement performance over material ranging from easy to difficult for individual readers. In addition, it will focus on any differences that exist among poor, average, and good readers from the effects of these variations in the difficulty (readability) of the material.

LITERATURE ON INFLUENCES AFFECTING THE INDIVIDUAL"S EYE MOVEMENTS

Eye movements can provide more than a reflection of the reading process. In addition, they can provide information about the relationship between physiological and performance variables by examining various factors which influence the individual's eye movements. Some of the

research has added to this body of knowledge. Factors which influence eye movements reviewed here include the following: (1) heredity, maturation and intelligence; (2) variations in readability; (3) the reliability of eye-movement components; (4) testing apparatus; (5) eye-movements of superior readers; (6) training for developing efficient eye movements; (7) changes in format and presentation; and (8) central process of comprehension.

Influence of Heredity, Maturation and Intelligence

Morgan studied the eye movements of 33 pairs of fraternal twins, 35 pairs of identical twins and 40 pairs of unrelated children. The pairs were matched according to C.A., I.Q., reading age, grade position and socio-economic factors. The correlations he obtained between eye-movement measures for fixations, regressions, and average pause duration for the pairs within each group ranged from 0.04 to 0.24 for pairs of unrelated children, 0.24 to 0.53 for fraternal pairs, and 0.66 to 0.72 for identical twins.[28] These results tended to lend some support to the influence of heredity on eye-movement behavior.

Several studies have demonstrated the influence of

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[28]David H. Morgan, "Twin Similarities in Photographic Measures of Eye Movements While Reading Prose," Journal of Educational Psychology 30 (November 1939): 572.86.

maturation on eye-movement behavior. Buswell studied 179 average readers from grade one to college, with all students, except grade one, reading the same selection. He found that the span of recognition underwent very rapid growth during the first four school years with little change until freshman high school years and then increased slightly through high school to college. Duration of fixation also improved rapidly during the first four years of school but often reached an upper limit around five twenty-fifths of a second with little possible change after grade four. He also found a rapid decrease in the number of regressions during the first four years of schooling but additional improvement usually took place through high school and college years. Buswell suggested that the emphasis on the study type of reading between the fifth grade and high school may possibly hinder the development of the span of recognition and the reduction of regressions because the reader may be learning to adjust to these new type materials.[29] He wondered if a modification of the reading program during the intermediate grades might eliminate the plateau that exists for regressions and span of recognition during those grades. Similarly, Gilbert, Gray, and Taylor observed that

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[29]Guy Thomas Buswell, "Developmental Stages in Eye Movements," in Research in the Three R's, eds. Clarence W. Hunnicutt and William J. Iverson (New York: Harper and Brothers, 1958), pp. 19-26.

eye-movement efficiency increases through the grades with the majority of this improvement achieved by the end of the fourth grade level.[30]

While little research seems to be available concerning the relationship of intelligence to eye movements, one study by Leavell and Sterling examined the reading of sixth grade students tested for I.Q. by the Kuhlmann-Anderson and Myers Mental Measures tests of intelligence. They found significant correlations between I.Q.'s as measured by the Kuhlmann-Anderson test and number of fixations, regressions, span of recognition, and rate. The Myers test provided significant correlations only for span of recognition, however.[31] A study by Winters and Gerjuoy investigated the eye movements and verbal reports of normal and retarded children performing a simple tachistoscopic recognition task. They found significant differences in that normal children's eye-movement patterns and verbal reports were

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[30]Luther C. Gilbert, "Functional Motor Efficiency of the Eyes and Its Relation to Reading," Clarence T. Gray, "Types of Reading Ability as Exhibited Through Tests and Laboratory Experiments," Early A. Taylor, "The Spans: Perception, Apprehension and Recognition," cited by Kenneth M. Ahrendt and Donald S. Mosedale, "Eye-Movement Photography and the Reading Process," Journal of the Reading Specialist (March 1971): 156.

[31]U. W. Leavell and Helen Sterling, "Reading and Intelligence," in Research in the Three R's, eds. C. W. Hunnicutt and W. J. Iverson (New York: Harper and Brothers, 1958), pp. 43-46.

more frequently left to right than those of retarded children.[32]

Influence of Readability

One of the areas of eye-movement research in which conflicting results have been obtained is that concerned with the effect of changes in readability on measures of eye movements. Judd and Buswell recorded the eye movements of 10 fifth grade pupils during silent reading of Gray's Standardized Reading Paragraphs. They found that, as the difficulty of the passages increased, the reader's attitude toward the task undertaken changed and resulted in new combinations of scope and duration of attention. They cautioned, however, that individual variations must be considered for proper analysis.[33] Other studies seem to support the contention that changes in readability are often reflected in changes in eye-movement behavior. Blommers and Lindquist, in a study of the relationship between rate of comprehension and power of comprehension found that good comprehenders adjusted their rate by slowing down as

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[32]John J. Winters and Irma R. Gerjuoy, "Eye Movements and Verbal Reports in Tachistoscopic Recognition by Normals and Retardates," Child Development 38 (December 1967): 1193-99.

[33]Charles Hubbard Judd and Guy Thomas Buswell, "The Effects of Changes in Purpose and Difficulty on Eye Movements," Research in the Three R's eds. C. W. Hunnicutt and C. J. Iverson (New York: Harper and Brothers), pp. 27-33.

material increased in difficulty, whereas poor comprehenders apparently read easy and difficult materials at much the same rate.[34] Ledbetter, in an analytical study of 60 eleventh grade students reading selections from four subject-matter fields found significant differences as revealed by eye-movement measures and comprehension scores even though the selections were of the same length in words and were approximately the same difficulty so far as vocabularly, sentence length and sentence structure were concerned. He concluded that meanings or concepts present more difficulty to the average student than vocabulary, sentence length, or sentence structure.[35] Perry and Whitlock concluded that vocabulary level and familiarity with the content were major determinants of the duration of fixation.[36] Tinker, in summarizing past research, concluded that as the difficulty of material increases and as the individual takes greater pains to read well, the fixation pauses become more frequent and grow longer. He also claimed that the readers

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[34]Paul Blommers and E. F. Lindquist, "Rate of Comprehension of Reading: Its Measurement and Its Relation to Comprehension," Journal of Educational Psychology 35 (November 1944): 449-73.

[35]Frances Gresham Ledbetter, "Reading Reactions for Varied Types of Subject Matter: An Analytical Study of the Eye Movements of Eleventh Grade Pupils," Journal of Educational Research 41 (October 1947): 102-15.

[36]William G. Perry, Jr., and Charles P. Whitlock, "A Clinicale Rationale for a Reading Film," Harvard Educational Review 24 (January-December 1954): 6-27.

are immature when eye movements do not vary with the difficulty of the reading matter.[37] Taylor found no difference in the number of fixations by junior high school subjects reading material at or below their grade level but found significant differences when subjects read material 2.5 grades above their grade level.[38] Thomas found that the average duration of fixation lengthens as the material becomes harder to comprehend.[39] A related study by Holland and Doran revealed that high blackout ratio material (low response contingency) resulted in fewer fixations and shorter duration of fixation than did low blackout material (high response contingency).[40]

Other studies of this problem have reached different conclusions. Seibert, as well as Ballantyne, found that changes in subject matter supported the proposition that people tend to maintain the same performance over a wide range of content.[41] Morse compared fifth grade and seventh

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[37]Miles A. Tinker, "Time Relations for Eye Movement Measures in Reading," Journal of Educational Psychology 38 (January 1947): 1-10.

[38]Taylor Frackenpohl, and Pettee, "Validity of Eye-Movement Photography", p. 8.

[39]Thomas, "Movements of the Eye," pp. 88-95.

[40]James G. Holland and Judith Doran, "Eye Movements as a Function of Response Contingencies Measured by Blackout Technique" based on Master's Thesis submitted by the junior author to the University of Pittsburgh), p. 7.

[41]Ahrendt and Mosedale, "Eye Movement Photography" p. 150.

grade pupils reading materials of equal or corresponding difficulty. He concluded that eye movements do not vary in a consistent fashion with difficulty. While comprehension was reduced on the more difficult passages, he found a stability of performance in terms of eye movements within each grade regardless of the difficulty of the material read.[42]

Reliability of Components Measured

Most studies have revealed that subjects maintain a high degree of consistency throughout a single reading in terms of fixations, regressions, duration, and rate. Eurich, Tinker, and Imus, Rothney and Bear compared performance on a test-retest basis and found correlations ranging from 0.59 to 0.91 for the factors of fixations, regressions, duration, and rate.[43]

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[42]William C. Morse, "The Individuality of Eye Movements," Research in the Three R's, eds. C. W. Hunnicutt and W. J. Iverson (New York: Harper and Brothers, 1958), pp. 33-38.

[43]Eurich, Alvin C., "The Reliability and Validity of Photographic Eye-Movement Records," Journal of Educational Psychology 24 (1933): 118-22; M. A. Tinker, "The Reliability and Validity of Eye Movement Measures of Reading," Journal of Experimental Psychology 19 (1936): 732-46; Henry A. Ismus, John W. Rothney, and Robert M. Bear, An Evaluation of Visual Factors in Reading, (Hanover, New Hampshire: Dartmouth College Publications, 1938), cited by Taylor, Frackenpohl, and Pettee, "Validity of Eye Movement Photography," p. 3.

Effect of Testing Apparatus

Studies by Gilbert and Tinker support the conclusion that students read similarly before and away from eye-movement apparatus. Tinker obtained correlations of 0.87 and 0.90 when students read portions of the Chapman-Cook Speed of Reading Test before and away from an eye-movement camera.[44]

Eye Movements of Superior Readers

Eye-movement records of superior and flexible readers by Gilbert and Taylor indicated that they possess more oculomotor efficiency in terms of fewer regressions, greater recognition span and shorter duration of fixations.[45] Walker studied the eye movements of 50 good readers and found them to average slightly more than eight fixations

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[44]Luther C. Gilbert, and Doris W. Gilbert, "Reading Before the Eye Movement Camera Versus Reading Away From It," Elementary School Journal 42 (1942): 443-47; M. A. Tinker, "The Reliability and Validity of Eye-Movement Measures of Reading," Journal of Experimental Psychology 19 (1936): 732-46, cited by Taylor, Frackenpohl and Pettee, "Validity of Eye Movement Photography," p. 2.

[45]Luther C. Gilbert, "Functional Motor Efficiency of the Eyes and Its Relation to Reading," University of California Publications in Education, Vol. II, No. 3 (Berleley: University of California Press, 1953), pp. 159-231, cited by Ahrendt and Mosedale, "Eye-Movement Photography," p. 151.

Earl A. Taylor, "The Spans: Perception, Apprehension and Recognition as Related to Reading and Speed Reading," American Journal of Ophthalmology 44 (October 1957): 501-507.

per four inch line on material of moderate difficulty.[46] Laycock studied college students who possessed varying degrees of flexibility in reading rate on prose material. He found significant differences in favor of the more flexible readers in terms of rate of eye movements and width of fixation span. He suggested that rate of progression and width of fixation span are eye-movement characteristics that training programs might best emphasize.[47]

Training for Efficient Eye Movements

While many studies have compared the effects of one method of training in reading efficiency over another, only one will be mentioned here because of its reference to eye-movement research. Glock studied the effect upon eye movements and reading rate at the college level of three methods of training. Two of these methods involved "controlled" reading practice using the Harvard Films. The third method involved mechanically uncontrolled reading from the printed page of the same material. He found a significant reduction in number of fixations, regressions,

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[46]Robert Y. Walker, "The Eye Movements of Good Readers," Studies in Experimental and Theoretical Psychology; Psychological Monographs 44 (1933): 95-117, cited by Taylor, The Reading Eye, p. 36.

[47]Frank Laycock, "Significant Characteristics of College Students with Varying Flexibility in Reading Rate: I Eye Movements in Reading Prose," Journal of Experimental Education 23 (June 1955): 311-19.

and average duration of fixations under all three methods. Span of recognition also improved under each method. Reading rate and rate of comprehension showed significant improvement as measured by the Traxler and Iowa tests of silent reading. However, he found no evidence to indicate that techniques designed specifically to train eye movements were generally more effective than other methods. He did conclude that the efficiency of the method varied with the criterion employed and the teacher involved.[48]

Influence of Format and Presentation

Five other studies concerned with factors that influence eye movements also deserve mention. Paterson and Tinker observed that line widths could be varied considerably without any adverse effect on speed. They found the optimum line width to be 19 picas: a line width of 9 picas was considered too short while one of 43 picas was considered too long. The short line resulted in longer fixations whereas the long line resulted in eye difficulty on return sweeps to the next line. This information they felt would be of particular value to advertisers and type setters.[49]

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[48]M. D. Glock, "The Effect Upon Eye Movements and Reading Rate at the College Level of Three Methods of Training," Journal of Educational Psychology 40 (February 1949): 93-106.

[49]D. G. Paterson and M. A. Tinker, "Influence of Line Width on Eye Movements," Journal of Experimental Psychology 27 (November 1940): 572-77.

In another study Paterson and Tinker found that reading Old English tended to reduce the span of perception, to increase the number of fixations, total perception time, and the number of regressive movements.[50]

Gilbert investigated the effect of intervening stimuli on reading ability and found that interfering stimuli affected slow readers more than fast readers. He also found that the narrower the individual's span the easier it was for him to avoid the influence of extraneous material.[51]

Smith, Cambria and Steffan investigated the inversion and reversal of printed matter on reading behavior. They observed that the appearance of print changed with orientation in space. There appeared to be a rotational breakdown threshold for each person and that left-handed subjects had a larger rotational breakdown threshold both to the left and right than did right handers. They suggested that there were "complex space organized dynamic behavior activities of the eye-movement system and of postural and transport behavior whose development and integration as

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[50]M. A. Tinker and D. G. Paterson, "Eye-Movements in Reading a Modern Typeface and Old English," American Journal of Psychology 54 (January 1941): 113-14

[51]Luther C. Gilbert, "Speed of Processing Visual Stimuli and Its Relation to Reading," Journal of Educational Psychology 55 (February 1959): 8-14.

sensory feedback mechanisms may precede the learning of reading."[52]

In another study, Smith, Schremser and Putz used computer methods to measure the time differences between the binocular saccadic movements of the eyes. Their results showed that the time differences between the eyes varied from near synchrony to the left eye leading by 14 msec. They found these time differences to be unrelated to the difficulty of the reading material, but the time was changed significantly by a fifteen degree horizontal rotation of the reading display. The authors concluded that their results challenged the established view that the eyes are perfectly conjugated in saccadic motion and that this data tended to support a "dynamic feedback doctrine of coordinate eye motion and functional disabilities in visual perception."[53]

Eye Movements and Central Processes

An important issue to the field of reading and to eye-movement research is the question of whether poor central processes are due in part to inefficient eye-movement habits, which might be improved by special training,

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[52]Karl Smith, Richard Cambria, and James Steffan, "Sensory-Feedback Analysis of Reading," Journal of Applied Psychology 48 (October 1946): 275-86.

[53]Karl Smith, Robert Schremser, and Vernon Putz, "Binocular Coordination in Reading," Journal of Applied Psychology 55 (June 1971): 251-58.

or that eye movements are determined by the central processes themselves. Brandt concluded that there was a functional relationship between eye movements and the central process.[54] Thomas and Tinker, however, held quite strongly to the view that eye-movement patterns reflect the efficiency of the central processes of comprehension.[55] On the other hand, studies by Gilbert; Smith, Schremser and Putz; and Norton and Stark, lend some support to the possibility that eye-movement patterns may influence the central processes of comprehension.[56]

If a functional relationship between eye movements and the central processes of comprehension can be demonstrated then eye-movement records may contribute some useful diagnostic and teaching information regarding an individual's reading behavior.

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[54]Herman F. Brandt, The Psychology of Seeing (New York: The Philosophical Library, 1945), pp. 13-14, cited by Taylor, The Reading Eye, p. 1.

[55]Thomas, "Movements of the Eye," pp. 88-95.

Tinker, "Recent Studies of Eye Movements," pp. 215-31.

[56]Gilbert, "Speed of Processing Visual Stimuli," pp. 8-14.

Smith, Schremer, and Putz, "Binocular Coordination in Reading," pp. 251-58.

David Norton and Lawrence Stark, "Eye Movements and Visual Perception" (unpublished article).

Summary

Research that has examined the various factors which influence the reader's eye movements has provided some insight into the relationship between eye movements and the reading process. Studies of twins as opposed to unrelated children lend some support to the influence of heredity on eye-movement behavior. Secondly, it appears that the largest improvement in eye-movement performance, as a result of maturation, takes place during the first four school years with moderate improvement occurring during high school and college years. In addition, some correlation exists between measures of intelligence and eye movements although the factors of intelligence which contribute to these correlations are not yet determined.

Studies at various grade levels have examined the relationships between eye movements and changes in readability. Some studies have supported the contention that eye-movement behavior is affected by changes in readability while others have concluded that there is a stability in eye movement performance of students within the same grade.

