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THE EFFECT OF METHOD OF MATERIAL PRESENTATION UPON
EYE MOVEMENTS AND COMPREHENSION

BY

DEAN WALLACE HOOVER, A.B., M.A.

A Dissertation submitted to the Graduate School
in partial fulfillment of the requirements
for the Degree
Doctor of Philosophy

Major Subject: Reading/Education

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THE EFFECT OF METHOD OF MATERIAL PRESENTATION UPON
EYE MOVEMENTS AND COMPREHENSION

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TABLE OF CONTENTS

	Page
ACKNOWLEDGMENTSiii
LIST OF TABLES	vi
CHAPTER	
I. INTRODUCTION	1
Problems of the Study	3
Purposes of the Study	3
Definition of Terms	4
Statements of Null Hypotheses	5
Limitations of the Study	6
Significance of the Study	7
II. REVIEW OF THE LITERATURE	9
Eye-Movement Research	9
Single and Multiple Channel Transmission of Information	15
Listening and Reading Research	18
Theoretical Model for Simultaneous Trans- mission of Information	24
III. DESIGN OF THE STUDY	29
Pupil Population	29
Criteria for Selection of Subjects	30
Tests and Procedures Used to Select Subjects	30
Tests and Procedures Used to Collect Data	31
Preparation of Testing Material	33
IV. PRESENTATION OF DATA	37
Measurements Obtained for Hypotheses	37
Hypothesis 1	37
Hypothesis 2	40
Hypothesis 3	43
Comparison of Treatments	45
Hypothesis 4	46
Hypothesis 5	55
Hypothesis 6	57

	Page
V. SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS . . .	62
Summary	62
Conclusions	63
Reading Treatment	63
Reading-Listening Treatment	64
Listening Treatment	66
Comparisons of Treatments	68
Reading Compared with Reading-Listening . .	68
Reading Compared with Listening	72
Listening Compared with Reading-Listening .	73
General Conclusions	74
Recommendations	76
BIBLIOGRAPHY	78
APPENDIX	86

LIST OF TABLES

Table	Page
1. Independent Variables	35
2. Analyses of Variance for Reading	38
3. Cell Means for Reading	39
4. Analyses of Variance: Reading-Listening . . .	40
5. Cell Means: Reading-Listening	42
6. Analysis of Variance: Listening Comprehension	43
7. Cell Means: Listening Comprehension	44
8. Analyses of Variance: Reading Fixations Compared with Reading-Listening Fixations . . .	47
9. Cell Means: Reading Fixations Compared with Reading-Listening Fixations	47
10. Analyses of Variance: Reading Regressions Compared with Reading-Listening Regressions .	49
11. Cell Means: Reading Regressions Compared with Reading-Listening Regressions	49
12. Analyses of Variance: Reading Span Compared with Reading-Listening Span	50
13. Cell Means: Reading Span Compared with Reading-Listening Span	51
14. Analyses of Variance: Reading Duration Compared with Reading-Listening Duration . . .	52
15. Cell Means: Reading Duration Compared with Reading-Listening Duration	53
16. Analyses of Variance: Reading Comprehension Compared with Reading-Listening Comprehension	54
17. Cell Means: Reading Comprehension Compared with Reading-Listening Comprehension	55

Table	Page
18. Analyses of Variance: Reading Comprehension Compared with Listening Comprehension	56
19. Cell Means: Reading Comprehension Compared with Listening Comprehension	56
20. Analyses of Variance: Listening Comprehension (125 w.p.m.) Compared with Reading-Listening Comprehension	57
21. Cell Means: Listening Comprehension (125 w.p.m.) Compared with Reading-Listening Comprehension .	58
22. Analyses of Variance: Listening Comprehension (175 w.p.m.) Compared with Reading-Listening Comprehension	59
23. Cell Means: Listening Comprehension (175 w.p.m.) Compared with Reading-Listening Comprehension .	59
24. Analyses of Variance: Listening Comprehension (225 w.p.m.) Compared with Reading-Listening Comprehension	61
25. Cell Means: Listening Comprehension (225 w.p.m.) Compared with Reading-Listening Comprehension .	61

THE EFFECT OF METHOD OF MATERIAL PRESENTATION UPON
EYE MOVEMENTS AND COMPREHENSION

CHAPTER I

INTRODUCTION

Much of the school day, especially for the elementary student, is devoted to some kind of reading instruction or activity. School administrators and teachers have placed much emphasis upon developing adequate reading programs at both the elementary and secondary levels, yet many children do not read well.

Various estimates have been given by authorities regarding the extent of poor reading. Harris¹ estimated that between 10 and 15 percent of the school population had problems with reading. Smith and Carrigan² said that if a discrepancy of one year or more between mental age and reading level was used as a standard of judging reading deficiency, over 15 percent of the school population exhibited a reading deficiency.

¹A. Harris, How to Increase Reading Ability, 4th ed. (New York: Longmans, Green, 1961), p. 18.

²D. Smith and Patricia Carrigan, The Nature of Reading Disability (New York: Harcourt Brace, 1959), pp. 1-2.

Deboer and Dallman commented about the extent of reading disability:

Estimates of significant retardation in reading in the elementary school vary greatly. Conservative approximations set the proportion at 10 to 20 percent of the pupils. ³Others place the estimate at 30 percent or more.

In the effort to overcome some of the problems involved in the teaching of reading, many methods have been utilized. One practice advocated is that of combining the visual and auditory modalities. An example of simultaneous use of the auditory and visual modalities is the practice of oral reading which often has been used as an integral part in the teaching of reading and literature. Many times this meant group work during which one person read as the remainder "read along." Emphasis was usually upon the visual aspect of reading "staying with" the auditory presentation. Also, with the development of learning packages using audiovisual materials and the concept of individualized instruction, the practice of combining reading and listening activities has grown in popularity as a means of meeting individual needs. As a result, much material using records or tapes with books, filmstrips, or slides has been developed. No study has investigated the effect upon eye movements of combining reading and listening activities. The following are some problems that arise from such a practice.

³J. Deboer and Martha Dallman, The Teaching of Reading (New York: Henry Holt, 1960), p. 267.

Problems of the Study

1. Will the difficulty level of reading matter significantly affect the measurements for comprehension or eye movements as subjects read?
2. Will (a) the rate of presentation of material or (b) the difficulty level of the reading material significantly affect the measurements for comprehension or eye movements as subjects read-listen?
3. Will (a) the rate of presentation of reading material or (b) the difficulty level of reading material significantly affect comprehension measurements as subjects listen?
4. Will significant differences exist between the measurements secured for reading and the measurements secured for reading-listening?
5. Will significant differences exist between the measurements secured for reading and the measurements secured for listening?
6. Will significant differences exist between the measurements secured for listening and the measurements secured for reading-listening?

Purposes of the Study

The purposes of this study were:

1. To investigate the effect upon eye-movement measurements and comprehension measurements of varying the difficulty level of reading material as subjects read.
2. To investigate the effect upon eye-movement measurements and comprehension measurement of varying (a) the difficulty level of the reading material, and (b) the presentation rate of the reading material as subjects read-listened.
3. To investigate the effect upon comprehension measurements of varying (a) the difficulty level of the material, and (b) the presentation rate of the reading material as subjects listened.

It was also the purpose of the study to compare measurements between the various treatments of the study; thus comparisons were made between reading and reading-listening, between reading and listening, and between listening and reading-listening.

Definition of Terms

1. Fixations.--A fixation is a period of time that the eye is still while information is derived through the visual process.
2. Regression.--The regression is a form of fixation. In our culture, reading proceeds from left to right. A regression is a fixation immediately following a right-to-left eye movement.
3. Span of fixation.--The span of fixation refers to the part of a word or words that the reader is able to see at one fixation. The average span of fixation is a derived score determined by dividing the number of fixations into the number of words read.
4. Duration of fixation.--The duration of fixation is the length of time that is taken to perceive the printed material, comprehend its significance and make necessary associations. The average duration of fixation is a derived score determined by dividing the number of fixations per 100 words into the reading time.
5. Rate of reading.--Rate of reading refers to the number of words per minute that an individual reads.
6. Reading treatment.--Reading is the treatment that refers to presentation of reading material through the visual modality only.
7. Reading-listening treatment.--Reading-listening is the treatment that refers to presentation of the same material through the use of the auditory and visual modalities.

8. Listening treatment.--Listening is the treatment that refers to the presentation of material through the auditory modality only.
9. Difficulty level of material.--Difficulty level of material refers to grade level as measured by readability formulas.
10. Presentation rate of material.--Presentation rate refers to the number of words per minute material is presented.
11. Reading achievement.--Reading achievement refers to scores achieved on the reading section of the Durrell Listening-Reading Series, Advanced Form, DE.
12. Listening achievement.--Listening achievement refers to scores achieved on the listening section of the Durrell Listening-Reading Series, Advanced Form, DE.
13. Remedial reader.--A remedial reader refers to a pupil whose listening grade score was one-half year or more higher than his reading score.

The Statements of Hypotheses

The specific hypotheses of this study involved three methods of acquiring information. Each method became a treatment of the study. The first three hypotheses were concerned with acquiring information by reading, reading-listening, and listening. The last three hypotheses were concerned with comparing information secured for hypotheses one, two and three.

1. There are no significant differences in measurements for comprehension or eye movements as subjects read at four levels of difficulty.
2. There are no significant differences in measurements for comprehension or eye movements as subjects read-listen (a) at three presentation rates (b) across four levels of difficulty.

3. There are no significant differences in measurements for comprehension as subjects listen at (a) three rates of presentation rates (b) across four levels of difficulty.
4. There are no significant differences in measurements for eye movement or comprehension when reading was compared with reading-listening.
5. There are no significant differences in comprehension measurements when reading was compared with listening.
6. There are no significant differences in comprehension measurements when listening was compared with reading-listening.

The level of .05 was selected as the statistical level of significance. This means that an obtained result at the .05 level could occur by chance only 5 times out of 100 trials.

Limitations of the Study

Several limitations of this study should be noted:

1. The study was limited to seventh-grade students who were regarded as remedial readers.
2. The Crooked Oak Independent School District, from which the subjects were drawn, is in a low socioeconomic area of Oklahoma City, Oklahoma. The school was racially integrated. About 75 percent of the student body was white, about 22 percent was black, and the remainder came from other racial groups.
3. The study involved thirty-two subjects. Four tests were used with each subject as he read at four different levels. Twelve tests were used on each subject as he read-listened at three rates of presentation at four levels of difficulty. Twelve tests were used on each subject as he listened at three rates of presentation at four levels of difficulty. Altogether twenty-eight tests were used with each subject.

4. Data were secured for comprehension and eye movements. By comparing the data, evaluations for the various treatments were made. Final evaluations and generalizations derived from the study are assumed to be valid only for the school population studied or school districts with a comparable student population.
5. The study was limited to the months of January through May of the 1971-72 school year.

Significance of the Study

Much of the information acquired by the learner in the classroom comes through either the auditory or visual modality. In most classroom the combining of these two sensory modalities is a common practice as many activities in the typical classroom involve both "looking" and "listening." This is true of most instruction given to assist the learner in the development of reading skills and is especially prevalent in the teaching of remedial reading. Due to the difficulty that remedial reading pupils have with the printed word along with their tendency to acquire information more readily through listening, much instruction for remedial readers combines the auditory and visual modalities and much instructional material has been developed for remedial readers which combines the use of sensory modalities.

One aspect of this investigation is to study the similarities and differences in eye movements as subjects read and as they read-listen. This will provide data on the effect of listening on reading performance. A second aspect

of the study is to investigate comprehension measurements for three methods of presenting information--reading, reading-listening, and listening. This will provide information on the relative efficiency of the three treatments as a means of presenting information.

CHAPTER II

REVIEW OF THE LITERATURE

An objective of this investigation was to evaluate what occurred during the reading process, measured by eye-movement performance, as subjects engaged in two methods of acquiring information. These two methods were reading and reading-listening. The study also attempted to evaluate the amount of information acquired through three methods of presenting information. The three methods were reading, reading-listening, and listening.

The review of the literature includes studies which involved eye movements, research which compared the visual and auditory modes of learning, and research concerned with listening and reading simultaneously. A discussion of a theoretical model for simultaneous reading and listening is also included.

Eye-Movement Research

The study of eye movements has contributed much to the understanding of reading behavior. Much of the research was done over a period ranging from 1930 through 1950. During that time, eye-movement research provided information which has furthered the understanding of various aspects of the reading process, such as the number of fixations and

regressions made per 100 words, the average span of fixation, the average duration of fixation, and reading rate.

Anderson and Morse¹ reported that eye movements when photographed by an eye-movement camera yielded adequate reliability scores if the length of the reading selection was sufficient. Tinker² reported that 20 to 40 lines of reading material resulted in reliabilities of about 0.80. For diagnostic evaluation, at least 20 lines of print are needed in order to adequately assess an individual's reading patterns. For group comparisons shorter passages are sufficient.

Validity for eye-movement measures has been assessed by comparing achievement scores while reading before the camera with those of paper-and-pencil tests away from the camera. Tinker³ reported that when the material used for both eye-movement photography and performance was comparable, validity was high.

Gilbert and Gilbert⁴ and Tinker⁵ reported that performances using eye-movement photography equipment were

¹Irving H. Anderson and William C. Morse, "The Place of Instrumentation in the Reading Program: I. Evaluation of the Ophthalm-O-Graph," Journal of Experimental Education, XIV (March, 1964), 256-262.

²Miles A. Tinker, "Reliability and Validity of Eye-Movement Measures of Reading," Journal of Experimental Psychology, XIX (December, 1936), 732-746.

³Ibid., p. 742.

⁴Luther C. Gilbert and Doris W. Gilbert, "Reading before the Eye-Movement Camera Versus Reading Away from It," Elementary School Journal, XLII (February, 1942), 443-447.

⁵Tinker, op. cit., p. 746.

essentially the same as reading away from the equipment. Data secured from eye photography are regarded as assessing valid reading performance.

Buswell⁶ made one of the first studies involving eye movements at various grade levels. He used 186 subjects, first grade through college, with eight to nineteen subjects in each grade. All subjects read the same passage except the first grade group, who read an easier passage. The first four grades showed the most pronounced development in the reduction of the number of fixations per line, number of regressions per line, and the length of duration of fixation.

Ballantine⁷ chose subjects from grades 2, 4, 6, 8, 10, and 12, consisting of 20 students per grade, equally divided between sexes. Each subject was photographed using a second-grade level selection and a selection at grade level. The differences in eye movements between the two levels of difficulty were not great. Ballantine reported growth of reading efficiency as high as the tenth grade.

⁶Guy T. Buswell, Fundamental Reading Habits: A Study of Their Development, Supplementary Educational Monographs, Number 21 (Chicago: University of Chicago Press, 1922) p. 25.

⁷Francis A. Ballantine, "Age Changes in Measures of Education," Studies in the Psychology of Reading, University of Michigan Monographs in Education, No. 4 (Ann Arbor: University of Michigan Press, 1951) 67-11.

Taylor, Frackenpohl, and Pettee⁸ conducted a study to establish normative data of eye movements at various grade levels. They studied more than a thousand subjects in each grade. Subjects were chosen from different sections of the country and from different socioeconomic groups in an attempt to get a representative sampling. Their findings revealed that the average number of fixations, including regressions per 100 words, decreased from 224 at first grade to 90 at college level; the average number of regressions per 100 words decreased from 52 at grade 1 to 15 at college; and average rate increased from 80 words per minute at grade 1 to 280 at college. See Appendix, Table 27 for a summary of their findings.

Several studies have investigated the effect upon eye movements of varying the difficulty of the selections being read. Seibert⁹ investigated eye movements as eighth-grade pupils read different types of subject matter: mathematics, biography, adventure, physical science, history, and geography. Eye-movement measures showed less difference than did comprehension scores, however, Seibert reported significant differences in eye movements between subject areas.

⁸Stanford E. Taylor, Helen Frackenpohl, and James L. Pettee, "Grade Level Norms for the Components of the Fundamental Reading Skill," EDL Research and Information Bulletin No. 3, Huntington, New York Educational Developmental Laboratories, 1960. pp 4-12.

⁹E. W. Seibert, "Reading Reactions for Varied Types of Subject Matter: An Analytical Study of Eye Movements of Eighth Grade Pupils," Journal of Experimental Education, XII (September, 1943), 37-44.

Morse¹⁰ studied the effects of having average fifth- and seventh-grade students read material at grade level as well as two years below and two years above grade level. Some of the findings were: seventh-grade students performed better than fifth graders when both groups read the same passages; seventh graders performed better when they read fifth-grade material than when fifth-grade students read third-grade material; seventh-grade students also performed better when they read seventh- or ninth-grade material than fifth-grade students as they read either the fifth- or third-grade material. He reported that an increase in difficulty of reading matter did not significantly affect eye movements, and that there was little statistical differences as fifth-grade students read third-, fifth-, or seventh-grade material.

Litterer¹¹ found that unless the difficulty of the material was far beyond the student's level of performance there was little difference in eye-movement patterns.

¹⁰William C. Morse, "A Comparison of the Eye-Movements of Average Fifth- and Seventh-Grade Pupils Reading Material of Corresponding Difficulty," Studies in the Psychology of Reading, Monographs on Education, No. 4 (Ann Arbor: University of Michigan Press, 1951), 62-63.

¹¹Oscar F. Litterer, "An Experimental Analysis of Reading Performance," Journal of Experimental Education, I (January, 1932), 28-37.

Taylor, Frackenpohl, and Pettee¹² studied the hypothesis that the components measured by eye-movement photography would prove to be largely independent of the degree of difficulty of the content. Eighth-grade subjects read at grade levels four, five, six, junior high, and high school-college. The findings indicated significant differences on most of the eye-movement measures when the reading material was two and one-half years above grade level. When the material was at some point less than two and one-half years above the student's ability level there were no significant differences in eye movements.

The research involving difficulty of material and eye movement is not without ambiguity. Two factors seem to make a contribution to eye movements--difficulty of material and the reading maturity of the individual. There is some evidence that poor readers read material that is difficult for them with what appears to be more efficient eye movements. What in reality they may be doing is merely looking at the words without deriving an adequate understanding of the subject matter.

¹²Stanford Taylor, Helen Frankenpohl, and James L. Pettee, "A Report on Two Studies of the Validity of Eye-Movement Photography as a Measurement of Reading Performance," EDL Research and Information Bulletin No. 2 (Huntington, N. Y.: Educational Developmental Laboratories, 1960), pp 7-12.

Single and Multiple Channel Trans-
mission of Information

Much research has been done comparing visual and auditory means of transmitting information. An early review of the research involving material presented aurally and visually was made by Day and Beach¹³ who reviewed thirty-four studies. The questions guiding their review were: Is material more easily understood when presented visually or aurally, and Under what conditions is a particular method of presentation more effective for comprehension? They found about half of the studies favored the aural method of presentation and about half the visual; furthermore, they reported that the conditions of each study varied to the extent that strict comparisons were not possible. Some of the generalizations of the Day and Beach review were: a combination of visual and auditory presentation of information was better than either modality alone; meaningful, familiar material was more efficiently learned when presented aurally, while meaningless, unfamiliar material was more efficiently comprehended with visually presented material; subjects with higher intelligence comprehended more efficiently with a visual presentation than subjects with lower intelligence; better readers learn relatively

¹³W. F. Day and B. R. Beach, A Survey of the Research Literature Comparing the Visual and Auditory Presentation of Information, Air Force Technical Report 5921 (PB 102410) (Charlottesville: University of Virginia, 1950).

more efficiently visually; difficult material is comprehended more efficiently visually, easy material is comprehended more efficiently with an auditory presentation.

The 1950 review of the literature published by Day and Beach has been referred to by most researchers who have compared listening and reading. This is especially true of the generalization that combined listening and reading results in more comprehension than either listening or reading alone.

A review of the research by Hartman¹⁴ divided the research into areas, such as, comparing the effectiveness of audio and print for nonsense syllables, digits, meaningful words, and meaningful prose; and various combinations of print, audio, and pictorial presentation of materials. Hartman reported that it was possible to generalize that adults comprehended better through print, while younger children learned more effectively through auditory presentation because of their limited reading skills. When redundant information is presented simultaneously using audio and print, Hartman¹⁵ reported that it was more effective than audio or print alone.

14 Frank R. Hartman, "Single and Multiple Channel Communication: A Review of Research and a Proposed Model," Audiovisual Communications Review, IX (November-December, 1961), 235-262.

15 Ibid., 243-244.

Hartman¹⁶ discussed the theory of stimulus generalization and questioned the practice followed in many studies of using a sensory modality for testing that was unlike the one used in the presentation of the information. He advocated using the same modality or combination of modalities for testing as was used in the presentation of information.

Travers¹⁷ criticized much of the research that has been done to investigate simultaneous transmission of auditory and visual information. He asserted that research has often been done using nonsense syllables, digits or words as the treatments and that generalizations were then made regarding meaningful prose. Travers maintained that in many studies tests of significance were not applied to data adequately and that information was not collected under carefully controlled conditions, such as the amount of exposure time the subject had for learning the material.

A careful first-hand examination of the studies leads one to the conclusion that they do not provide any information relevant to the problem which they were designed to solve.¹⁸

Travers advocated more carefully controlled research. Using a model proposed by Broadbent, he developed a theoretical basis for conducting research when information is

¹⁶Ibid., p. 254.

¹⁷R. M. W. Travers, Research and Theory Related to Audiovisual Information Transmission (Washington, D. C.: U. S. Department of Health, Education, and Welfare, 1967), pp 88-105.

¹⁸Ibid., p. 105.

presented simultaneously using two sensory modalities. This theory will be discussed more thoroughly in this chapter under the heading "Theoretical Model for Simultaneous Transmission of Information."

Listening and Reading Research

Reading and listening are both receptive communication skills as contrasted to speaking and writing which are expressive skills. The efficiency of reading and listening has been compared in several studies. Russell¹⁹ used 1,080 pupils in fifth, seventh, and ninth grades as subjects and reported that listening was a superior mode of gaining information through grade five. By grade nine the visual mode was superior to the auditory mode as a means of gaining information.

Young²⁰ reported that grade five might be regarded as the point at which reading ability equals listening ability. Young compared oral teacher presentation (the teacher reading the material while the pupils listened) against the pupils reading silently. A part of the study consisted of the teacher reading the material as the pupils read silently. Fourth-grade students scored better on oral teacher presentation of reading material than from reading silently for

¹⁹R. C. Russell, "A Comparison of Two Methods of Learning," Journal of Educational Research, XVIII (October, 1928) 235-239.

²⁰William E. Young, "The Relation of Reading Comprehension and Retention to Hearing Comprehension and Retention," Journal of Experimental Education, V (September, 1936), 30-39.

themselves. By sixth grade there was little difference between the two methods. Teacher oral presentation of material while the pupils read silently was roughly equally as effective as the teacher oral presentation alone. Young²¹ cited evidence that children through the intermediate grades improve in reading ability at a pace equal to or exceeding the ability to learn through hearing. He found that children who read poorly usually also comprehended less through hearing than do better readers.