Eye movement behavior, however, does appear to be consistent within the reading of the same passage or when performance is retested with the same material. In addition, students read similarly before and away from eye-movement apparatus used for recording eye movements.

The studies have shown that superior and flexible readers exhibit greater oculo-motor efficiency in eye movements and that, to some degree, eye movements, at least at the college level, can be improved through a variety of training methods.

The format and presentation of material also have an affect on the reader's eye movements. There appears to exist an optimum line width for efficient reading. Also, eye movements are affected by changes in type style, such as Old English, and are influenced by interfering stimuli as well as by inversion or reversal of the print. It also appears that there exist time differences between the binocular saccadic movements of the eyes which, though not affected by the difficulty of the material, are significantly affected by a horizontal rotation of the reading display.

SUMMARY OF CONTRIBUTIONS TO EYE MOVEMENT RESEARCH

Eye movement research has contributed in several areas, to the understanding of reading behavior. From it, a better understanding of the way in which the eyes function during reading has been obtained.

Eye movement photography has demonstrated that, during reading, the eyes make a series of stops knows as fixations and that these fixations occupy most of the reading time. The reader does not identify and recognize

material while his eyes are in motion, only during fixations.

Saccadic movements of the eye (with the exception of the return sweep) occupy the remainder of the time. These movements take the reader either to the right or the left and allow him to move to another point of fixation.

Regressions are fixations that follow saccadic movements made to the left along a line of print. Most regressions are considered to result from habit rather than from a conscious desire to reread. They occupy from one-fifth to one-third of the reading time.

The average span of recognition is considered to be relatively small, usually less than two words, but conclusions vary concerning the maximum possible span and the role of peripheral vision as well as anticipation of meaning in reading.

Variation in duration of fixation is very small, rarely shorter than one-third of a second. Usually there exists an inverse relationship between duration of fixation and span of recognition. That is, a person who makes fewer fixations usually has a longer average duration of fixation and a person who makes more fixations usually has a shorter average duration of fixation.

The research has also provided information on how eye movements change as the reader matures and on what influences eye movements during reading. Eye movements appear to be influenced by heredity, maturation and

intelligence. Morgan's study of identical twins, fraternal twins and unrelated children lends some support to the influence of heredity on eye-movements.[57] Buswell,[58] Taylor[59] and others observed that eye-movement efficiency increases through the grades with most of this improvement achieved by the end of the fourth grade level. Significant correlations were obtained by Leavell and Sterling between I.Q.'s and number of fixations, regressions, span of recognition and rate.[60]

Studies of the effect of readability on eye movements have reached conflicting conclusions. Morse[61] found a stability of eye-movement performance within the same grade level over a wide range of content while studies by Judd and Buswell,[62] Ledbetter,[63] Thomas,[64] Taylor,[65] and Holland and Doran[66] found significant differences in eye movement components when material was increased in difficulty.

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[57]Morgan, pp. 572-86.

[58]Buswell, "Developmental Stages in Eye Movements, pp. 19-26.

[59]Earl A. Taylor, "The Spans," pp. 501-507.

[60]Leavell and Sterling, pp. 43-46.

[61]Morse, pp. 33-38.

[62]Judd and Buswell, pp. 27-33.

[63]Ledbetter, pp. 102-15.

[64]Thomas, "Movements of the Eye," pp. 88-95.

While there is some disagreement on the effects of variations in readability on eye movements, most studies have revealed that the reader maintains a high degree of consistency in eye movements throughout a single reading and that students read similarly before and away from eye-movement apparatus.

Studies have also shown that good readers differ from poor readers in terms of eye-movement efficiency and that, while no one method of training is significantly better than another, eye movement efficiency can be improved through training methods.

Format and presentation of material also significantly influence eye movements. Line width, type set, intervening stimuli, inversion, reversal and rotation of printed material all have some effect on the reader's eye movements.

The relationship between eye movements and the central processes of comprehension remains an important yet controversial issue. However, few studies have attempted to examine the relationship between these physiological components, which are so readily observable, and the cognitive, emotional, cultural, and other perceptual bases of reading.

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[65]Taylor, Frackenpohl, and Pettee, "Validity of Eye Movement Photography." p. 8.

[66]Holland and Doran, p. 7.

NEED FOR FURTHER RESEARCH

Some possible avenues of research in this area have yet to be fully explored. Controversy still exists over the effect of readability on eye movements. Studies by Smith, Cambria, and Steffan[67] suggest the possible value of sensory feedback techniques for analysis of reading behavior. In addition, more information is needed regarding the relationship between central processes of comprehension and eye-movement patterns. Investigation of personality variables and their influence on the individuality of eye movements could also prove valuable. It would appear, therefore, that while much has already been learned about oculomotor functioning during reading behavior, there are still several avenues for fruitful research such as:

(1) What is the relationship of eye movements to variations in readability levels?

(2) Can linguistic factors contribute to changes in observed reading behavior?

(3) Can personality variables contribute to changes in observed reading behavior?

(4) What is the relationship between the child's self concept and observed reading behavior?

(5) What is the relationship between eye movements

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[67]Smith, Cambria, and Steffan, "Sensory-Feedback Analysis of Reading," pp. 275-86.

and cognitive factors such as the ability to abstract and the ability to generalize?

(6) What is the relationship between manifest anxiety and observed reading behavior?

This study will investigate only the first of these problems. It will examine the hypothesis that changes in eye-movement behavior of grade five pupils of poor, average, and good reading ability will result from reading passages which vary in readability according to the pupil's functional (independent, instructional, and frustration) reading levels.

CHAPTER III

DESIGN AND PROCEDURES

Introduction

The present study sought to determine the effect of variations in readability levels on the eye movements of grade five pupils of poor, average, and good reading ability. For this purpose, a testing program was conducted with a sample of grade five pupils who were selected on the basis of their present reading ability and then tested to determine their independent, instructional, and frustration levels of functioning. The questions of major interest were:

(1) What effect will materials at the pupil's independent, instructional, and frustration levels of reading achievement have on the number of fixations, number of regressions, average span of recognition, average duration of fixation, and reading rate he exhibits during reading?

(2) What differences will exist among poor, average, and good readers in the number of fixations, number of regressions, average span of recognition, average duration

of fixation, and reading rate exhibited when reading passages at their independent, instructional, and frustration levels of reading achievement?

The design and procedures are discussed in this chapter. The discussion includes the description of:

1. Sampling Procedures
2. Method
3. The Measuring Instruments
4. Statement of the Null Hypotheses
5. Statistical Treatment of Data

Sampling Procedures

Subjects for the sample used in this study were drawn from a population of 213 grade five pupils in the Brandon School Division Number 40. Sixty pupils were selected from eight classrooms in four elementary schools chosen at random. Mid year performance in both reading and vocabulary on the Canadian Tests of Basic Skills was used as criteria for selecting randomly twenty pupils for each of three groupings of poor, average, and good readers. A measurement of I.Q. was not administered since I.Q. and reading comprehension have been found to be highly correlated.[1] The poor readers were selected from those

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[1]Victor Froese, "Cloze Readability Versus the Dale-Chall Formula," Teachers, Tangibles, Techniques: Comprehension of Content in Reading, ed. Bonnie Smith Schulwitz (Newark: International Reading Association, 1975), pp. 23-30.

scoring below the fortieth percentile on both reading and vocabulary for grade five, based on local norms. The average readers were selected from those scoring between the fortieth and sixtieth percentile on both reading and vocabulary for grade five, based on local norms. The good readers were selected from those scoring above the sixtieth percentile on both reading and vocabulary for grade five, based on local norms.

Method

The Botel Word Opposites Test Form A was administered to all grade five pupils attending the four schools selected. Within a week after completing this test, each of the subjects selected for the testing was administered the Botel Word Reading Test Form A, and each subject's independent, instructional, and frustration levels of reading performance were computed from the results of both the Word Opposites and Word Reading tests using the standards for the Botel Reading Inventory.[2]

Using a table of random numbers, the subjects from each group were then assigned to treatment patterns from one to six (Table 3.01) to designate the order in which they would be presented with reading passages graded at their independent, instructional and frustration levels of

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[2]Morton Botel, Revised Guide to the Botel Reading Inventory, (Chicago: Follett Publishing Co., 1970), p. 20.

reading performance.

TABLE 3.01

TREATMENT PATTERNS FOR TESTING SUBJECTS

Treatment	Graph 1	Graph 2	Graph 3	N	Percent
1	Instructional	Independent	Frustration	11	18.3
2	Frustration	Independent	Instructional	10	16.7
3	Independent	Instructional	Frustration	10	16.7
4	Instructional	Frustration	Independent	9	15.0
5	Frustration	Instructional	Independent	10	16.7
6	Independent	Frustration	Instructional	10	16.7

Eye movements were recorded using Educational Developmental Laboratories' Biometric Reading Eye II and the corresponding eye movement passages from the Reading Eye Test Selections. Subjects presented themselves for testing in groups of four or five at a time. The procedure to be followed was explained to them and the Reading Eye II was briefly demonstrated. Each subject was instructed to sit as comfortably as possible but to try to refrain from moving his head. Each subject was also requested to read as he normally does and to try to remember what he was reading as best as he could.

Subjects were graphed on a rotational basis, each subject reading one passage at the Reading Eye and then responding orally Yes or No in private with another

examiner to the ten comprehension questions corresponding to the Reading Eye Test Selection just read.[3] After each subject in the group had completed one eye movement recording and one oral comprehension test, the procedure was repeated for the other two levels of reading performance.

Subjects were given no indication of how well they performed on either the eye movement recordings or on the comprehension quizzes. After each recording, eye movement graphs were identified by student number and reading level recorded. These graphs were later analyzed to assess the independent, instructional and frustration level performance for each subject. Comprehension percentages corresponding to each reading performance were also computed for each reading.

The Measuring Instruments

Canadian Tests of Basic Skills

The Canadian Tests of Basic Skills is an achievement battery which aims at the evaluation of generalized educational skills and abilities. The battery provides tests in Vocabulary, Reading Comprehension, Language, Mathematics Skills, and Work Study Skills. This Battery

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[3]A sample of the passages and comprehension questions appears in Appendix C.

is used as a standardized measure of achievement and administered twice yearly by the Brandon School Division Number 40. Students' scores are compared to national and local norms.[4] The availability of this data made it suitable for selecting samples of poor, average, and good readers.

Botel Reading Inventory A

The Botel Word Recognition Test consists of eight graded lists of words from preprimer through the fourth reader level. Pupils who score 4+ on the Word Recognition Test have been found to be capable enough in word attack so that their Instructional level can be determined by the Word Opposites Test alone.

The Word Opposites Test consists of ten graded lists of words from the first reader through the senior high school level. The Word Opposites Test gives an estimate of comprehension.

The Botel Reading Inventory provides an estimate of the pupil's functional reading levels (independent, instructional, and frustration), and an objective scoring procedure for determining these levels. In addition, the Word Opposites Test, a part of the inventory, has been

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[4]The Seventh Mental Measurements Yearbook, Volume I, ed. Oscar Krisen Buros (Highland Park, New Jersey: The Gryphon Press, 1972), pp. 6-7.

shown to be highly related to comprehension measures. A study by Botel, Bradley, and Kashuba assessed the ability of various informal reading tests to match the reader's instructional level with criterion performance (comprehension) in reading materials. They found that the best estimate of test-criterion correspondence was obtained by using the Word Opposites Test of the Botel Reading Inventory with the Spache, Dale-Chall estimate (readability) of the criterion.[5]

Functional reading levels were established according to the standards for the Botel Reading Inventory.[6] The criteria for establishing the independent level of reading performance for each subject was nine-five percent accuracy or better on the Word Recognition Test and ninety percent or better accuracy on the Word Opposites Test (Table 3.02). The criteria for establishing the subject's instructional level was the ability to recognize and pronounce seventy to ninety percent of the words in the Word Recognition Test and to score seventy to eighty percent on the items of the Word Opposites Test (Table 3.03).

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[5]Morton Botel, John Bradley, and Michael Kashuba, "The Validity of Informal Reading Testing," in Reading Difficulties: Diagnosis, Correction, and Remediation, edited by William K. Durr (Newark, Deleware: International Reading Association, 1970), pp. 85-103.

[6]Botel, Botel Reading Inventory, p. 20.

The criteria for establishing the subject's frustration level of reading performance was a score on the Word Recognition Test of less than seventy percent and a score on the Word Opposites Test of less than seventy percent. (Table 3.04)

The combination of these two tests, therefore, were used to establish the independent, instructional and frustration levels of reading performance for each subject tested.

TABLE 3.02

NUMBER AND PERCENTAGE OF SUBJECTS AT EACH INDEPENDENT READING LEVEL ACCORDING TO BOTEL READING INVENTORY A

Grade Level	Number	Per cent
1	3	5.0
2	7	11.7
3	28	46.7
4	2	3.3
5	12	20.0
6	8	13.3
Total	60	100.0

TABLE 3.03

NUMBER AND PERCENTAGE OF SUBJECTS AT EACH INSTRUCTIONAL READING LEVEL ACCORDING TO BOTEL READING INVENTORY A

Grade Level	Number	Per cent
2	2	3.3
2	2	3.3
4	8	13.3
5	5	8.3
6	16	26.7
Junior-High (7-8)	27	45.0
Total	60	100.0

TABLE 3.04

NUMBER AND PERCENTAGE OF SUBJECTS AT EACH FRUSTRATION READING LEVEL ACCORDING TO BOTEL READING INVENTORY A

Grade Level	Number	Per cent
3	2	3.3
4	2	3.3
5	5	8.3
6	4	6.7
Junior-High (7-8)	20	33.3
Senior-High (9-12)	27	45.0
Total	60	100.0

The Biometrics Reading Eye II

The Educational Developmental Laboratories/Biometrics Reading Eye II is a diagnostic instrument which records eye movements of the individual during the reading process. The individual is seated at the recorder and as he reads, light reflected from the eyes is monitored by independent pairs of photocells, and the signals are then amplified electronically and recorded on heat-sensitive paper. The following measurements are derived from the reading: fixations, regressions, duration of fixation, span of recognition, and reading rate with comprehension.

The Passages

The test selections used were from the standard test file that is normally used with the Biometrics Reading Eye II.[7] These selections are printed on 3½ x 5" cards. The selections for grade 1-3 contain 65 to 70 words (with 50 countable words), and the selections for grade 4 and above contain from 115 to 120 words (with 100 countable words). A full description of the subject areas and preparation of the test selections is presented by Taylor, Frackenpohl and Pettee.[8]

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[7]A reproduction of the passages, reading levels, and comprehension questions used in this study are presented in Appendix C.

[8]Taylor, Frackenpohl and Pettee, Grade Level Norms, pp. 9-10.

Statement of the Null Hypotheses

In order to investigate the relationship between eye movements and variations in readability levels, the following hypotheses were formulated:

1. There will be no significant difference in the number of fixations exhibited by grade five pupils reading materials at their independent, instructional, and frustration levels of reading performance.
2. There will be no significant difference in the number of regressions exhibited by grade five pupils reading materials at their independent, instructional, and frustration levels of reading performance.
3. There will be no significant difference in the span of recognition exhibited by grade five pupils reading materials at their independent, instructional, and frustration levels.
4. There will be no significant difference in the duration of fixation exhibited by grade five pupils reading materials at their independent, instructional and frustration levels.
5. There will be no significant differences in the reading rate exhibited by grade five pupils reading materials at their independent, instructional and frustration levels.
6. There will be no significant difference between poor, average, and good readers in the mean number of

fixations exhibited in reading passages at their independent, instructional, and frustration levels.

7. There will be no significant difference between poor, average, and good readers in the mean number of regressions exhibited in reading passages at their independent, instructional and frustration levels.
8. There will be no significant difference between poor, average, and good readers in the mean span of recognition exhibited in reading passages at their independent, instructional and frustration levels.
9. There will be no significant difference between poor, average, and good readers in the mean duration of fixation exhibited in reading passages at their independent, instructional and frustration levels.
10. There will be no significant difference between poor, average, and good readers in the mean reading rate exhibited in reading passages at their independent, instructional, and frustration levels.

Statistical Treatment of Data

Analysis of variance was used to determine the significance of both inter-group and intra-group variations with respect to the hypotheses under investigation. A 3 x 3 factorial design with repeated measures was employed to examine the effects of independent, instructional, and frustration levels of difficulty on individual

reading performance as measured by the number of fixations and regressions, the average duration of fixation, average span of recognition, reading rate, and comprehension score for each pupil. The mean values of these reading performance variables for poor, average, and good readers were compared to determine the significance of any differences that existed. Post hoc comparisons were made using the Student Newman-Keuls procedure applied to locate significant contrasts. The five percent level of significance was set as the acceptable level for significant difference.

CHAPTER IV

ANALYSIS AND PRESENTATION OF DATA

Introduction

This study attempted to examine empirically the relationships that exist between functional reading level as determined by the individual's independent, instructional, and frustration levels of reading performance on the Botel Reading Inventory and the eye movements of grade five pupils. The dependent variables in the study were the eye movement components of fixations, regressions, average span of recognition, average duration of fixation, and reading rate as recorded by the E.D.L. Biometrics Reading Eye II. It was hypothesized that different patterns of eye movements would be employed depending upon the functional reading level at which the subject was required to perform. In addition, the subject's comprehension of each passage read was tested using the ten true-false questions that accompany the Reading Eye Test Selections. Relationships that were observed between these scores and other effects of the independent variable, functional reading level, were also noted.