Hampleman²² compared listening and reading comprehension ability of fourth- and sixth-grade children. He found that listening comprehension was superior to reading comprehension for both fourth- and sixth-grade students, listening comprehension for easy material was superior to that of more difficult material, and that as mental age increased the difference between listening and reading comprehension lessened.

In a study with adults, Goldstein²³ compared the relative efficiency of reading and listening comprehension at various rates of presentation. Two hundred and eight subjects

²¹Ibid.

²²R. S. Hampleman, "Comparison of Listening and Reading Comprehension Ability of Fourth and Sixth Grade Pupils," Elementary English, XXXV (January, 1958), 49-53.

²³Harry Goldstein, "Reading and Listening Comprehension at Various Controlled Rates," Teachers College Contributions to Education No. 821 (New York: Bureau of Publications, Teachers College, Columbia University, 1940).

from age 18 through 65 read and listened at speeds of 100, 137, 174, 211, 248, 285, and 322 words per minute. Material for listening was recorded and then adjusted to the desired speed by a variable controlled phonograph. Reading passages were presented visually by a film projector and aurally by a phonograph. Findings indicated that listening comprehension was superior to reading comprehension at all rates except the fastest rates where the difference was slightly in favor of reading. Goldstein commented:

It is very interesting that listening comprehension should hold its own with reading comprehension at a rate of presentation of about 325 words per minute, in view of the fact that none of the subjects had ever heard speech delivered at that rate before, whereas many may have read at even faster rates.²⁴

Swalm²⁵ studied the effect upon comprehension scores of second-, third-, and fourth-grade students as they read orally, read silently, and listened. The material used was at grade level. Findings indicated that the reading level of the student was important for determining the effectiveness of comprehension with the three methods in each grade. Comprehension was better for reading for above-average students, and for listening for below-average students. Average students performed equally well with all three methods.

When the students' reading abilities were above the difficulty level of the article, they comprehended better with some form of reading than they

²⁴Ibid., p.61

²⁵James E. Swalm, "Comparison of Oral Reading, Silent Reading, and Listening Comprehension Assessed by Cloze," Unpublished doctoral dissertation, Rutgers University, 1972.

did with listening. When the students' reading abilities and the readability level of the article were about the same, the three learning methods resulted in about the same amount of comprehension. When the students' reading abilities were below the difficulty level of the article, listening was better for comprehension purposes than silent reading.²⁶

Reeves²⁷ found that significant differences existed in listening performances for high, middle, and low reading groups of sixth-grade pupils. Good readers were good listeners, average readers were average listeners, and poor readers were poor listeners.

The presentation of information through more than one sensory modality has been frequently advocated as a means of increasing reading ability. Since listening and reading have the common element of being receptive means of handling language, the simultaneous use of listening and reading as a means of improving reading ability has been the object of several studies.

Nye²⁸ in a study involving second-grade students had three treatment groups--one that listened and used markers to follow while reading, one that listened and read without the use of markers, and one that read the story without listening.

²⁶ Ibid.

²⁷ Rachael J. Reeves, "A Study of the Relation Between Listening Performance of Sixth-Grade Pupils as Measured by Certain Standardized Tests," Unpublished doctoral dissertation, University of Alabama, 1968.

²⁸ Marilyn L. Nye, "The Effects of a Listening-Reading Program upon the Reading of Second-Grade Students," Unpublished doctoral dissertation, University of California, Berkeley, 1969.

The group that listened and read without the use of markers made significantly higher gains than the other two groups. The low ability students in the group that listened and read made significantly higher gains than the high ability students. High ability students made gains reading from books; however, low ability students did not.

Smith²⁹ used methods of reading, listening, and reading and listening with sixth-grade students. Six subgroups were designated: (1) high IQ and high reading achievement, (2) average IQ and high reading achievement, (3) average IQ and average reading achievement, (4) average IQ and low reading achievement, (5) low IQ and low reading achievement, and (6) remedial readers. Oral presentation was made at 110 words per minute. Total population results indicated that combined listening and reading was superior to listening but not to reading. There were significant differences between subgroups. The group composed of students with high IQ's and high reading achievement made significantly higher comprehension scores by reading-listening than by listening; however, reading-listening was not superior to reading. The remedial group had higher comprehension through listening-reading than through either of the other two methods.

²⁹Jack E. Smith, "Reading, Listening, and Reading-Listening Comprehension by Sixth-Grade Children," Unpublished doctoral dissertation, Columbia University, 1959.

Three groups of students were used by Hasselriis³⁰ in a study with eighth-grade students in social studies. One group read only, one listened, and one listened and read simultaneously. There were no significant differences when the groups were compared. With students lowest in comprehension, simultaneous reading and listening resulted in higher gains in comprehension.

Heckleman³¹ investigated the neurological impress method of teaching reading, a system that provided for the teacher and student reading at the same time in unison. In such a procedure, the student uses his finger to follow along and read aloud as the teacher, providing a correct model, also reads aloud. The method includes visual, aural, oral, and tactile senses. The teacher sits back of the student and reads aloud with his voice directed into the subject's ear. Twenty-four students made a mean gain of one year and nine months after fifteen daily lessons for six weeks.

Hollingsworth³² conducted a variation of the neurological impress method. He used eight students in an experimental

³⁰Peter Hasselriis, "Effects on Reading Skill and Social Studies Achievement from Three Modes of Presentation: Simultaneous Reading-Listening, Listening, and Reading," Syracuse University, 1968.

³¹R. C. Heckleman, A Neurological Impress Method of Reading Instruction (Merced, California: Merced County Schools Office, 1962).

³²Paul Hollingsworth, "An Experiment with the Impress Method of Teaching Reading," The Reading Teacher, XXIV (November, 1970), 112-114, 187.

group matched on reading and IQ scores with eight students used as a control group. Instead of using a live voice, tapes were made for the lessons. Each child in the experimental group listened to thirty lessons. A teacher monitored the students to assure that they were reading along with the taped voice. No significant differences were found between the experimental and control groups. Hollingsworth theorized that the method should be studied with remedial readers and with more subjects. He suggested that the loss of personal contact might have been a contributing factor in the differences in results in the two investigations.

In an investigation with tenth-grade biology students, Holliday³³ assigned three groups of thirty-six students each to one of three methods of material presentation. One group read, one group was read to, and one group read the material while it was read to them. There were no significant differences among the scores of the groups.

Theoretical Model for Simultaneous
Transmission of Information

Travers³⁴ reviewed research pertaining to imparting information through the aural and visual modalities. He was critical of the kinds of controls used in much of the research,

³³William G. Holliday, "The Effects of Utilizing Simultaneous Audio and Printed Media in Science." (Paper Presented at the National Association for Research in Science Teaching Meeting, March, 1971).

³⁴R. M. W. Travers, op. cit., p.105.

the lack of statistical information in many studies, and the conclusions reached.

Travers suggested a theory for transmission of audio-visual information based upon a model developed by Broadbent.³⁵ The theory implies that the perceptual system is a single channel system and that information from only one sensory source can gain access to the higher centers of the brain at one time. When two sensory sets of data, such as visual and aural, are transmitted simultaneously, it is necessary for the nervous system to make a selection between them. One set is utilized while the other set enters a temporary storage where it remains for a few seconds and is either used or fades and is lost.

In addition to being a single channel system, Broadbent theorized that the perceptual system has a limited capacity which prevents it from handling an excessive amount of information at one time, therefore, it is necessary for a filtering process to select and limit data so that the system can adequately function. The filter system is an important aspect of Broadbent's model. Travers summarized the following rules which apply for allowing information from the multiple channel short-term storage to the single channel perceptual system.

1. If two messages do not arrive absolutely simultaneously, the first to arrive has advantage in obtaining access to the P system.

³⁵D. E. Broadbent, Perception and Communication, (New York: Pergamon Press, 1958).

2. If two messages arrive simultaneously, the one which arrives with the greatest force (loudness, brightness, etc.) has the advantage in obtaining access to the P system. . . .
5. Instructions given prior to the transmission of information may determine which one of two simultaneously transmitted messages will enter the P system.
6. The transmission of a highly redundant (monotonous) message eventually results in either the blocking of the transmission of the message to the P system or the sampling of the message from time to time by the P system.
7. If two or more messages with high information content are received through two different internal channels at the same time, the system may jam and information is not transmitted to the P system in an orderly way.³⁶

Information goes from the senses into a short-term storage where it can be held briefly. Information either fades or is allowed to enter the filter. From the filter system information enters the perceptual system which in turn advances it to more permanent storage. Information has to pass into the perceptual system before it becomes capable of permanent retention. In the diagram this is the box labeled "Limited Capacity Channel (P System)." Broadbent postulated that some information may be retained in the short-term storage for longer periods of time through a recycling process which is similar to a person repeating a telephone number while he walks across the room. The number never becomes permanent information but the repetition extends the length of time that the information is available for utilization.

³⁶R. M. W. Travers, op. cit., p. 166.

Any interruption may result in loss of information.

The diagram is intended to be taken as a tentative representation of the way information flows from the point of the senses to the point that it becomes permanent information.

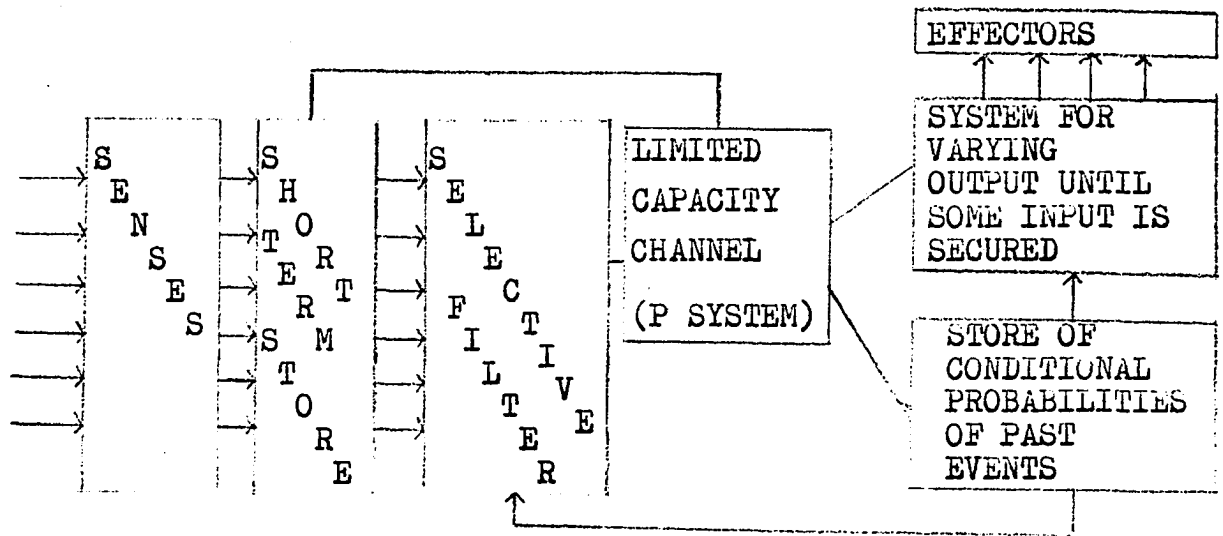


FIGURE 1--BROADBENT'S MODEL OF THE PERCEPTUAL SYSTEM

Summary

Eye movement research has indicated that eye movements become increasingly more efficient as the learner progresses through the grade levels as characterized by fewer eye fixations and regressions per 100 words, by longer spans of fixations, and by shorter durations of fixations. Mature readers have more efficient eye movements than poor readers. No research was found which studied eye movements while subjects simultaneously read and listened as material was presented at various presentation rates.

Conflicting findings were reported for the relative

efficiency of visual and auditory modalities of learning. Neither the visual nor auditory modality was superior in all circumstances. The intellectual level of the student, educational level of the student, the type of material, and the age of the student were found to be factors which determined whether a visual or aural presentation of material resulted in more learning taking place.