Subjects were allocated to one of three groups according to their reading ability as measured by the Canadian Tests of Basic Skills. These three groups were referred to as good, average, and poor readers. To examine the effects of the independent variable, functional reading level, each subject read three passages: one at his independent level of functioning, one at his instructional level, and one at his frustration level as determined by the Botel Reading Inventory A.

It was hypothesized that the three reading groups would show a significantly different reading performance from one another as measured by eye movement components at each of these three functional reading levels.

Eye-movement graphs were recorded for each reading performance and the eye-movement components of fixations, regressions, average span of recognition, average duration of fixation, and reading rate were calculated for each subject at each functional reading level. Mean scores for each of these components were then calculated for each of the groups at the three functional reading levels. Analyses of variance, in the form of a 3 x 3 factorial design with repeated measures, were used to test the significance of observed differences in means and to investigate whether the reading of passages at each of the three functional reading levels had significantly affected the dependent variables. Post hoc comparisons were made using the Student

Newman-Keuls procedure to determine the source of any significant differences observed in inter-group or intra-group variations. The findings of these statistical analyses are presented in this chapter.

Hypotheses One and Six

These hypotheses asserted that grade five pupils would exhibit a difference in the number of fixations recorded when reading passages at their independent, instructional, and frustration levels of reading performance. The assertion was tested in its null hypothesis form by examining the difference in mean scores among fixations recorded for all subjects, poor, average, and good readers. The dependent variable was measured by counting the number of fixations for the middle one hundred words for each of the three passages. Table 4.01 shows the comparison for number of fixations. Table 4.01 indicates that the obtained differences were significant at the .05 level. Thus it was possible to reject null hypotheses one and six and to accept the alternative hypotheses that significant differences do exist in the number of fixations exhibited by grade five pupils reading passages at their independent, instructional, and frustration levels of reading performance and that significant differences exist between poor, average, and good readers in the mean number of fixations exhibited in reading passages at their independent,

instructional, and frustration levels of reading performance.

TABLE 4.01

TWO WAY ANOVA FOR NUMBER OF FIXATIONS PER 100 WORDS AT INDEPENDENT, INSTRUCTIONAL, AND FRUSTRATION LEVELS FOR POOR, AVERAGE, AND GOOD READERS

Source of Variation	d.f.	S.S.	M.S.	F
Between Subjects				
Reading Ability (RAB)	2	71820.2500	35910.1250	12.385*
Subjects within groups	54	156574.0625	2899.5195	
Within Subjects				
Readability (RED)	2	9774.3125	4887.1563	10.251**
RAB X RED	4	960.6370	240.1592	0.504
Readability X Subjects within groups	108	51488.2500	476.7429	
Total	170	287753.000		

*Critical Value F .95 (2,54) = 3.18

**Critical Value F .95 (2,108) = 3.09

Tables 4.02 and 4.03 present the results for the Student Newman-Keuls procedure applied to the relevant contrasts. The contrasts between independent and frustration levels of reading performance and between instructional and frustration levels of reading performance were significant since the obtained values exceeded the theoretical values for these comparisons. Therefore, it

was possible to reject null hypothesis one for these comparisons and to accept the alternative hypothesis that differences do exist for the number of fixations exhibited by pupils reading passages at their instructional and frustration levels of reading performance. However, the mean difference between number of fixations exhibited at their independent level and number of fixations exhibited at their instructional level was not significant and so the null hypothesis could not be rejected for this comparison.

The contrasts between poor, average, and good readers were significant since the obtained values exceeded the theoretical values for all comparisons. Therefore, it was possible to reject null hypthesis six and to accept the alternative hypothesis that the means for the three groups could not have been drawn from the same population. More specifically, it is possible to say that poor readers exhibit more fixations than either average or good readers when reading passages at their independent, instructional, and frustration levels of reading performance and that average readers exhibit more fixations than good readers when reading passages at their independent, instructional, and frustration levels of reading performance.

Hypotheses Two and Seven

These hypotheses asserted that grade five pupils would exhibit a difference in the number of regressions

TABLE 4.02

STUDENT NEWMAN-KEULS TESTS FOR FIXATIONS PER 100 WORDS FOR INDEPENDENT, INSTRUCTIONAL, AND FRUSTRATION LEVELS OF READING PERFORMANCE

Comparison	Mean	Diff.	Obtained Value	Theoretical Value
Independent vs. Instructional	127.111 122.522	4.589	1.587	2.83
Independent vs. Frustration	127.111 140.354	13.243	4.579	2.83*
Instructional vs. Frustration	122.522 140.354	17.832	6.166	3.40**

*Critical Value q .95 (2,108)

**Critical Value q .95 (3,108)

TABLE 4.03

STUDENT NEWMAN-KEULS TESTS FOR FIXATIONS PER 100 WORDS FOR POOR, AVERAGE, AND GOOD READERS

Comparison	Mean	Diff.	Obtained Value	Theoretical Value
Poor Readers vs. Average Readers	156.175 127.889	28.286	4.064	2.86*
Poor Readers vs. Good Readers	156.175 105.922	50.253	6.847	3.44**
Average Readers vs. Good Readers	127.889 105.922	21.967	3.063	2.86*

*Critical Value q .95 (2,54)

**Critical Value q .95 (3,54)

recorded when reading passages at their independent, instructional, and frustration levels of reading performance. The assertion was tested in its null hypothesis form by examining the difference in mean scores among regressions recorded for all subjects, poor, average, and good readers. The dependent variable was measured by counting the number of regressions for the middle one hundred words for each of the three passages. Table 4.04 shows the comparison for number of regressions.

TABLE 4.04

TWO WAY ANOVA FOR NUMBER OF REGRESSIONS PER 100 WORDS AT INDEPENDENT, INSTRUCTIONAL, AND FRUSTRATION LEVELS FOR POOR, AVERAGE, AND GOOD READERS

Source of Variation	d.f.	S.S.	M.S.	F.
Between Subjects				
Reading Ability (RAB)	2	10103.4844	5051.7422	7.153*
Subjects within groups	54	38134.4492	706.1934	
Within Subjects				
Readability (RED)	2	1845.8945	922.9473	5.981**
RAB X RED	4	407.6812	101.9203	0.661
Readability X Subjects within groups	108	16665.1094	154.3066	
Total	170	66800.1250		

*Critical Value F .95 (2,54) = 3.18

**Critical Value F .95 (2,108) = 3.09

Table 4.04 indicates that the obtained differences were significant at the .05 level. Thus it was possible to reject null hypotheses two and seven and to accept the alternative hypotheses that significant differences do exist in the number of regressions exhibited by grade five pupils reading passages at their independent, instructional and frustration levels of reading performance and that significant differences exist between poor, average, and good readers in the mean number of regressions exhibited in reading passages at their independent, instructional and frustration levels of reading performance.

Tables 4.05 and 4.06 present the results for the Student Newman-Keuls procedure applied to the relevant constrasts.

The contrasts between poor, average, and good readers were significant since the obtained values exceeded the theoretical values for all comparisons. Therefore, it was possible to reject null hypothesis seven and to accept the alternative hypothesis that the means for the three groups could not have been drawn from the same population. More specifically, it is possible to say that poor readers exhibit more regressions than either average or good readers when reading passages at their independent, instructional, and frustration levels of reading performance and that average readers exhibit more regressions than good readers when reading passages at their independent,

TABLE 4.05

STUDENT NEWMAN-KEULS TESTS FOR REGRESSIONS PER 100 WORDS FOR POOR, AVERAGE, AND GOOD READERS

Comparison	Mean	Diff.	Obtained Value	Theoretical Value
Poor Readers vs.	43.228			
Average Readers	32.698	10.530	3.065	2.86*
Poor Readers vs.	43.228			
Good Readers	24.373	18.855	5.206	3.44**
Average Readers vs.	32.698			
Good Readers	24.373	8.325	2.952	2.86*

*Critical Value q .95 (2,54)

**Critical Value q .95 (3,54)

TABLE 4.06

STUDENT NEWMAN-KEULS TESTS FOR REGRESSIONS PER 100 WORDS FOR INDEPENDENT, INSTRUCTIONAL, AND FRUSTRATION LEVELS OF READING PERFORMANCE

Comparison	Mean	Diff.	Obtained Value	Theoretical Value
Independent vs.	32.898			
Instructional	29.704	3.194	1.941	2.83
Independent vs.	32.898			
Frustration	37.698	4.800	2.917	2.83*
Instructional vs.	29.704			
Frustration	37.698	7.994	4.859	3.40**

*Critical Value q .95 (2,108)

**Critical Value q .95 (3,108)

instructional, and frustration levels of reading performance.

The constrasts between independent and frustration levels of reading performance and between instructional and frustration levels of reading performance were significant since the obtained values exceeded the theoretical values for these comparisons. Therefore, it was possible to reject null hypothesis two for these comparisons and to accept the alternative hypothesis that significant differences do exist for the number of regressions exhibited by pupils reading at their independent and frustration levels of reading performance and by pupils reading at their instructional and frustration levels of reading performance. However, the mean difference between number of regressions exhibited at their independent level and number of regressions exhibited at their instructional level was not significant and so the null hypothesis could not be rejected for this comparison.

Hypotheses Three and Eight

These hypotheses asserted that grade five pupils would exhibit a difference in the average span of recognition computed from passages read at their independent, instructional, and frustration levels of reading performance. The assertion was tested in its null hypothesis form by examining the differences in mean scores

among average span of recognition for all subjects, poor, average and good readers. The dependent variable was computed for each of the three passages by dividing one hundred words read by the number of fixations for one hundred words. Table 4.07 shows the comparison for average span of recognition.

TABLE 4.07

TWO WAY ANOVA FOR AVERAGE SPAN OF RECOGNITION AT INDEPENDENT, INSTRUCTIONAL, AND FRUSTRATION LEVELS FOR POOR, AVERAGE, AND GOOD READERS

Source of Variation	d.f.	S.S.	M.S.	F.
Between Subjects				
Reading Ability (RAB)	2	2.6725	1.3363	14.361*
Subjects within groups	54	5.0246	0.0930	
Within Subjects				
Readability (RED)	2	0.2887	0.1444	11.808**
RAB X RED	4	0.1326	0.0331	2.711***
Readability X Subjects within groups	108	1.3204	0.0122	
Total	170	9.3189		

*Critical Value F .95 (2,54) = 3.18

**Critical Value F .95 (2,108) = 3.09

***Critical Value F .95 (4,108) = 2.46

The obtained differences for main effects were significant at the .05 level. Furthermore the obtained difference for the interaction of reading groups (RAB) and performance levels (RED) was also significant at the .05

level. A graph depicting this interaction is presented in figure 1. The graph suggests a decreasing linear trend for average span of recognition for average and good readers but not for poor readers.

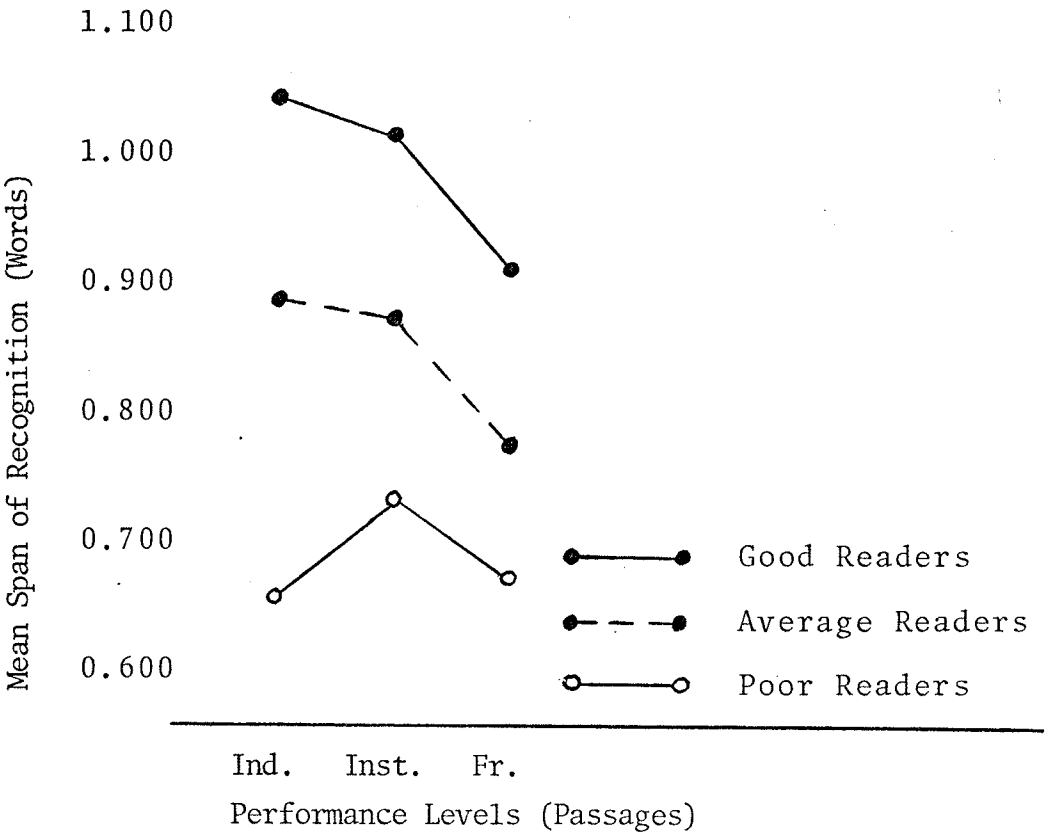

Figure 1: Mean Frequency of Average Span of Recognition For Poor, Average, and Good Readers at Independent, Instructional and Frustration Levels.

Tables 4.08 and 4.09 present the results for the Student Newman-Keuls procedure applied to the relevant contrasts. The contrasts between poor, average, and good readers were significant since the obtained values exceeded the theoretical values for all comparisons. Therefore, it

was possible to reject null hypothesis eight and to accept the alternative hypothesis that the means for these three groups could not have been drawn from the same population. More specifically, it is possible to say that poor readers exhibit a smaller average span of recognition than either average or good readers when reading passages at their independent, instructional and frustration levels of reading performance. Furthermore, an observation of the mean frequency of span of recognition for poor, average, and good readers (figure 1) suggests that the average span of recognition for poor readers does not follow the same decreasing linear trend as it does for average and good readers.

The contrasts between independent and frustration levels of reading performance and between instructional and frustration levels of reading performance were significant since the obtained values exceeded the theoretical values for these comparisons. Therefore, it was possible to reject null hypothesis three for these comparisons and to accept the alternative hypothesis that significant differences do exist for the average span of recognition exhibited by pupils reading at their independent and frustration levels of reading performance and by pupils reading at their instructional and frustration levels of reading performance. However, the mean difference between average span of recognition exhibited at their independent level

TABLE 4.08

STUDENT NEWMAN-KEULS TESTS FOR AVERAGE SPAN OF RECOGNITION FOR POOR, AVERAGE, AND GOOD READERS

Comparison	Mean	Diffs.	Obtained Value	Theoretical Value
Poor Readers vs.	0.686			
Average Readers	0.843	0.157	3.983	2.86*
Poor Readers vs.	0.686			
Good Readers	0.993	0.307	7.386	3.44**
Average Readers vs.	0.843			
Good Readers	0.993	0.150	3.693	2.86*

*Critical Value q .95 (2,54)

**Critical Value q .95 (3,54)

TABLE 4.09

STUDENT NEWMAN-KEULS TESTS FOR AVERAGE SPAN OF RECOGNITION FOR INDEPENDENT, INSTRUCTIONAL AND FRUSTRATION LEVELS OF READING PERFORMANCE

Comparison	Mean	Diffs.	Obtained Value	Theoretical Value
Independent vs.	0.866			
Instructional	0.874	0.008	0.547	2.83
Independent vs.	0.866			
Frustration	0.783	0.083	5.673	2.83*
Instructional vs.	0.874			
Frustration	0.783	0.091	6.220	3.40**

*Critical Value q .95 (2,108)

**Critical Value q .95 (3,108)

and average span of recognition exhibited at their instructional level was not significant and so null hypothesis three could not be rejected for this comparison.

Hypotheses Four and Nine

These hypotheses asserted that grade five students would exhibit a difference in the average duration of fixation computed from passages read at their independent, instructional, and frustration levels of reading performance. The assertion was tested in its null hypothesis form by examining the differences in mean scores among average duration of fixation for all subjects, poor, average, and good readers. The dependent variable was computed for each of the three passages by dividing the time to read one hundred words by the number of fixations for one hundred words. Table 4.10 shows the comparison for average duration of fixation. The obtained differences for main effects were significant at the .05 level. The obtained difference for the interaction of reading groups (RAB) and performance levels (RED) was also significant at the .05 level. A graph depicting this interaction is presented in figure 2. The graph suggests an increasing linear trend for average duration of fixation for average and good readers but not for poor readers.