Research indicated that listening was a more efficient means of acquiring information than reading in the early grades. As reading ability increased, reading became the more efficient method of acquiring information. The conclusions reached by various researchers indicated that by grade eight most learners were acquiring information more efficiently by reading. Poorer readers generally acquired information more efficiently through listening at all levels.

Research involving simultaneous reading and listening resulted in inconclusive findings. The relative reading and listening ability of the learner, the type and difficulty of the material, intellectual level and chronological age of the learner were found to be factors which determined whether a combination of modalities resulted in more efficient learning.

CHAPTER III

DESIGN OF THE STUDY

Eye-movement research has contributed much to the understanding of the reading process. Such research has shown that good and poor readers can be differentiated by eye-movement patterns. Poor readers make more fixations and regressions per 100 words, take more time per fixation, and have a shorter span of fixation than good readers.

Numerous activities in the classroom combine reading and listening. There is little information available relative to the effect the auditory modality has upon the visual modality. This study attempted to provide information on eye movements as remedial readers read and read-listened. This study also attempted to secure comprehension measurements as subjects read, read-listened, and listened in order to evaluate the effect of each treatment upon understanding.

Pupil Population

Pupils for this study were selected from the seventh grade of the junior high of Crooked Oak Public Schools, Oklahoma City, Oklahoma, during the 1971-72 school year. Crooked Oak is a school with a total enrollment of around 3,000 students. Racially, the composition was about

75 percent white, 22 percent black, with the remainder made up of Indian, Spanish-American, Chinese, and other racial groups. Students in the Crooked Oak School system come from a wide range of socioeconomic and cultural backgrounds; however, a large proportion of the school population comes from families with limited economical resources. Over 50 percent of the junior high students were eligible for and received free lunches through the Federally supported lunch program.

Criteria for Selection of Subjects

Criteria for subjects selected for the study were that they be seventh-grade pupils, that they be reading at least two years below grade level, and that their listening ability exceed their reading ability by one-half year or more.

Tests and Procedures Used to Select Subjects

In order to determine reading and listening abilities, the Durrell Listening-Reading Series, Advance Form, DE,¹ was administered. This test consists of two sections which are approximately equal in difficulty. The student read and made responses on one section and listened and made responses on the other. By comparing the pupil's scores with normative

¹Donald Durrell, Listening-Reading Test (New York: Harcourt, Brace and World, Inc., 1969).

data²; it was possible to determine if the pupil would fit the criteria for a remedial reader.

About ninety-five pupils who were in the lower half of their class as determined by pupil records and guidance personnel reports were tested. This was approximately one-half of the total seventh grade. From this group, thirty-two pupils were randomly selected as subjects. Reading scores ranged from 3.2 through 5.5. Listening grade scores ranged from 4.0 through 6.6. Each pupil selected for the study scored at least one-half year higher on listening ability than on reading ability. Individual scores are located in Table 26. Mean grade score for reading was 4.1 and mean grade score for listening was 5.3. Subjects consisted of seventeen girls and fifteen boys. Eleven of the girls were white, six were black; eleven of the boys were white, three were black, and one was Spanish-American.

Tests and Procedures Used to Collect Data

Eye Movements

Eye movement photographs were taken with the Reading Eye camera. Taylor³ has discussed the history of eye-movement photography, the procedures used to photograph eye movements

²Donald Durrell, Manual for Listening and Reading Tests (New York: Harcourt, Brace and World, Inc., 1969).

³Stanford E. Taylor, Eye-Movement Photography with the Reading Eye (Huntington, N. Y.: Educational Developmental Laboratories, Inc., 1960).

with the Reading Eye, and how the photographs are analyzed and interpreted. The Reading Eye operates in this fashion:

As a person reads a grade level or appropriate level test selection before the camera, beads of light are reflected from the corneas of the eyes, photographed through lenses onto moving film. As the eyes stop and the film travels, each stop is recorded as a vertical line. Each regression is recorded as a reverse, or right-to-left, fixation. A line of print read binocularly in the usual manner is represented by twin staircases progressing from left to right. The lighter horizontal lines connecting the vertical lines represent interfixational movements (moving from one eye stop to another), and return sweeps (when the eyes sweep back or return to the new line of print). The length of time the eyes pause is termed the 'duration of fixation,' and the rate of reading is reflected in the amount of film (or length of time) required to read 100 words.⁴

Several important concepts are useful in understanding eye photographs. First, it is noted that eye movements are, for the most part, not subject to conscious control. A reader has little knowledge as to the number of fixations, number of regressions, or length and duration of fixations as he reads. Most readers have characteristic reading patterns that do not alter significantly with varying difficulty levels or with different types of reading material. Reading performance while photographs are being recorded by the Reading Eye has been found to be similar to that of reading from a book. The eye movements also give data that are objective as they reflect the relative time, effort and efficiency the subject displays

⁴Stanford Taylor, Helen Frackenpohl, and James L. Pettee, "The Validity of Eye-Movement Photography as a Measurement of Reading Performance," EDL Research and Information Bulletin No. 2 (Huntington, N. Y.: Educational Developmental Laboratories, 1960) p. 2.

during the reading process. From eye-movement photographs five scores are secured: eye fixations, eye regressions, average span of fixations, average duration of fixations, and reading rate in words per minute.

Comprehension

A comprehension quiz accompanied each reading test selection. The quiz, consisting of ten true-false questions, was administered immediately following the presentation of the test selection. In accordance with the theory of stimulus generalization subjects read the questions used for the treatment of reading, read and listened to the questions used for the treatment of reading-listening, and listened to the questions for the treatment of listening.

Preparation of Testing Material

Determining Rates of Presentation and Material Difficulty

The material used for testing were the reading selections that accompanied the Reading Eye. The development of the reading selections, the writing of the comprehension questions, and the control of readability has been described by Taylor.⁵

The reading selections at grade levels 4, 5, and 6 had 100 countable words. Since grade 3 selections had only 50 countable words, 7 reading selections from McCall-Crabbs Standard Test Lessons in Reading were modified according to

⁵Taylor, Eye-Movement Photography, pp. 16-17

Spache's readability formula so that they had 100 countable words with a readability level of 3.2.

From the research reviewed in Chapter II, it was found that, in certain instances, reading performance as measured by eye movements was affected by the difficulty level of the reading material. It was also found that comprehension was affected by the rate of presentation for activities involving listening or listening combined with reading. It was determined that various difficulty levels of testing material and different presentation rates should be used. Information from the Durrell Listening-Reading Tests was used in determining the difficulty levels of reading selections to be used as tests. The average reading level of subjects involved in the study was found to be 4.1. It was determined that difficulty levels at grades 3, 4, 5, and 6 be used to investigate the effect of material difficulty. In determining the rates of presentation, information from Taylor, Frackenpohl, and Pettee⁶ was used. A summary of their findings which includes average reading rates for subjects at various grade levels is found in the Appendix, Table 27. From their data it was determined that three rates of presentation should be used in this study--125 w.p.m., 175 w.p.m., and 225 w.p.m. Taylor, Frackenpohl, and Pettee found that a reading rate

⁶Stanford Taylor, Helen Frackenpohl, and James L. Pettee, "Grade Level Norms for the Components of the Fundamental Reading Skill," EDL Research and Information Bulletin No. 3 (Huntington, N.Y.: Educational Developmental Laboratories, 1960) p. 12.

of 125 words per minute was between the second- and third-grade average. The rate of 175 w.p.m. was at the fifth-grade level. The rate of 225 w.p.m. was at the tenth-grade level.

To test each grade level and each presentation rate, it was necessary to have 28 separate tests. Each of the 28 selections was recorded at each of the three presentation rates making a total of 84 recordings. Table 1 will permit an examination of the treatments, rates of presentation, and grade levels of difficulty. Each X represents a test selection.

TABLE 1
INDEPENDENT VARIABLES

Condition	Presentation Rate	Grade Level of Difficulty			
		3	4	5	6
Reading		X	X	X	X
Reading- Listening	125	X	X	X	X
	175	X	X	X	X
	225	X	X	X	X
Listening	125	X	X	X	X
	175	X	X	X	X
	225	X	X	X	X

A Norelco 2401 cassette recorder was used for both recording and playback. For playback two external speakers were used.

Measurement Procedures

Subjects were randomly assigned the order of test selections which were used for the various grade levels of difficulty and the different presentation rates of material for each treatment. Testing was done in the classroom used for remedial reading during an hour the room was not in use. Subjects were individually given the four tests involved in the reading treatment and the twelve tests involved in the reading-listening treatment during two hours on successive days. The comprehension tests for the listening treatment were also given on two successive days, however, groups of three or four were tested together.

Analysis of the Data

Data were treated statistically by the technique known as analysis of variance. Analysis of variance is a statistical method which divides variation in experimental data into parts, each part attributable to a source. For the treatment of reading, data were analyzed to determine the effect of material difficulty upon eye movements and comprehension; data were analyzed to determine the effect of various presentation rates and the effect of material difficulty for the reading-listening treatment; data were analyzed to determine the effect of various presentation rates and the effect of material difficulty for the listening treatment.

CHAPTER IV

PRESENTATION OF DATA

Chapter IV presents data from the six hypotheses tested. Data were collected as subjects were presented information through reading, reading-listening, and listening. Comprehension measurements were secured on each of the three treatments after the material was presented. Eye movements were secured while the material was being presented for the reading treatment and for the reading-listening treatment. For the reading treatment, data were secured as subjects read silently at their own rate on reading selections at the third, fourth, fifth, and sixth grade level. For the reading-listening treatment and the listening treatment, information was secured from twelve tests which involved the presentation of material at the three rates of 125 w.p.m., 175 w.p.m., and 225 w.p.m. across four levels of difficulty.

Measurements Obtained for Hypotheses

Hypothesis 1.--There are no significant differences in measurements for comprehension or eye movements as subjects read at four levels of difficulty.

The effect of difficulty level upon eye movements.-- An inspection of Table 2 shows that the F-ratios for all

eye-movement components were non-significant. The cell means for each eye-movement component, as shown in Table 3, indicate the lack of differences among the four levels of difficulty. The least and most difficult level of material, that of the third- and sixth-grade level, was

TABLE 2
ANALYSES OF VARIANCE FOR READING

Variable	Source	df	SS	MS	F
Fixations	Difficulties	3	163.94	54.65	<1.
	Within Cells	<u>124</u>	<u>82763.25</u>	667.74	
	Total	127	82927.25		
Refressions	Difficulties	3	71.41	23.80	<1.
	Within Cells	<u>124</u>	<u>22650.72</u>	182.67	
	Total	127	22722.12		
Span	Difficulties	3	.004	.001	<1.
	Within Cells	<u>124</u>	<u>5.41</u>	.044	
	Total	127	5.414		
Duration	Difficulties	3	.005	.002	<1.
	Within Cells	<u>124</u>	<u>.43</u>	.003	
	Total	127	.435		
Rate	Difficulties	3	2166.34	722.11	<1.
	Within Cells	<u>124</u>	<u>516825.22</u>	4167.95	
	Total	127	518991.56		
Comprehension	Difficulties	3	.84	.28	<1.
	Within Cells	<u>124</u>	<u>318.37</u>	2.57	
	Total	127	319.21		

not sufficiently different to cause a significant change in eye-movement behavior. There was a tendency toward more efficient eye movements at the third-grade level of difficulty as subjects made fewer fixations and regressions per 100 words, the average span of fixation was longer, and the average duration of fixation was shorter.