TABLE 4.10

TWO WAY ANOVA FOR AVERAGE DURATION OF FIXATION AT INDEPENDENT, INSTRUCTIONAL AND FRUSTRATION LEVELS FOR POOR, AVERAGE AND GOOD READERS

Source of Variation	d.f.	S.S.	M.S.	F
Between Subjects				
Reading Ability (RAB)	2	0.0735	0.0368	6.503*
Subjects within groups	54	0.3053	0.0057	
Within Subjects				
Readability (RED)	2	0.0311	0.0156	18.613**
RAB X RED	4	0.0083	0.0021	2.484***
Readability X Subjects within groups	108	0.0903	0.0008	
Total	170	0.5069		

*Critical Value F .95 (2,54) = 3.18

**Critical Value F .95 (2,108) = 3.09

***Critical Value F .95 (4,108) = 2.46

Tables 4.11 and 4.12 present the results for the Student Newman-Keuls procedure applied to the relevant contrasts. The contrasts between poor readers and average readers and between poor readers and good readers were significant since the obtained values exceeded the theoretical values for these comparisons. Therefore, it was possible to reject null hypothesis nine for these comparisons and to accept the alternative hypothesis that the mean for poor readers could not have been drawn from the same population as that for average or good readers. More specifically, it is possible to say that poor readers

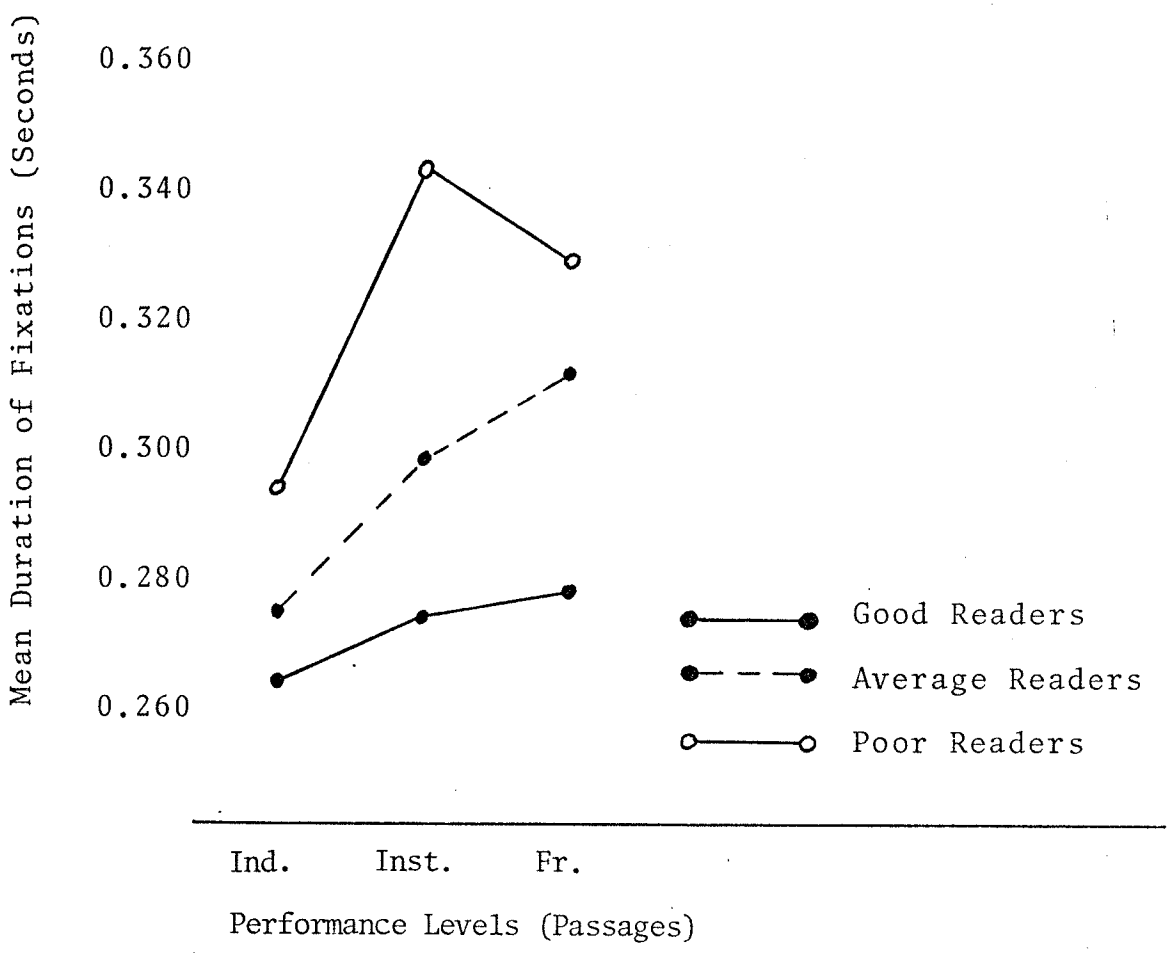

Figure 2: Mean Frequency of Average Duration of Fixation for Poor, Average, and Good Readers at Independent, Instructional and Frustration Levels.

TABLE 4.11

STUDENT NEWMAN-KEULS TESTS FOR AVERAGE DURATION OF FIXATION FOR POOR, AVERAGE, AND GOOD READERS

Comparison	Mean	Diffs.	Obtained Value	Theoretical Value
Poor Readers vs. Average Readers	0.324 0.296	0.028	2.869	2.86*
Poor Readers vs. Good Readers	0.324 0.273	0.051	4.956	3.44**
Average Readers vs. Good Readers	0.296 0.273	0.023	2.287	2.86

*Critical Value q .95 (2,54)

**Critical Value q .95 (3,54)

TABLE 4.12

STUDENT NEWMAN-KEULS TESTS FOR AVERAGE DURATION OF FIXATION FOR INDEPENDENT, INSTRUCTIONAL AND FRUSTRATION LEVELS OF READING PERFORMANCE

Comparison	Mean	Diffs.	Obtained Value	Theoretical Value
Independent vs. Instructional	0.279 0.307	0.028	7.474	2.83*
Independent vs. Frustration	0.279 0.307	0.028	7.474	3.40**
Instructional vs. Frustration	0.307 0.307	0.000	0.000	2.83

*Critical Value q .95 (2,108)

**Critical Value q .95 (3,108)

exhibit a longer duration of fixation than either average or good readers when reading passages at their independent, instructional, and frustration levels of reading performance. An observation of the mean frequency of average duration of fixation for poor, average, and good readers (figure 2) suggests that the average duration of fixation for poor readers does not follow the same increasing linear trend that it does for average and good readers.

The mean difference between average duration of fixation exhibited by average readers and average duration of fixation exhibited by good readers was not significant and so null hypothesis nine could not be rejected for this comparison.

The contrasts between independent and instructional levels of reading performance and between independent and frustration levels of reading performance were significant since the obtained values exceeded the theoretical values for these comparisons. Therefore, it was possible to reject null hypothesis four for these comparisons and to accept the alternative hypothesis that significant differences do exist for the average duration of fixation exhibited by pupils reading passages at their independent and instructional levels of reading performance and by pupils reading passages at their independent and frustration levels of reading performance. However, the mean difference between average duration of fixation exhibited at their

instructional level and average duration of fixation exhibited at their frustration level was not significant and so the null hypothesis four could not be rejected for this comparison.

Hypotheses Five and Ten

These hypotheses asserted that grade five students would exhibit a difference in the average rate of reading (words per minute) computed from passages read at their independent, instructional and frustration levels of reading performance. The assertion was tested in its null hypothesis form by examining the differences in mean scores among average reading rate for poor, average, and good readers. The dependent variable was computed for each of the three passages by dividing 6000 by the time (in seconds) to read the middle one hundred words.[1]

Table 4.13 shows the comparison for average reading rate in words per minute. The obtained differences were significant at the .05 level. Thus it was possible to reject null hypotheses five and ten and to accept the alternative hypotheses that significant differences do exist in the average reading rate exhibited by grade five pupils reading passages at their independent, instructional,

[1]Biometrics Reading Eye II records at a rate of 10 m.m./sec. or 60 cms./min. Reading rate (w.p.m.) is equal to 100 words divided by one sixtieth of the length of the eye-movement graph (cm.) or 6000 divided by the time (secs.) to read 100 words.

TABLE 4.13

TWO WAY ANOVA FOR AVERAGE READING RATE (WORDS PER MINUTE) AT INDEPENDENT, INSTRUCTIONAL AND FRUSTRATION LEVELS FOR POOR, AVERAGE AND GOOD READERS

Source of Variation	d.f.	S.S.	M.S.	F
Between Subjects				
Reading Ability (RAB)	2	229397.7500	114698.8750	21.127*
Subjects within groups	54	293169.6875	5429.0664	
Within Subjects				
Readability (RED)	2	27152.1875	13576.0938	20.887**
RAB X RED	4	4601.6250	1150.4063	1.770
Readability X Subjects within groups	108	70196.5625	649.9680	
Total	170	613485.0000		

*Critical Value F .95 (2,54) = 3.18

**Critical Value F .95 (2,108) = 3.09

TABLE 4.14

STUDENT NEWMAN-KEULS TESTS FOR AVERAGE READING RATE FOR POOR, AVERAGE, AND GOOD READERS

Comparison	Mean	Diffs.	Obtained Value	Theoretical Value
Poor Readers vs. Average Readers	130.667 173.048	42.381	4.450	2.86*
Poor Readers vs. Good Readers	130.667 220.667	90.000	8.962	3.44**
Average Readers vs. Good Readers	173.048 220.667	47.619	4.852	2.86*

*Critical Value q .95 (2,54)

**Critical Value q .95 (3,54)

and frustration levels of reading performance and that significant differences exist between poor, average, and good readers in the average reading rate exhibited in reading passages at their independent, instructional, and frustration levels of reading performance.

Tables 4.14 and 4.15 present the results for the Student Newman-Keuls procedure applied to the relevant contrasts. The contrasts between poor, average, and good readers were significant since the obtained values exceeded the theoretical values for all comparisons. Therefore, it was possible to reject null hypothesis ten and to accept the alternative hypothesis that the means for the three groups could not have been drawn from the same population. More specifically, it was possible to say that poor readers exhibit a slower average rate of reading than either average or good readers when reading passages at their independent, instructional, and frustration levels of reading performance and that average readers exhibit a slower average rate of reading than good readers when reading passages at their independent, instructional, and frustration levels of reading performance.

The contrasts between independent, instructional and frustration levels of reading performance were significant since the obtained values exceeded the theoretical values for all comparisons. Therefore, it was possible to reject null hypothesis five and to accept the alternative

hypothesis that significant differences do exist among average reading rates exhibited by pupils reading at their independent, instructional, and frustration levels of reading performance. More specifically, it is possible to say that grade five pupils exhibit a faster average reading rate when reading passages at their independent level than when reading passages at either their instructional level or frustration level of reading performance. In addition, grade five pupils exhibit a faster average reading rate when reading passages at their instructional level than when reading passages at their frustration level of reading performance.

TABLE 4.15

STUDENT NEWMAN-KEULS TEST FOR AVERAGE READING RATE FOR INDEPENDENT, INSTRUCTIONAL, AND FRUSTRATION LEVELS OF READING PERFORMANCE

Comparison	Mean	Diffs.	Obtained Value	Theoretical Value
Independent vs. Instructional	189.096 176.849	12.247	3.627	2.83*
Independent vs. Frustration	189.096 158.436	30.660	9.080	3.40**
Instructional vs. Frustration	176.849 158.436	18.413	5.453	2.83*

*Critical Value q .95 (2,108)

**Critical Value q .95 (3,108)

Results of Comprehension Tests

Table 4.16 presents the results for an analysis of variance for comprehension scores on the ten true-false questions that accompany the Reading Eye Test Selections. The obtained difference for the variation among the three reading groups was not significant at the .05 level, so it was not possible to compare this result with other effects of the independent variable. The obtained difference for the main effect of readability (RED) was significant at the .05 level so it was possible to say that grade five pupils exhibit a difference in their comprehension of passages at their independent, instructional, and frustration levels of reading performance.

Table 4.17 presents the results for the Student Newman-Keuls procedure applied to the relevant contrasts. The contrast for comprehension between independent level of reading performance and frustration level of reading performance was significant since the obtained value exceeded the theoretical value for this comparison. More specifically, it is possible to say that grade five pupils exhibit a higher comprehension when reading passages at their independent level than when reading passages at their frustration level. However, the mean differences between comprehension scores exhibited at their independent level and instructional level or their instructional level and frustration level were not significant since the obtained values did not exceed the theoretical values for these comparisons.

TABLE 4.16

TWO WAY ANOVA FOR COMPREHENSION AT INDEPENDENT, INSTRUCTIONAL, AND FRUSTRATION LEVELS FOR POOR, AVERAGE, AND GOOD READERS

Source of Variation	d.f.	S.S.	M.S.	F
Between Subjects				
Reading Ability (RAB)	2	107.7033	53.8517	0.159
Subjects within groups	54	18245.5625	337.8806	
Within Subjects				
Readability (RED)	2	1141.9297	570.9648	3.225**
RAB X RED	4	1075.2649	268.8162	1.518
Readability & Subjects within groups	108	19122.5625	177.0608	
Total	170	39818.7500		

**Critical Value F .95 (2,108) = 3.09

TABLE 4.17

STUDENT NEWMAN-KEULS TESTS FOR AVERAGE COMPREHENSION AT INDEPENDENT, INSTRUCTIONAL, AND FRUSTRATION LEVELS OF READING PERFORMANCE

Comparison	Mean	Diff.	Obtained Value	Theoretical Value
Independent vs. Instructional	71.128 65.491	5.637	3.198	3.40
Independent vs. Frustration	71.128 65.824	5.304	3.009	2.83*
Instructional vs. Frustration	65.491 65.824	.333	.189	2.83

*Critical Value q .95 (2,108)

Figure 3 presents a comparison of the mean values for comprehension scores among poor, average, and good readers at their independent, instructional, and frustration levels of reading performance. An observation of this graph suggests that the comprehension for poor and good readers does not follow the same decreasing linear trend as that for average readers.

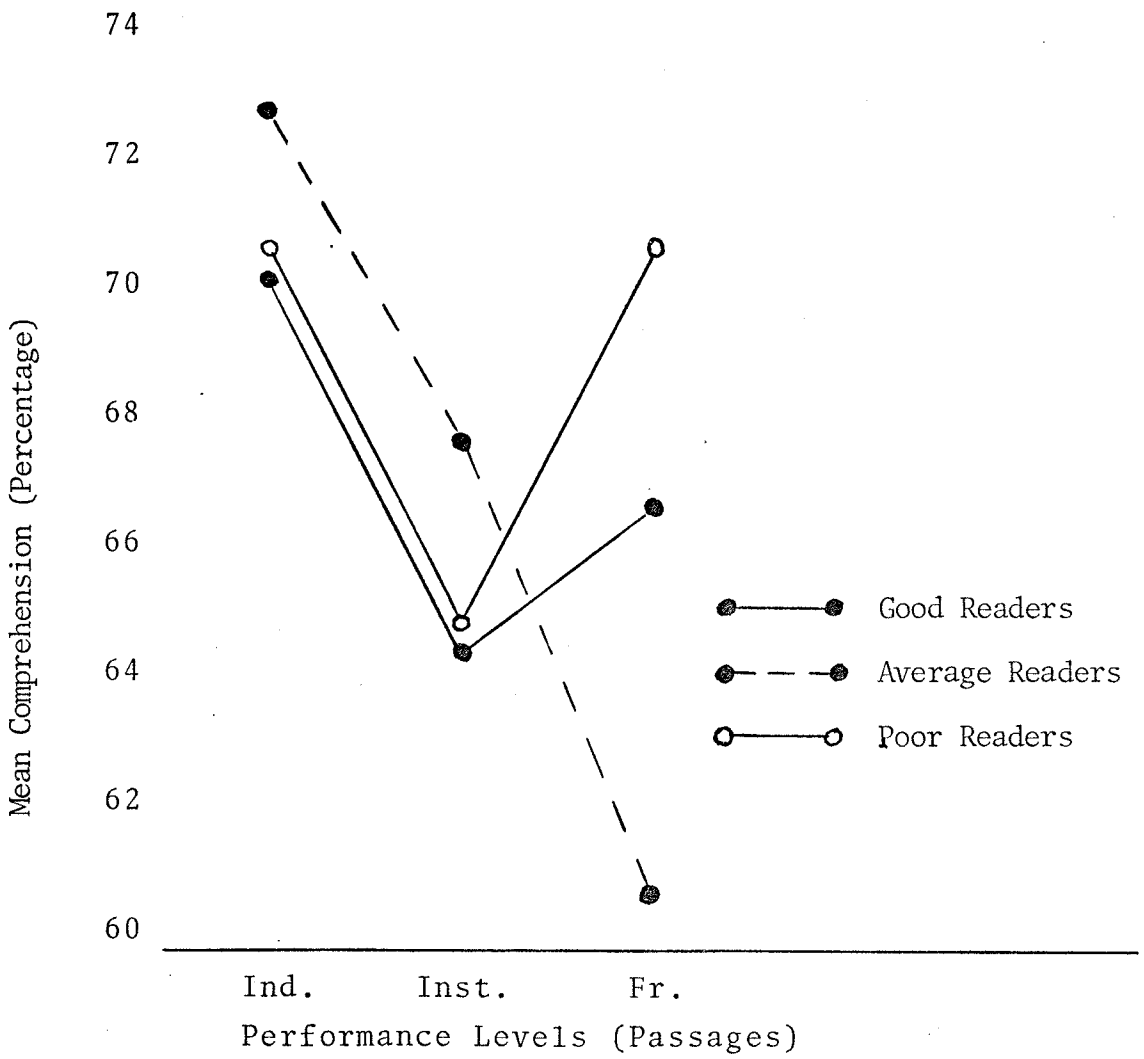

Figure 3: Mean Values for Comprehension Scores Poor, Average, and Good Readers at Independent, Instructional, and Frustration Levels.