TABLE 3
CELL MEANS FOR READING

	Grade Level of Material				Mean
	3	4	5	6	
Fixation	116.28	119.19	118.88	117.91	118.06
Regression	25.13	26.94	25.66	26.72	26.11
Av. Span	0.90	0.89	0.88	0.89	0.89
Av. Duration	0.30	0.30	0.32	0.31	0.31
Rate	180.81	177.81	169.81	178.16	176.65
Comprehension	6.63	6.63	6.44	6.63	6.58

The effect of difficulty level upon comprehension.-- The F-ratios from Table 2 indicate that the difficulty level of the material did not significantly affect comprehension. An examination of the four cell means in Table 3 shows that only the fifth-grade level of difficulty resulted in any difference in comprehension. The rather low average comprehension scores indicate the problem remedial reading subjects have with acquiring information through the reading process.

Hypothesis 2.--There are no significant differences in measurements for comprehension or eye movements as subjects read-listen (a) at three rates of presentation (b) across four levels of difficulty.

Eye movements as affected by rate of presentation.--

An examination of Table 4 indicates that as subjects

TABLE 4

ANALYSES OF VARIANCE: READING-LISTENING

Variable	Source	df	SS	MS	F
Fixation:	Rates	2	103844.38	51922.19	393.95**
	Difficulties	3	660.03	220.01	1.67
	Interaction	6	99.09	16.52	<1.
	Within Cells	<u>372</u>	<u>49029.43</u>	131.80	
	Total	383	153632.93		
Regression	Rates	2	14774.93	7387.46	104.34**
	Difficulties	3	95.59	31.86	<1.
	Interaction	6	95.20	15.87	<1.
	Within Cells	<u>372</u>	<u>26339.04</u>	70.80	
	Total	383	41304.76		
Span	Rates	2	6.29	3.15	324.74**
	Difficulties	3	.06	.02	2.06
	Interaction	6	.011	.0019	<1.
	Within Cells	<u>372</u>	<u>3.62</u>	.0097	
	Total	383	9.98		
Duration	Rates	2	.2147	.11	78.57**
	Difficulties	3	.0068	.0023	1.64
	Interaction	6	.0033	.0005	<1.
	Within Cells	<u>372</u>	<u>.53</u>	.0014	
	Total	383	.7548		
Compre- hension	Rates	2	3.97	1.99	<1.
	Difficulties	3	14.34	4.78	1.74
	Interaction	6	10.55	1.76	<1.
	Within Cells	<u>372</u>	<u>1020.30</u>	2.74	
	Total	383	1049.16		

** $p < .01$; $F(.01, 2, 372) = 4.71$

read-listened, the presentation rate of material significantly affected eye movements for all four components-- the average number of fixations per 100 words, the average number of regressions per 100 words, the average span of fixation, and the average duration of fixation. For each component significance was beyond the .01 level of confidence. An inspection of cell means for reading-listening in Table 5 shows that as the presentation rate increased from 125 w.p.m. to 175 w.p.m. and then to 225 w.p.m., the average number of fixations per 100 words and the average number of regressions per 100 words decreased, the average span of fixation lengthened, and the average duration of fixation shortened. These findings indicate the extent the auditory modality had upon subjects' reading performance when the visual and auditory modalities were combined. The tendency of subjects to adjust the visual performance to auditory stimulation suggests the possibility that characteristic reading patterns for many students may be strongly influenced by the amount and kind of oral reading encountered in the learning-to-read experience.

Eye movements as affected by difficulty level.--The difficulty level of the reading material did not significantly affect any of the eye-movement components as subjects read-listened. An examination of Table 5 indicates the similarity among cell means for eye movements across the four levels of material difficulty.

TABLE 5

CELL MEANS: READING-LISTENING

Grade Level of Material					
	3	4	5	6	Mean
Fixation					
Rate: 125	134.25	134.19	137.38	133.09	134.73
175	109.59	109.72	112.09	109.44	110.21
225	<u>94.88</u>	<u>95.47</u>	<u>96.41</u>	<u>92.41</u>	<u>94.79</u>
	112.91	113.13	115.29	111.65	
					$\bar{X} = 113.24$
Regression					
Rate: 125	34.34	33.09	34.56	33.03	33.75
175	23.31	24.13	24.63	23.59	23.91
225	<u>19.87</u>	<u>19.16</u>	<u>18.78</u>	<u>17.47</u>	<u>18.81</u>
	25.83	25.46	25.99	24.70	
					$\bar{X} = 25.49$
Span					
Rate: 125	0.75	0.75	0.74	0.77	0.75
175	0.92	0.92	0.90	0.92	0.91
225	<u>1.07</u>	<u>1.06</u>	<u>1.05</u>	<u>1.09</u>	<u>1.07</u>
	0.91	0.91	0.89	0.93	
					$\bar{X} = 0.91$
Duration					
Rate: 125	0.34	0.34	0.36	0.35	0.35
175	0.31	0.31	0.31	0.31	0.31
225	<u>0.28</u>	<u>0.29</u>	<u>0.29</u>	<u>0.29</u>	<u>0.29</u>
	0.31	0.31	0.32	0.32	
					$\bar{X} = 0.32$
Comprehension					
Rate: 125	7.63	6.97	7.84	7.41	7.46
175	7.34	7.41	7.47	6.81	7.26
225	<u>7.21</u>	<u>7.19</u>	<u>7.47</u>	<u>7.07</u>	<u>7.23</u>
	7.40	7.19	7.60	7.09	
					$\bar{X} = 7.32$

Comprehension as affected by presentation rate.--An inspection of Table 4 indicates the presentation rate of material did not significantly affect comprehension as subjects read-listened. Cell means in Table 5 show a slight decrease across all levels as the rate of presentation increased.

Comprehension as affected by difficulty level.--The level of the reading material did not significantly affect comprehension scores as subjects read-listened at four difficulty levels. An examination of Table 5 shows little variation among cell means for comprehension scores.

Hypothesis 3.--There are no significant differences in measurements for comprehension as subjects listen at (a) three rates of presentation (b) across four levels of difficulty.

Comprehension as affected by presentation rate.--The computed F value in Table 6 indicates the various rates

TABLE 6
ANALYSIS OF VARIANCE: LISTENING COMPREHENSION

Source	df	SS	MS	F
Rates	2	6.01	3.00	1.11
Difficulties	3	43.26	14.42	5.34**
Interaction	6	9.45	1.58	< 1.
Within Cells	<u>372</u>	<u>1004.40</u>	2.70	
Total	383	1063.12		

** $p < .01$; $F(.01, 3, 372) = 3.83$

of presentation did not significantly affect comprehension. The cell means for listening comprehension, presented in Table 7 show that across all four levels of difficulty subjects scored slightly higher at the 125 w.p.m. presentation rate than at 175 w.p.m.; the 175 w.p.m. scores were slightly higher than the scores achieved at the 225 w.p.m. presentation rate. These findings indicate that when material was presented to remedial readers through the auditory modality, faster rates of presentation could be utilized without serious loss of understanding.

TABLE 7
CELL MEANS FOR LISTENING COMPREHENSION

		Grade Level of Material				Mean
		3	4	5	6	
Rate:	125	8.03	7.13	7.69	7.28	7.53
	175	8.06	7.41	7.47	6.69	7.41
	225	<u>7.56</u>	<u>7.06</u>	<u>7.28</u>	<u>7.00</u>	<u>7.23</u>
		7.88	7.20	7.48	6.99	
					$\bar{X} =$	7.39

Comprehension as affected by difficulty level.--Significant differences existed at the .01 level of confidence as a result of the difficulty level of the material used for listening as indicated by Table 6. Table 7 shows the cell means. The largest difference in scores were between third-grade level and sixth-grade level. Subjects scored higher on

third-grade level than on sixth-grade level material. The cell means show that subjects made better comprehension scores on fifth-grade level material than on fourth. These findings indicate the auditory modality to be more effective as a means of transmitting information when material of low difficulty level is utilized.

Comparisons of Treatments

In order to determine if the performance of subjects varied between treatments, the following comparisons were made.

1. Reading was compared with reading-listening.
2. Reading was compared with listening.
3. Listening was compared with reading-listening.

The difficulty levels of material did not discriminate either for eye movements or comprehension except in the case of listening where significance resulted for comprehension between the third- and sixth-grade level of material. The lack of validity for difficulty level of material was consistently shown when the fourth-and fifth-grade material was compared. For both eye-movement and comprehension measurements the scores indicated that the fourth grade material was more difficult than the fifth. Because of the lack of validity for the difficulty of the material, hypotheses four, five, and six make comparisons between treatments only.

Hypothesis 4.--There are no significant differences in measurements for eye movements or comprehension when reading was compared with reading-listening.

Hypothesis 4 involved comparisons for the following eye-movement variables: fixations, regressions, span, and duration. Comprehension measurements between the two treatments were also compared. Each of the variables has been treated separately, thus Tables 8 through 17 provide data for hypothesis 4.

Fixations as affected by treatments.--As can be seen from table 8, significant differences were found when fixation data were compared for reading and reading-listening. Cell means in Table 9 indicate that the slower presentation rate of 125 w.p.m. for reading-listening resulted in significantly more fixations per 100 words than did the treatment for reading. At the faster presentation rate of 225 w.p.m. for reading-listening, subjects made significantly fewer fixations per 100 words than while reading at their own rate. An interesting result is the significance between reading and reading-listening at the presentation rate of 175 w.p.m. When subjects read at their rate, the average reading rate across all difficulty levels was 177 w.p.m., only two w.p.m. different from the reading-listening presentation rate of 175 w.p.m. Yet when comparisons between the two treatments were made, there was an average of eight fewer fixations per 100 words for reading-listening.

TABLE 8

ANAYLSES OF VARIANCE

READING FIXATIONS COMPARED WITH READING-LISTENING FIXATIONS

=====					
	Source	df	SS	MS	F
R vs.	Treatments	1	17772.22	17772.22	40.20**
R-L 125	Difficulties	3	329.92	109.97	
	Interaction	3	160.36	53.45	<1.
	Within Cells	<u>248</u>	<u>109648.32</u>	442.13	
	Total	255	127910.82		
R vs.	Treatments	1	3945.41	3945.41	10.38**
R-L 175	Difficulties	3	228.51	76.17	
	Interaction	3	87.95	29.31	<1.
	Within Cells	<u>248</u>	<u>94308.51</u>	380.28	
	Total	255	98570.38		
R vs.	Treatments	1	34665.78	34665.78	92.08**
R-L 225	Difficulties	3	295.70	98.57	
	Interaction	3	148.61	49.54	<1.
	Within Cells	<u>248</u>	<u>93361.52</u>	376.46	
	Total	255	128471.61		

** $p < .01$; $F(.01, 1, 248) = 6.76$

TABLE 9

CELL MEANS

READING FIXATIONS COMPARED WITH READING-LISTENING FIXATIONS

=====					
	Grade Level of Material				
	3	4	5	6	Mean
R	116.28	119.19	116.88	117.91	118.06
R-L 125	134.25	134.19	137.38	133.09	134.73
R-L 175	109.59	109.72	112.09	109.44	110.21
R-L 225	94.88	95.47	96.41	92.41	94.79

This suggests that remedial reading subjects relied upon the auditory modality to supply some of the meaning thereby lessening the need to make as many fixations per 100 words as when reading without auditory assistance.

Regressions as affected by treatment.--An inspection of Table 10 indicates that the treatment significantly affected the average number of regressions per 100 words when reading was compared with reading-listening at presentation rates of 125 w.p.m. and 225 w.p.m. No significant differences existed for regressions when reading was compared with reading-listening at the 175 w.p.m. presentation rate. The presentation rate of 175 w.p.m. is only two w.p.m. slower than the average w.p.m. silent reading rate of subjects used in the study and accounts for the lack of significance at that rate. Table 11 reveals that as the presentation rate for reading-listening varied from the readers' natural reading rate, significant differences were found in the number of regressions per 100 words. At the slower presentation rate of 125 w.p.m. for reading-listening, subjects made significantly more regressions per 100 words than for reading; while at the faster presentation rate of 225 w.p.m. for reading-listening, they made significantly fewer regressions per 100 words than for reading. This indicates that when reading was combined with listening, the auditory modality determined the performance of the visual modality.