CHAPTER V

SUMMARY, CONCLUSIONS AND DISCUSSION

Introduction

The purpose of this study was to investigate the relationship of eye movements to variations in readability levels by assessing the reading performance of approximately sixty Grade five pupils reading passages at their independent, instructional, and frustration levels. Eye movements of students of poor, average, and good reading ability were assessed to determine the effect of variations in readability.

The specific purposes of this study were to answer the following questions:

1. What effect will materials at the pupil's independent, instructional, and frustration levels of reading achievement have on the number of fixations and regressions he exhibited in reading?
2. How will the average span of recognition, average duration of fixation and reading rate the pupil exhibits during reading be affected by reading materials at his independent, instructional, and frustration levels?

3. What differences will exist among poor, average, and good readers in the number of fixations and regressions exhibited when reading passages at their independent, instructional, and frustration levels.
4. What differences will exist among poor, average, and good readers in the average span of recognition, average duration of fixation, and reading rate exhibited in reading passages at their independent, instructional, and frustration levels?

Summary

Analysis of the data presented in Chapter IV yielded the following findings concerning inter-group and intra-group variations in eye-movement behavior of grade five pupils as a result of variations in readability. Conclusions one to ten deal with comparisons among poor, average, and good readers at independent, instructional and frustration levels of reading performance:

1. Poor readers made more fixations than either average or good readers when reading passages at their independent, instructional, and frustration levels of reading performance.
2. Average readers made more fixations than good readers when reading passages at their independent, instructional and frustration levels of reading performance.
3. Poor readers made more regressions than either average

or good readers when reading passages at their independent, instructional, and frustration levels of reading performance.

4. Average readers made more regressions than good readers when reading passages at their independent, instructional, and frustration levels of reading performance.
5. Poor readers exhibited a smaller average span of recognition than either average or good readers when reading passages at their independent, instructional, and frustration levels of reading performance.
6. Average readers exhibited a smaller average span of recognition than good readers when reading at their independent, instructional, and frustration levels of reading performance.
7. Poor readers exhibited a longer average duration of fixation than either average or good readers when reading passages at their independent, instructional, and frustration levels of reading performance.
8. There was no significant difference between average readers and good readers in the average duration of fixation exhibited in reading passages at their independent, instructional, and frustration levels of reading performance.
9. Poor readers exhibited a slower reading rate than either average or good readers when reading passages at their independent, instructional, and frustration

levels of reading performance.

10. Average readers exhibited a slower reading rate than good readers when reading passages at their independent, instructional and frustration levels of reading performance.

The following conclusions refer to all students in the study regardless of reading ability:

11. There was no significant difference in the number of fixations exhibited by grade five pupils reading passages at their independent or instructional levels of reading performance. These pupils made fewer fixations when reading passages at their independent or instructional levels of reading performance than when reading passages at their frustration level of reading performance.

12. There was no significant difference in the number of regressions exhibited by grade five pupils reading passages at their independent or instructional levels of reading performance. These pupils made fewer regressions when reading passages at their independent or instructional levels of reading performance than when reading passages at their frustration level of reading performance.

13. There was no significant difference in the average span of recognition exhibited by grade five pupils reading passages at their independent or instructional

levels of reading performance. These pupils exhibited a larger average span of recognition when reading passages at their independent or instructional levels of reading performance than when reading passages at their frustration level of reading performance.

14. Grade five pupils exhibited a shorter average duration of fixation when reading passages at their independent level of reading performance than when reading passages at their instructional or frustration levels of reading performance. However, there was no significant difference in the average duration of fixation exhibited by grade five pupils reading passages at their instructional or frustration levels of reading performance.

15. Grade five pupils exhibited a slower reading rate when reading passages at their independent level of reading performance than when reading passages at their instructional or frustration levels of reading performance. Also, grade five pupils exhibited a slower reading rate when reading passages at their instructional level of reading performance than when reading passages at their frustration level of reading performance.

Limitations of the Study

The major limitation of the study pertains to the procedures used to determine pupils' functional reading

levels. The determination of functional reading levels was limited by the use of the Botel Reading Inventory A. This test does not provide specific grade level placement for students functioning at Junior High and Senior High levels. These functional levels correspond to grades seven to eight for Junior High and grades nine to twelve for Senior High.[1] Therefore, in conjunction with these approximations, the passages used from the Reading Eye Test Selections had a readability of 8.0 for Junior High and 10.5 for Senior High levels.[2]

Since formulas for determining readability presently in use consider only sentence length and number of difficult or polysyllabic words, the materials selected to examine the effects of variations in readability were limited to a consideration of these two factors. Further studies could profitably match pupils' functional reading levels with passages selected on the basis of additional linguistic factors such as number of T-units and sentence combining transformations.

The generalizations based on the results of this study must be limited to the population of grade five pupils sampled. Furthermore, since there was an attempt to control the number of good, average, and poor readers

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[1]Botel, The Botel Reading Inventory, p. 16.

[2]Taylor, Grade Level Norms, p. 10.

involved in the study, the generalizations based upon the results should be limited to these categories. No attempt was made to control sampling in terms of sex, chronological age, or socio-economic status. However, within this context, generalizations were possible concerning inter-group and intra-group variations in reading behavior.

The hypotheses under investigation did not include a study of comprehension. The measurement of comprehension in this study was limited to checking the validity of the pupil's reading of the passages as suggested by the manual for use with the Reading Eye Test Selections.[3] A related study could investigate the effect of such variations in readability on more sophisticated measures of comprehension.

The sensitivity to head movements of the Biometrics Reading Eye II required that graphs from four of the subjects (three average readers, one poor reader) had to be eliminated from the study.

Finally, the novelty of the equipment and testing procedures used may have resulted in somewhat atypical recordings of eye movements.

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[3]Taylor, Eye-Movement Photography with the Reading Eye, p. 36.

Conclusions

Results indicate that poor readers and average readers exhibited fewer fixations and regressions at their instructional level than at either their independent or frustration levels (Figure 4 and 5). Good readers, on the other hand, exhibited almost the same number of fixations and regressions at their independent and instructional levels but both levels are well below their frustration level (Figure 4 and 5). In addition, poor readers exhibited a longer average span of recognition and longer average duration of fixation at their instructional level than at either their independent or frustration levels (Figure 1 and 2). Average readers and good readers, on the other hand, exhibited a decreasing average span of recognition and an increasing average duration of fixation as they read from their independent to instructional to frustration levels (Figure 1 and 2).

While further studies would be required to determine the meaning of these latter variations, the results seem to conflict with the conclusions of Tinker, Taylor, Seibert, Ballantyne, and Morse with regard to the stability of eye-movement performance.[4] It does, on the other hand, support the investigations of Ruddell, Strickland, and Smith concerning the importance of matching the appropriateness of material to the syntactic maturity of the reader.[5]

Smith examined the effects of changes in the syntax

of a set of passages while retaining the same vocabulary and content. He found that students in grades four, five, and six were able to read fourth grade writing more easily than writing by more mature students but that for older students the fourth grade writing was not the easiest. More mature students in grades eight through twelve found the eighth grade writing easier to read than either the less complex fourth grade writing or the more complex twelfth grade writing.[6]

Froese, Braun, and Neilson in studying the potential of eye-movement photography as an instructional tool found similar results to the present study. Typical student profiles showed an increase in the number of fixations per one hundred words when reading easy or difficult materials and lower comprehension when reading easy or difficult materials. They examined the passages used and discovered that the materials at different readability

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[4]Tinker, "Time Relations for Eye Movement Measures," pp. 1-10.
Taylor, Frackenpohl, and Pettee, "Validity of Eye-Movement Photography," p.8.
Ahrendt and Mosedale, "Eye Movement Photography," p. 150.
Morse, "The Individuality of Eye Movements," pp. 33-38.

[5]Ruddell, Language Acquisition and the Reading Process," pp. 1-19.
Strickland, The Language of Elementary School Children, p. 86.
Smith, "Transformed Syntactic Structure in Reading," pp. 52-62.

levels were varied in linguistic composition. A sharp increase in the number of sentence-combining transformations was present from independent to instructional to frustration levels of reading performance. They postulated that these transformations might affect reading performance.[7]

The significantly superior performance of all subjects at their independent and instructional levels as opposed to their frustration level provides a physiological basis for the need to avoid the use of material that is above the instructional level if students are to perform efficiently in terms of eye movements in reading. In addition the results for poor readers suggest that the instructional level elicits a greater degree of concentration than is evident at either their independent or frustration levels.

Poor readers exhibited significantly slower average reading rates than either average or good readers at their

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[6] Ibid.

[7] Victor Froese, Carl Braun, and Allan Neilsen, "Eye Movement Photography: An Instructional Tool?" In Reading: Convention and Inquiry, 24th yearbook of the National Reading Conference, edited by George H. McNich and Wallace D. Miller, (Clemson, South Carolina: The National Reading Conference, Inc., 1975) pp. 106-11.

independent, instructional, and frustration levels of reading. Average readers exhibited significantly slower reading rates than good readers at their independent, instructional, and frustration levels of reading. In Addition, the decrease in average reading rate for poor readers was much smaller (14.1 w.p.m.) between independent and frustration levels than it was for either average readers (40.8 w.p.m.) or good readers (37.1 w.p.m.). These results seem to support the conclusion of Blommers and Lindquist who found that good comprehenders adjusted their rate by slowing down as material increased in difficulty whereas poor comprehenders apparently read easy and difficult material at much the same rate.[8] A closer examination of the mean values for reading rates (Figure 6) indicates that good readers and average readers decreased their reading rate approximately twice as much between instructional and frustration levels as between independent and instructional levels while poor readers decreased their reading rate approximately one half as much between instructional and frustration levels as between independent and instructional levels. While further studies are required to determine the meaning of these variations, it may be that for poor readers there exists a level of

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[8]Blommers and Lindquist, "Rate of Comprehension of Reading," pp. 449-73.

complexity in the material (e.g. instructional level) beyond which they are unable to discriminate. Smith in his study of the effect of material written at different levels of syntactic maturity speculated that for students in the lower grades, four, five, and six, factors such as redundancy of material may play an important part in word predictability, commonly referred to as cloze. On the other hand, the more mature students in grade eight to twelve performed better on material which was less redundant and structurally more complex.[9] If the better readers in this study possess greater syntactic skills than poor readers they may also be more able to perceive changes in the complexity of material and adjust their reading rates accordingly. Smith in examining the usual processing system of the individual refers to this type of information overload as producing "tunnel vision". Since the amount of visual information that can be picked up in a single glance is limited by the processing requirement of about 200 msec for every new input, the amount one apprehends will depend upon prior knowledge and experience.[10]

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[9]Smith, "Transformed Syntactic Structure in Reading," pp. 52-62.

[10]Frank Smith, Understanding Reading: A Psycholinguistic Analysis of Reading and Learning to Read. (New York: Holt, Rinehart and Winston, Inc., 1971), p. 103.

Implications for Educational Practice

The implications of this study apply to various educational practitioners. In particular, the findings suggest certain needs in the area of diagnosis, individualization for instruction, and selection of appropriate materials.

The major implication of the findings of the present study is that eye movement behavior of grade five pupils is affected by variations in readability levels and that these changes are reflected in eye movements that are exhibited most efficiently at the pupil's instructional level. This appears to be more crucial for poor readers than for average or good readers. This result demonstrates that the reader possesses a heightened degree of cognitive clarity and an increased capacity for short term memory at the instructional level as opposed to either the independent or frustration levels.[11]

Increases in the number of fixations and regressions when reading easy (independent level) or difficult (frustration level) material demonstrate, physiologically, the need

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[11]John Downing, "A Summary of Evidence Related to the Cognitive Clarity Theory of Reading," Diversity in Mature Reading: Theory, and Research, 22nd Yearbook of the National Reading Conference, Volume I, edited by Phil L. Nacke (Boone, North Carolina: The National Reading Conference, Inc., 1973), pp. 178-84.

Frank Smith, Understanding Reading, pp. 77-78.

for instruction at appropriate reading levels.

In addition, the comparatively greater effect of these variations in readability on the eye movements of poor readers as opposed to average and good readers underlines the need to consider appropriate reading levels when planning instruction for poor readers.

Many studies have stressed the need to provide greater individualization of instruction for reading and language development and diagnostic methods such as the individualized reading inventory have been devised to aid in the identification of functional reading levels. This study supports the need for these measures and reveals the importance for teachers to determine the instructional level(s) for each pupil and to select materials that are both appropriate to that instructional level and appropriate in linguistic composition. Furthermore the evidence relating to poor readers reveals that reading imposes a greater physiological demand on poor readers than on average or good readers. Possibly more frequent yet shorter periods of instruction would be appropriate for poor readers. In addition the comparatively longer duration of fixation and larger span of recognition exhibited at the instructional level for poor readers suggests a greater degree of concentration than is evident at either their independent or frustration level. Teachers might profitably employ strategies for poor readers that would develop concentration.

Activities such as those that require the pupil to recall objects or sequences of events, or to set specific purposes for reading could help to expand the reader's attention span.

While further studies are required to determine the relative effects of the variables that influence readability of materials, the relationships described in this study between variations in readability and eye movements of grade five pupils support the need to provide curriculum materials to accommodate poor, average and good readers that are appropriate in interest level yet vary widely in readability. In selecting these materials, curriculum developers might consider not only the more common variables identified by readability formulas such as sentence length and number of polysyllable words but also such factors as passage length, number of T-Units and sentence combining transformations. Material should be used that progresses from common to uncommon language structures and that presents and teaches the use of syntactic cues while providing the teacher with necessary scientific knowledge of language development useful for the instruction of these cues.

Administrators of reading programs, in order to allow for the need for greater individualization of instruction, must provide teachers with a wider range of appropriate reading materials that recognize the importance

of the maturation of language development in learners. Teachers need time for, and expertise in determining appropriate levels of instruction. Classes of readers for instruction need to be based on functional reading levels as well as factors of interest and age. Poor readers require more time to develop necessary language facility and instructional procedures must take into consideration the physiological demands of reading and the individual differences that exist amongst readers with regard to these demands. It is in the assessment of these demands upon the reader where eye movement photography may provide important instructional information concerning the productive performance level of a student's reading ability.

Implications for Further Research

While the data demonstrate the effects on eye movements of variations in readability as determined by accepted readability formulae, there is a need to expand our understanding of what factors contribute to the readability of material. Further studies are required to examine the importance of such factors as T-Units, sentence combining transformations, other linguistic structures on readability and the physiological measures of eye movements

In addition, there is a need to develop more accurate and widely accepted measures of functional levels of reading ability. Powell, for example, suggested that

younger children can tolerate more word recognition errors and maintain acceptable comprehension levels than can older youngsters in grades three through six.[12] Froese, in examining the use of Informal Reading Inventories raised the following concerns that relate to the levels established.

(1) The criteria for acceptable word recognition errors may need to vary with the grade placement and ability level of the student.

(2) The types of errors scored may affect the level indicated. Some, for example, count repetitions as errors while others do not.

(3) Not all functional levels may be equally valid constructs. The differences exhibited in performance between the independent level and the instructional level may be of greater significance than that which exists between the instructional and frustration level.

(4) Comprehension questions used vary considerably in type and predictive value. In the present study no significant differences in mean comprehension percentages were exhibited by students reading at independent, instructional

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[12]W. R. Powell, "Reappraising the Criteria for Interpreting Informal Reading Inventories." In Reading Evaluation, edited by D. de Boer. (Newark: International Reading Association, 1968).

or frustration levels. This was not unexpected since the simple true or false response required of the student could not be considered a valid measure of his comprehension ability at the levels established. A related study is needed to assess the effects of variations in readability on more sophisticated measures of comprehension.

(5) The interest of passages used is generally not controlled across Informal Reading Inventories and though not considered in assessing readability can, nevertheless, affect performance.

(6) Informal Reading Inventories constructed by different authors do not necessarily agree on the functional reading level they predict since no standard exists against which Informal Reading Inventories can be compared.[13]

Certainly, more research is required to establish the validity of the constructs for functional reading levels. In addition, greater standardization in the

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[13]Victor Froese, "I.R.I.'s at the Secondary Level Re-Examined," in Interaction: Research and Practice in College Adult Reading, 23rd Yearbook of the National Reading Conference, edited by Phil L. Nacke (Clemson, South Carolina: The National Reading Conference, Inc., 1974) pp. 120-24.

construction of materials and criteria used to establish these levels is necessary.

It may be that further studies of the effects of reading behavior on physiological responses, such as those conducted by Eckwall[14] using the polygraph and Rugel[15] using G.S.R. as a measure of anxiety, will produce a clearer understanding of functional reading levels.

The data partially support the findings of Taylor with respect to the effect of difficulty of content at or below grade level.[16] For fixations, regressions and average span of recognition no significant differences were noted for grade five students reading passages at their independent and instructional levels. However, significant differences were found for average duration of fixation and reading rate at these levels. Perhaps the fact that the present study established individual instructional levels rather than a group mean reading achievement level may have accounted for these differences.[17] Further studies

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[14]E. E. Eckwall, and J. K. English, "Use of the Polygraph to Determine Elementary School Students' Frustration Reading Level," Final Report. E D 052 915, 1971.

[15]R. P. Rugel, "Arousal and Levels of Reading Difficulty," The Reading Teacher 24 (January 1971): 458-60.

[16]Taylor, Frackenpohl, and Pettee, "Validity of Eye Movement Photography," p. 8.

[17]Ibid, p. 7.

might profitably explore the relationship between factors of readability, syntax, and average duration of fixation particularly as it affects poor readers.

While not meeting the established criteria for significance (.05) for all subjects reading at their independent and instructional levels, the drop in mean values for number of fixations and regressions at the instructional level by poor and average readers (Figures 4 and 5) may suggest a relationship between the appropriateness of the material in terms of some factors of readability or syntactical structure and the efficiency of reading behavior in terms of fixations and regressions. Further investigations of this relationship and of the factors involved could indicate their importance for instructional procedures.

The disparity in performance by poor readers as compared to average and good readers with respect to average span of recognition (figure 1) and average duration of fixation (figure 2) also seems to point to a significant relationship between the appropriateness of material (instructional level) and eye-movement behavior. These deviations from an apparent linear trend for average and good readers with respect to average span of recognition and average duration of fixation require further study to determine their importance and implications for instructional procedures applied to poor readers.

While reading rate is but a derivative of the eye-movement factors previously discussed, the results of the study not only support previous research which has pointed out the greater flexibility of good readers as opposed to poor readers but also suggests an individual criteria level for passage complexity or for factors affecting that complexity beyond which reading rate is more significantly affected. Smith has suggested that a state of "tunnel vision" develops as a result of information overload since the individual does not possess the necessary prior knowledge and experience to apprehend the same amount of information at that level.[18] Therefore, more research is required to examine the possible existence of an individual critical level and, if so, by what means that level might be determined.

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[18]Frank Smith, Understanding Reading, p. 103.

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APPENDIX A

RAW SCORE DATA

APPENDIX A

RAW DATA

Explanation of Columnar Headings.

Column	Data
1	Reading ability sub-group: P=poor A=average G=good
2	Independent reading level.
3	Instructional reading level.
4	Frustration reading level.
5	Testing treatment pattern: 1= Instructional, Independent, Frustration 2= Frustration, Independent, Instructional 3= Independent, Instructional, Frustration 4= Instructional, Frustration, Independent 5= Frustration, Instructional, Independent 6= Independent, Frustration, Instructional
6	Number of fixations per 100 words at independent level.
7	Number of fixations per 100 words at instructional level.
8	Number of fixations per 100 words at frustration level.
9	Number of regressions per 100 words at independent level.
10	Number of regressions per 100 words at instructional level.
11	Number of regressions per 100 words at frustration level.
12	Average span of recognition at independent level.

13 Average span of recognition at instructional level.

14 Average span of recognition at frustration level.

15 Average duration of fixation at independent level.

16 Average duration of fixation at instructional level.

17 Average duration of fixation at frustration level.

18 Average reading rate in words per minute at independent level.

19 Average reading rate in words per minute at instructional level.

20 Average reading rate in words per minute at frustration level.

21 Comprehension percentage at independent level.

22 Comprehension percentage at instructional level.

23 Comprehension percentage at frustration level.

Student Number	1	2	3	4	5	6	7	8	9	10	11
1	P	3	6	J.H.	1	130	95	126	36	21	32
2	A	3	J.H.	SR.H.	3	122	133	144	32	34	37
3	P	1	2	3	5	230	202	234	68	44	58
4	P	2	6	J.H.	4	120	135	119	18	30	25
5	A	3	6	J.H.	5	96	100	137	20	25	33
6	A	3	J.H.	SR.H.	2	96	73	107	22	17	21
7	P	3	4	5	2	134	87	122	50	28	27
8	A	4	6	J.H.	5	84	99	101	13	15	16
9	A	2	5	J.H.	6	136	146	156	38	20	45
10	G	5	J.H.	SR.H.	2	95	103	114	16	19	27
11	A	3	J.H.	SR.H.	6	112	133	170	28	43	57
12	P	1	2	3	2	192	224	240	60	62	66
13	G	3	J.H.	SR.H.	4	84	85	103	16	18	28
14	G	6	J.H.	SR.H.	1	73	77	68	11	14	12
15	P	3	4	6	5	142	124	162	10	10	24

Student Number	1	2	3	4	5	6	7	8	9	10	11
16	G	6	J.H.	SR.H.	3	101	107	120	17	20	24
17	G	6	J.H.	SR.H.	6	78	88	105	12	20	15
18	P	3	4	5	1	202	164	172	64	27	43
20	A	5	J.H.	SR.H.	5	132	146	187	46	44	58
22	P	3	4	J.H.	1	138	144	140	30	28	28
24	G	6	J.H.	SR.H.	1	122	104	107	36	31	36
26	G	3	J.H.	SR.H.	6	128	136	157	28	33	34
27	G	6	J.H.	SR.H.	6	101	108	105	33	36	29
28	A	5	6	J.H.	5	94	87	95	16	19	31
29	G	5	J.H.	SR.H.	3	88	81	82	18	20	15
30	G	3	J.H.	SR.H.	1	120	100	117	38	27	26
31	A	3	J.H.	SR.H.	3	140	163	189	40	50	73
32	A	5	6	J.H.	2	94	112	92	16	30	19
33	A	5	J.H.	SR.H.	1	126	148	204	33	35	68
34	A	5	J.H.	SR.H.	6	65	94	113	14	19	34

Student Number	1	2	3	4	5	6	7	8	9	10	11
35	G	6	J.H.	SR.H.	3	72	89	87	13	24	30
36	G	4	J.H.	SR.H.	3	91	97	96	16	22	16
37	G	5	J.H.	SR.H.	4	136	132	139	34	30	26
38	A	3	6	J.H.	4	120	123	100	22	22	17
39	G	5	J.H.	SR.H.	1	72	81	104	13	11	21
40	A	3	4	5	6	102	107	140	32	22	36
41	A	2	6	J.H.	4	126	104	116	24	17	14
42	P	2	4	5	2	146	108	116	44	40	33
43	G	6	J.H.	SR.H.	6	124	125	167	32	29	37
44	P	2	5	J.H.	2	178	167	210	42	35	50
45	A	3	6	J.H.	3	220	100	121	100	19	32
46	A	3	6	J.H.	2	194	105	115	28	34	36
47	A	3	6	J.H.	5	124	103	142	36	20	26
48	A	4	5	6	4	105	120	111	24	24	24
49	P	5	6	J.H.	4	155	190	187	33	49	62

Student Number	1	2	3	4	5	6	7	8	9	10	11
50	A	3	6	J.H.	1	160	160	191	56	36	48
51	P	3	5	J.H.	1	112	132	140	38	20	38
52	P	3	4	5	4	138	114	97	46	32	32
53	G	5	6	J.H.	5	89	87	119	21	19	27
54	G	6	J.H.	SR.H.	6	129	120	190	28	29	56
55	P	3	4	6	1	168	145	192	62	44	78
56	P	3	6	J.H.	3	136	119	126	40	32	32
57	P	2	5	6	4	164	124	134	34	24	33
58	P	3	J.H.	SR.H.	2	118	126	123	28	39	26
59	A	3	J.H.	SR.H.	3	146	160	216	40	45	65
60	P	3	6	J.H.	5	198	171	145	58	51	51
61	P	2	3	4	3	194	214	337	72	94	183

Student Number	12	13	14	15	16	17	18	19	20	21	22	23
1	0.77	1.05	0.79	0.27	0.34	0.32	171	185	148	80	80	60
2	0.82	0.75	0.69	0.29	0.30	0.31	171	152	133	40	50	40
3	0.43	0.50	0.43	0.43	0.48	0.53	61	62	49	70	40	80
4	0.83	0.74	0.84	0.31	0.32	0.35	162	138	143	90	40	60
5	1.04	1.00	0.73	0.26	0.32	0.31	240	190	140	70	70	50
6	1.04	1.37	0.93	0.28	0.34	0.36	222	240	154	70	80	50
7	0.75	1.15	0.82	0.39	0.29	0.35	115	240	141	60	60	70
8	1.19	1.01	0.99	0.27	0.29	0.26	267	207	226	40	50	60
9	0.73	0.68	0.64	0.32	0.35	0.44	140	119	87	80	100	90
10	1.05	0.97	0.88	0.32	0.31	0.36	200	188	145	90	70	70
11	0.89	0.75	0.59	0.24	0.33	0.28	222	138	128	70	70	30
12	0.52	0.45	0.42	0.38	0.40	0.39	83	67	64	100	80	70
13	1.19	1.18	0.97	0.26	0.31	0.27	273	231	214	70	50	70
14	1.37	1.30	1.47	0.27	0.25	0.25	300	316	353	100	70	90
15	0.70	0.81	0.62	0.37	0.41	0.42	115	118	88	60	50	30

Student Number	12	13	14	15	16	17	18	19	20	21	22	23
16	0.99	0.93	0.83	0.25	0.28	0.27	235	200	188	50	70	50
17	1.28	1.14	0.95	0.25	0.26	0.29	308	261	200	80	60	70
18	0.50	0.61	0.58	0.32	0.45	0.38	95	82	92	70	60	80
20	0.76	0.68	0.54	0.25	0.24	0.26	185	174	124	70	70	70
22	0.72	0.69	0.71	0.22	0.26	0.25	194	158	169	70	60	90
24	0.82	0.96	0.94	0.25	0.26	0.25	197	218	222	60	60	60
26	0.78	0.73	0.64	0.24	0.28	0.28	194	160	138	70	60	80
27	0.99	0.93	0.95	0.29	0.24	0.27	204	228	213	60	60	70
28	1.06	1.15	1.05	0.29	0.29	0.33	223	240	190	70	60	50
29	1.14	1.23	1.22	0.25	0.23	0.24	274	320	300	50	60	70
30	0.83	1.00	0.85	0.22	0.24	0.28	230	250	186	70	50	50
31	0.71	0.61	0.53	0.27	0.25	0.26	160	145	122	80	80	70
32	1.06	0.89	1.09	0.26	0.25	0.28	246	210	234	50	30	40
33	0.79	0.68	0.49	0.29	0.30	0.31	163	135	93	90	80	60
34	1.54	1.06	0.88	0.28	0.23	0.25	325	276	213	80	80	70

Student Number	12	13	14	15	16	17	18	19	20	21	22	23
35	1.39	1.12	1.15	0.28	0.30	0.28	295	223	245	80	80	60
36	1.10	1.03	1.04	0.23	0.25	0.26	282	245	237	60	60	70
37	0.74	0.76	0.72	0.26	0.30	0.32	168	154	135	90	60	70
38	0.83	0.81	1.00	0.29	0.29	0.32	175	166	190	90	50	70
39	1.40	1.24	0.96	0.29	0.29	0.27	290	259	213	90	90	50
40	0.99	0.93	0.71	0.27	0.31	0.30	218	181	142	80	60	90
41	0.80	0.96	0.86	0.34	0.39	0.34	139	148	153	70	50	60
42	0.68	0.92	0.86	0.26	0.31	0.34	162	181	154	90	80	90
43	0.80	0.80	0.65	0.27	0.31	0.31	180	154	119	40	60	50
44	0.56	0.60	0.48	0.26	0.32	0.27	130	113	107	50	70	40
45	0.45	1.00	0.83	0.28	0.37	0.36	98	162	136	90	90	70
46	1.03	0.95	0.87	0.28	0.30	0.27	111	194	190	80	80	40
47	0.81	0.97	0.70	0.28	0.35	0.33	175	167	129	90	90	50
48	0.95	0.83	0.90	0.26	0.22	0.27	214	222	194	70	60	70
49	0.64	0.52	0.53	0.25	0.27	0.27	154	114	117	70	80	90

Student Number	12	13	14	15	16	17	18	19	20	21	22	23
50	0.63	0.63	0.51	0.22	0.23	0.25	172	161	121	90	60	60
51	0.89	0.76	0.71	0.33	0.34	0.34	162	135	128	60	70	70
52	0.72	0.88	1.03	0.30	0.30	0.35	143	135	179	70	90	50
53	1.12	1.15	0.84	0.28	0.31	0.27	245	222	188	60	70	90
54	0.77	0.83	0.52	0.28	0.27	0.28	162	182	110	70	60	60
55	0.60	0.69	0.50	0.29	0.39	0.30	123	106	103	50	70	80
56	0.73	0.84	0.79	0.25	0.36	0.32	168	139	147	60	80	80
57	0.60	0.80	0.74	0.29	0.31	0.30	125	152	141	70	70	70
58	0.84	0.79	0.81	0.23	0.38	0.31	214	124	156	50	60	70
59	0.68	0.62	0.48	0.27	0.37	0.46	150	100	60	60	60	80
60	0.50	0.58	0.72	0.26	0.38	0.30	117	91	139	90	40	80
61	0.51	0.50	0.33	0.22	0.25	0.19	139	109	96	80	50	80

APPENDIX B

MEAN VALUES

APPENDIX B

1. FIXATIONS

	Independent	Instructional	Frustration
Poor	157.632	146.579	164.316
Average	123.524	119.810	140.333
Good	100.176	101.176	116.412

2. REGRESSIONS

	Independent	Instructional	Frustration
Poor	43.842	37.368	48.474
Average	32.381	28.095	37.619
Good	22.471	23.647	27.000

3. AVERAGE SPAN OF RECOGNITION

	Independent	Instructional	Frustration
Poor	0.657	0.731	0.669
Average	0.895	0.873	0.763
Good	1.045	1.018	0.916

4. AVERAGE DURATION OF FIXATION

	Independent	Instructional	Frustration
Poor	0.296	0.345	0.331
Average	0.276	0.301	0.312
Good	0.264	0.276	0.279

5. AVERAGE READING RATE (Words per minute)

	Independent	Instructional	Frustration
Poor	138.579	128.895	124.526
Average	191.238	177.476	150.429
Good	237.471	224.176	200.353

6. COMPREHENSION (Percentage)

	Independent	Instructional	Frustration
Poor	70.526	64.737	70.526
Average	72.857	67.619	60.476
Good	70.000	64.118	66.471

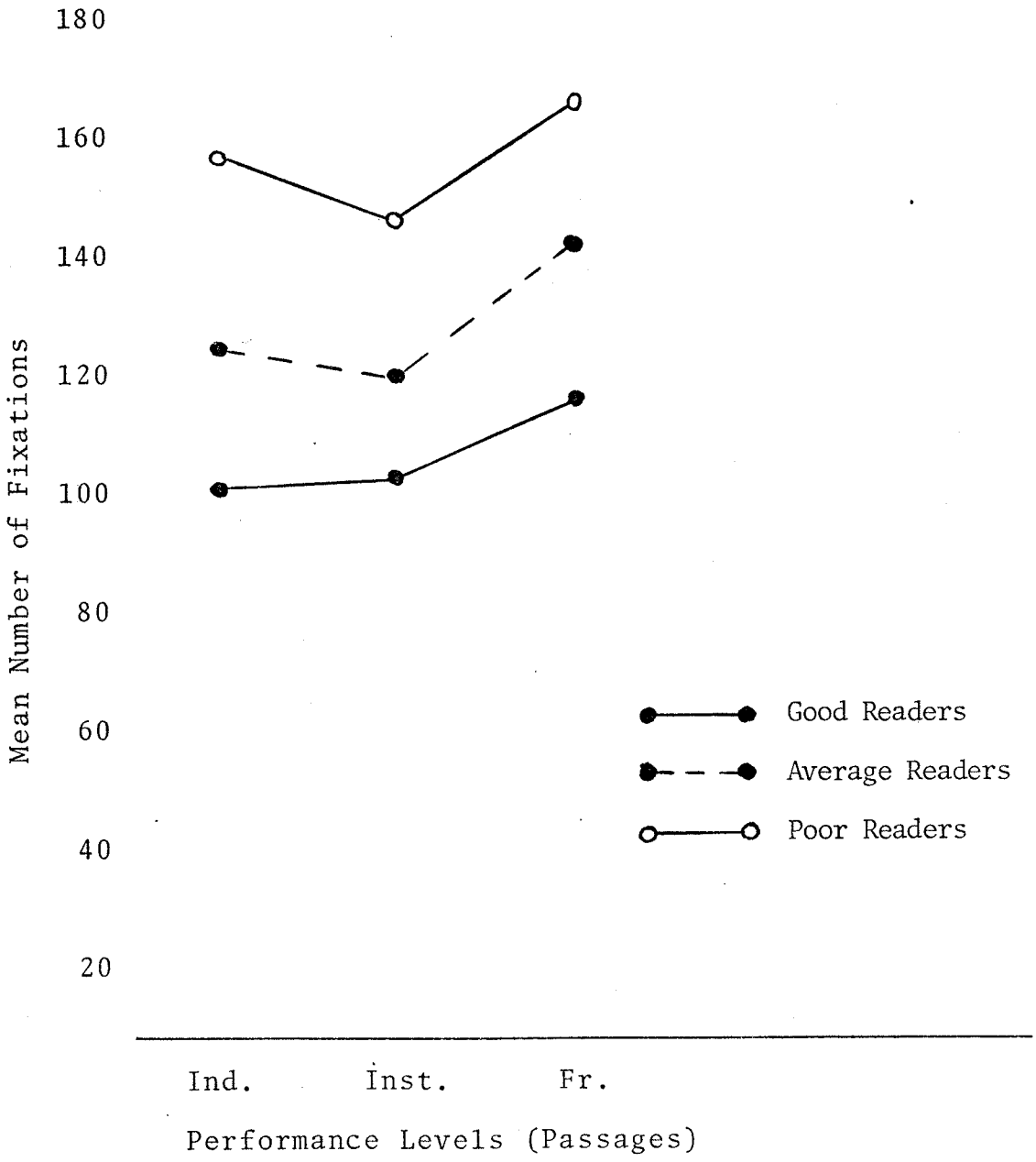

Figure 4: Mean values for fixations for poor, average, and good readers at Independent, Instructional and Frustration levels.