TABLE 10
ANALYSES OF VARIANCE

READING REGRESSIONS COMPARED WITH READING-LISTENING REGRESSIONS

=====					
	Source	df	SS	MS	F
R vs.	Treatments	1	3743.91	3743.91	26.51**
R-L 125	Difficulties	3	5.17	1.72	
	Interaction	3	128.95	42.98	< 1.
	Within Cells	<u>248</u>	<u>35023.02</u>	141.22	
	Total	255	38901.05		
R vs.	Treatments	1	308.44	308.44	2.50
R-L 175	Difficulties	3	59.92	19.97	
	Interaction	3	43.95	14.65	< 1.
	Within Cells	<u>248</u>	<u>30567.84</u>	123.26	
	Total	255	30980.15		
R vs.	Treatments	1	3407.64	3407.64	29.44**
R-L 225	Difficulties	3	34.39	11.46	
	Interaction	3	132.64	44.21	< 1.
	Within Cells	<u>248</u>	<u>28700.14</u>	115.73	
	Total	255	32274.81		

** $p < .01$; $F(.01, 1, 248) = 6.76$

TABLE 11
CELL MEANS

READING REGRESSIONS COMPARED WITH READING-LISTENING REGRESSIONS

=====					
	Grade Level of Material				
	3	4	5	6	Mean
R	25.13	26.94	25.66	26.72	26.11
R-L 125	34.34	33.09	34.56	33.03	33.76
R-L 175	23.31	24.13	24.63	23.60	23.92
R-L 225	19.84	19.16	18.78	17.47	18.81

Span as affected by treatment.--An inspection of Table 12 shows that when reading was compared with reading-listening at presentation rates of 125 w.p.m. and 225 w.p.m., significant differences existed for the average span of eye fixation. A non-significant F-ratio was found for span of fixation as a result of treatment when reading was compared with reading-listening at the 175 w.p.m. presentation rate.

TABLE 12
ANALYSES OF VARIANCE
READING SPAN COMPARED WITH READING-LISTENING SPAN

=====					
	Source	df	SS	MS	F

R vs.	Treatments	1	1.20	1.20	40.00**
R-L 125	Difficulties	3	.01	.003	
	Interaction	3	.01	.003	<1.
	Within Cells	<u>248</u>	<u>6.58</u>	.03	
	Total	255	7.80		
R vs.	Treatments	1	.04	.04	1.60
R-L 175	Difficulties	3	.01	.003	
	Interaction	3	.003	.001	<1.
	Within Cells	<u>248</u>	<u>.27</u>	.025	
	Total	255	.323		
R vs.	Treatments	1	1.99	1.99	71.07**
R-L 225	Difficulties	3	.03	.01	
	Interaction	3	.02	.006	<1.
	Within Cells	<u>248</u>	<u>7.01</u>	.028	
	Total	255	9.05		

** $p < .01$; $F(.01, 1, 248) = 6.76$

As reported in Table 13, the cell mean across all four difficulty levels for reading was .89 of a word. For reading-listening at 125 w.p.m. subjects averaged .75 of a word for each span. At the slower presentation rate it was possible for the subjects to keep up with the auditory message with eye spans that took in less information. At the faster rate of presentation of 225 w.p.m., the span of fixation lengthened to 1.07 words. Such a span length was equal to that achieved by average twelfth-grade students as reported in Table 27 in the Appendix. Since eye movements must be assessed in terms of comprehension, it should be noted that comprehension was higher, as reported in another section of this hypothesis, for reading-listening at the presentation rate of 225 w.p.m. than for reading. This would indicate that remedial readers were able to depend upon the auditory modality to supply much of the informational content. It should be noted that span of fixation is a derived score dependent upon visual fixations. Subjects may "read along" visually allowing the oral presentation to both determine their eye movements and to transmit information to them.

TABLE 13

CELL MEANS
READING SPAN COMPARED WITH READING-LISTENING SPAN

	Grade Level of Material				Mean
	3	4	5	6	
R	0.90	0.89	0.88	0.89	0.89
R-L 125	0.75	0.75	0.74	0.77	0.75
R-L 175	0.92	0.92	0.90	0.92	0.91
R-L 225	1.07	1.06	1.05	1.09	1.07

Duration of fixation as affected by treatment.--The computed F-ratios in Table 14 indicate that the treatment utilized by subjects to acquire information resulted in significant differences in the average duration of fixation when reading was compared with reading-listening at the presentation rates of 125 w.p.m. and 225 w.p.m., but not at the 175 w.p.m. presentation rate. Table 15 presents the cell means for both treatments. The average duration across all four levels of difficulty was .31 of a second for reading and .35 of a second for reading-listening at 125 w.p.m.

TABLE 14

ANALYSES OF VARIANCE

READING DURATION COMPARED WITH READING-LISTENING DURATION

=====					
	Source	df	SS	MS	F
R vs.	Treatments	1	.096	.096	32.00**
R-L 125	Difficulties	3	.011	.004	
	Interaction	3	.0007	.0002	<1.
	Within Cells	<u>248</u>	<u>.70</u>	.003	
	Total	255	.81		
R vs.	Treatments	1	.0008	.0008	<1.
R-L 175	Difficulties	3	.0037	.0012	
	Interaction	3	.0014	.0005	<1.
	Within Cells	<u>248</u>	<u>.5546</u>	.0022	
	Total	255	.5605		
R vs.	Treatments	1	.29	.29	131.82**
R-L 225	Difficulties	3	.02	.006	
	Interaction	3	.002	.0006	<1.
	Within Cells	<u>248</u>	<u>.55</u>	.0022	
	Total	255	.862		

** $p < .01; F(.01, 1, 248) = 6.76$

There was little difference in average durations when reading was compared with reading-listening at the 175 w.p.m. presentation rate. The average duration for reading-listening at the 225 presentation rate was only .29 of a second. This means that subjects' reading performance as characterized by average duration of fixations shortened as the rate of presentation for reading-listening was increased. Subjects compensated for the increased rate of presentation by making shorter durations of fixations.

TABLE 15

CELL MEANS

READING DURATION COMPARED WITH READING-LISTENING DURATION

	Grade Level of Material				Mean
	3	4	5	6	
R	0.30	0.30	0.32	0.31	0.31
R-L 125	0.34	0.34	0.36	0.35	0.35
R-L 175	0.31	0.31	0.31	0.31	0.31
R-L 225	0.28	0.29	0.29	0.29	0.29

Comprehension as affected by treatment.--The treatment used by the subjects to acquire information resulted in significant differences in comprehension when reading was compared with reading-listening at all three rates of presentation. The cell means in Table 17 show that comprehension was higher for reading-listening for all three rates of presentation and for all four difficulty levels than for reading.

Subjects of this study, who were handicapped in the skills of reading, acquired information more readily through two modalities than they did through a single modality.

TABLE 16
ANALYSES OF VARIANCE
READING COMPREHENSION
COMPARED WITH READING-LISTENING COMPREHENSION.

=====					
	Source	df	SS	MS	F

R vs. R-L 125	Treatments	1	29.88	49.88	19.95**
	Difficulties	3	4.82	1.61	
	Interaction	3	9.42	3.14	1.26
	Within Cells	<u>248</u>	<u>620.74</u>	2.50	
	Total	255	684.86		
R vs. R-L 175	Treatments	1	29.57	27.57	10.64**
	Difficulties	3	3.51	1.17	
	Interaction	3	6.04	2.01	< 1.
	Within Cells	<u>248</u>	<u>688.12</u>	2.78	
	Total	255	727.24		
R vs. R-L 225	Treatments	1	27.56	27.56	10.25**
	Difficulties	3	.41	.14	
	Interaction	3	3.22	1.07	< 1.
	Within Cells	<u>248</u>	<u>666.53</u>	2.69	
	Total	255	697.72		

** $p < .01; F(.01, 1, 248) = 6.76$

TABLE 17
CELL MEANS

READING COMPREHENSION
COMPARED WITH READING-LISTENING COMPREHENSION

=====

	Grade Level of Material				Mean
	3	4	5	6	
R	6.63	6.63	6.44	6.63	6.58
R-L 125	7.63	6.97	7.84	7.41	7.46
R-L 175	7.34	7.41	7.47	6.81	7.26
R-L 225	7.22	7.19	7.47	7.06	7.23

=====

Hypothesis 5.--There are no significant differences in comprehension measurements when reading was compared with reading-listening.

Comprehension as affected by treatment.--The computed F-ratios in Table 18 indicate that the treatment affected comprehension beyond the .01 level of confidence when reading was compared with listening at each of the three rates of presentation. Table 19 data show that comprehension was higher for listening than for reading for all cell means irrespective of presentation rate of material or the difficulty level of material. Subjects were able to score significantly higher on comprehension when information was presented through the auditory modality than through the visual modality.

TABLE 18
ANALYSES OF VARIANCE

READING COMPREHENSION COMPARED WITH LISTENING COMPREHENSION

=====					
	Source	df	SS	MS	F
R vs.	Treatments	1	58.14	58.14	22.89**
L 125	Difficulties	3	7.52	2.51	
	Interaction	3	9.39	3.13	1.23
	Within Cells	<u>248</u>	<u>630.15</u>	2.54	
	Total	255	705.20		
R vs.	Treatments	1	43.89	43.89	16.44**
L 175	Difficulties	3	15.27	5.09	
	Interaction	3	16.02	5.34	2.00
	Within Cells	<u>248</u>	<u>662.77</u>	2.67	
	Total	255	737.95		
R vs.	Treatments	1	26.91	26.91	10.00**
L 225	Difficulties	3	3.19	1.06	
	Interaction	3	3.86	1.29	
	Within Cells	<u>248</u>	<u>666.56</u>	2.69	
	Total	255	700.52		

** $p < .01$; $F(.01, 1, 248) = 6.76$

TABLE 19

CELL MEANS

READING COMPREHENSION COMPARED WITH LISTENING COMPREHENSION

=====					
	Grade Level of Difficulty				
	3	4	5	6	Mean
R	6.63	6.63	6.44	6.63	6.58
L 125	8.03	7.13	7.69	7.28	7.53
L 175	8.06	7.41	7.47	6.69	7.41
L 225	7.56	7.06	7.28	7.00	7.23

Hypothesis 6.--There are no significant differences in comprehension measurements when listening was compared with reading-listening. Hypothesis 6 compared listening comprehension at three presentation rates with reading-listening comprehension at three presentation rates.

Listening Comprehension at 125 WPM
Compared with Reading-Listening
Comprehension at 125, 175, 225 WPM

Analyses of variance data are given in Table 19. The treatments resulted in non-significant F-ratios when listening comprehension at the 125 w.p.m. presentation rate

TABLE 20

ANALYSES OF VARIANCE

LISTENING COMPREHENSION
 COMPARED WITH READING-LISTENING COMPREHENSION

=====					
	Source	df	SS	MS	F

L 125	Treatments	1	.32	.32	<1.
vs.	Difficulties	3	26.11	8.70	
R-L 125	Interaction	3	3.36	1.12	<1.
	Within Cells	248	614.18	2.48	
	Total	255	643.97		
L 125	Treatments	1	4.79	4.79	1.74
vs	Difficulties	3	16.45	5.48	
R-L 175	Interaction	3	8.32	2.77	1.00
	Within Cells	248	681.55	2.75	
	Total	255	711.11		
L 125	Treatments	1	5.64	5.64	2.12
vs	Difficulties	3	12.33	4.11	
L-R 225	Interaction	3	6.52	2.17	41.
	Within Cells	248	659.96	2.66	
	Total	255	684.45		

was compared with reading-listening comprehension across the three presentation rates. Table 20 reveals that as the rate of presentation increased for reading-listening, there was a slight loss in comprehension as compared to listening at the 125 w.p.m. presentation rate.

TABLE 21
CELL MEANS
LISTENING COMPREHENSION
COMPARED WITH READING-LISTENING COMPREHENSION

		Grade Level of Material				
		3	4	5	6	Mean
L	125	8.03	7.13	7.69	7.28	7.53
L-R	125	7.63	6.97	7.84	7.41	7.46
L-R	175	7.34	7.41	7.47	6.81	7.26
L-R	225	7.22	7.19	7.47	7.06	7.23

Listening Comprehension at 175 WPM
Compared with Reading-Listening
Comprehension at 125, 175, 225, WPM

An examination of Table 21 shows that when listening at the 175 w.p.m. presentation rate was compared with reading-listening across the three presentation rates, the F-ratios were non-significant. The cell means in Table 22 reveal the similarity between listening comprehension at the 175 w.p.m. presentation rate and reading-listening comprehension at each of three presentation rates.

TABLE 22

ANALYSES OF VARIANCE
LISTENING COMPREHENSION
COMPARED WITH READING-LISTENING COMPREHENSION

=====					
	Source	df	SS	MS	F
L 175	Treatments	1	.19	.19	< 1.
vs.	Difficulties	3	27.39	9.13	
L-R 125	Interaction	3	16.45	5.48	2.10
	Within Cells	<u>248</u>	<u>646.80</u>	2.61	
	Total	255	690.83		
L 175	Treatments	1	1.41	1.41	< 1.
vs.	Difficulties	3	32.04	10.68	
L-R 175	Interaction	3	7.11	2.37	< 1.
	Within Cells	<u>248</u>	<u>714.18</u>	2.88	
	Total	255	754.74		
L 175	Treatments	1	1.89	1.89	< 1.
vs.	Difficulties	3	20.70	6.90	
L-R 225	Interaction	3	12.52	4.17	
	Within Cells	<u>248</u>	<u>692.58</u>	2.79	
	Total	255	727.69		

TABLE 23

CELL MEANS

LISTENING COMPREHENSION
COMPARED WITH READING-LISTENING COMPREHENSION

=====					
	Grade Level of Material				
	3	4	5	6	Mean
L 175	8.06	7.41	7.47	6.69	7.41
R-L 125	7.63	6.97	7.84	7.41	7.46
R-L 175	7.34	7.41	7.47	6.81	7.26
R-L 225	7.22	7.19	7.47	7.06	7.23

Listening Comprehension at 225 WPM
Compared with Reading-Listening
Comprehension at 125, 175, 225 WPM

An examination of data given in Table 23 shows that the method of presentation did not result in significant differences in comprehension as listening at the 225 presentation rate was compared with reading-listening across three rates of presentation. An interesting comparison was that of listening comprehension at the 225 w.p.m. presentation with reading-listening comprehension at the 225 w.p.m. presentation rate. Across all four levels of difficulty, the mean average was 7.23 for each. This suggests that the purpose for the acquisition of information might be a consideration in determining the method used to present information. If the purpose is solely that of acquiring information, the auditory modality is as efficient and perhaps less frustrating to the learner than a method combining the visual and auditory modalities. If the purpose includes training in the process of reading, the method which combines the auditory and visual modalities, if carefully controlled, can be utilized as a method of informational input. The cell means in Table 24 indicate the similarity between listening comprehension at the 225 w.p.m. presentation rate and that of reading-listening at the various presentation rates.

TABLE 24

ANALYSES OF VARIANCE

LISTENING COMPREHENSION
COMPARED WITH READING-LISTENING COMPREHENSION

		Source	df	SS	MS	F
L	225	Treatments	1	3.52	3.52	1.34
vs.		Difficulties	3	15.22	5.07	
R-L	125	Interaction	3	4.39	1.46	<1.
		Within Cells	<u>248</u>	<u>650.72</u>	2.62	
		Total	255	673.72		
L	225	Treatments	1	.06	.06	<1.
vs.		Difficulties	3	11.20	3.73	
R-L	175	Interaction	3	3.72	1.24	<1.
		Within Cells	<u>248</u>	<u>717.96</u>	2.90	
		Total	255	732.94		
L	225	Treatments	1	.004	.004	<1.
vs.		Difficulties	3	6.23	2.08	
R-L	225	Interactions	3	2.76	.92	<1.
		Within Cells	<u>248</u>	<u>678.37</u>		
		Total	255	687.364		

TABLE 25

CELL MEANS

LISTENING COMPREHENSION
COMPARED WITH READING-LISTENING COMPREHENSION

		Grade Level of Material				Mean
		3	4	5	6	
L	225	7.56	7.06	7.28	7.00	7.23
R-L	125	7.63	6.97	7.84	7.41	7.46
R-L	175	7.34	7.41	7.47	6.81	7.26
R-L	225	7.22	7.19	7.47	7.06	7.23

CHAPTER V

SUMMARY, CONCLUSIONS, AND RECOMMENDATIONS

Chapter V consists of a summary, conclusions, and recommendations. The summary lists the hypotheses that were tested. The conclusions include interpretations from the data gathered. The recommendations are stated to supplement and clarify the findings of the study.

Summary

One objective of this study was concerned with the effect upon eye movements as subjects read and as they read-listened. A second objective was to evaluate three treatments--reading, reading-listening, and listening--as methods of presenting information.

Hypotheses 1 and 2 were concerned with gathering eye-movement and comprehension measurements for the treatment of reading and the treatment of reading-listening. Hypothesis 3 was concerned with gathering comprehension measurements for the listening treatment. Hypotheses 4, 5, and 6 were concerned with comparing the various treatments. Hypothesis 4 compared eye-movement and comprehension measurements secured while reading with those secured while reading-listening; hypothesis 5 compared reading comprehension with listening comprehension; hypothesis 6 compared listening comprehension with reading-listening comprehension.

Conclusions

The findings and the specific conclusions are included with each hypothesis tested. These are followed by general conclusions.

Reading Treatment

The specific null hypothesis.--There are no significant differences in measurements for eye movements or comprehension as subjects read at four levels of difficulty.

Eye Movements

Findings.--No significant differences were found for any eye-movement component as subjects read at grade levels 3, 4, 5, and 6. The components tested were fixations, regressions, average span, and average duration.

Conclusions.--The level of material difficulty did not affect eye-movement measurements as subjects read at four different levels of difficulty. Since eye-movement patterns are regarded as reflecting the relative efficiency of reading performance, the findings indicated that either the remedial reading subjects were not able to alter their eye-movement performance as they read material at various difficulty levels, or the levels of material difficulty were not sufficiently differentiated to result in eye-movement alterations.

Comprehension

Findings.--No significant differences in comprehension measurements were found as subjects read at grade levels 3, 4, 5, or 6.

Conclusions.--The level of material difficulty did not significantly affect comprehension measurements as subjects read selections across four levels of difficulty.

Reading-Listening Treatment

The specific null hypothesis stated.--There are no significant differences in measurements for comprehension or eye movements as subjects read-listen (a) at three rates of presentation (b) across four levels of difficulty.

Eye Movements: Effect of Presentation Rate

Findings.--Significant differences were found in all eye-movement measurements as material was presented at various rates for the reading-listening treatment. The number of fixations and regressions decreased, the average span of fixation increased, and the average duration of fixation shortened as the presentation rate was increased from 125 w.p.m. to 175 w.p.m. and to 225 w.p.m. The F-ratio for each was significant beyond the .01 level of confidence.

Conclusions.--The presentation rate of material significantly affected eye movement as subjects read-listened. Carmichael and Dearborn discussed the involuntary nature of eye movements:

....the normal reader cannot 'voluntarily' control the number of his fixation pauses, regressive movements, or the regular actions of his eyes as he reads. It is possible by very specific training to change the frequency and character of such movements, but this is not accomplished merely by 'consciously trying' to do so. It was not possible, that is, for any subject with whom

we have worked to change his eye movements merely by resolving to himself, 'I will now fixate less frequently than I have in the past and make fewer regressive movements while I carefully read for comprehension this printed page.' The normal subject of course has no direct knowledge of the number of fixation pauses or regressive movements that his eyes make as he reads.¹

The highly significant F-ratios for eye movements linked with the concept that eye movements cannot be consciously controlled indicate the extent that the auditory presentation of material at various presentation rates influenced visual performance. When material was presented at a slower presentation rate, the number of fixations and the number of regressions per 100 words increased, the average span of fixation shortened, and the average duration of fixation lengthened. When the material was presented at a faster presentation rate, the number of fixations and regressions per 100 words decreased, the average span of fixation lengthened, and the average duration of fixation shortened.

Eye Movements: Effect
of Difficulty Level

Findings.--No significant differences were found in eye-movement measurements as subjects read-listened at four levels of difficulty.

Conclusions.--The level of material difficulty did not influence eye movements as subjects read-listened across four levels.

¹Leonard Carmichael and Walter F. Dearborn, Reading and Visual Fatigue (Boston: Houghton Mifflin Company, 1947), pp. 353-354.

Comprehension: Effect
of Presentation Rate

Findings:--No significant differences were found among the three rates of presentation as subjects read-listened.

Conclusions:--The rate of presentation did not influence the comprehension of remedial readers as they read-listened. Subjects read-listened at the presentation rates of 125 w.p.m., 175 w.p.m., and 225 w.p.m. This indicates that if reading-listening activities are used as a means of acquiring information, faster presentation rates can be used without serious loss of information.

Comprehension: Effect
of Difficulty Level

Findings:--No significant differences were found as subjects read-listened across four levels of difficulty.

Conclusions:--The level of difficulty did not influence comprehension as subjects read-listened across four levels of difficulty.

Listening Treatment

The specific null hypothesis tested.--There are no significant differences in measurements for comprehension as subjects read-listen (a) at three presentation rates (b) across four levels of difficulty.

Comprehension: Effect
of Presentation Rate

Findings:--No significant differences were found in

comprehension measurements as subjects listened at three presentation rates.

Conclusions.--The rate of presentation did not significantly affect comprehension measurements as subjects listened across four levels of difficulty. This indicates that listening at faster rates of presentations can be an effective means of acquiring information for remedial readers.

Comprehension: Effect
of Difficulty Level

Findings:--Significant differences were found in comprehension measurements as subjects listened across four difficulty levels. The F-ratio for difficulty of material tests was significant beyond the .01 level of confidence. The findings were not as expected in that listening comprehension was better for fifth-grade selections than for fourth-grade. This suggests lack of validity for the difficulty level of the material at the fourth- and fifth-grade level, or that some factor other than readability may be contributing to comprehension scores, such as interest or familiarity of the material. Comprehension scores were highest for third-grade level material and lowest for sixth-grade level material.

Conclusions:--The level of the material significantly affected comprehension measurements as subjects listened across four levels of difficulty. The differences were between the third- and sixth-grade level of difficulty.

There is an indication that listening is an effective means of transmitting low difficulty level material and that such material can be presented at faster rates of presentation without serious loss of understanding.

Comparing Treatments

Hypothesis 4 through 6 are comparisons of treatments. Hypothesis 4 compares reading eye-movements and comprehension measurements with reading-listening eye movements and comprehension. Hypothesis 5 compares reading comprehension with listening comprehension. Hypothesis 6 compares listening comprehension with reading-listening comprehension.

Reading Compared with Reading-Listening

The specific null hypothesis stated.--There are no significant differences in measurements for eye movements or comprehension when reading was compared with reading-listening.