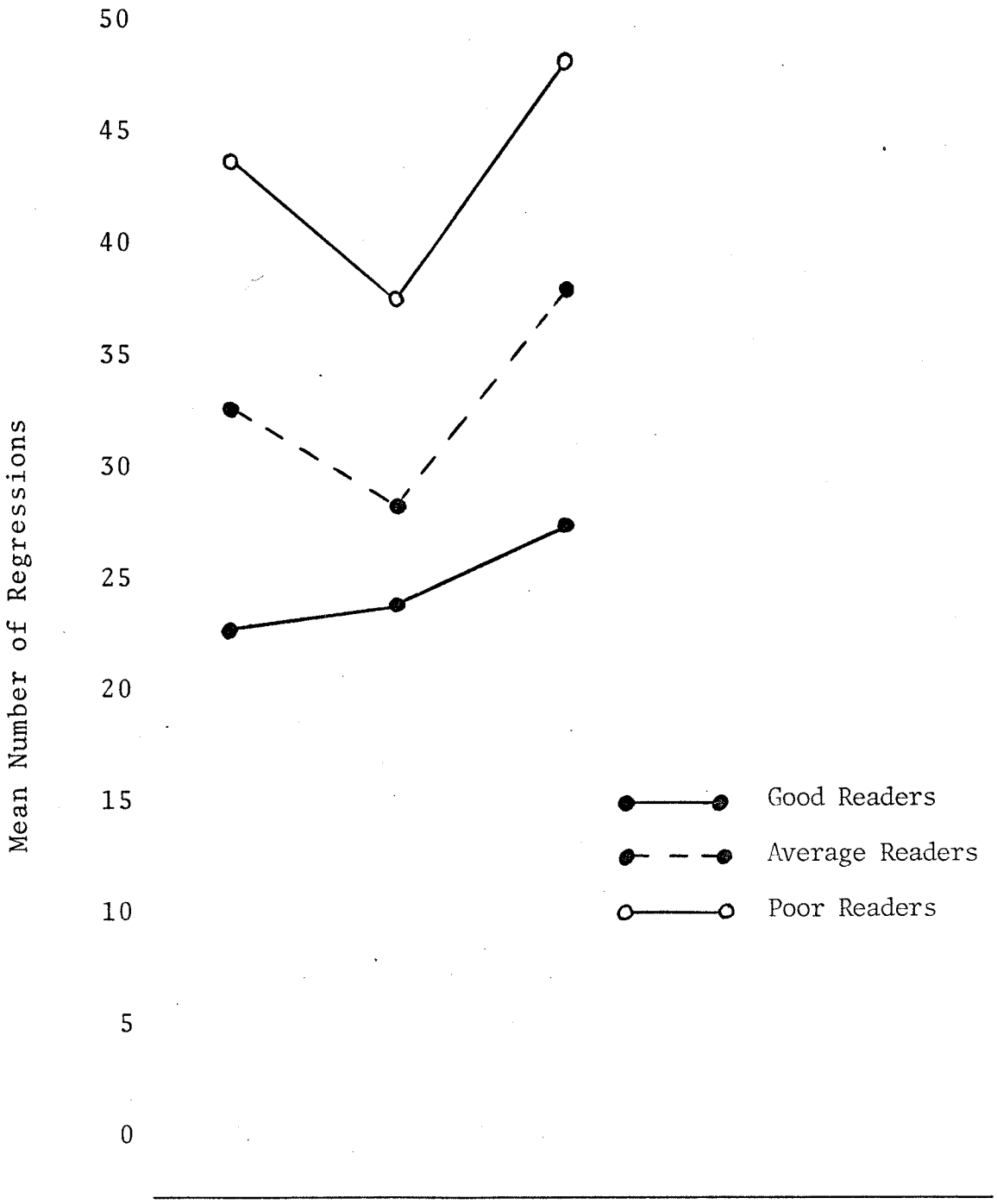

Figure 5: Mean values for regressions for poor, average, and good readers at Independent, Instructional, and Frustration levels.

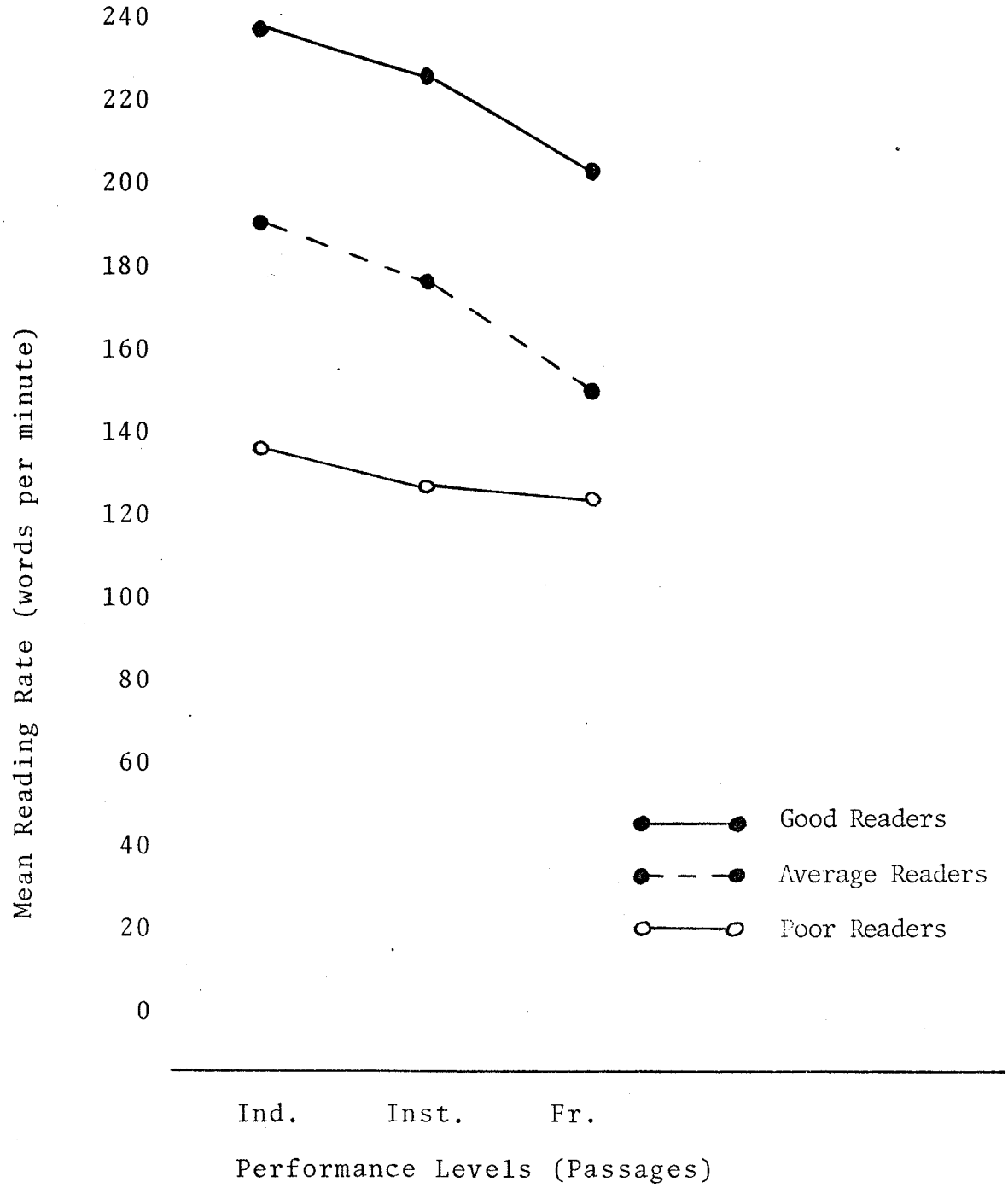

Figure 6: Mean Values for reading rate (words per minutes) for poor, average; and good readers at Independent, Instructional, and Frustration levels of reading performance.

APPENDIX C

THE PASSAGES

APPENDIX C

1. Passage and Comprehension Questions from Reading Eye Test Selections for use with the Biometrics Reading Eye II

	Grade Level	Subject Area	Readability
1	Grade One	Pets	1.8
2	Grade Two	Community	2.5
3	Grade Three	Hobbies	3.5
4	Grade Four	Pioneers and Indians	4.5
5	Grade Five	Animals	5.5
6	Grade Six	Foreign Lands	6.5
7	Junior High	Inventions	8.0
8	Senior High	Biography	10.5

2. Letter of Permission to enclose copyrighted parts of the Reading Eye Test Selections.

PASSAGE ONE

Jack wished he had a pet. One day he saw three yellow ducks. "I can catch a duck," thought Jack. Jack and the ducks ran to the water. Jack was not afraid of the water. He walked in to catch the ducks. But they went too fast for him. Then Jack went home, cold and wet. "I will find another pet," he said.

COMPREHENSION ONE

		Answer Yes or No
1.	Jack had a new pet.	No
2.	He saw some white ducks.	No
3.	He saw three ducks.	Yes
4.	Jack wanted to catch a duck.	Yes
5.	The ducks ran to the water.	Yes
6.	Jack was afraid of the water.	No
7.	Jack fell into the water.	No
8.	Jack got a duck for a pet.	No
9.	The ducks went too fast for Jack.	Yes
10.	Jack said, "I will find another pet."	Yes

PASSAGE TWO

One summer Ed worked on a farm. The farmer asked Ed to pick apples for five pennies a basket. He said, "Pick only the very big, red apples." The first day Ed picked only two baskets because he ate so many. That night he was very sick. After that, he didn't eat apples. He just picked them. He was the best apple picker there.

COMPREHENSION TWO

		Answer Yes or No
1.	One summer Ed worked on a farm	Yes
2.	Ed asked if he could pick apples.	No
3.	The farmer gave Ed five pennies a basket.	Yes
4.	Ed was told to pick all the apples from each tree.	No
5.	Ed ate many apples the first day.	Yes
6.	Ed picked five baskets of apples the first day.	No
7.	Ed got sick the next day.	No
8.	Ed got sick from eating apples.	Yes
9.	After that, Ed didn't eat apples.	Yes
10.	Ed was the best apple picker there.	Yes

PASSAGE THREE

Peter has a fine model railroad. He and his father built it together. The train has an engine, ten passenger cars and a baggage car. He pushes a special button to make it move forward or back up. The train falls off the track when it goes too fast. It whistles when going around a turn. Peter wants to be a conductor.

COMPREHENSION THREE

		Answer Yes or No
1.	Peter has a model railroad.	Yes
2.	His uncle built it for him.	No
3.	His train has ten passenger cars.	Yes
4.	It has three baggage cars.	No
5.	He pushes a special button to make the lights go on.	No
6.	His train can move forward and back up.	Yes
7.	The train falls off the track when it is stopped too fast.	No
8.	It whistles when it comes to a stop.	No
9.	Peter wants to work for a railroad some day.	Yes
10.	Peter wants to be a conductor.	Yes

PASSAGE FOUR

A big hunt was planned because winter was coming. Blackhawk was to go for the first time. The hunters planned to be away for several months. Often they went thirty miles in one day. When scouting for game, the men walked in single file behind the leader, but when a man sighted game, they scattered quickly in the woods. How proud Blackhawk was to shoot his first deer! When an animal was killed, it was skinned and the meat cut into strips to be smoked over the campfire. The skins and meat were packed and hidden in the woods. All the way home, the hunters gathered up these bundles. They often needed several weeks to reach home.

COMPREHENSION FOUR

		Answer Yes or No
1.	A big spring hunt was planned	No
2.	Blackhawk was going on a hunt for the first time.	Yes
3.	The hunters planned to be away for several months.	Yes
4.	Often the hunters traveled thirty miles in one day.	Yes
5.	The hunters camped while a scout went to look for game.	No
6.	When game was sighted, the hunters scattered through the woods.	Yes
7.	On this hunt, Blackhawk killed his first bear.	No
8.	When an animal was killed, its meat was packed into bundles and carried along.	No
9.	The bundles of meat were hidden to be picked up on the way home.	Yes
10.	It often took several weeks to reach home.	Yes

PASSAGE FIVE

The ostrich is the largest bird in the world. A full grown ostrich stands eight feet high. It certainly is a strange looking creature with its small head, long neck, a heavy feathered body and long sturdy legs. The short wings of the ostrich are useless for flying, but they are sometimes used as sails when running to help pick up speed. The strong legs of the ostrich make it a very swift runner. It takes enormous strides and can speed along at nearly sixty miles per hour. If it ran straight, no horse could catch it. However the ostrich is a dull creature and always runs in circles. It is no trick for a good hunter to capture one.

COMPREHENSION FIVE

		Answer Yes or No
1.	The ostrich is the world's largest bird.	Yes
2.	Ostriches grow to a height of more than nine feet.	No
3.	The ostrich's body is heavily covered with feathers.	Yes
4.	The ostrich is able to fly short distances.	No
5.	Its wings are sometimes used to gain speed in running.	Yes
6.	The ostrich is a fast runner because of the enormous strides he can take.	Yes
7.	The ostrich can run nearly sixty miles an hour.	Yes
8.	Many people consider the ostrich a clever bird.	No
9.	The ostrich always runs in circles.	Yes
10.	It is difficult to capture an ostrich.	No

PASSAGE SIX

Greece and sponges are closely connected. The Greeks were the first to discover sponges growing in the ocean and to supply them to other countries. Sponges are gathered in shallow water by men in glass-bottomed boats. When they see sponges on the ocean floor, they reach for them with hooks on poles that are sometimes fifty feet long. In deeper water, men in diving suits bring up sponges. Then all the sponges are strung together and hung up to dry. When sponges were found off the coast of Florida, Greek divers moved there to carry on this trade. Most of our sponges are from Florida. But the world's finest sponges still come from Greece.

COMPREHENSION SIX

		Answer Yes or No
1.	Greeks were the first to discover sponges.	Yes
2.	Greece still supplies sponges.	Yes
3.	Sponges grow only in ocean caves.	No
4.	The hooked poles used to gather sponges are sometimes fifty feet long.	Yes
5.	In deep water sponges are gathered by men in diving suits.	Yes
6.	Men in glass-bottomed boats point out sponges to the divers.	No
7.	Sponges must be kept moist until they are taken to market.	No
8.	Greek divers went to Florida to gather sponges.	Yes
9.	Most of our sponges come from Florida.	Yes
10.	Florida supplies the world's finest sponges.	No

PASSAGE SEVEN

John Holland invented a successful submarine in 1898. This Irishman hoped to free Ireland from England, and became interested in submarines in hopes of sinking the British Navy. Earlier submarines did not dive easily or stay level once submerged. When a torpedo was fired, loss of weight caused the submarine to rise to the surface. Holland worked out a clever system of taking on water or releasing air. To dive, water was pumped into two tanks. To surface, compressed air was released into the tanks, forcing the water out and making the submarine lighter. The value of Holland's invention was not realized until World War I was fought. Submarines today still use many of Holland's principles.