Eye Movements: Effect of Treatment

Findings: Fixations.--Significant differences in the number of fixations per 100 words were found when reading was compared to reading-listening at each of the three presentation rates. The F-ratio was significant beyond the .01 level of confidence. Subjects made more fixations while reading-listening at the presentation rate of 125 w.p.m. than they made while reading. They made fewer fixations while reading-listening at 175 w.p.m. and 225 w.p.m. than they made while reading.

Findings: Regressions.--Significant differences in the number of regression per 100 words were found when reading was compared with reading-listening at the presentation rate of 125 w.p.m. and at the presentation rate of 225 w.p.m. When reading was compared with reading-listening at the 175 w.p.m. presentation rate, the difference in number of regressions per 100 words was non-significant. The number of regressions per 100 words was more for reading-listening at the presentation rate of 125 w.p.m. than for reading; it was less for reading-listening at presentation rates of 175 w.p.m. and 225 w.p.m. than for reading.

Findings: Span.--Significant differences in the average span of fixations were found when reading was compared to reading-listening at the presentation rates of 125 w.p.m. and 225 w.p.m., but not for the presentation rate of 175 w.p.m. The F-ratio was significant beyond the .01 level of confidence. The average span of fixation was shorter for reading-listening at the presentation rate of 125 w.p.m. than it was for reading. The average span of fixation was longer for reading-listening at presentation rates of 175 w.p.m. and 225 w.p.m. than for reading.

Findings: Duration.--Significances differences beyond the .01 level of confidence existed when reading was compared with reading-listening at presentation rates of 125 w.p.m. and 225 w.p.m. Differences were non-significant when reading was compared with reading-listening at the presentation rate of 175 w.p.m.

Conclusions: Eye movements.--The findings for fixations, regressions, span, and duration indicate significant differences in eye movements as the result of the treatment used to present information. In reality the differences were the result of the rates of presentation as subjects read-listened. As subjects read-listened at the slower presentation of 125 w.p.m., more fixations and regressions per 100 words were recorded than for reading; the average span of fixation was shorter and the average duration of fixation was longer as subjects read-listened at the slower rate of presentation than for reading. At the faster presentation rate of 225 w.p.m. for reading-listening, fewer fixations and regressions per 100 words were recorded than for reading, while the average span of fixation was longer and the average duration of fixation was shorter. This means that eye movements were influenced negatively by the slower presentation rate and positively by the faster presentation rate. It should be noted that for each of the eye-movement components except fixations there was no significant difference when reading was compared with reading-listening at a presentation rate of 175 w.p.m. This lack of significance is probably explained because the presentation rate of 175 w.p.m. is very similar to the subjects average reading rate of 177 w.p.m. The difference between the characteristic eye-movement performance while reading and the eye-movement performance as subjects read-listened at different presentation rates showed the effect of the auditory upon the visual.

Comprehension: Effect
of Treatment

Findings.--Significant differences in comprehension measurements were found when reading was compared with reading-listening at each of the three presentation rates. Each F-ratio was significant beyond the .01 level. Comprehension was better for reading-listening at each of the three presentation rates than for reading.

Conclusions.--The treatment used to present information resulted in significant differences in comprehension when reading was compared with reading-listening. Remedial reading subjects acquired more information as they read-listened than they did as they read.

Of interest to this investigation was the theoretical model which affirms that the human sensory mechanism is a one-channel system and can handle sensory input from only one sensory modality at a time. Thus when information is presented using two modalities, it is necessary for the system to switch from one modality to the other. An overload of information causes an interference with the learning process. For subjects of this study, the combining of two modalities as in reading-listening resulted in higher comprehension scores than resulted for the one-modality presentation as in reading. It should be noted that, as a whole, the difficulty levels of the various selections did not result in differences for either eye movements or comprehension. The difficulty levels of the material may have

been within the ability range of the subjects and not difficult enough to cause interference.

Reading Compared with Listening

The specific null hypothesis stated.--There are no significant differences in comprehension measurements when reading was compared with listening.

Comprehension: Effect of Treatment

Findings.--Significant differences in comprehension were found when reading was compared with listening at the presentation rate of 125 w.p.m., at the presentation rate of 175 w.p.m., and at the presentation rate of 225 w.p.m. The F-ratios for all three were significant beyond the .01 level of confidence. Comprehension scores were higher as subjects listened at all three presentation rates than it was for reading.

Conclusions.--The treatment by which subjects received information significantly affected measurements when reading comprehension was compared with listening comprehension. This would suggest that the purpose for instruction should be a consideration in determining the method of instruction to be used with students. If the objective of a given segment of teaching involves instruction meant to further the reading process, information should be presented visually using printed matter. If the objective is primarily that of transmission of information, the auditory modality could be used.

Listening Compared with Reading-Listening

The specific null hypothesis stated.--There are no significant differences in comprehension measurements when reading was compared with reading-listening.

The Effect of TreatmentListening at 125 WPM Compared with Reading-Listening at 125 WPM, 175 WPM, and 225 WPM

Findings.--There were no significant differences in measurements when listening comprehension at the presentation rate of 125 w.p.m was compared with reading-listening comprehension at three presentation rates.

Conclusions.--The treatment did not significantly affect comprehension measurements when listening at 125 w.p.m. was compared with reading-listening at 125 w.p.m., 175 w.p.m., and 225 w.p.m.

Listening at 175 WPM Compared with Reading-Listening at 125 WPM, 175 WPM, and 225 WPM

Findings.--There were no significant differences in measurements when listening comprehension at the presentation rate of 175 w.p.m. was compared with reading-listening comprehension at three rates of presentation.

Conclusions.--The treatment did not significantly affect comprehension measurements when listening at 175 w.p.m. was compared with reading-listening at 125 w.p.m., 175 w.p.m., and 225 w.p.m.

Listening at 225 WPM Compared
with Reading-Listening at
125 WPM, 175 WPM, and 225 WPM

Findings.--There were significant differences in measurements when listening comprehension at the 225 w.p.m. presentation rate was compared with reading-listening at each of the three presentation rates.

Conclusions.--The treatment did not significantly affect comprehension measurements when listening at 225 w.p.m. was compared with reading-listening at 125 w.p.m., 175 w.p.m., and 225 w.p.m. presentation rates.

General Conclusions

1. Eye movements were significantly different as subjects read and as they read-listened. When eye movements for reading were compared with reading-listening eye movements, the reading-listening presentation rate determined the level of significance. Highly significant differences existed when reading was compared with reading-listening at the presentation rate of 125 w.p.m. and 225 w.p.m., but not at the 175 w.p.m. presentation rate. When reading was compared with reading-listening at the 125 w.p.m. presentation rate, subjects made more fixations and regressions for the reading-listening treatment. When reading was compared with reading-listening at the 225 w.p.m. presentation rate, subjects made fewer fixations and regressions for the reading-listening treatment. The average span of fixation was shorter

and the average duration of fixation was longer for reading-listening at 125 w.p.m. presentation rate than for reading; while for reading-listening at the 225 w.p.m. presentation rate, the average span was shorter and the average duration was longer. These differences in eye movements indicate the extent that the auditory modality had upon visual performance when reading-listening activities were combined.

2. Reading comprehension and reading-listening comprehension were significantly different. Reading-listening comprehension was higher than reading comprehension.

3. Reading comprehension and listening comprehension were significantly different. Listening comprehension was higher than reading comprehension.

4. No significant differences existed when reading-listening comprehension was compared with listening comprehension.

5. Except for listening comprehension, no significant differences were found as a result of varying the difficulty level of the material. The differences in listening comprehension were between the third- and sixth-grade level material. The difficulty level of the material did not result in differences for either eye movements or comprehension for reading or reading-listening treatments.

6. Presentation rate of material significantly affected eye movements for the reading-listening treatment. The presentation rate of material did not significantly influence

comprehension for the reading-listening or listening treatment. The highly significant differences in eye movements for the reading-listening treatment as the presentation rate of the material was varied indicated the effect that the auditory modality had upon the visual modality as measured by eye movements. Subjects used for this investigation adjusted their eye performance to the auditory stimulation at each of the three presentation rates, ranging from 125 w.p.m. to 225 w.p.m. This is interpreted as meaning that indiscriminate reading-listening activities may, for some students, adversely affect the development of reading skills. Conversely, reading-listening activities under carefully controlled conditions very possibly could be used as an effective means of furthering reading ability, especially for those students who are impaired in the ability to derive meaning from the printed word alone.

When the reading-listening presentation rate was slow (125 w.p.m.), which provided additional time for the visual process, subjects made more fixations and regressions per 100 words. This indicates that reading-listening activities in which a slow presentation rate is used may provide training that does not contribute to the development of reading skills. When the reading-listening presentation rate was fast (225 w.p.m.), which provided less time for the visual process, subjects made fewer fixations and regressions per 100 words. This indicates that students may not have adequate time for thorough visual perception at faster presentation rates.

Recommendations

1. Further study should be performed with carefully controlled reading-listening activities over a period of time to determine if combining the auditory and visual modalities is an effective means of developing more efficient eye movements and reading skills.

2. Auditory variations in loudness, pitch, rate, phrasing, and the use of pauses should be investigated to determine their affect upon visual performance when the auditory and visual modalities are combined.

3. The purpose for instruction should be considered when determining the method of instruction to be used. If the objective for a specific segment of teaching involves instruction meant to further the reading process, the instruction should be done using either the visual modality or perhaps a combination of the auditory and visual modalities.

4. If acquisition of information is the primary consideration, apart from any eye-movement modification or instruction in the reading process, consideration should be given to providing information through the auditory modality.

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APPENDIX

TABLE 26

GRADE SCORES ON DURRELL LISTENING-READING TEST

Subject	Listening	Reading	Sex*	Race**
1	4.5	3.3	F	B
2	5.1	4.6	F	B
3	6.3	4.1	M	W
4	5.1	3.5	M	W
5	5.9	5.3	F	W
6	6.4	5.1	F	W
7	4.5	3.5	F	W
8	4.7	4.2	F	B
9	6.6	3.4	M	W
10	6.4	5.1	F	W
11	6.4	5.5	M	W
12	6.5	5.5	M	W
13	5.9	4.1	M	W
14	6.1	5.0	M	B
15	4.8	3.6	F	B
16	5.2	4.2	F	W
17	5.7	4.2	M	W
18	4.2	3.4	M	W
19	5.7	4.2	M	W
20	5.3	3.5	M	W
21	5.9	4.1	M	B
22	4.1	3.6	F	B
23	4.8	4.2	M	B
24	5.8	4.6	F	W
25	6.6	3.4	F	W
26	5.2	3.9	M	W
27	6.2	4.2	M	Sp Am
28	5.9	4.1	F	W
29	5.6	4.7	F	W
30	4.0	3.2	F	W
31	4.1	3.5	F	B
32	<u>5.6</u>	<u>4.7</u>	F	W
Mean	5.3	4.1		

*M = male; F = female

**B = black W = white; Sp Am = Spanish American

TABLE 27

EYE MOVEMENT AVERAGES

	3	4	5	6	7	8	9	10	11	12	Col.
Fixations	155	139	129	120	114	109	105	101	96	94	90
Regressions	35	31	28	25	23	21	20	19	18	17	15
Av. Span	.65	.72	.78	.83	.88	.92	.95	.99	1.04	1.06	1.11
Av. Duration	.28	.27	.27	.27	.27	.27	.27	.26	.26	.25	.24
Rate	138	158	173	185	195	204	214	224	237	250	280

Source: Stanford E. Taylor, Helen Frackenpohl, and James L. Pettee, "Grade Level Norms for the Components of the Fundamental Reading Skill," EDL Research and Information Bulletin No. 3 (Huntington, N.Y.: Educational Developmental Laboratories, 1960), p. 12.

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