COMPREHENSION SEVEN

		Answer Yes or No
1.	John Holland invented the submarine in 1898.	Yes
2.	He had hopes of sinking the British Navy.	Yes
3.	Holland was the first to attempt the invention of a submarine.	No
4.	The earlier submarines had difficulty rising to the surface.	No
5.	Loss of weight after firing a torpedo caused earlier submarines to rise.	Yes
6.	Holland's system was to take on air when diving and release air when surfacing.	No
7.	Water was pumped into two tanks for diving.	Yes
8.	Compressed air forced the water out of the tanks for surfacing.	Yes
9.	The submarines value was not generally realized until World War I.	Yes
10.	Today Holland's ideas are completely out of date.	No

PASSAGE EIGHT

Clarence Darrow was an exceptionally able lawyer. He began his career as a corporation lawyer, but resigned his position to defend a prominent labor leader. When the defense was successful, he decided to spend his life defending the "underdog." As a firm opponent of capital punishment, he used his tremendous courtroom skill to save over a hundred persons charged with murder. None of his clients was ever sentenced to death. In 1925, he defended a school teacher who was charged with breaking a Tennessee law that forbade teaching evolution. He lost the case, but was so persuasive that many a state was discouraged from passing similar laws. Darrow was also an author of novels and books on crime.

		Answer Yes or No
1.	Clarence Darrow gained his fame as a criminal lawyer.	Yes
2.	He began his career as a patent attorney.	No
3.	Defending a labor leader caused him to lose his position in a corporation.	No
4.	He was opposed to capital punishment.	Yes
5.	He defended a hundred persons charged with murder.	Yes
6.	Only one of his clients received the death penalty.	No
7.	In 1925, he unsuccessfully defended a Tennessee teacher.	Yes
8.	The teacher was charged with illegally teaching evolution.	Yes
9.	His defense caused many states to pass laws prohibiting the teaching of evolution.	No
10.	Darrow wrote books on crime.	Yes

Educational Developmental Laboratories
McGraw-Hill Book Company

1221 Avenue of the Americas
New York, New York 10020
Telephone 212/997-1221

December 23, 1975

Mr. Digby Ferries
Brandon University
Brandon, Manitoba
Canada

Dear Mr. Ferries:

Your letter of November 28, 1975 directed to our branch office in Scarborough, Ontario, has just been referred to me for attention.

To assist you in completing your masters thesis in reading for the University of Manitoba, EDL is pleased to grant you permission to use the passages and accompanying comprehension questions from the Reading Eye Test Selections indicated below:

One - 5	Four - 5	JH - 5
Two - 6	Five - 6	HSCA - 6
Three - 7	Six - 6	

Consent for use of the foregoing is limited to your thesis; at no time is it intended for commercial sale. In addition, appropriate designation should be made in its contents giving credit to Educational Developmental Laboratories, Inc., a Division of McGraw-Hill Book Company.

Your proposed study, Relationship of Eye Movements to Variations in Readability Levels, is certainly pertinent to our area of interest. I wonder if it is possible for you to furnish us with a copy upon its completion.

We trust this will aid in enabling you to realize your academic goal.

Donald R. Senter, Ed. D.
Director of Product Development

Copy:
M. Biello

DD

APPENDIX D

PERMISSION FOR THE STUDY

The Brandon School Division No. 40

603 Eleventh Street Brandon, Manitoba R7A 4K5

March 28th, 1972.

Mr. D. D. Ferries,
Reading & Study Skills Specialist,
Brandon University,
Brandon, Manitoba.

Dear Mr. Ferries:

Your letter of March 20th was presented to the School Board at its meeting held March 27th and the following motion was passed:

> "That the request of Mr. D. D. Ferries of the Brandon University staff for permission to conduct a study in Brandon schools during the latter part of April, 1972 for the purpose of investigating the eye movements of Grade five students as a basis for his thesis for the degree of Master of Education be granted."

Yours truly,

A. E. Hepinstall,
Associate Secretary-Treasurer.

AEH:eaw

APPENDIX E

RECORD FORMS

1. Botel Reading Inventory A:
   a. Word Recognition Scoring Sheet
   b. Word Opposites Test (Reading)

2. Eye-Movement Photography Record Sheet

3. Comprehension Answer Sheet

Word Recognition Scoring Sheet

Directions: Use the following codes in response column:

correct word	√	
mispronunciation	M	(and word said)
substitution	S	(and word said)
refusal (after 5 seconds)	R	

To get percentage of accuracy, multiply number of errors by 5 and deduct total from 100.

Pupil_____

Date_____

Instructional Levels_____

Teacher_____

A *(Pre-Primer)*

	Word	*Response*
1.	a	
2.	ball	
3.	blue	
4.	come	
5.	father	
6.	get	
7.	have	
8.	house	
9.	in	
10.	it	
11.	little	
12.	make	
13.	mother	
14.	not	
15.	play	
16.	ride	
17.	see	
18.	to	
19.	want	
20.	will	

Score _____%

B *(Primer)*

Word	*Response*
all	
at	
boat	
but	
do	
duck	
find	
girl	
he	
kitten	
like	
now	
out	
put	
saw	
stop	
thank	
there	
three	
train	

Score _____%

C *(First)*

Word	*Response*
about	
as	
be	
by	
could	
fast	
friend	
guess	
hen	
how	
long	
mitten	
never	
old	
party	
sat	
some	
tell	
tree	
walk	

Score _____%

89◆7574737271

0862

D *(Second–1)*

	Word	*Response*
1.	across	
2.	balloon	
3.	best	
4.	burn	
5.	care	
6.	coat	
7.	dress	
8.	fire	
9.	gone	
10.	knew	
11.	miss	
12.	off	
13.	pig	
14.	right	
15.	shall	
16.	six	
17.	table	
18.	together	
19.	turn	
20.	wood	

Score _____%

E *(Second–2)*

Word	*Response*
above	
bakery	
broke	
clown	
done	
face	
flew	
grass	
heavy	
joke	
leave	
most	
pass	
pumpkin	
rode	
sell	
sorry	
strong	
third	
wet	

Score _____%

F *(Third–1)*

Word	*Response*
able	
block	
child	
daddy	
edge	
fix	
half	
Indian	
lot	
mind	
north	
pile	
pour	
rich	
secret	
silver	
squirrel	
teeth	
trap	
watch	

Score _____%

G *(Third–2)*

	Word	*Response*
1.	act	_____
2.	beach	_____
3.	bounce	_____
4.	chance	_____
5.	cottage	_____
6.	distance	_____
7.	except	_____
8.	fog	_____
9.	hoof	_____
10.	journey	_____
11.	lever	_____
12.	nod	_____
13.	peak	_____
14.	quite	_____
15.	scared	_____
16.	shoot	_____
17.	spill	_____
18.	stupid	_____
19.	ticket	_____
20.	wire	_____

Score _____%

H *(Fourth)*

Word	*Response*
abandon	_____
armor	_____
borrow	_____
chimney	_____
costly	_____
digest	_____
encounter	_____
flourish	_____
guilty	_____
imperial	_____
junior	_____
majesty	_____
naval	_____
papa	_____
preparation	_____
release	_____
security	_____
speaker	_____
telegram	_____
underneath	_____

Score _____%

Word Opposites Test (Reading)

Directions: Pick a word in each line which means the opposite or nearly the opposite of the numbered word. Draw a line under it.
Example:
1. no oh yes not

Name_____

Date_____

Teacher_____

A

		a	b	c
1.	white	yellow	black	back
2.	work	funny	happy	play
3.	day	play	red	night
4.	take	away	give	find
5.	now	the	them	then
6.	under	away	over	out
7.	old	mother	on	new
8.	stay	here	open	go
9.	run	walk	fast	look
10.	man	little	woman	work

Score _____%

B

		a	b	c	d
1.	front	under	back	up	little
2.	always	never	every	nothing	more
3.	last	run	fast	first	will
4.	before	near	prize	high	after
5.	near	far	in	laugh	next
6.	little	every	big	hungry	better
7.	laugh	train	little	cry	funny
8.	city	garden	farm	fish	friend
9.	off	out	high	behind	on
10.	found	lost	good	top	all

Score _____%

123456789◆757473727170

0863

C

		a	b	c	d
1.	left	above	right	change	straight
2.	dark	black	surprise	red	light
3.	happy	loud	sing	laugh	sad
4.	hard	soft	silly	large	pony
5.	warm	change	cold	supper	kitchen
6.	finished	thank	began	story	right
7.	young	ago	sister	old	teacher
8.	glad	money	seven	sorry	laugh
9.	push	pull	honk	picnic	straight
10.	forget	believe	remember	magic	sure

Score _____%

D

		a	b	c	d
1.	easy	plenty	hard	welcome	trouble
2.	right	light	rain	wrong	yes
3.	against	again	farm	for	dark
4.	rich	tree	poor	yard	good
5.	empty	plenty	almost	full	perhaps
6.	lead	enjoy	follow	important	sign
7.	whole	cabbage	pass	part	begin
8.	whisper	lucky	shout	enter	quiet
9.	mean	pleasant	excite	clever	slide
10.	dirty	face	clean	smooth	black

Score _____%

E

		a	b	c	d
1.	silent	wiggle	bounce	loud	scare
2.	swiftly	slowly	silently	lonely	scared
3.	discover	arrive	look	lose	lesson
4.	tame	foolish	ashamed	lean	wild
5.	foolish	wise	sick	sorry	sweet
6.	thin	think	thick	tall	short
7.	smart	mad	sting	stupid	empty
8.	wide	small	narrow	pleasant	full
9.	husband	father	uncle	son	wife
10.	enemy	friend	escape	question	bottom

Score _____%

F

		a	b	c	d
1.	absent	able	present	accident	clever
2.	wake	morning	night	throat	sleep
3.	careful	angel	devil	appetite	careless
4.	gather	scatter	since	spoil	wide
5.	expensive	chance	cheap	rich	tomorrow
6.	fail	capture	succeed	special	laundry
7.	uncertain	simple	never	sure	freedom
8.	reward	ribbon	medal	punish	answer
9.	beneath	above	around	about	joy
10.	answer	quickly	question	state	letter

Score _____%

G

		a	b	c	d
1.	ugly	witch	beautiful	unpleasant	heavy
2.	noisy	children	tight	quiet	quaint
3.	moisture	dazzle	lower	dryness	sunshine
4.	merry	party	unhappy	unknown	teacher
5.	tough	weary	mountain	weak	loyal
6.	outer	injure	inner	yard	overflow
7.	imprison	worry	wander	free	journey
8.	length	wisely	wisdom	width	southward
9.	idle	busy	bulletin	deny	agree
10.	accept	often	refuse	normal	loose

Score _____%

H

		a	b	c	d
1.	strengthen	stronger	weaken	support	luncheon
2.	advance	retreat	release	correct	apply
3.	include	angle	shelter	omit	scatter
4.	positive	needless	accept	worthwhile	negative
5.	abundant	scarce	rarely	insist	scandal
6.	villain	actor	hero	crisis	ugly
7.	frequently	sensitive	normal	seldom	usual
8.	completely	parlor	partly	careful	simple
9.	fertile	garden	crude	bargain	barren
10.	surrender	continue	concerned	complaint	battle

Score _____%

I

		a	b	c	d
1.	accidental	agreeable	intentional	timely	trial
2.	usually	readiness	normal	average	rarely
3.	tardy	strict	frequently	seldom	early
4.	idiot	genius	average	vulgar	stupid
5.	reluctant	implement	enthusiastic	negative	indifferent
6.	antique	modesty	modern	president	co-operate
7.	accurate	question	instructor	incorrect	apply
8.	ebb	aspire	flattery	flood	confess
9.	inferior	superior	gentle	surplus	exterior
10.	abhor	adjust	admire	absent	deny

Score _____%

J

		a	b	c	d
1.	colorless	jovial	glamorous	ignorant	drastic
2.	chastise	antique	sympathize	applaud	naughty
3.	restrained	small	refined	expansive	acclaimed
4.	illegal	lawyer	lawful	illusion	admonish
5.	irrelevant	irresistible	fragile	pertinent	festive
6.	prolific	punctual	barren	citadel	prohibit
7.	authentic	interfere	glimmer	imitation	conceal
8.	obsolete	absolute	curiosity	current	obvious
9.	refute	sustain	intentional	refuse	absent
10.	literal	petite	figurative	lenient	ignorant

Score _____%

EYE-MOVEMENT PHOTOGRAPHY RECORD SHEET

Name _____ Age _____ Grade _____ Graph No. _____

Address _____ School or Org. _____

TESTING DATES

1	2	3

A-1 READING PERFORMANCE PROFILE PART I[1] PART II[2]

Component	Grade[3] 1	2	3	4	5	6	7	8	9	10	11	12	Col.	Adv. 1	Adv. 2	Adv. 3	Adv. 4	Adv. 5
Fixations/100 w.	224	174	155	139	129	120	114	109	105	101	96	94	90	77	65	57	48	44
Regressions/100 w.	52	40	35	31	28	25	23	21	20	19	18	17	15	11	8	5	4	2
Av. Span of Recog.	.45	.57	.65	.72	.78	.83	.88	.92	.95	.99	1.04	1.06	1.11	1.30	1.53	1.75	2.08	2.27
Av. Dur. of Fix.	.33	.30	.28	.27	.27	.27	.27	.27	.27	.26	.26	.25	.24	.23	.23	.22	.22	.22
Rate With Comp.	80	115	138	158	173	185	195	204	214	224	237	250	280	340	400	480	560	620

DATA

Comprehension (70-80% — adequate, 90-100% — good, 60% and below — retest)

Card (indicate both Level and Card No.)

GRADE EQUIVALENT

A-2 RELATIVE EFFICIENCY

Relative Efficiency = $\frac{\text{Rate}}{\text{Fix. (\quad) + Reg. (\quad)}}$ = _____ Grade

B DIRECTIONAL ATTACK

Indicate Pattern: Good, Average, Poor

$\frac{\text{Regressions (\quad)}}{\text{Fixations (\quad)}}$ = _____ %

INDICATE PERCENTAGE

%	%	%

Very Efficient — 10% or less	Grade 1-6	22%
Average Range — 15-24%	Grade 7-9	21%
Very Inefficient — 25% or more	Grade 10 up	18%

C VISUAL ADJUSTMENT

			No evidence of difficulty
			Unusually prolonged durations
			Refixation on return sweep
			Binocular coordination difficulty
			Lateral control difficulty
			Vertical control difficulty
			Other

D GENERAL ADJUSTMENT TO READING

			Tremors
			Blinking
			Head movement
			Vocalization
			Interruption or distraction
			Extreme difference in durations
			Extreme difference in interfixational excursions
			Rereading

R. E. Scale

R. E.	Grade Level
.29	1.0
.41	1.5
.54	2.0
.63	2.5
.73	3.0
.83	3.5
.93	4.0
1.01	4.5
1.10	5.0
1.18	5.5
1.28	6.0
1.34	6.5
1.42	7.0
1.50	7.5
1.57	8.0
1.64	8.5
1.71	9.0
1.79	9.5
1.87	10.0
1.97	10.5
2.07	11.0
2.16	11.5
2.25	12.0
2.40	12.5
2.66	13.0
2.77	13.5
2.95	14.0
3.86	Adv. 1
5.48	Adv. 2
7.74	Adv. 3
10.77	Adv. 4
13.48	Adv. 5

1. Part I of this table of averages is taken from "Grade Level Norms for the Components of the Fundamental Reading Skill," by Stanford E. Taylor, Helen Frackenpohl, and James L. Pettee, EDL Research and Information Bulletin No. 3, Educational Developmental Laboratories, 1960.
2. Part II of this table represents typical reading performance characteristics for trained readers, based on the accumulated data of various reading clinics employing instrument training techniques and using eye-movement photography as the diagnostic procedure by which to evaluate growth in performance efficiency.
3. First grade averages are those of pupils capable of reading silently material of 1.8 difficulty with at least 70% comprehension. Above grade 1, averages are those of students at mid-year reading silently material of mid-year difficulty with at least 70% comprehension.

(USE REVERSE SIDE FOR COMMENTS)

kepron's 8/16 mm limited - 1151 SANFORD ST., WINNIPEG 21, MAN.

Student No. _____

COMPREHENSION

Passage 1 Selection No. ____

1. Yes No
2. Yes No
3. Yes No
4. Yes No
5. Yes No
6. Yes No
7. Yes No
8. Yes No
9. Yes No
10. Yes No

Score %_____

Passage 3 Selection No. ____

1. Yes No
2. Yes No
3. Yes No
4. Yes No
5. Yes No
6. Yes No
7. Yes No
8. Yes No
9. Yes No
10. Yes No

Score % _____

Passage 2 Selection No. ____

1. Yes No
2. Yes No
3. Yes No
4. Yes No
5. Yes No
6. Yes No
7. Yes No
8. Yes No
9. Yes No
10. Yes No

Score %_____